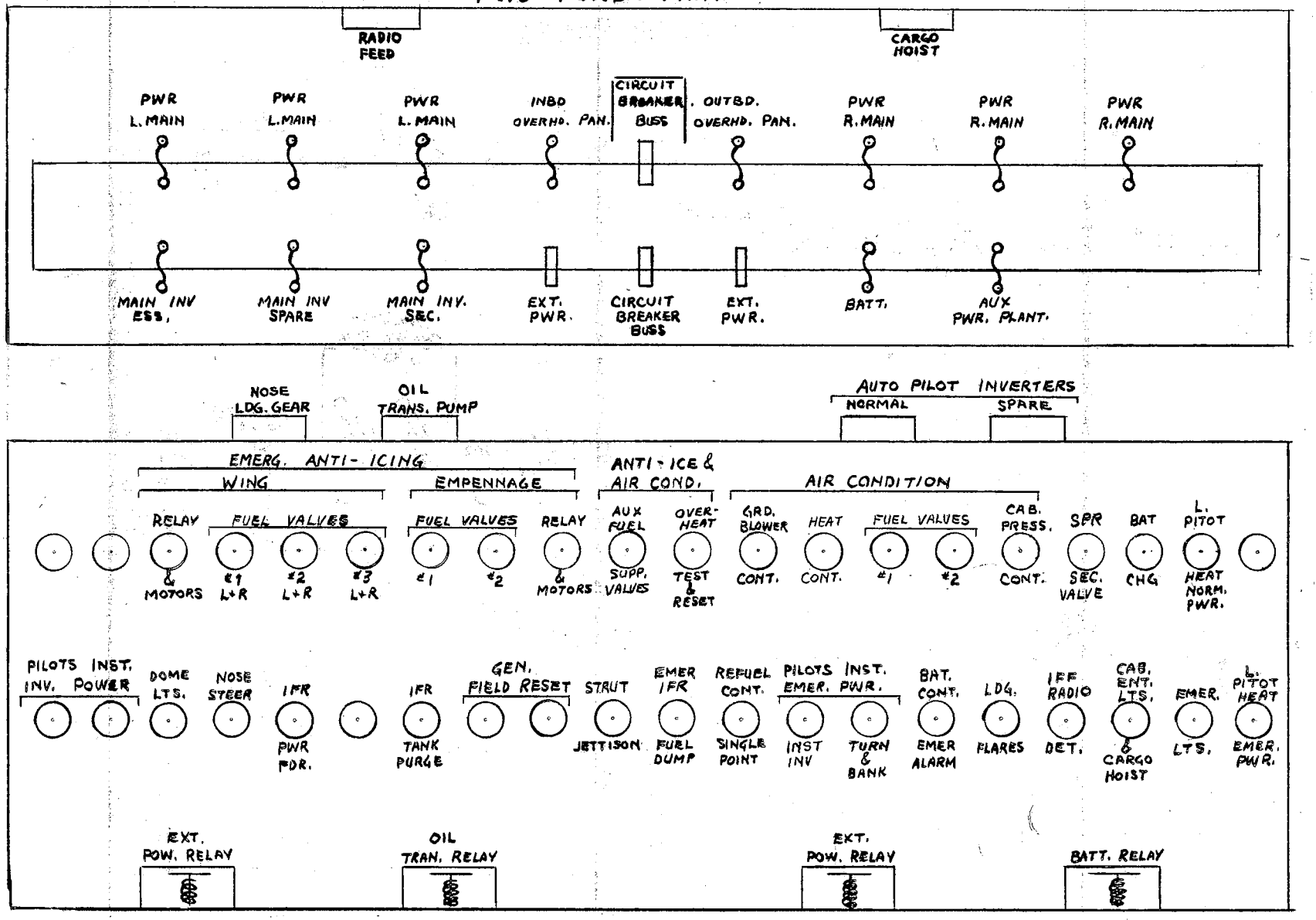
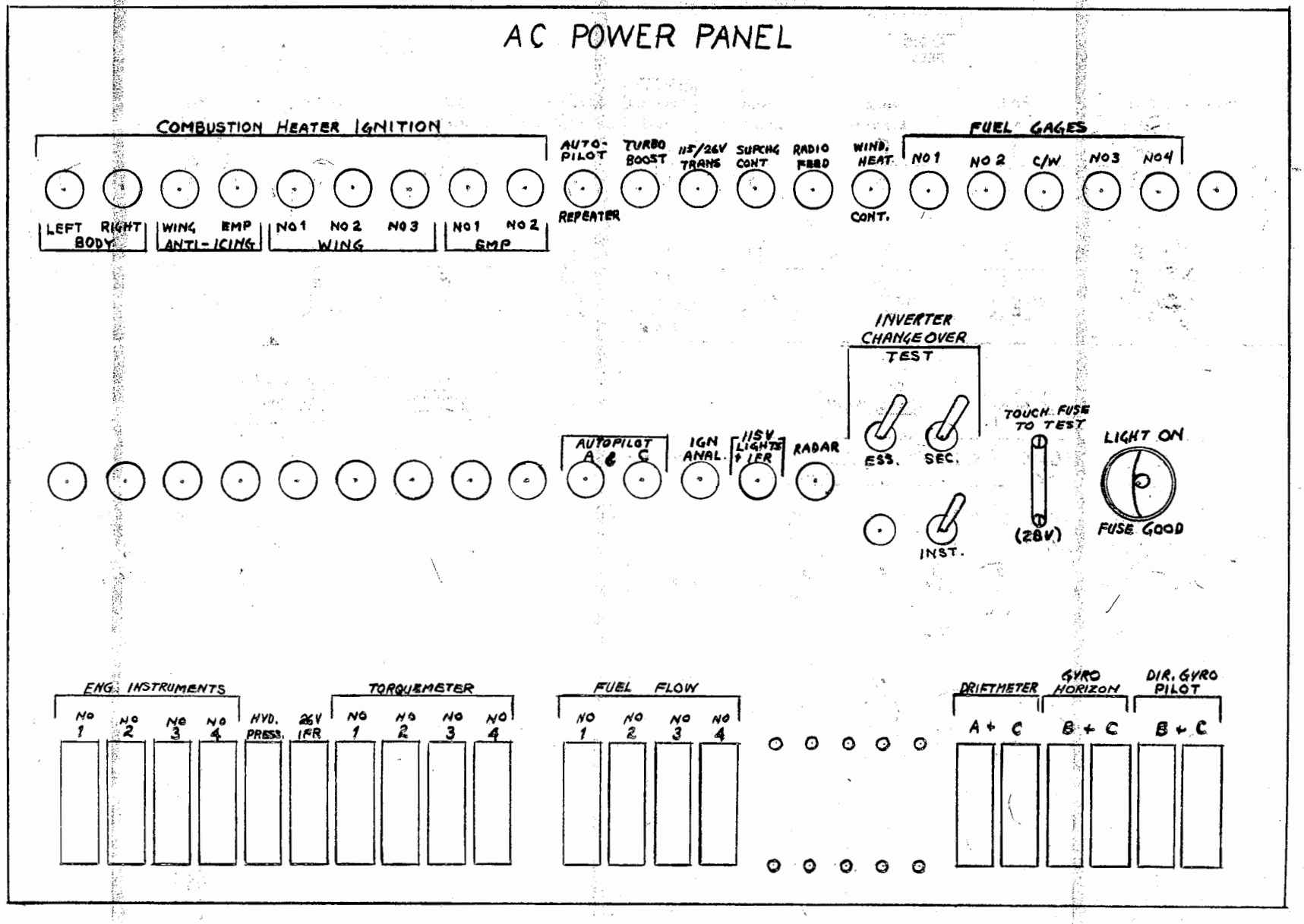
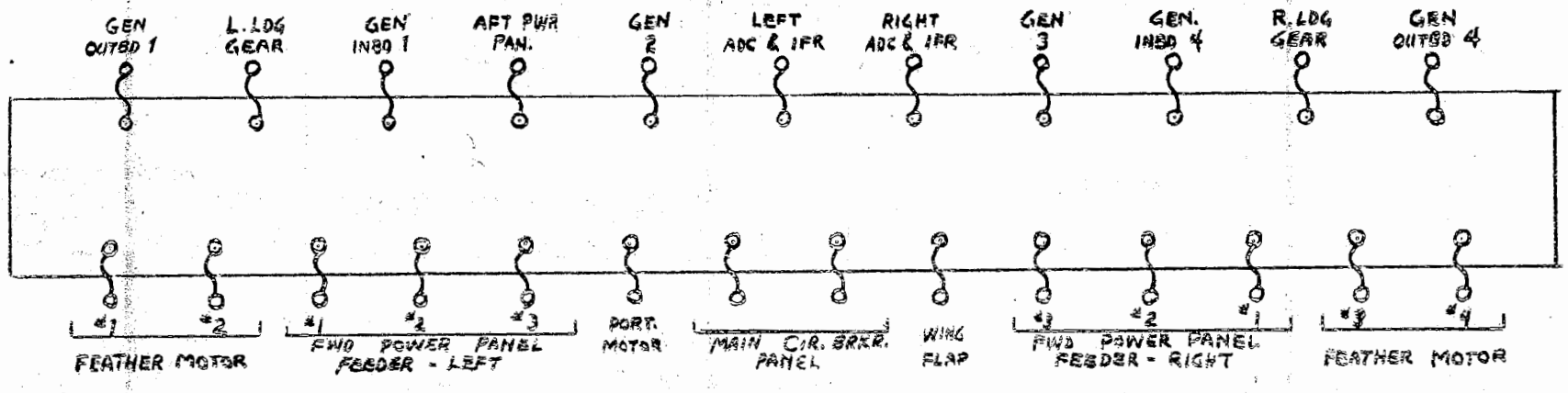
FWD POWER PANEL

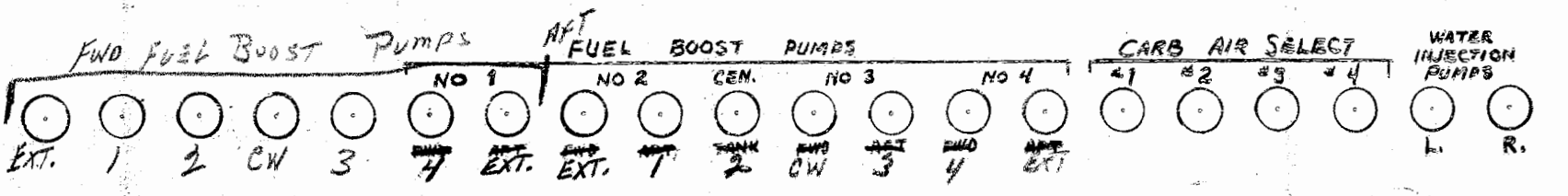


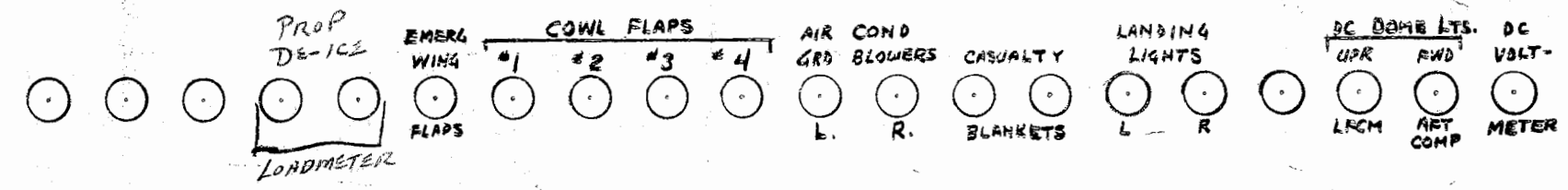
AC POWER PANEL

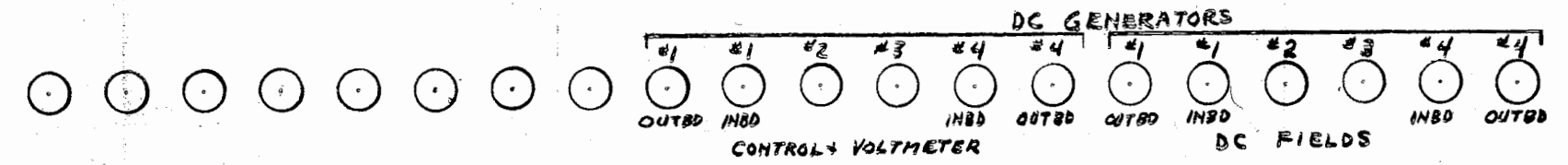


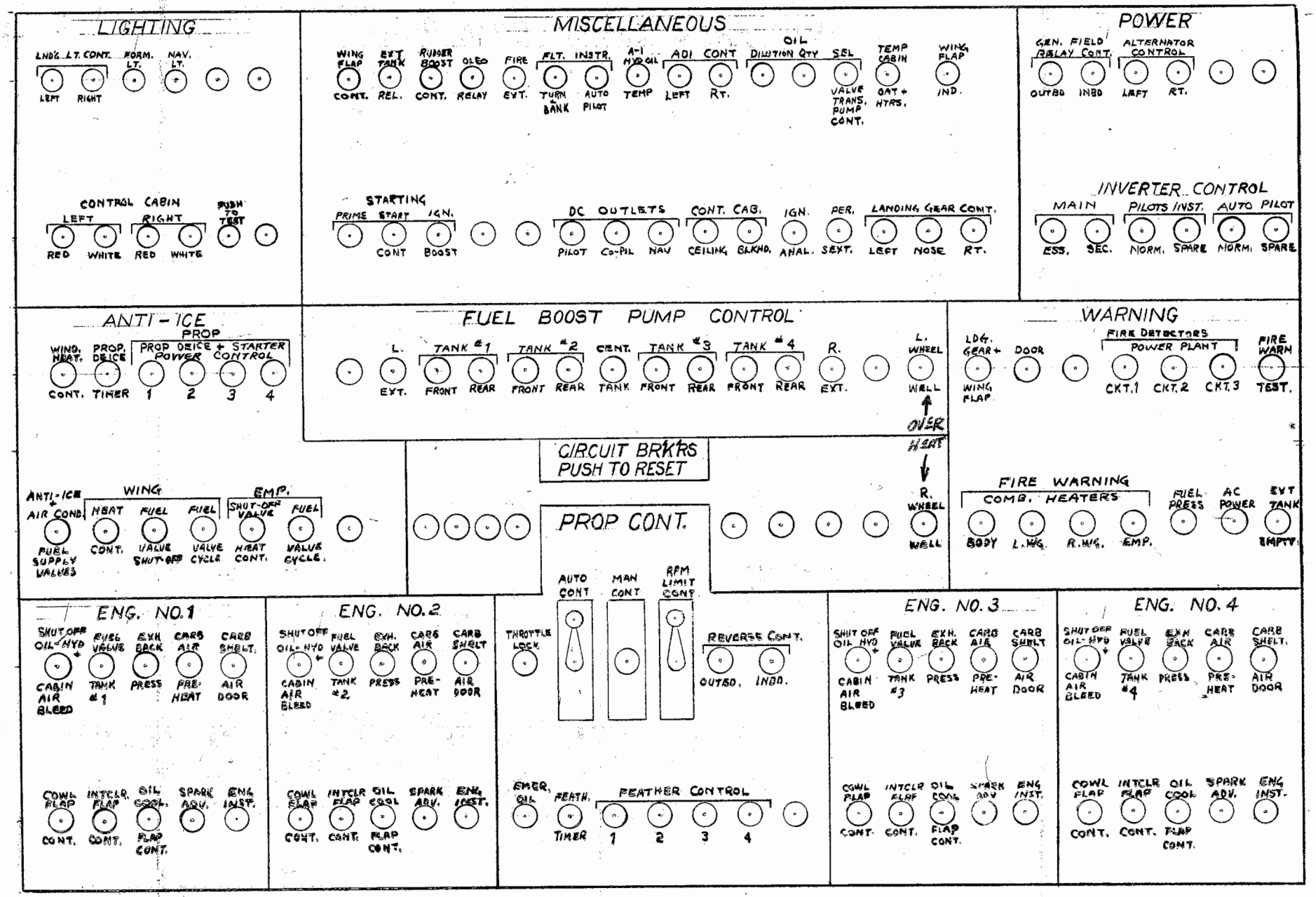
MAIN PWR & CIRCUIT BRKR PANEL










LIGHTING
LNDG. LT. CONT.
LEFT
RIGHT
FORM. LT.
NAV. LT.
CONTROL CABIN
LEFT
RIGHT
RED
WHITE
RED
WHITE
PUSH TO TEST
MISCELLANEOUS
WING FLAP CONT.
EXT. TANK REL.
RUBBER BOOST CONT.
OLEO RELAY
FIRE EXT.
FLT. INSTR. TURN & BANK
AUTO PILOT
A-I HYD OIL TEMP
ADI CONT LEFT
RT.
OIL DILUTION QTY SEL VALVE TRANS. PUMP CONT.
TEMP CABIN OAT + HTRS.
WING FLAP IND.
STARTING
PRIME
START
IGN.
CONT
BOOST
DC OUTLETS
PILOT
Co-PIL
NAV
CONT. CAB.
CEILING
GLKHD.
IGN.
ANAL.
PER.
SEXT.
LANDING GEAR CONT.
LEFT
NOSE
RT.
POWER
GEN. FIELD RELAY CONT.
OUTBD
INBD
ALTERNATOR CONTROL
LEFT
RT.
INVERTER CONTROL
MAIN
ESS.
SEC.
PILOTS INST.
NORM.
SPARE
AUTO PILOT
NORM.
SPARE
ANTI-ICE
WIND. HEAT.
CONT.
PROP. DEICE
TIMER
PROP DEICE + STARTER POWER CONTROL
1
2
3
4
FUEL BOOST PUMP CONTROL
L. EXT.
TANK #1 FRONT
TANK #1 REAR
TANK #2 FRONT
TANK #2 REAR
CENT. TANK
TANK #3 FRONT
TANK #3 REAR
TANK #4 FRONT
TANK #4 REAR
R. EXT.
L. WHEEL WELL
OVER HEAT
R. WHEEL WELL
WARNING
LDG. GEAR + WING FLAP
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CKT. 2
CKT. 3
FIRE WARN TEST.
CIRCUIT BRKRS PUSH TO RESET
ANTI-ICE & AIR COND. FUEL SUPPLY VALVES
WING HEAT CONT.
WING FUEL VALVE SHUT-OFF
WING FUEL VALVE CYCLE
EMP. SHUT-OFF VALVE HEAT CONT.
EMP. FUEL VALVE CYCLE.
PROP CONT.
AUTO CONT
MAN CONT
RPM LIMIT CONT
THROTTLE LOCK
REVERSE CONT. OUTBD.
INBD.
FIRE WARNING
COMB. HEATERS
BODY
L. WG.
R. WG.
EMP.
FUEL PRESS
AC POWER
EXT TANK EMPTY
ENG. NO. 1
SHUT OFF OIL-HYD
CABIN AIR BLEED
FUEL VALVE TANK #1
EXH BACK PRESS
CARB AIR PRE-HEAT
CARB SHELT. AIR DOOR
COWL FLAP CONT.
INTCLR FLAP CONT.
OIL COOL FLAP CONT.
SPARK ADV.
ENG INST.
ENG. NO. 2
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EXH. BACK PRESS
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CARB SHELT AIR DOOR
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INTCLR FLAP CONT.
OIL COOL FLAP CONT.
SPARK ADV.
ENG INST.
EMER. OIL
FEATH. TIMER
FEATHER CONTROL
1
2
3
4
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CARB SHELT AIR DOOR
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INTCLR FLAP CONT.
OIL COOL FLAP CONT.
SPARK ADV
ENG INST.
ENG. NO. 4
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FUEL VALVE TANK #4
EXH BACK PRESS
CARB AIR PRE-HEAT
CARB SHELT. AIR DOOR
COWL FLAP CONT.
INTCLR FLAP CONT.
OIL COOL FLAP CONT.
SPARK ADV.
ENG INST.

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT MANUAL

USAF SERIES

KC-97F
KC-97G

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1C-97(K)F-1. Reference to this supplement will be made on the title page of the basic manual by personnel responsible for maintaining the publication in current status.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AF PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

NOTICE: Reproduction for non-military use of the information or illustrations contained in this publication is not permitted without specific approval of the issuing service.

7 NOVEMBER 1962

NOTICE

Cut out the attached curve (figure 1) and insert it in your checklist binder for inflight reference. Write in safety of flight number at bottom of figure 1.

1. PURPOSE.

To provide slippery runway distance factors and procedure relative to the new reporting system for runway conditions.

2. GENERAL.

Explanation of Terms

RCR - Runway condition reading

P - Patchy

WR - Wet runway

SLR - Slush on runway

LSR - Loose snow on runway

PSR - Packed snow on runway

IR - Ice on runway

When other than dry conditions exist on active runways, base operations officers are responsible for determining and relaying to the base weather station the type of runway covering and the relative slickness of the runway as determined by the James brake decelerometer. This information will be transmitted as part of the teletype weather sequence. The relative slickness of the runway is determined as outlined in T.O. 33-1-23. This number will either be a one or two digit number and is referred to as the runway condition reading. This number will be followed by the letter "P" if the runway is patchy. A report of SLR14P would indicate slush on the runway, RCR of 14, and patchy conditions.

3. INSTRUCTIONS.

a. Using the latest reported RCR, determine the stopping distance factor.

b. Multiply the dry runway ground roll by the stopping distance factor to determine the ground roll on the slippery runway.

NOTE

If no RCR is available, use 12 for wet runways and 5 for icy runways.

SAFETY OF FLIGHT

T.O.1C-97(K)F-1

FLIGHT MANUAL

USAF SERIES AIRCRAFT

CONTRACT NO AF42(600) - 22302

KC-97F
KC-97G

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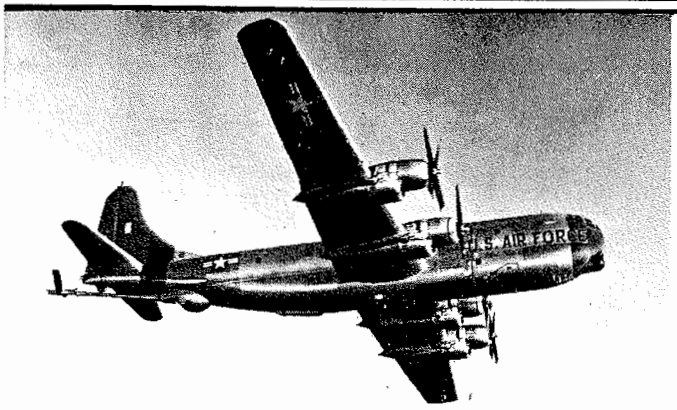
Insert changed pages into basic publication. Destroy superseded pages.



THIS PUBLICATION IS INCOMPLETE WITHOUT T.O. IC-97(K)F-1-1

See weekly index T.O. 0-1-1A for current status of Safety of Flight Supplements.

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PUBLISHED UNDER THE AUTHORITY OF THE SECRETARY OF THE AIR FORCE

Air Force, Craftsman Press, Seattle, Wash. 2/20/63 -12,000(BOEING)

15 OCTOBER 1961

CHANGED 15 ~~DECEMBER 1962~~ MARCH 1963

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NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page.

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Navigator's	1C-97(K)F-(CL)1-2	15 Oct 1961, Changed 15 Dec 1962
Flight Engineer's	1C-97(K)F-(CL)1-3	15 Oct 1961, Changed 15 Dec 1962
Boom Operator's	1C-97(K)F-(CL)1-4	15 Oct 1961, Changed 15 Dec 1962
Radio Operator's	1C-97(K)F-(CL)1-5	15 Oct 1961, Changed 15 Dec 1962
Ground Crewman's	1C-97(K)F-(CL)1-6	15 Oct 1961, Changed 15 Dec 1962

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24	15 Jun 1962
25	15 Jun 1962
26	Original

SAFETY OF FLIGHT SUPPLEMENTS SUMMARY

Safety of Flight Supplements prior to 15 July 1960 are numbered with suffix letters after the -1 of the flight manual technical order number. Effective 15 July 1960, Safety of Flight Supplements will be identified with "-SF" immediately preceding the -1 contained in the basic publication number and will be assigned consecutive dash numbers. Example: 1C-97(K)F-SF-1-1, -2, -3, etc. Existing Safety of Flight Supplements will not be renumbered and will remain effective until rescinded or replaced. The supplements you receive should follow in sequence and if you find you are missing one, check Weekly Index of Safety of Flight Supplements T.O. 0-1-1A 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. It should be noted that a supplement number will never be used more than once.

SAFETY OF FLIGHT SUPPLEMENTS IN THIS CHANGE

Number	Date	Short Title	Disposition
-4	23 May 62	Revised Engine Operating Procedures	Section VII

SAFETY OF FLIGHT 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 Safety of Flight Supplements T.O. 0-1-1A for latest information if any questions arise. Supplements outstanding at the time of preparation of this page have been listed below for your convenience.

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INDEX
ALPHABETICAL 1

TIME COMPLIANCE TECHNICAL ORDERS

NOTE

- The following time compliance technical orders (T.C.T.O.'s) are only those which 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

TCTO 133 — Installation of Periscopic Sextant, 8 Mar 1956

TCTO 224 — Installation of Throttle Reverse Lock Plate, 20 Apr 1956

TCTO 239 — DC Electrical Power System Improvement, 30 Aug 1954

TCTO 292 — Emergency Power Provisions for Pitot Heater, 10 Jun 1955

TCTO 299 — Landing Gear Safety Switch Revision, 7 Jan 1955

TCTO 320 — Turbo Amplifier Modification, 11 Mar 1957

TCTO 321 — Installation of AN/ARA-25 Directional Finding Group, 30 Dec 1955

TCTO 338 — Revision of Turbo Control Circuit and Installation of Exhaust Back Pressure Switch, 26 Mar 1956

TCTO 515 — Modification of Wing Thermal Anti-Ice Electrical Circuit, 16 Jan 1956

TCTO 526 — Modification of Fuel Tank Interconnect Line, 3 Apr 1956

TCTO 528 — Installation of AN/APX-25 System, 12 Sep 1956

TCTO 529 — Installation of Improved Emergency Escape Hatch Assemblies, 13 Sep 1957

TCTO 531 — Replacement of Propeller RPM Manual Control Circuit Breaker, 1 Aug 1956

TCTO 534 — Installation of Propeller Deicing Loadmeters, 31 Oct 1956

TCTO 558 — Installation of Wheel Well Overheat Warning System, 5 Dec 1956

TCTO 563 — Installation of Type MF-2 Attitude Gyro, 2 May 1957

TCTO 566 — Installation of MB-1 Fire Fighters Oxygen Sets 12 Aug 1958

TCTO 572 — Installation of AN/ARN-21, 5 Sep 1958

TCTO 582 — Installation of Combustion Heater Timers, 6 Jun 1958

TCTO 590 — Installation of AN/APX-25 Group B Components 2 Sep 1958

TCTO 591 — Installation of Anti-Collision Lights, 29 Dec 1958

TCTO 595 — Installation of Fuel Enrichment System, 19 Mar 1959

TCTO 600 — Installation of UHF Quick Manual Tuner, 7 Aug 1959

TCTO 606 — Removal of Fuel Enrichment Provisions, 11 Mar 1960

TCTO 611 — Installation of Turbosupercharger Bearing Temperature Indicating System, 13 Dec 1961

TCTO K

TCTO K211 — Installation of AN/APN-69 Rendezvous Radar Set, 16 May 1955

TCTO K228 — Modification of Antenna System to Permit AN/APN-9 to Utilize the AN/ART-13 Antenna, 31 May 1955

TCTO K231 — Installation of Tail Cone Lights, 2 Sep 1955

TCTO K235 — Installation of Type B-6A Driftmeter, 25 Jan 1956

TCTO K239 — Installation of Life Raft Stowage Provisions, 23 Sep 1955

TCTO K504 — Installation of Type MS-28023-1 Wing Flap Position Indicators, 9 Jun 1955

TCTO K509 — Inactivation of Ruddevator Anti-Ice System, 28 Mar 1956

TCTO K512 — Installation of Life Raft Stowage Provisions, 11 Jun 1956

TCTO K513 — Installation of Type K-3 Airspeed Indicator, 6 Aug 1956

TCTO K520 — Installation of Boom Operator's Heat Duct, 24 Dec 1956

TCTO K521 — External Power Receptacle Circuit Revision, 29 Aug 1956

TCTO K526 — Installation of Additional Pilot Director Lights, 21 Mar 1958

TCTO K527 Installation of VHF-UHF Simultaneous Keying Provisions, 14 Sep 1956

TCTO K528 Modification of the Air Refueling Boom Markings 12 Oct 1956

TCTO K538 Ventilation of Solar APU, 19 Dec 1958

TCTO K540 Relocation of Troop Seating Accommodations for Takeoff and Landing, 2 Jun 1961

TCTO K551 Installation of Nickel Cadmium Battery, 2 Feb 1959

TCTO K553 Installation of Aerial Refueling Hydraulic System Surge Dampers, 13 Apr 1959

TCTO K554 Revision of Solar APU Ventilating Blower Wiring, 8 Apr 1959

TCTO K555 Interchange of Main Landing Gear Wheel and Brakes, 15 Mar 1955

TCTO K562 Modification of Radio Navigator's Seat, 19 Nov 1959

TCTO K564 Deactivation of R4360-59B and -65 Engine Spark Advance, 10 Apr 1960

TCTO K572 Removal of AN/APN-76 and Auxiliary Liaison Group B Components, 14 Oct 1960

TCTO K576 Installation of Diode in A/R Signal Amplifier Circuit, 22 Feb 1961

TCTO KG

TCTO KG206 Installation of AN/ARR-36 Radio Receiver Replacing BC-348 Equipment, 30 Mar 1956

TCTO KG211 Installation of Revised AN/ARC-21 and AN/ART-13 Antenna Systems, 23 Oct 1957

TCTO KG502 Restoration of Paired Pulse Function in AN/ARA-76C Radar Set, 11 May 1955

TCTO KG513 Revision of Receiving Antenna Circuit, 19 Mar 1956

TCTO KGT

TCTO KGT507 Installation of A/R Fuel to Engine Fuel System Provisions, 6 Feb 1956

EQUIPMENT TCTO'S

TCTO 1-1-666 Installation of AN/ARC-65 Single Side Band Radio, 5 Jun 1958

2RA4-3-508 Modification of Turbosupercharger, 5 Oct 1961

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

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.

CODING

The following Air Force serial numbers are assigned to KC-97F and KC-97G airplanes:

KC-97F	51-243	thru	51-397	KC-97G	52-2694	thru	52-2761
KC-97F	51-7256	thru	51-7259	KC-97G	52-2763	thru	52-2806
KC-97G	51-7260	thru	51-7271	KC-97G	53-106	thru	53-365
KC-97G	52-826	thru	52-938	KC-97G	53-3815	and	53-3816
KC-97G	52-2602	thru	52-2692				

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	1243	51-243	10243
EXAMPLE 2	17259	51-7259	17259
EXAMPLE 3	3147	53-147	30147

Information on all KC-97F and KC-97G 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 series and/or 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 KC-97F and KC-97G airplanes.

Information which is affected by incorporation of a TCTO modification, is coded by use of a special symbol bearing the TCTO dash number. When this symbol 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 following the code examples. Most KC-97F and KC-97G airplanes are in the tanker configuration; therefore, with few exceptions, all illustrations showing the whole airplane depict the tanker configuration. In the cases where it is not the purpose of the illustration to show the difference between tanker and cargo airplanes, the A/R pod and boom are not coded; also when it is not the purpose of the illustration to show the difference between the KC-97F and KC-97G airplanes, the external tanks are not coded.

EXAMPLES OF CODES

SYMBOL

F	Information applies only to KC-97F airplanes.
G	Information applies only to KC-97G airplanes.
V	Information applies only to airplanes with A/R equipment (Tankers).
C	Information applies only to airplanes equipped to carry only cargo (A/R equipment removed).
1243	Airplane code number. Number shown is for airplane AF51-243.
▶	Means "THRU" or "AND ON"
TCTO K553	T.O. 1C-97(K)-553. Item applies only to airplanes having this numbered Time Compliance Technical Order (TCTO) incorporated.

The symbols are put together in various combinations to specify a group of airplanes. An example code is: F G 1243 ▶ 3141 less TCTO 292. This code means that the information applies to each KC-97F and KC-97G airplane that has a serial number between AF51-243 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)F-1-1 to obtain all the necessary information for safe and efficient operation of the KC-97F and KC-97G airplanes. T.O. 1C-97(K)F-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 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. 0-1-1A which is issued weekly and devoted solely to the listing of all current Flight Manuals, Safety of Flight Supplements, and Checklists. Its frequency of issue and brevity assures 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 OF FLIGHT SUPPLEMENTS. Information involving safety will be promptly forwarded to you by Safety of Flight Supplements. Supplements covering loss of life will get to you in 48 hours by TWX, and those concerning serious damage to equipment within 10 days by mail. The title page of the Flight Manual and the title block of each Safety of Flight Supplement should 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.

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 of your latest checklist. Line items in the Flight Manual and checklists are identical with respect to arrangement and item number. Whenever a safety of Flight Supplement affects the condensed (abbreviated) checklist, write in the applicable change on the affected checklist page. As soon as possible, a new checklist page, incorporating the supplement will be issued. This will keep hand-written entries of Safety of Flight Supplement information in your checklist to a minimum.

PAGES. . . . . .

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

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 through your Command Headquarters to Commander, OCAMA, Tinker Air Force Base, Oklahoma, Attention: OCNE.

ABBREVIATIONS AND DEFINITIONS

NOTE

- It is not intended that this list include abbreviations used in decals and markings on the airplane.
- See AIR REFUELING TERMINOLOGY in Section IV for special air refueling symbols and definitions.

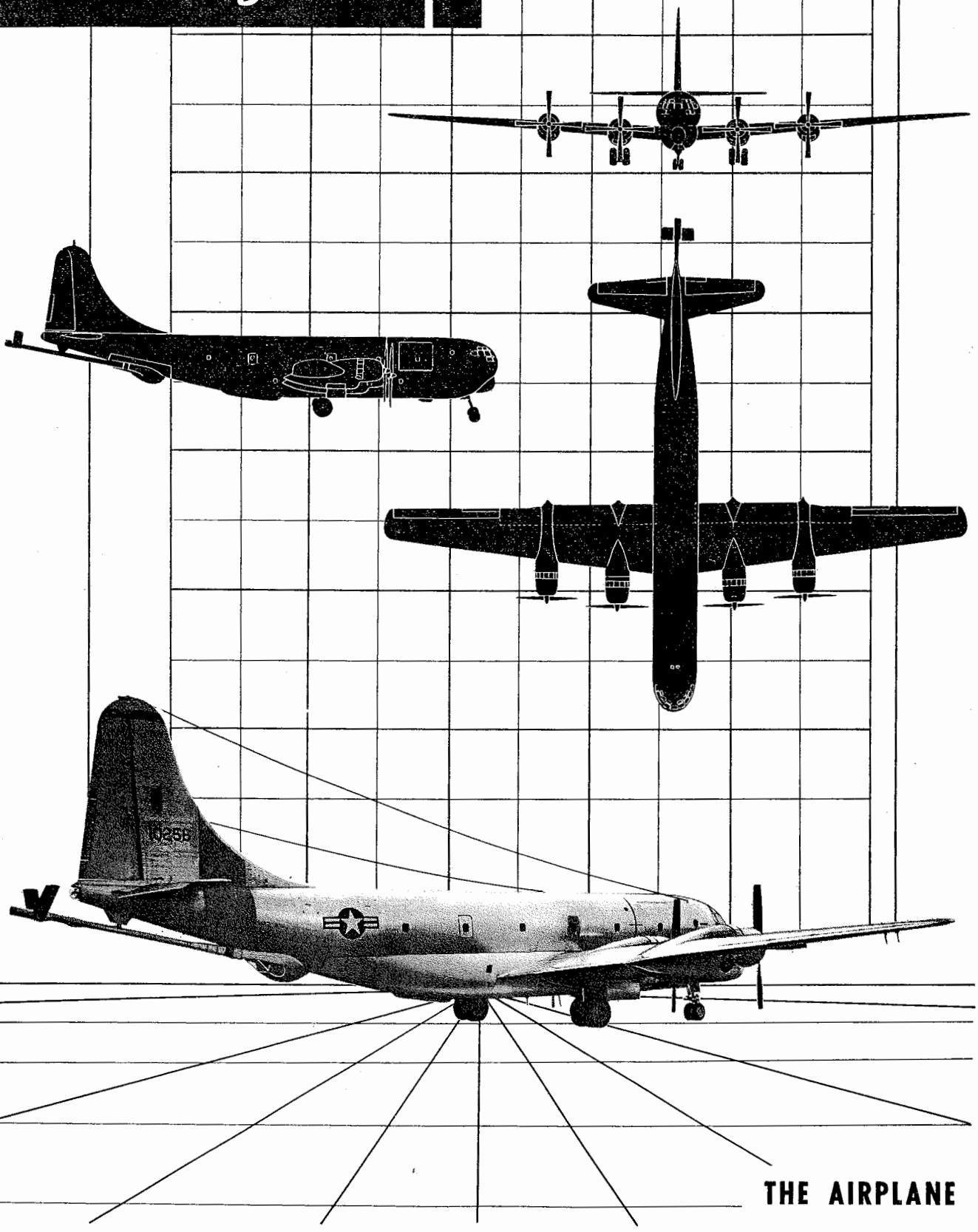
ABBREVIATIONS	DEFINITIONS
AC	Alternating Current
ACCEL	Acceleration
ACP	Allied Communications Publication
ADF	Automatic Direction Finding
ADI	Anti-Detonation Injection System
ADIZ	Air Defense Identification Zone
ALT	Altitude
AM	Amplitude Modulation (Communication Radios)
AME	Equivalent AM
amp	Ampere
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 Air Speed (Indicated Airspeed Corrected for Position Error)
CAT	Carburetor Air Temperature (In Degrees Centigrade)
CB	Circuit Breaker
CCW	Counterclockwise Rotation
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 Rotation
(CW)	Continuous Wave
CWG	Closed Waste Gate
CWT	Center Wing Tank
CYL	Cylinder
DC	Direct Current
D/F	Direction Finding
DIST	Distance
DN	Down
DR	Dead Reckoning
(E)	Engineer
EAS	Equivalent Air Speed (Calibrated Airspeed Corrected for Compressibility)

ABBREVIATIONS	DEFINITIONS
EBP	Exhaust Back Pressure
ENG	Engine
EPW	Equivalent Performance Weight
EST	Estimated
°F	Degrees Fahrenheit
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. (One Inch Mercury Equals Approximately .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
Kts	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
MI	Miles
MIN	Minutes
MP	Manifold Pressure, Inches of Mercury
(N)	Navigator
NAM	Nautical Air Miles
NM	Nautical Miles
NMPP	Nautical Miles Per Pound
No.	Number

ABBREVIATIONS AND DEFINITIONS

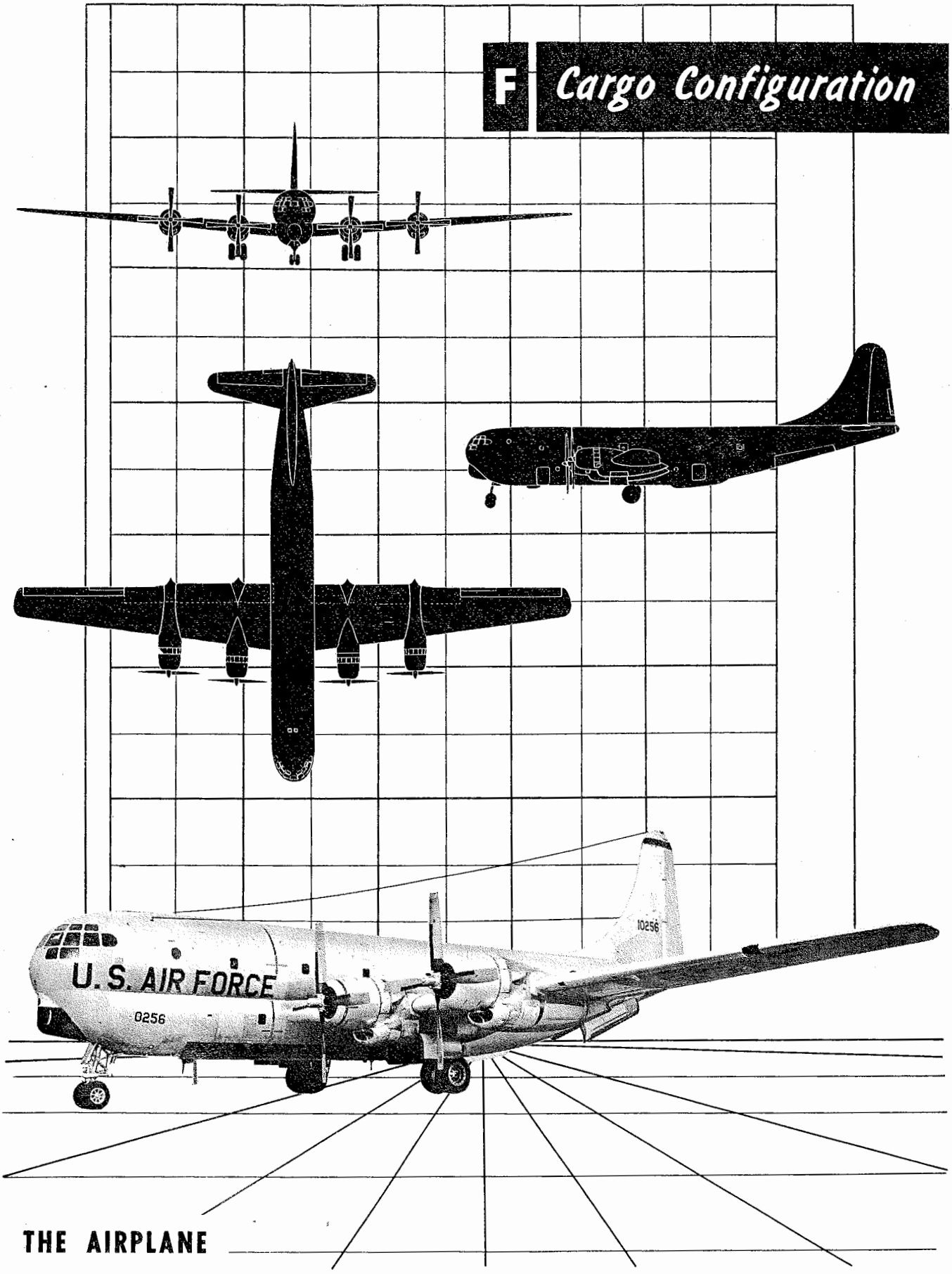
ABBREVIATIONS	DEFINITIONS
OAT	Outside Air Temperature
OWE	Operating Weight Empty
P	Static Pressure In Atmosphere
(P)	Pilot
ph	Pounds Per Hour
pm	Pounds Per Minute
POS	Position
PPI	Plan Position Indicator
PRESS	Pressure
PSI	Pounds Per Square Inch
R/C	Rate of Climb
R/D	Rate of Descent
(RO)	Radio Operator
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
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
V_W	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.

Tanker Configuration F



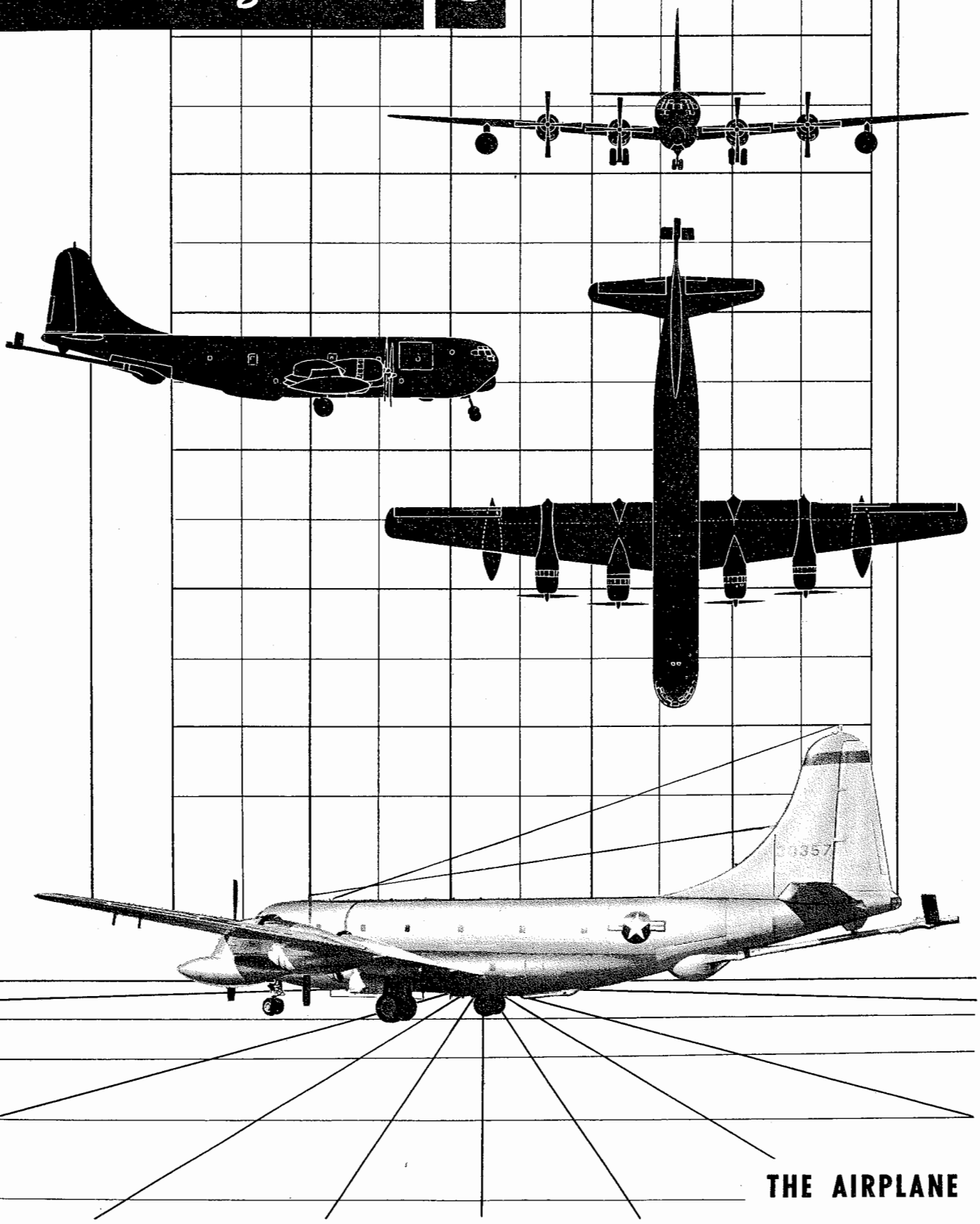
THE AIRPLANE

F Cargo Configuration

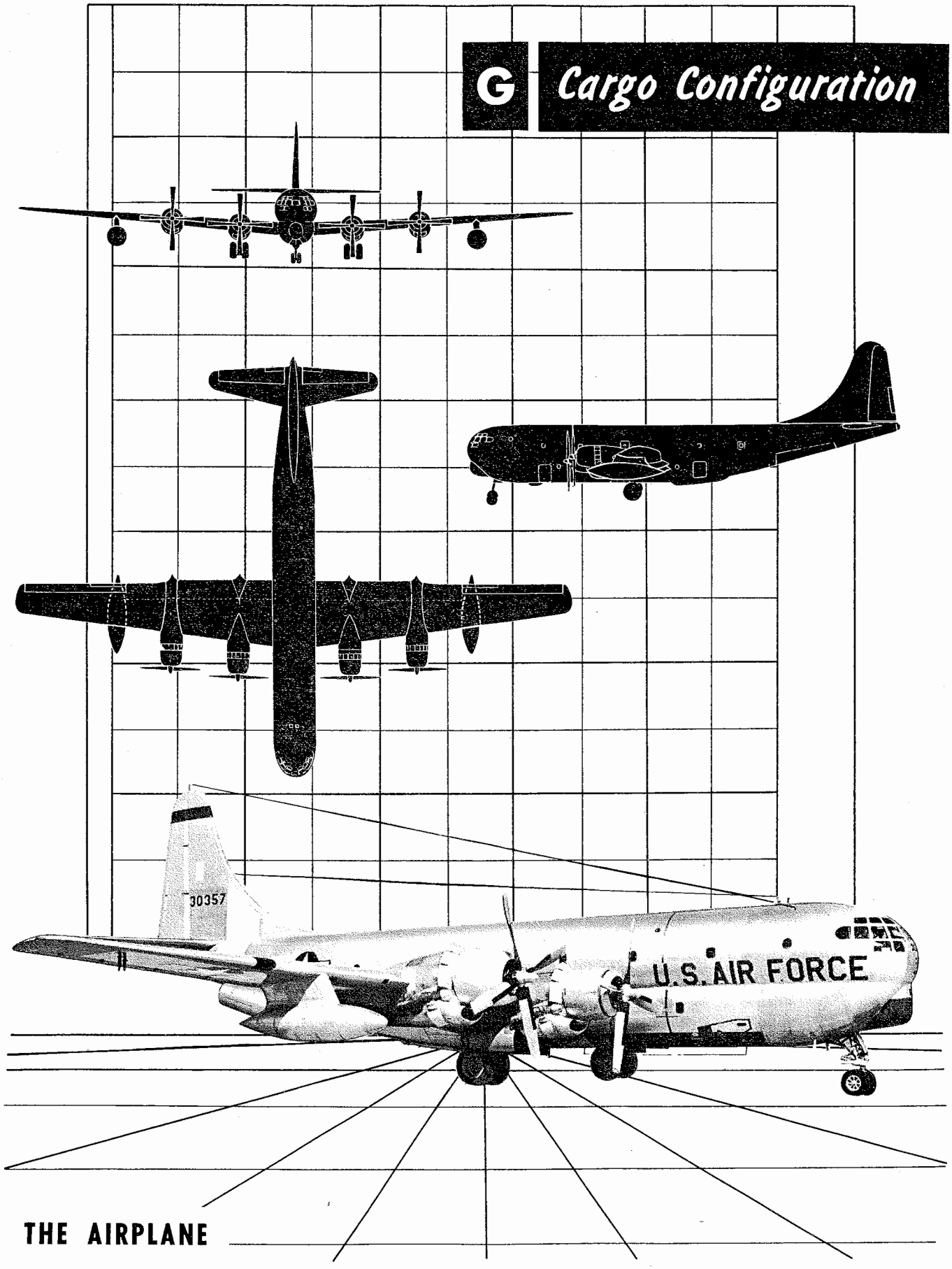


THE AIRPLANE

Tanker Configuration G



G Cargo Configuration



THE AIRPLANE

Section I Description

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HYDRAULIC SYSTEM 1-82
FLIGHT CONTROL SYSTEM 1-84
WING FLAP SYSTEM 1-85
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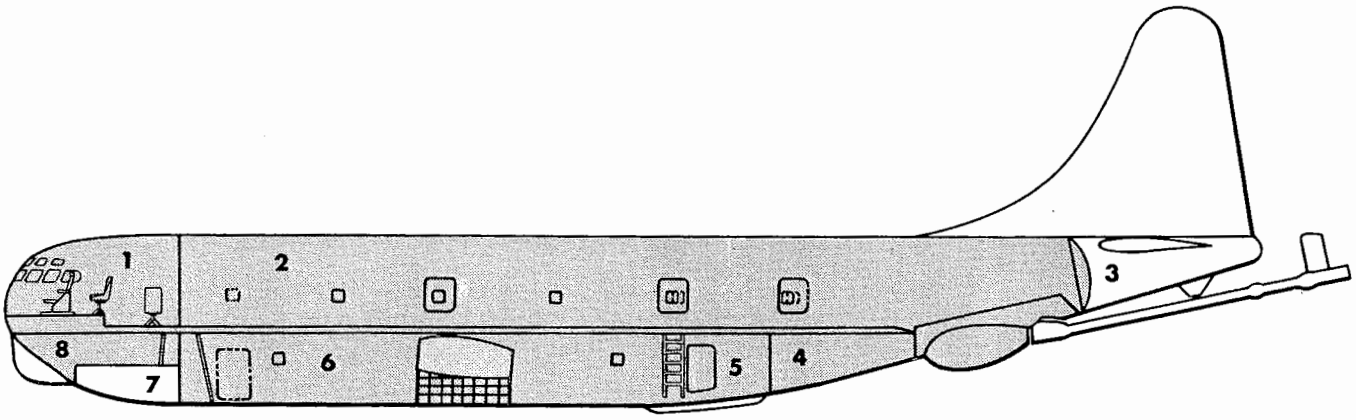
ENTRY DOORS 1-104
SEATS 1-104
AUXILIARY EQUIPMENT 1-105

ITEM	KC-97E	KC-97F	KC-97G
EXTERNAL FUEL TANKS	None	None	One droppable tank under each wing
V AIR REFUELING FUEL TANKS	Four tanks in the main compartment	Four tanks in the main compartment	Seven tanks on LH side of main compartment and eight tanks, two on each side of lower fwd and aft compartment
ENGINES	P & W R-4360-65	P & W R-4360-59B	P & W R-4360-59B
TROOP CARRYING CAPACITY	C 130 V 34	C 130 V 34	C 96 V 63

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 Boeing KC-97F and KC-97G airplanes are four engine, long range, high altitude, high speed transports equipped for use primarily as flying boom tankers for the inflight refueling of other airplanes. Provisions have been incorporated into the airplanes to convert them into cargo carriers or troop transports. On the KC-97F the A/R equipment can be quickly removed or installed to permit maximum utilization of the airplane as either a tanker, cargo/troop carrier, or stretcher casualty carrier. The arrangement of the A/R equipment on the KC-97G 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 engines. Each 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 hydraulic steering system, windshield wipers, rudder hydraulic boost system, and on ▼ G 22737 ▶ the A/R boom hydraulic system. Tanker airplanes also have an independent engine driven hydraulic system which operates the A/R fuel pumps and on F G 1243 ▶ 22736 operates the A/R boom hydraulic system. All other equipment in the airplane is electrically operated.

The normal crew consists of the pilot, copilot, engineer and navigator. A radio operator is used on airplanes F G 1243 ▶ 3177 and/or all airplanes which do not have an operable AN/ARC-21 or AN/ARC-65 liaison radio installed. Tanker airplanes also have a 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

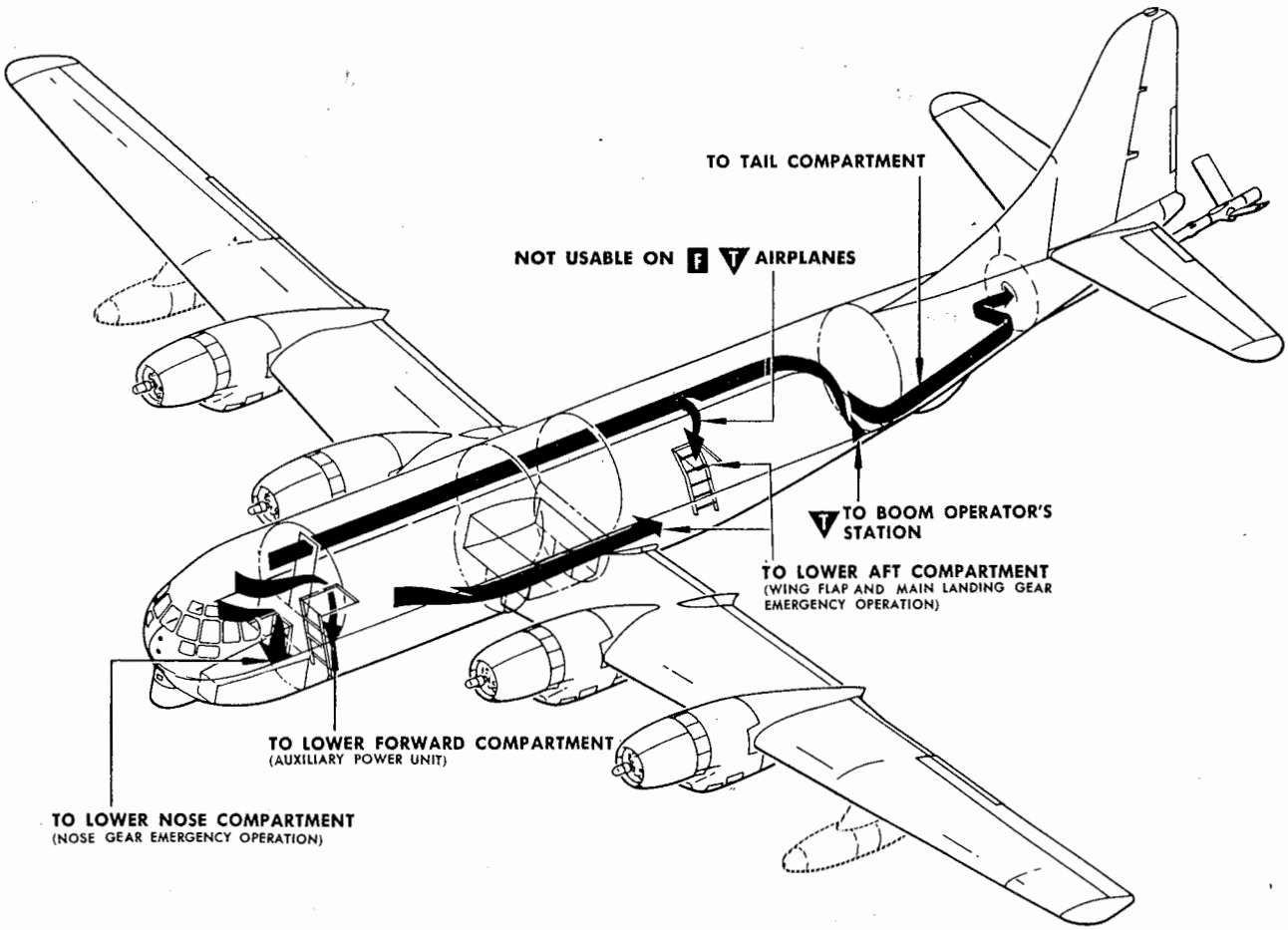
The design gross weight of this airplane is 153,000 pounds. For additional gross weight information see Section V.

SPECIAL FEATURES

Special features of this model are the installation of flying boom air refueling equipment for Code T airplanes and on 1255▶ single point refueling. The rudder and vertical fin can be folded onto the horizontal stabilizer for ease of maintenance and to permit the airplane to be housed in average hangers. Structural provisions have also been made for the installation of an aerial delivery system when the airplane is converted for carrying cargo only.

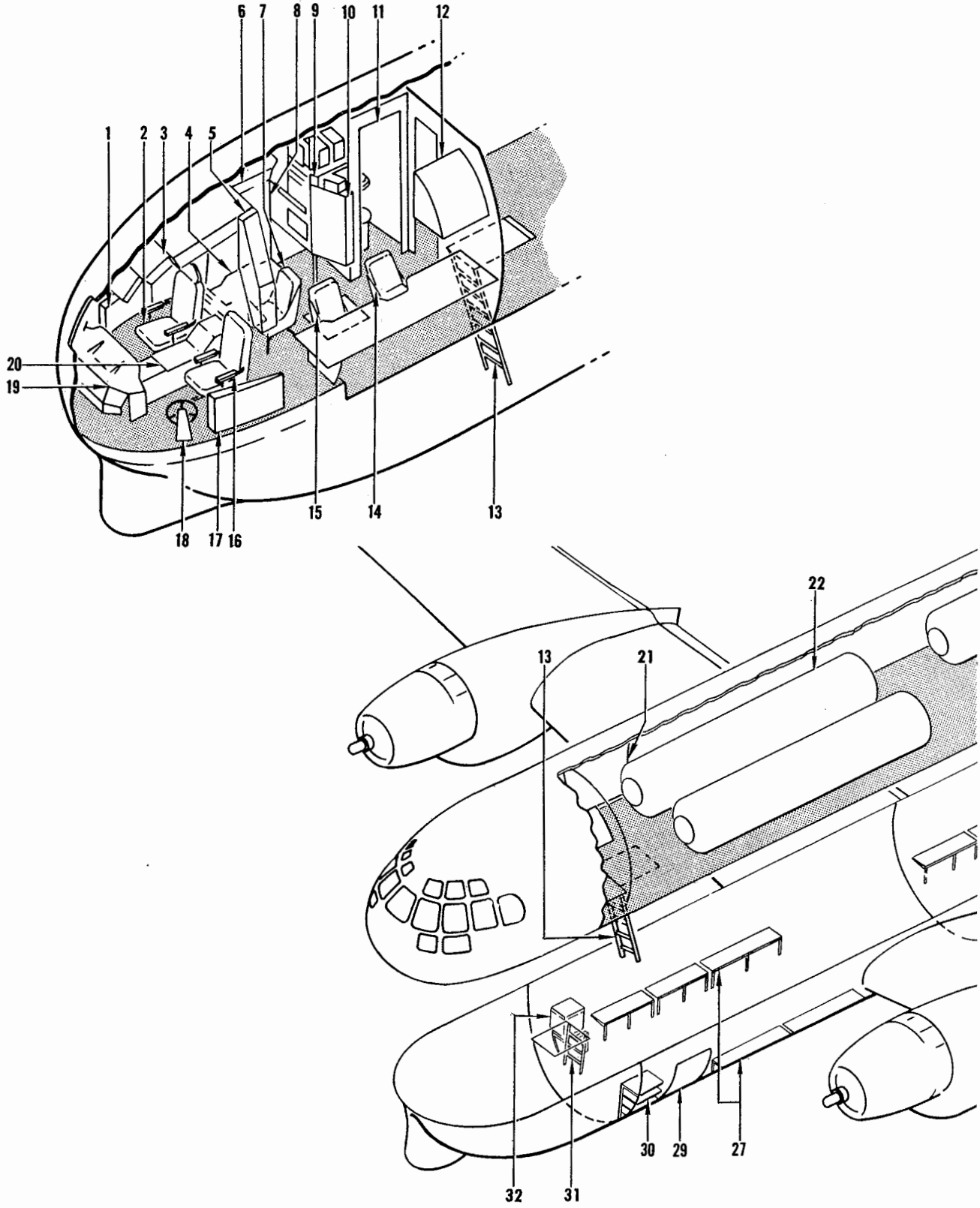
INTERIOR ARRANGEMENT AND CREW MOVEMENT

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

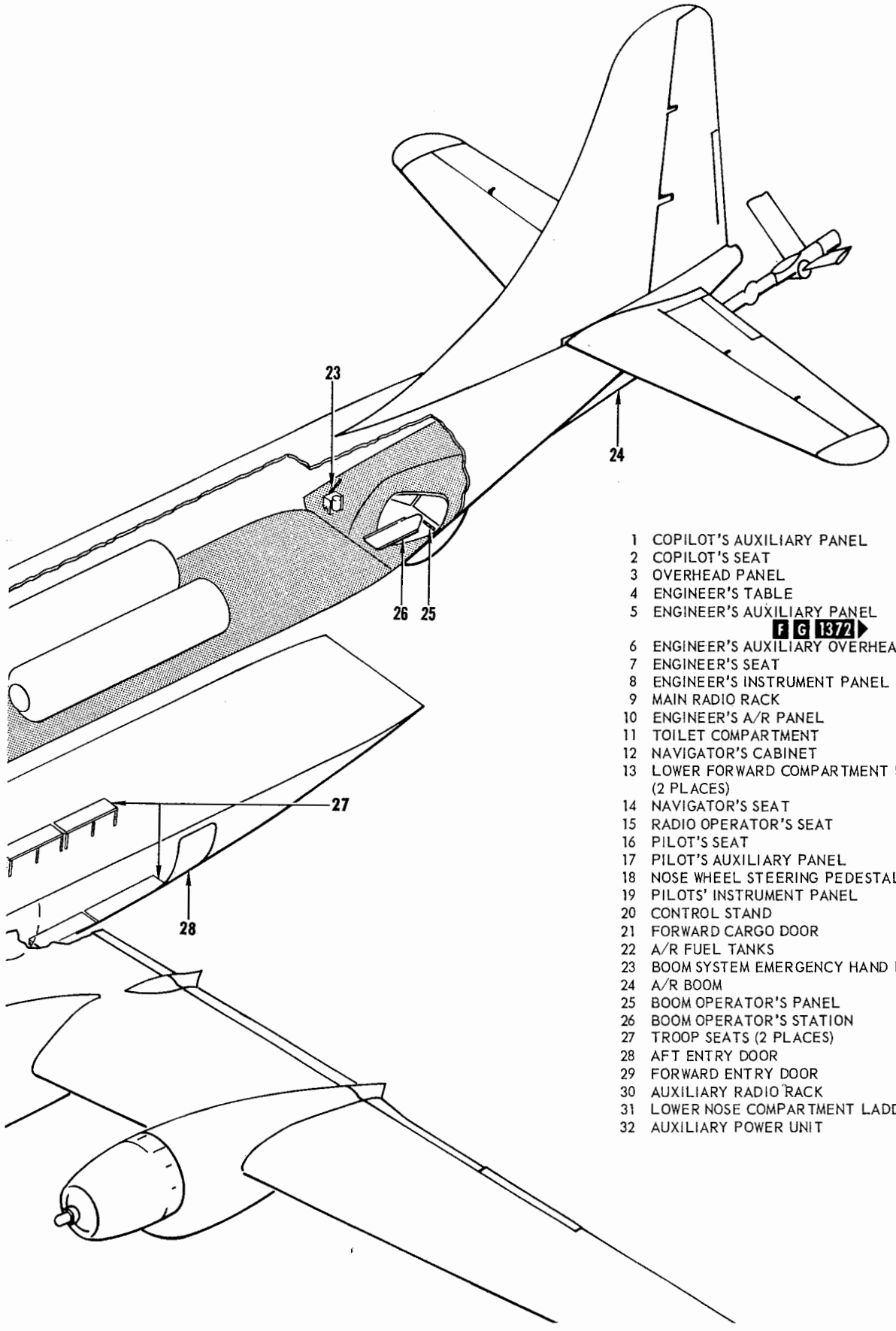
Figure 1-3



GENERAL ARRANGEMENT V

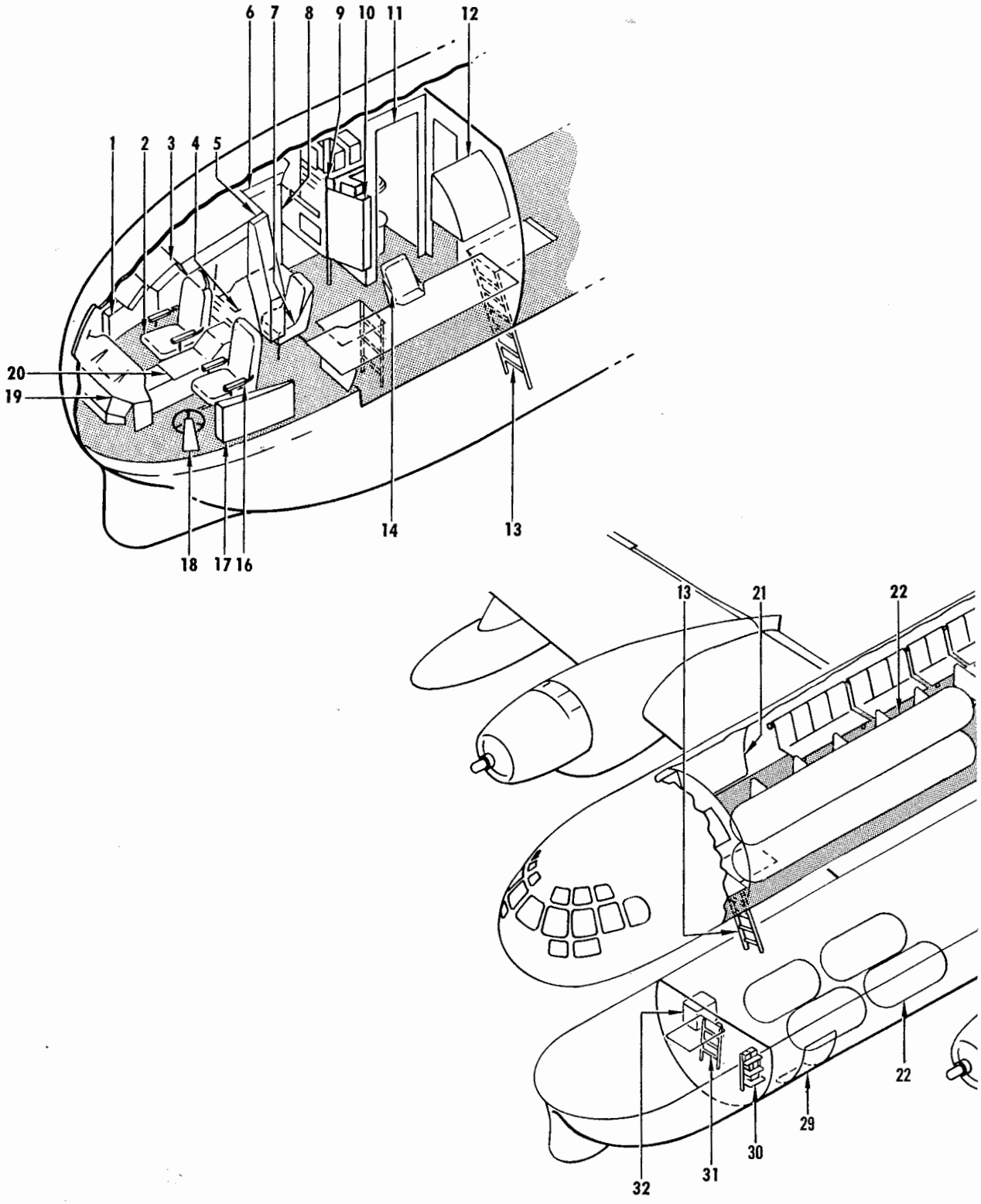
F

Figure 1-4 (Sheet 1 of 4)



1 COPILOT'S AUXILIARY PANEL
2 COPILOT'S SEAT
3 OVERHEAD PANEL
4 ENGINEER'S TABLE
5 ENGINEER'S AUXILIARY PANEL
F G 1372 ▶
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 RADIO OPERATOR'S SEAT
16 PILOT'S SEAT
17 PILOT'S AUXILIARY PANEL
18 NOSE WHEEL STEERING PEDESTAL
19 PILOTS' INSTRUMENT PANEL
20 CONTROL STAND
21 FORWARD CARGO DOOR
22 A/R FUEL TANKS
23 BOOM SYSTEM EMERGENCY HAND PUMP
24 A/R BOOM
25 BOOM OPERATOR'S PANEL
26 BOOM OPERATOR'S STATION
27 TROOP SEATS (2 PLACES)
28 AFT ENTRY DOOR
29 FORWARD ENTRY DOOR
30 AUXILIARY RADIO RACK
31 LOWER NOSE COMPARTMENT LADDER
32 AUXILIARY POWER UNIT

Figure 1-4 (Sheet 2 of 4)



GENERAL ARRANGEMENT ▽ (CONT)

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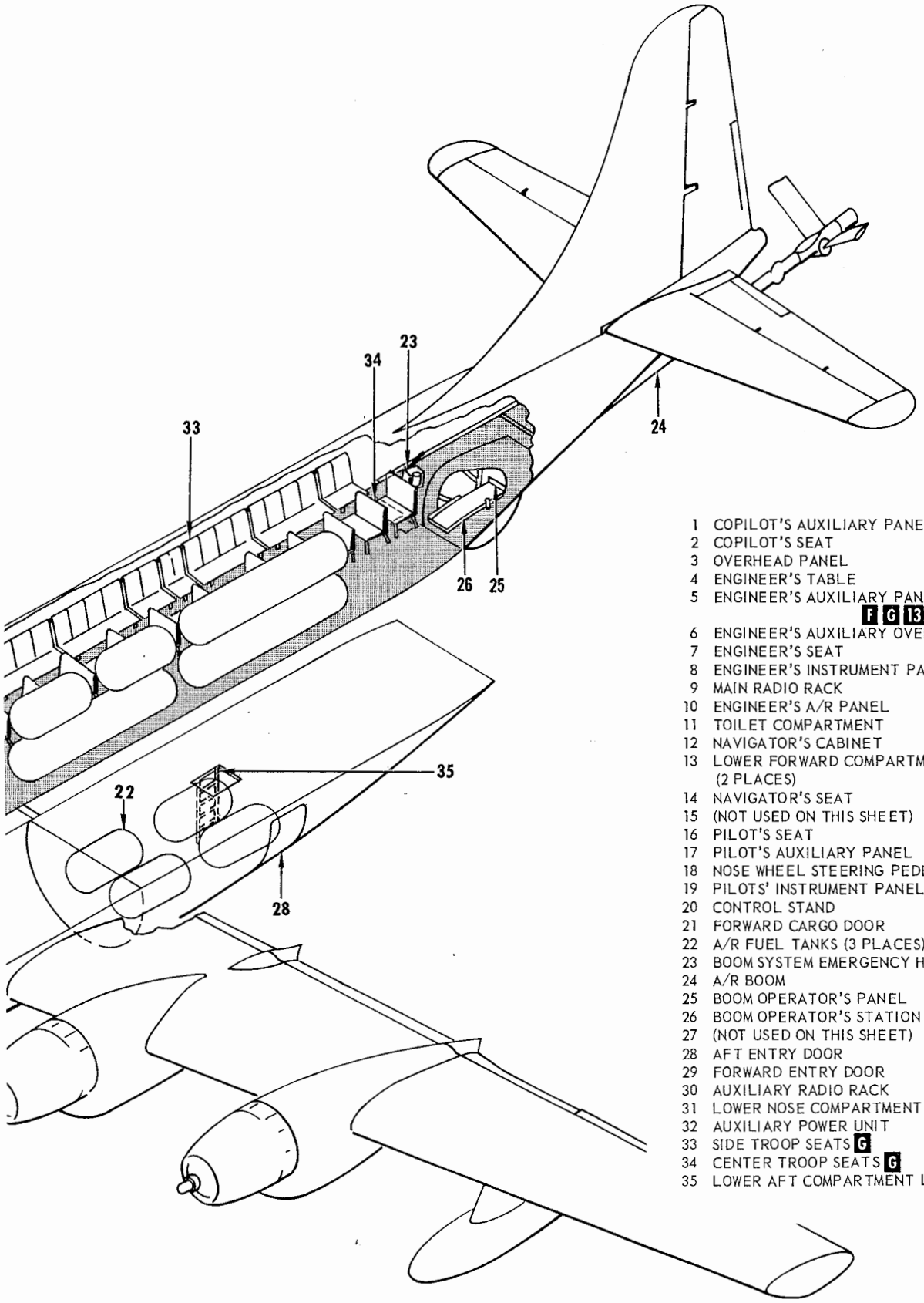
Figure 1-4 (Sheet 3 of 4)



1 COPILOT'S AUXILIARY PANEL
2 COPILOT'S SEAT
3 OVERHEAD PANEL
4 ENGINEER'S TABLE
5 ENGINEER'S AUXILIARY PANEL F G 1372
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9 MAIN RADIO RACK
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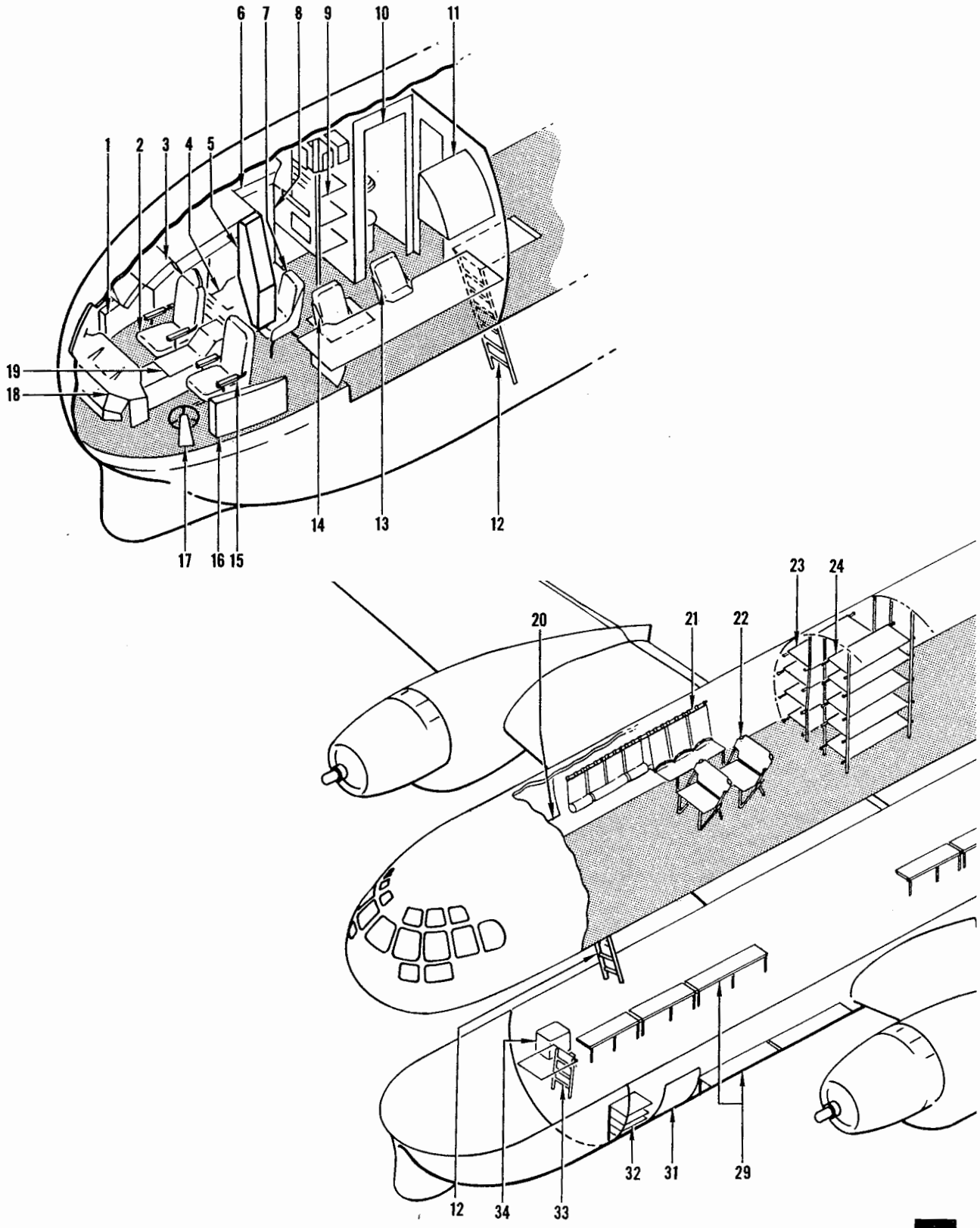
11 TOILET COMPARTMENT
12 NAVIGATOR'S CABINET
13 LOWER FORWARD COMPARTMENT LADDER (2 PLACES)
14 NAVIGATOR'S SEAT
15 (NOT USED ON THIS SHEET)
16 PILOT'S SEAT
17 PILOT'S AUXILIARY PANEL
18 NOSE WHEEL STEERING PEDESTAL
19 PILOTS' INSTRUMENT PANEL
20 CONTROL STAND
21 FORWARD CARGO DOOR
22 A/R FUEL TANKS (3 PLACES)
23 BOOM SYSTEM EMERGENCY HAND PUMP
24 A/R BOOM
25 BOOM OPERATOR'S PANEL
26 BOOM OPERATOR'S STATION
27 (NOT USED ON THIS SHEET)
28 AFT ENTRY DOOR
29 FORWARD ENTRY DOOR
30 AUXILIARY RADIO RACK
31 LOWER NOSE COMPARTMENT LADDER
32 AUXILIARY POWER UNIT
33 SIDE TROOP SEATS G
34 CENTER TROOP SEATS G
35 LOWER AFT COMPARTMENT LADDER G

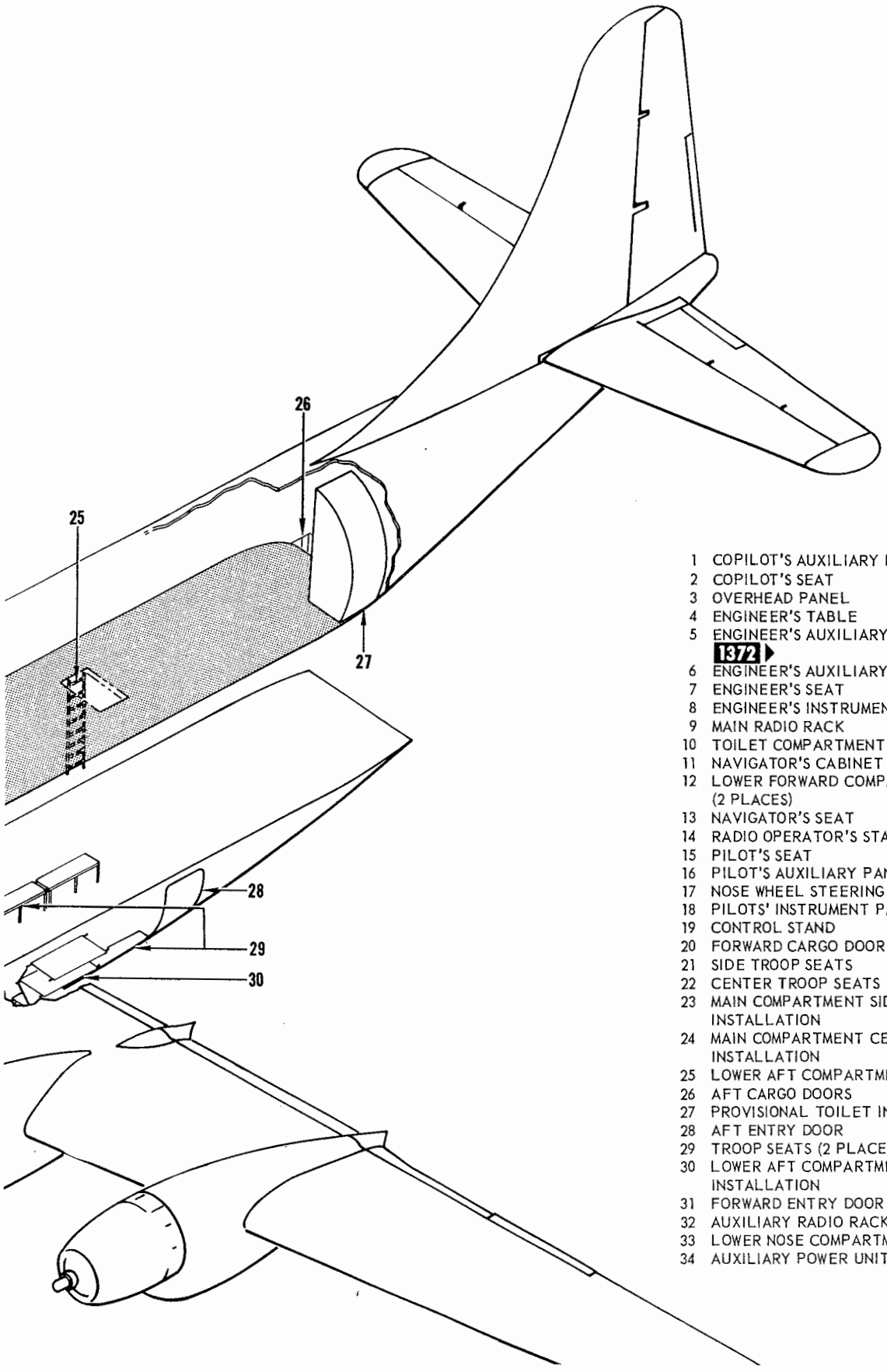
Figure 1-4 (Sheet 4 of 4)



GENERAL ARRANGEMENT ©

F

Figure 1-5 (Sheet 1 of 4)



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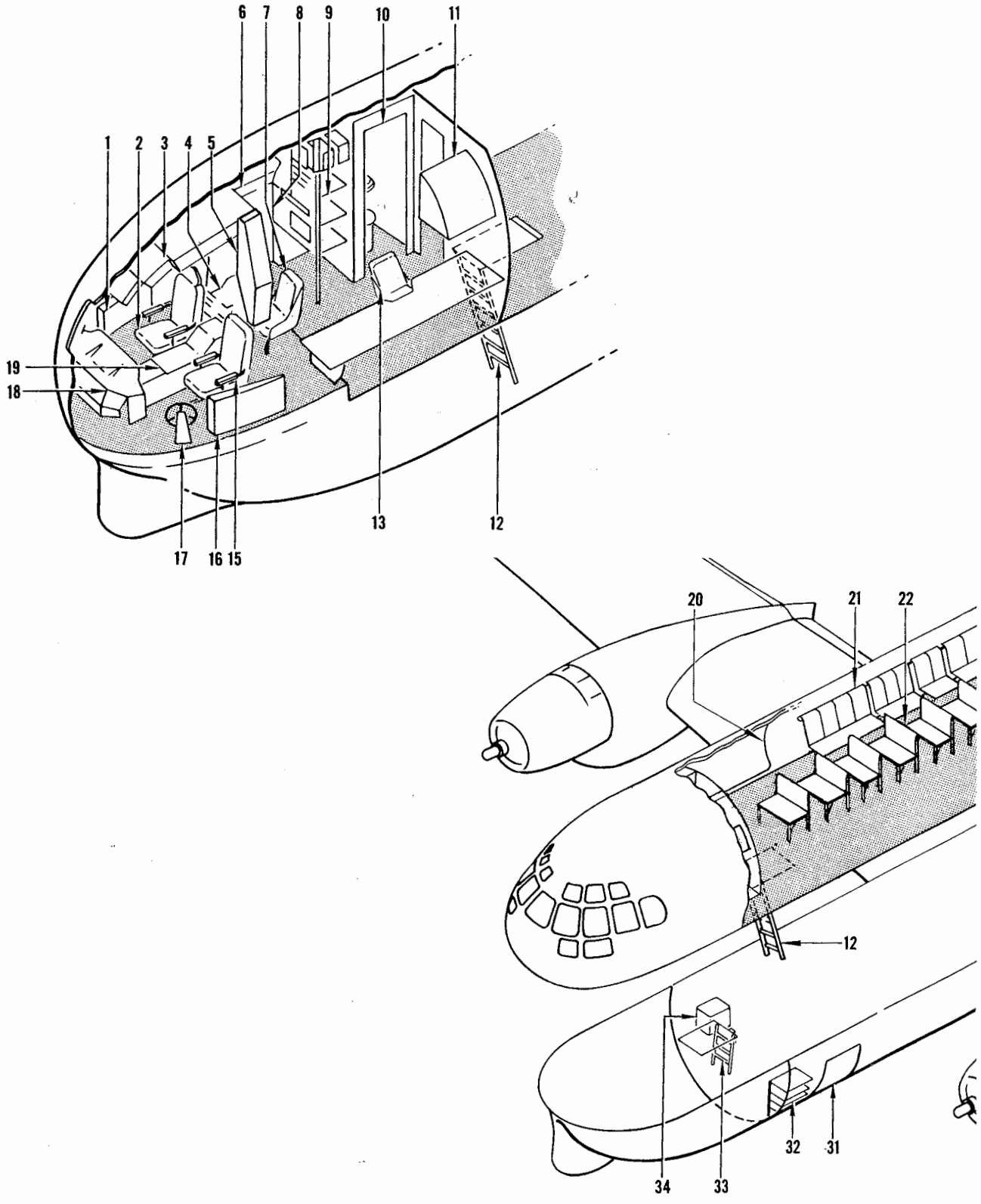
6 ENGINEER'S AUXILIARY OVERHEAD PANEL
7 ENGINEER'S SEAT
8 ENGINEER'S INSTRUMENT PANEL
9 MAIN RADIO RACK
10 TOILET COMPARTMENT
11 NAVIGATOR'S CABINET
12 LOWER FORWARD COMPARTMENT LADDER (2 PLACES)
13 NAVIGATOR'S SEAT
14 RADIO OPERATOR'S STATION
15 PILOT'S SEAT
16 PILOT'S AUXILIARY PANEL
17 NOSE WHEEL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

Figure 1-5 (Sheet 2 of 4)



GENERAL ARRANGEMENT © (CONT)

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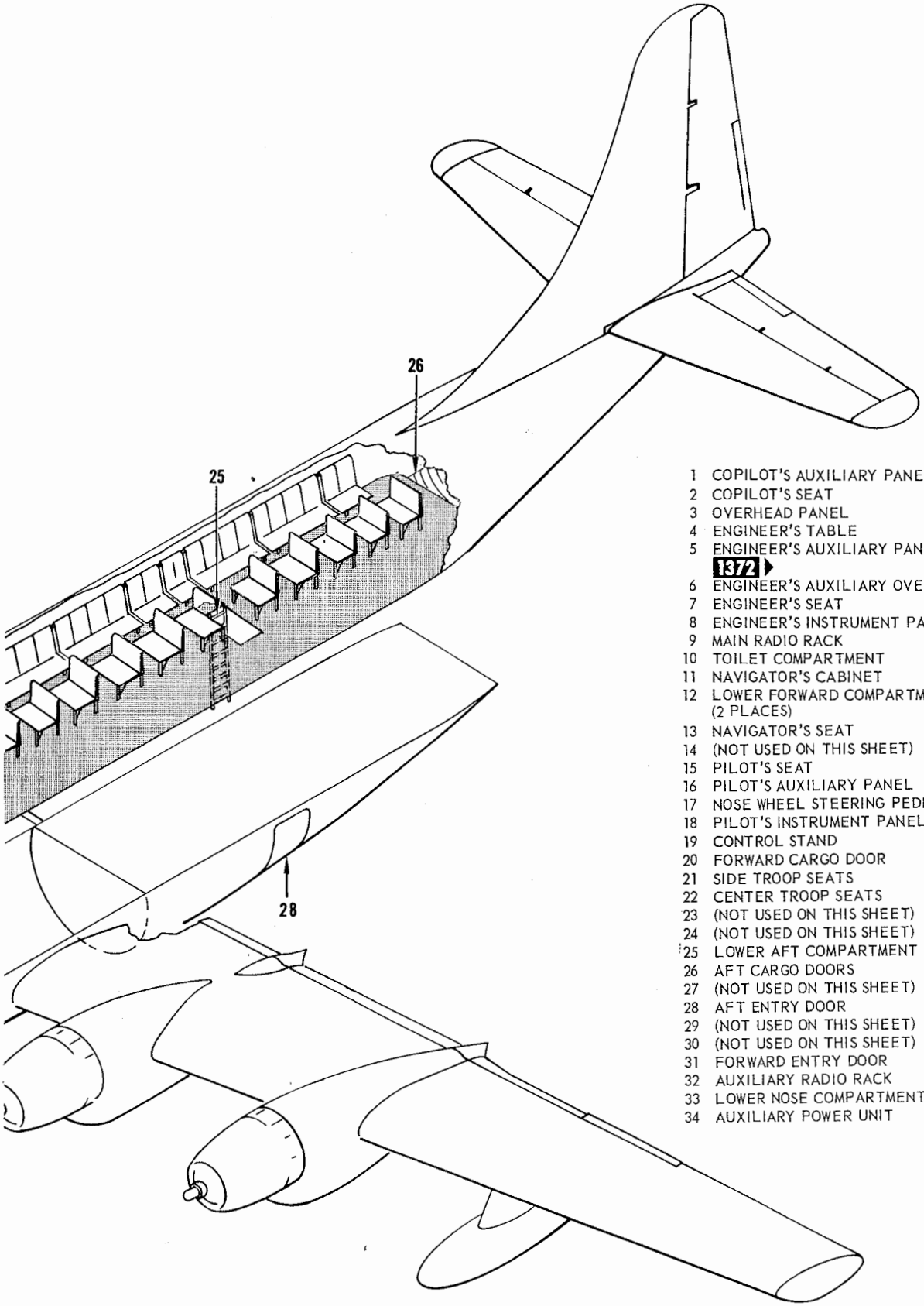
Figure 1-5 (Sheet 3 of 4)



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27 (NOT USED ON THIS SHEET)
28 AFT ENTRY DOOR
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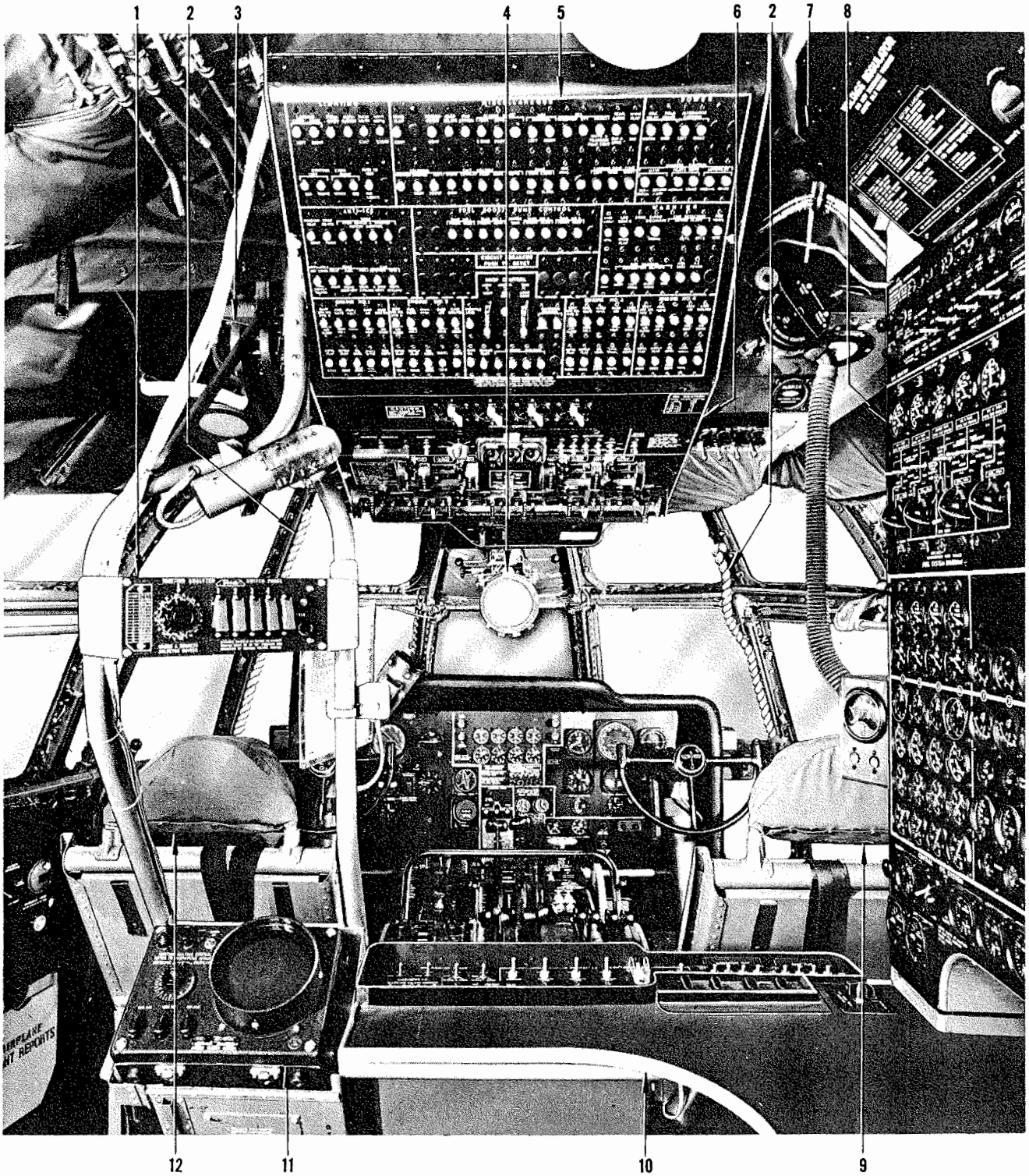
33 LOWER NOSE COMPARTMENT LADDER
34 AUXILIARY POWER UNIT

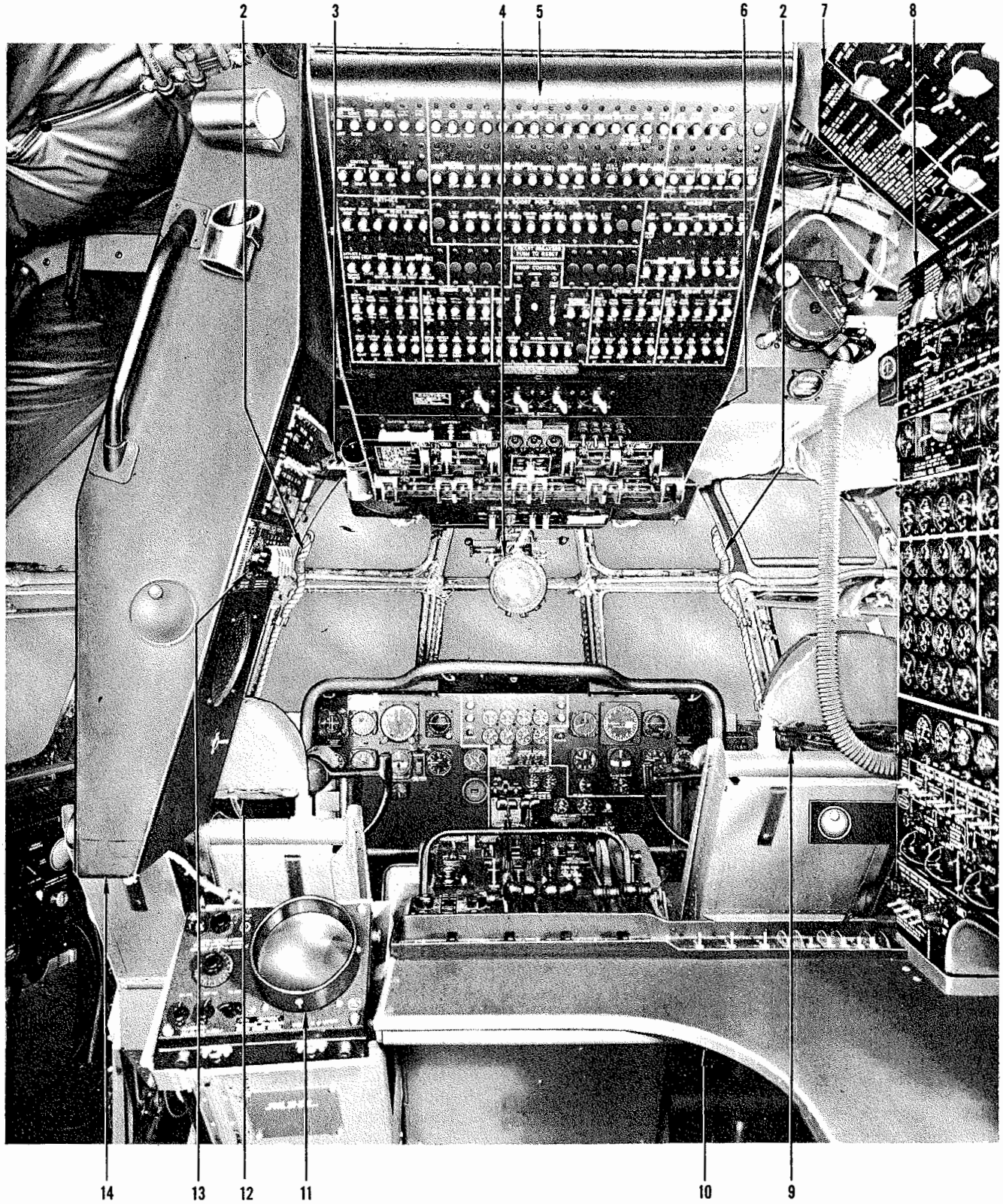
Figure 1-5 (Sheet 4 of 4)



1 IGNITION ANALYZER SWITCH PANEL F 1243 ▶ 1371
2 ESCAPE ROPE (4 PLACES)
3 EMERGENCY BRAKE LEVERS (2 PLACES)
4 SEARCH RADAR INDICATOR (2 PLACES)
5 OVERHEAD CIRCUIT BREAKER PANEL (2 PLACES)
6 OVERHEAD PANEL (2 PLACES)
7 ENGINEER'S AUXILIARY OVERHEAD PANEL (2 PLACES)
8 ENGINEER'S INSTRUMENT PANEL (2 PLACES)

CONTROL CABIN (TYPICAL) F

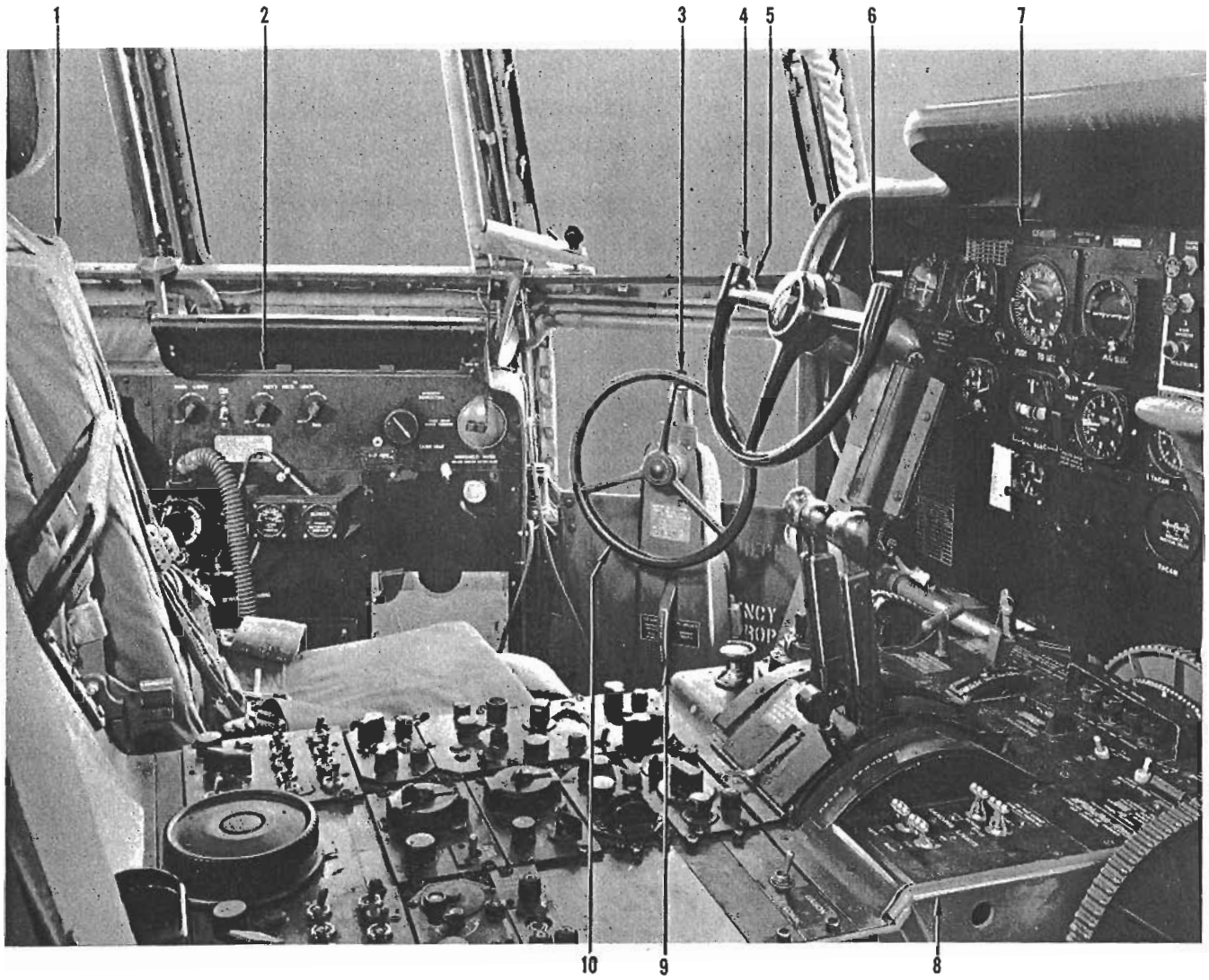
Figure 1-6 (Sheet 1 of 2)



9 COPILOT'S STATION (2 PLACES)
10 ENGINEER'S STATION (2 PLACES)
11 IGNITION ANALYZER (2 PLACES)
12 PILOT'S STATION (2 PLACES)
13 IGNITION ANALYZER SWITCH PANEL F G 1372 ▶
14 ENGINEER'S AUXILIARY PANEL F G 1372 ▶

G

Figure 1-6 (Sheet 2 of 2)



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)

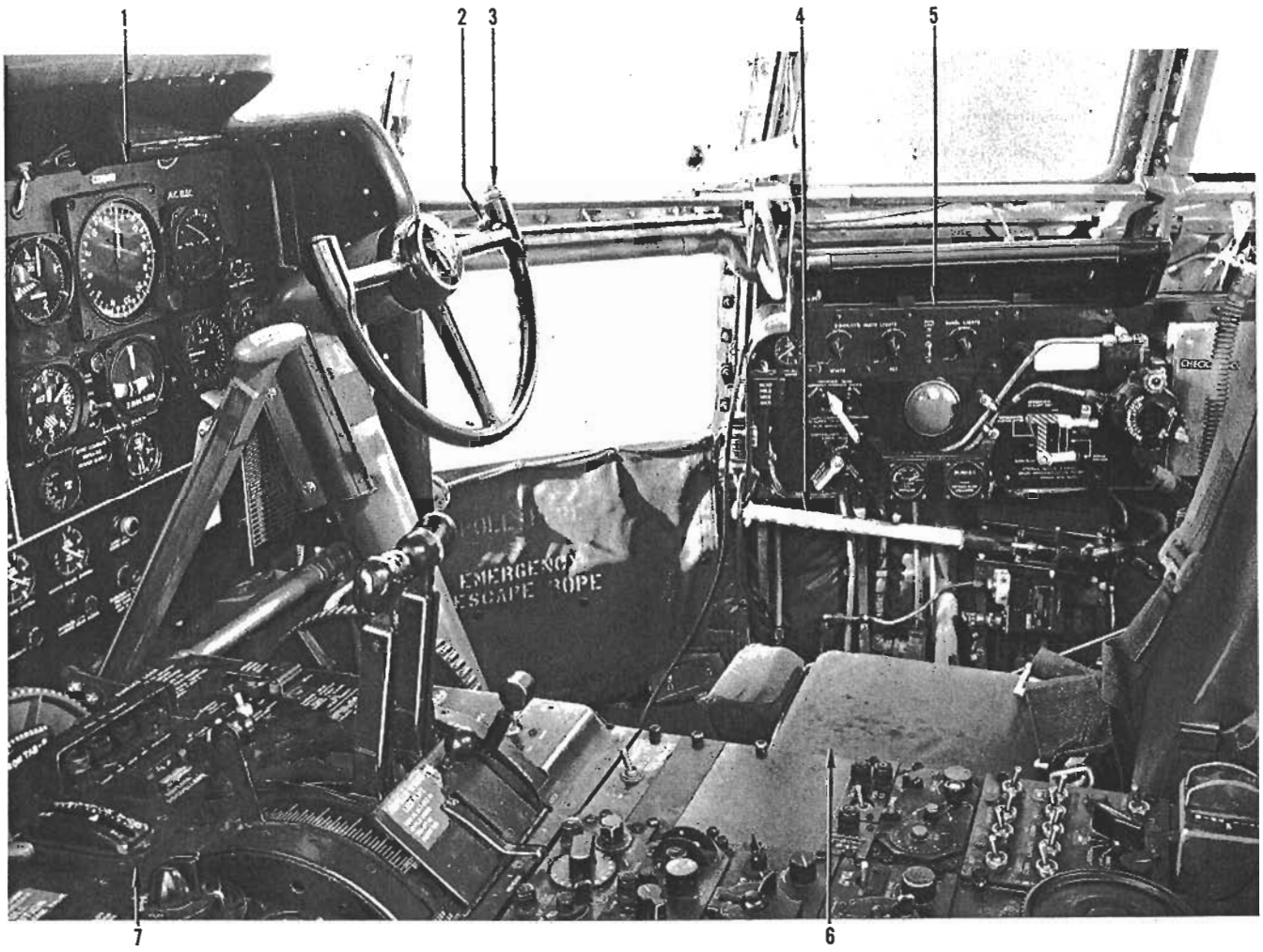
Figure 1-7

ENGINE CONTROL SYSTEMS

The airplane is powered by four Pratt and Whitney R-4360-59B, 28-cylinder air cooled 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,



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

COPILOT'S STATION (TYPICAL)

Figure 1-8

supercharger, and sheltered air door assembly, see INDUCTION SYSTEM and TURBOSUPERCHARGER in this Section.

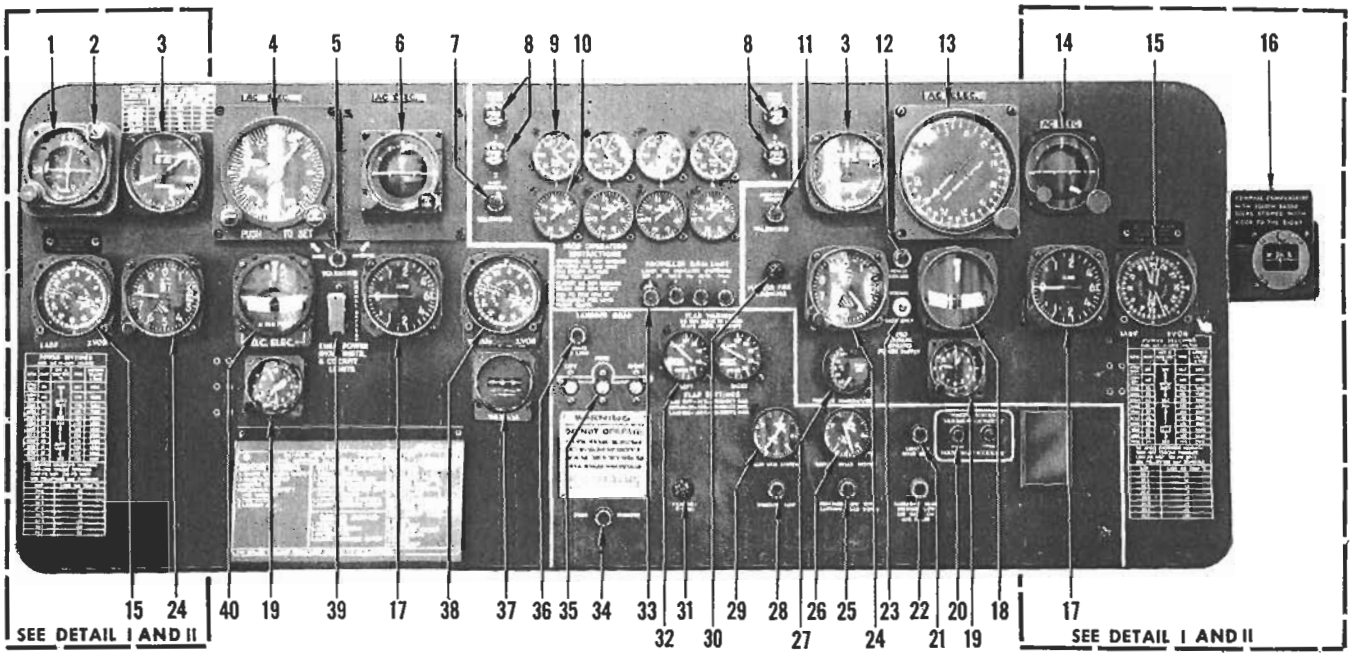
THROTTLES

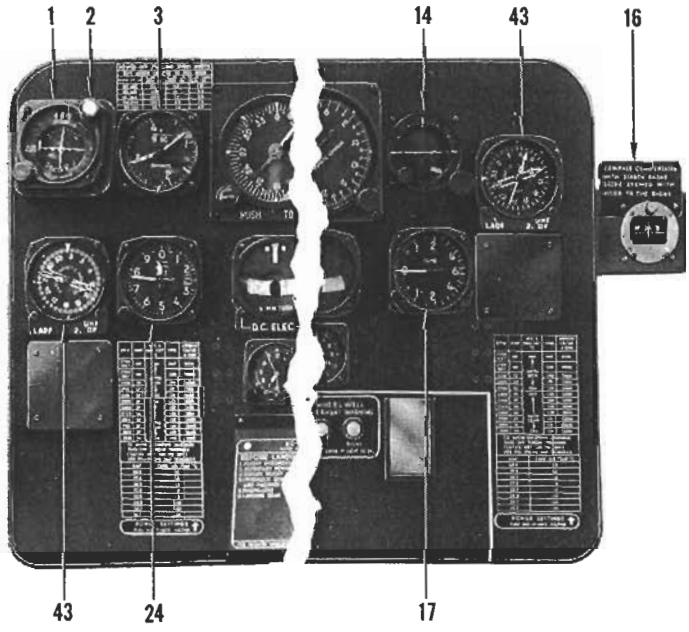
Throttle Actuated Equipment

Two sets of throttles (36,and 45, figure 1-16) 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 lock plate (44, figure 1-16) prevents inadvertent reversing of the propellers. A throttle lock lever (13, figure 1-16) to the right of the pilots' throttles, provides a friction braking force to hold the throttles in any desired position. With the water injection pump switch (10, figure 1-16) 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 of manifold pressure. See WATER INJECTION (ADI) SYSTEM in this Section.

Throttle Operation

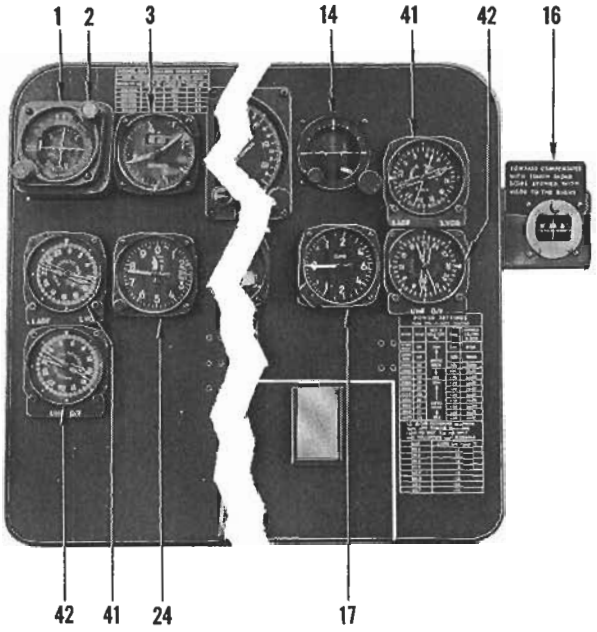
The pilots' throttles have OPEN--CLOSED--REVERSE OPEN and intermediate positions. The pilots' throttle operation is conventional in the OPEN--CLOSED range. Holding the throttles aft against the CLOSED stop maintains the throttles in forward idle. The throttles can be moved into reverse range by raising the throttle handles 1/4 inch and moving the levers aft beyond the CLOSED stop. A friction can be felt as the propeller reverse





DETAIL I

G 3178 ▶ WITH TCTO 572 ◀



DETAIL II

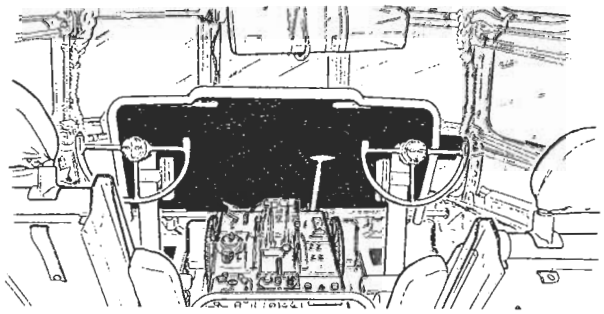
G 3178 ▶ WITHOUT TCTO 572 ◀

1 COURSE INDICATOR (3 PLACES)
2 MARKER BEACON LIGHT (3 PLACES)
3 AIRSPEED INDICATOR (4 PLACES)
4 PILOT'S DIRECTION 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 AUTOPILOT INVERTER WARNING LIGHT
12 DIRECTION INDICATOR REPEATER WARNING LIGHT
13 DIRECTION INDICATOR REPEATER
14 COPILOT'S ATTITUDE INDICATOR (3 PLACES)
15 RADIO MAGNETIC INDICATOR (RMI) ADF/VOR (2 PLACES)
16 MAGNETIC COMPASS (3 PLACES)
17 VERTICAL VELOCITY INDICATOR (4 PLACES)

PILOTS' INSTRUMENT PANEL

Figure 1-9 (Sheet 1 of 2)

18 COPILOT'S TURN AND SLIP INDICATOR
19 CLOCK (2 PLACES)
20 WHEEL WELL OVERHEAT WARNING LIGHTS TCTO 558
21 DOOR WARNING LIGHT
22 EMERGENCY BRAKE LOW PRESSURE WARNING LIGHT
23 DIRECTION INDICATOR REPEATER EMERGENCY POWER SWITCH
24 ALTIMETER (4 PLACES)
25 SERVICE BRAKE LOW PRESSURE WARNING LIGHT
26 HYDRAULIC PRESSURE GAGE SERVICE BRAKE SYSTEM
27 OUTSIDE AIR TEMPERATURE GAGE
28 MAIN HYDRAULIC LOW PRESSURE WARNING LIGHT
29 HYDRAULIC PRESSURE GAGE MAIN HYDRAULIC SYSTEM
30 MASTER FIRE WARNING LIGHT G 2930 ▶
31 MASTER FIRE WARNING LIGHT F G 1243 ▶ 2929
32 WING FLAP POSITION INDICATORS
33 RPM LIMIT LIGHTS
34 BOOM ENGAGED INDICATOR LIGHT
35 LANDING GEAR POSITION INDICATOR
36 LANDING GEAR WARNING LIGHT
37 RANGE INDICATOR TCTO 572



38 RADIO MAGNETIC INDICATOR (RMI) TACAN/VOR TCTO 572
39 PILOT'S INSTRUMENT INVERTER EMERGENCY POWER SWITCH G 2930 ▶ PLUS TCTO 239
40 PILOT'S TURN AND SLIP INDICATOR
41 RADIO MAGNETIC INDICATOR (RMI) ADF/VOR G 3178 ▶ WITHOUT TCTO 572 (2 PLACES)
42 RADIO MAGNETIC INDICATOR (RMI) UHF-DF G 3178 ▶ WITHOUT TCTO 572 (2 PLACES)
43 RADIO MAGNETIC INDICATOR (RMI) ADF/UHF-DF G 3178 ▶ WITH TCTO 572

Figure 1-9 (Sheet 2 of 2)

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 percent to 44 percent and with the weight of the airplane on the landing gear.

PROPELLER REVERSE LOCK

The throttles are equipped with an automatic reverse propeller 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 eight seconds after the airplane is airborne. This propeller reverse lock operates in conjunction with a propeller reverse warning flag (4, figure 1-16), located at 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 through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1). For more information concerning this flag see PROPELLER SYSTEM in this Section.

PROPELLER REVERSE LOCK PLATE TCTO 224

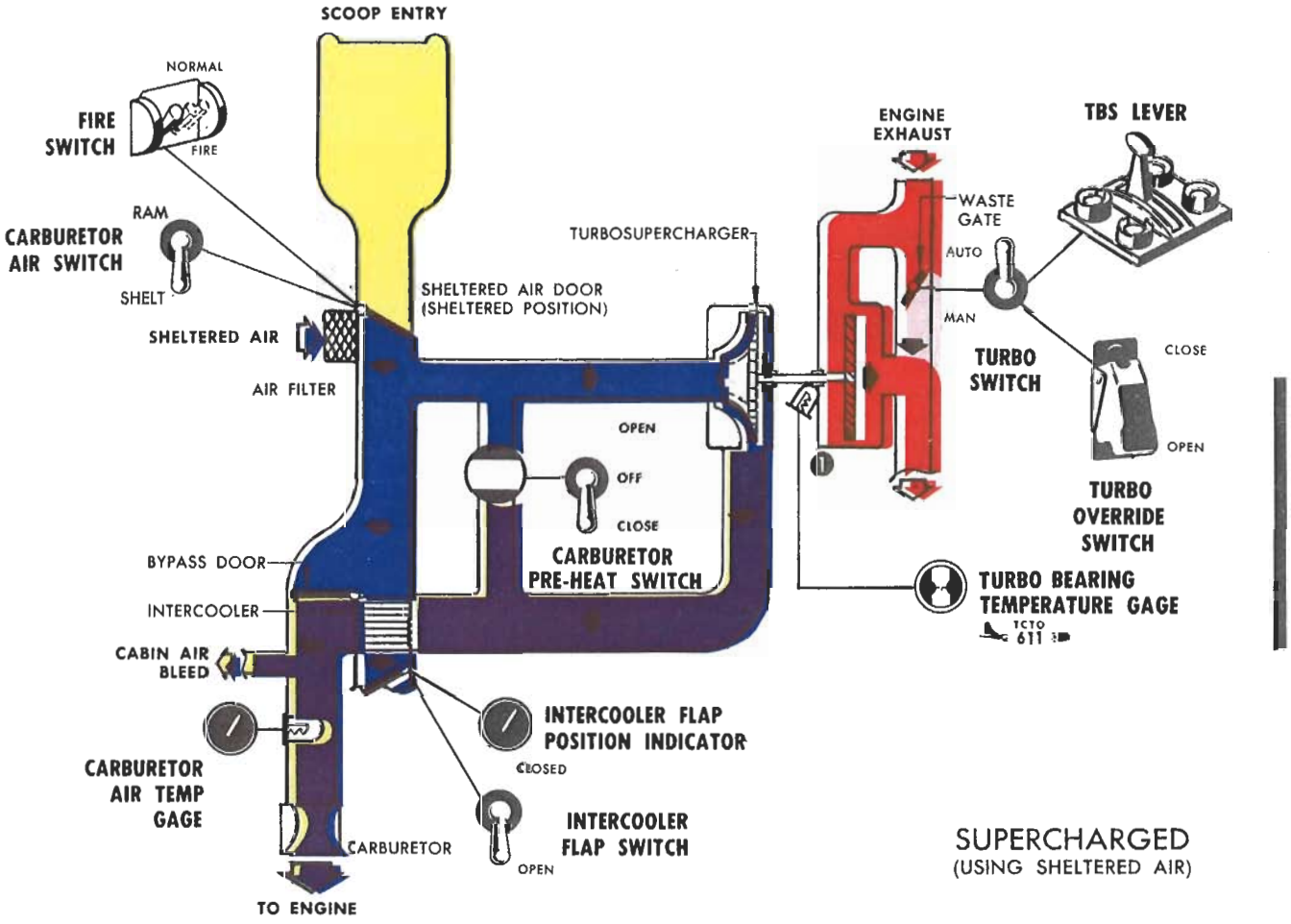
A metal lock plate (44, figure 1-16) on the aft side of the pilots' throttle quadrant prevents the throttle from being moved inadvertently into the propeller reverse range. The lock is hinged on the aft edge and must be opened whenever the throttles are to be operated in the propeller reverse range.

MIXTURE CONTROLS AND MIXTURE LOCK LEVER

Four mixture controls (24, figure 1-16) 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 other positions using the procedures outlined under MANUAL LEAN FUEL CONTROL in Section VII. A locking lever (23, figure 1-16) adjacent to the mixture control levers, provides a friction braking force to hold the mixture control levers at any desired position.

INDUCTION SYSTEM

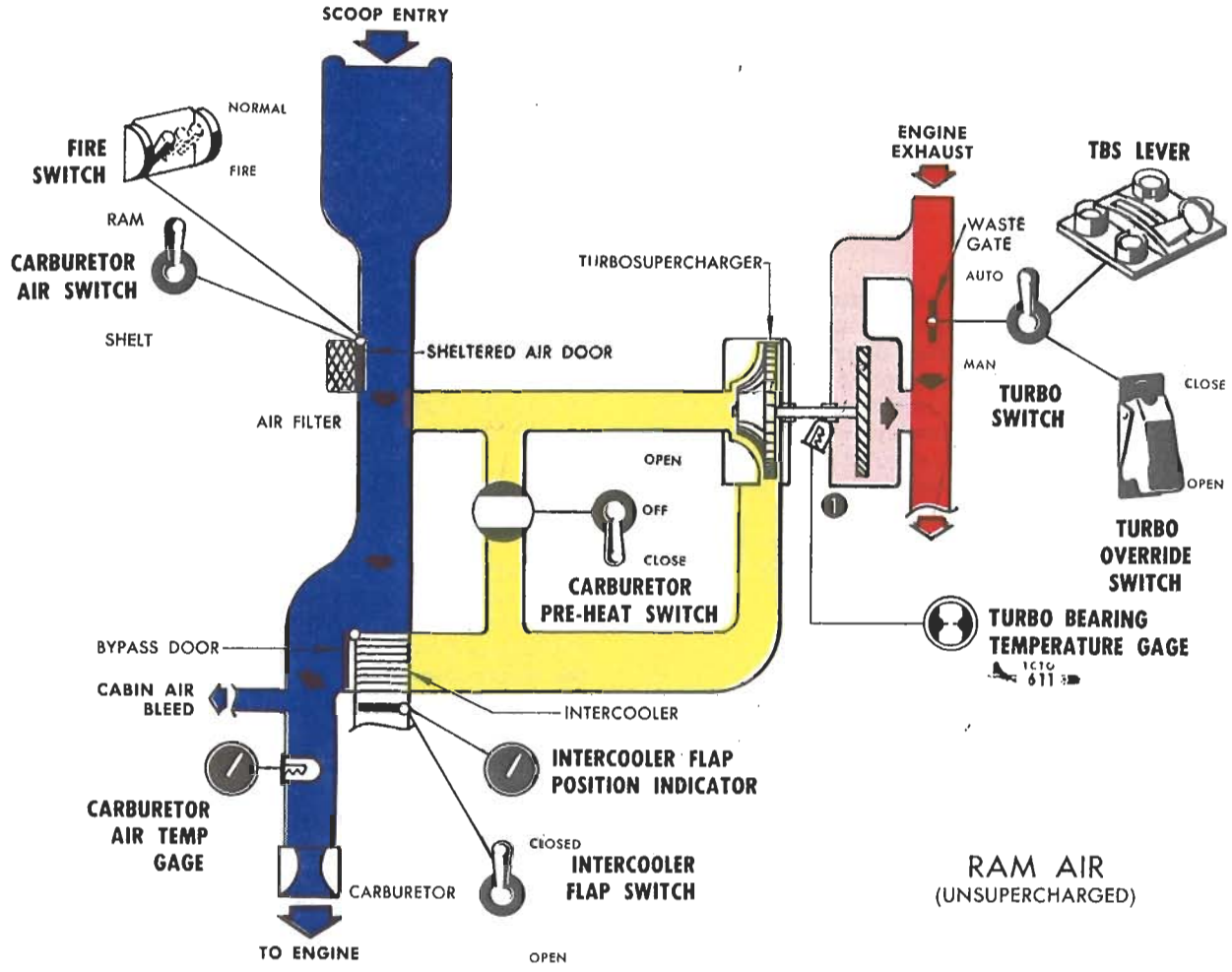
The induction system (figure 1-10) consists of an entry scoop, a sheltered air door and sheltered air inlet assembly, turbosupercharger, intercooler, carburetor preheat valve, and connecting ducting. Either ram

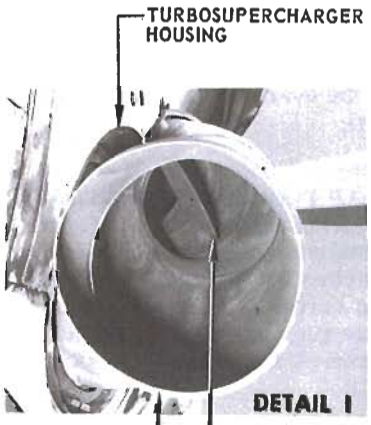


❶ Temperature pickup installed by TCTO 2RA4-3-508

INDUCTION SYSTEM

Figure 1-10 (Sheet 1 of 2)





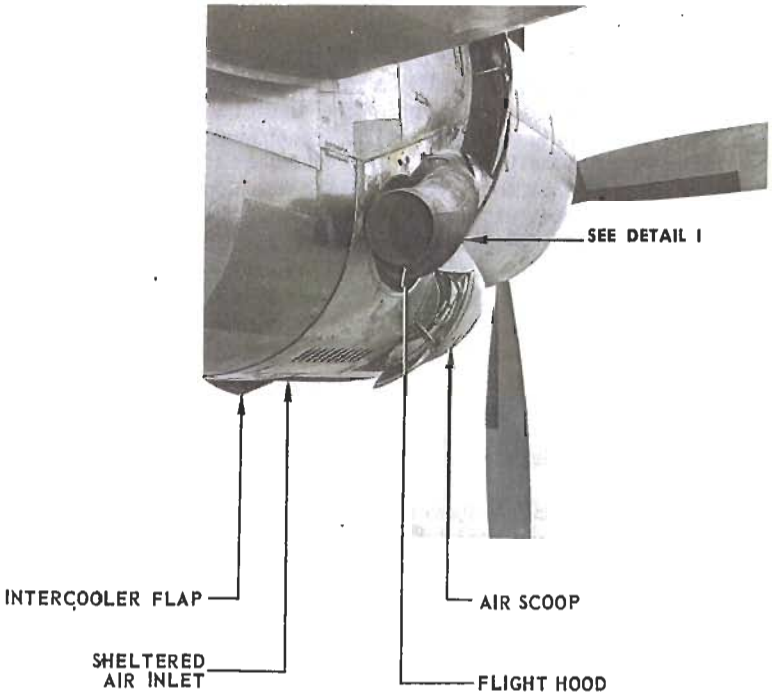


Figure 1-10 (Sheet 2 of 2)

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, see TURBOSUPERCHARGER in this Section.

Sheltered Air Door

An electrically operated sheltered air door and inlet assembly is 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 assembly to filter dust particles from the air.

Carburetor Preheat Valve

An electrically operated gate-type carburetor preheat valve (figure 1-10) 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 switches (35, figure 1-16) on the aft end of the control stand F, and (95, figure 1-22) on the engineer's instrument panel G control operation of the sheltered air doors. The switches have RAM--SHELT positions. Gang flappers permit actuation of all four switches to either position at the same time. In the RAM position air enters the air scoop and passes directly into the induction system. In the SHELT position, the shutoff door closes the air intake scoop and allows air to enter the induction system from the bottom of the air scoop. The circuit is supplied with 28 volt DC through circuit breakers on the overhead circuit breaker panel and the main circuit breaker panel (figure 1-35, sheets 1 and 5).

Carburetor Preheat Switches

Four OPEN--OFF--CLOSE switches (33, figure 1-16) on the aft end of the control stand F, and (93, figure 1-22) on the engineer's instrument panel G control the carburetor preheat valves. The switches are spring-loaded only from the OPEN position to the OFF position. Gang flappers 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 through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

Carburetor Air Temperature Gages

A resistance bulb type carburetor air temperature gage (52, figure 1-22) 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 through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

Intercooler

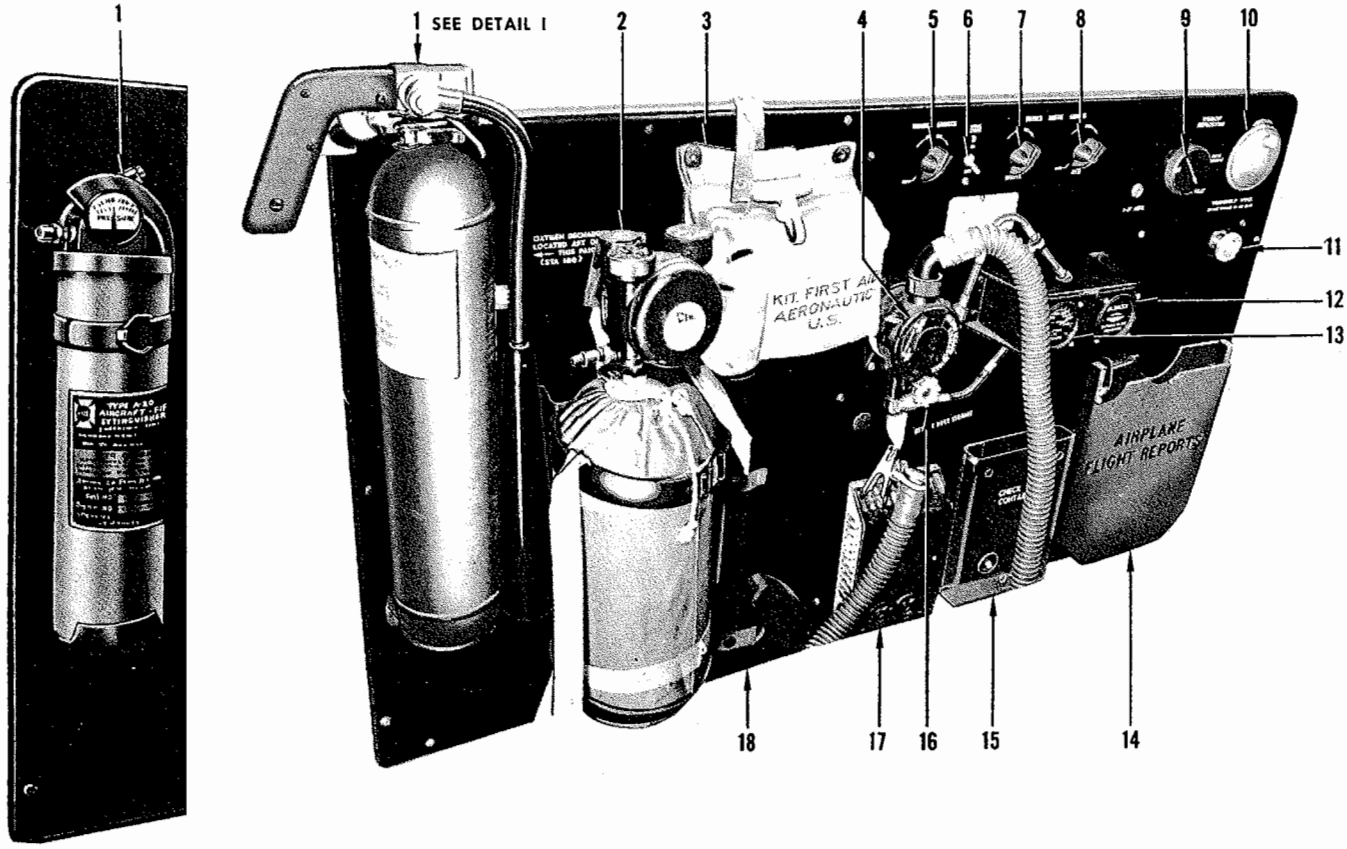
An intercooler (figure 1-10) located downstream from the turbocompressor, is used to provide cooling of supercharged air to the carburetor. Intercooler operation is controlled electrically by positioning of the intercooler flap, which limits the amount of ram air passing through the intercooler.

INTERCOOLER FLAP SWITCHES. Four OPEN--OFF--CLOSED switches (28, figure 1-16), on the aft end of the engine control stand F, and (94, figure 1-22) on the engineer's instrument panel G control the intercooler flaps. The switches are spring-loaded to return 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 cooling air to pass through the intercooler. Holding the switch in the CLOSED position decreases the amount of flap opening. Gang flappers permit actuation of all four switches to either position at the same time. The circuit is supplied with 28 volt DC through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

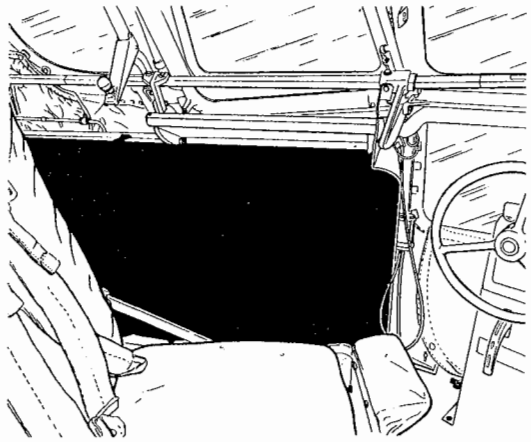
INTERCOOLER FLAP POSITION INDICATORS. Four intercooler flap position indicators (51, figure 1-22) on the engineer's instrument panel show intercooler flap positions in inches of opening. The reading is taken from the flap screw driving mechanism. The indicator circuits are supplied with 26 volt AC through the four engine instrument fuses on the AC power panel (figure 1-35, sheet 3).

TURBOSUPERCHARGER SYSTEM

The turbosupercharger (figure 1-10) is an exhaust-driven centrifugal air compressor which is used to



DETAIL I F G 1279 ▶

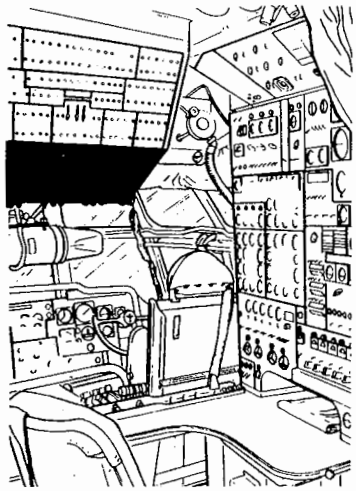


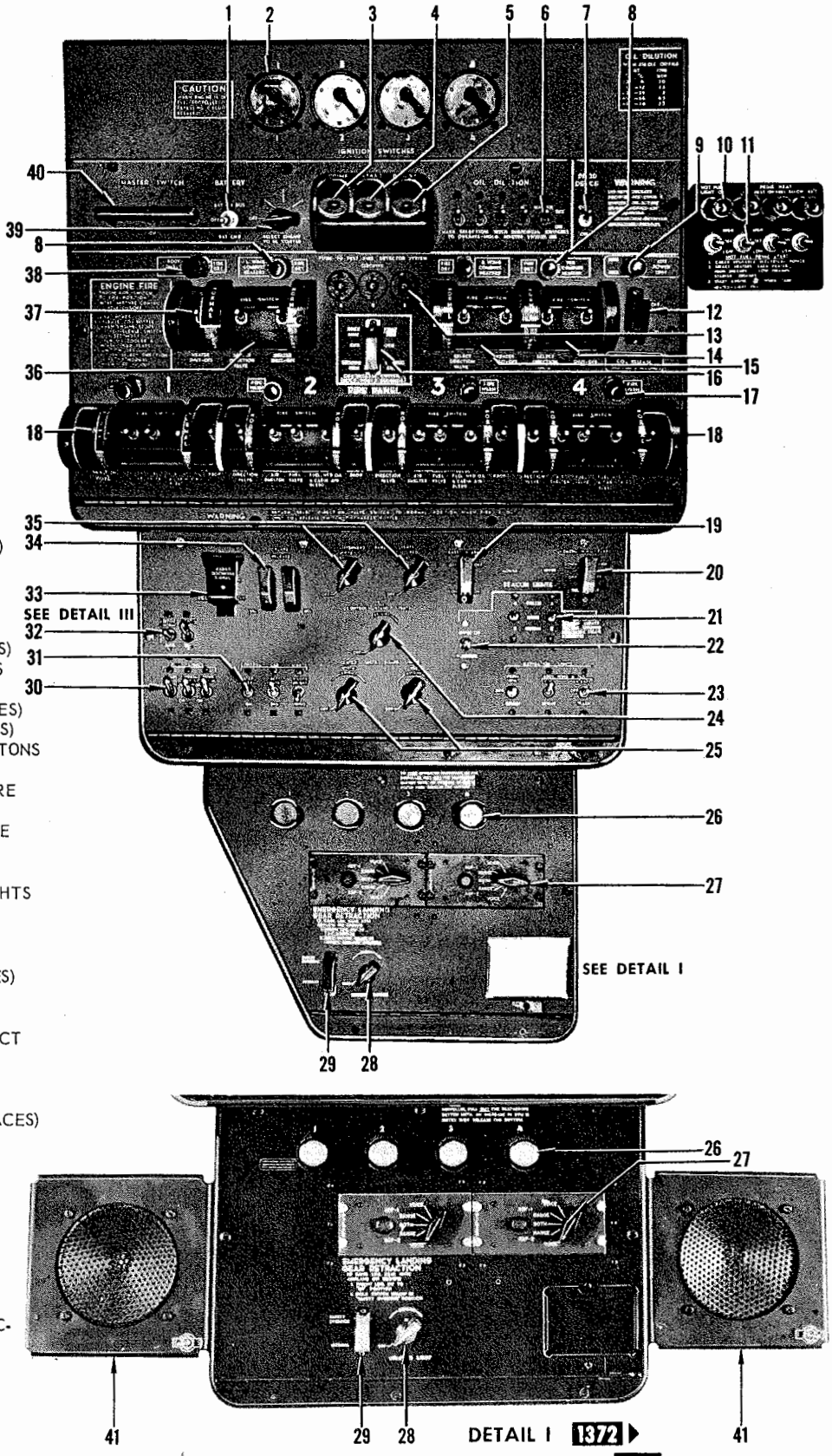
1 FIRE EXTINGUISHER (2 PLACES)
2 OXYGEN BOTTLE
3 FIRST AID KIT
4 OXYGEN FLOW REGULATOR
5 PILOT'S AUXILIARY PANEL LIGHT RHEOSTAT
6 DOME LIGHT SWITCH
7 PILOTS' INSTRUMENT PANEL LIGHT RHEOSTAT (LEFT SIDE WHITE)
8 PILOTS' INSTRUMENT PANEL LIGHT RHEOSTAT (LEFT SIDE RED)
9 WINDOW DEFROSTING CONTROL KNOB
10 ASH TRAY
11 WINDSHIELD WIPER SPEED CONTROL KNOB
12 OXYGEN FLOW INDICATOR
13 OXYGEN PRESSURE GAGE
14 AIRPLANE FLIGHT REPORT CONTAINER
15 PILOT'S CHECK LIST CONTAINER
16 OXYGEN REGULATOR EMERGENCY VALVE KNOB
17 PILOT'S HEATED SUIT CONTROL PANEL F G 1243 ▶ 2859
18 CRASH AXE

PILOT'S AUXILIARY PANEL

Figure 1-11

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.



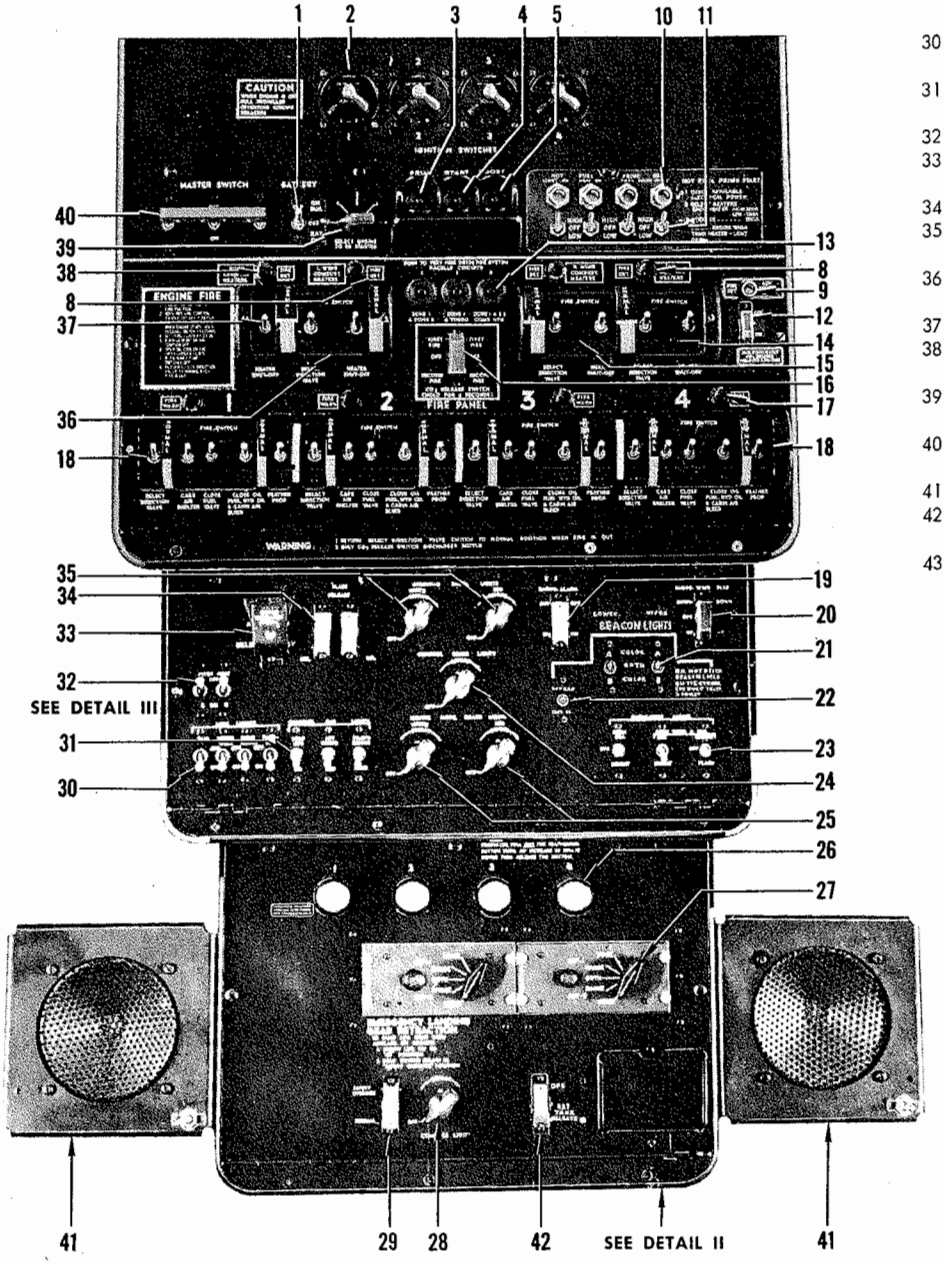


1 BATTERY SWITCH (2 PLACES)
2 IGNITION SWITCHES (2 PLACES)
3 PRIMER BUTTON (2 PLACES)
4 STARTER BUTTON (2 PLACES)
5 IGNITION BOOST BUTTON (2 PLACES)
6 OIL DILUTION SWITCHES
7 PROPELLER DE-ICE SWITCH
8 ANTI-ICING HEATER FIRE WARNING LIGHTS (4 PLACES)
9 APU FIRE WARNING LIGHT (2 PLACES)
10 HOT FUEL PRIME INDICATOR LIGHTS (2 PLACES)
11 HOT FUEL PRIME SWITCHES (2 PLACES)
12 APU CO_2 RELEASE SWITCH (2 PLACES)
13 FIRE DETECTION SYSTEM TEST BUTTONS (2 PLACES)
14 EMPENNAGE ANTI-ICING HEATER FIRE GANG SWITCH (2 PLACES)
15 RIGHT WING ANTI-ICING HEATER FIRE GANG SWITCH (2 PLACES)
16 CO_2 RELEASE SWITCH (2 PLACES)
17 POWER PACKAGE FIRE WARNING LIGHTS (2 PLACES)
18 POWER PACKAGE FIRE GANG BAR SWITCHES (4 PLACES)
19 EMERGENCY ALARM BELL (2 PLACES)
20 EMERGENCY WING FLAP SWITCH (2 PLACES)
21 ANTI-COLLISION LIGHT COLOR SELECT SWITCHES TCTO 591 (2 PLACES)
22 ANTI-COLLISION LIGHT SWITCH TCTO 591 (2 PLACES)
23 NAVIGATION LIGHT SWITCHES (2 PLACES)
24 CONTROL STAND LIGHTS RHEOSTAT (2 PLACES)
25 PILOT'S INSTRUMENT PANEL LIGHT RHEOSTAT (2 PLACES)
26 PROPELLER FEATHERING BUTTONS (2 PLACES)
27 RADIO COMPASS FILTER PANELS (4 PLACES)
28 COMPASS LIGHT RHEOSTAT
29 LANDING GEAR EMERGENCY RETRACTION SWITCH (2 PLACES)

OVERHEAD PANEL

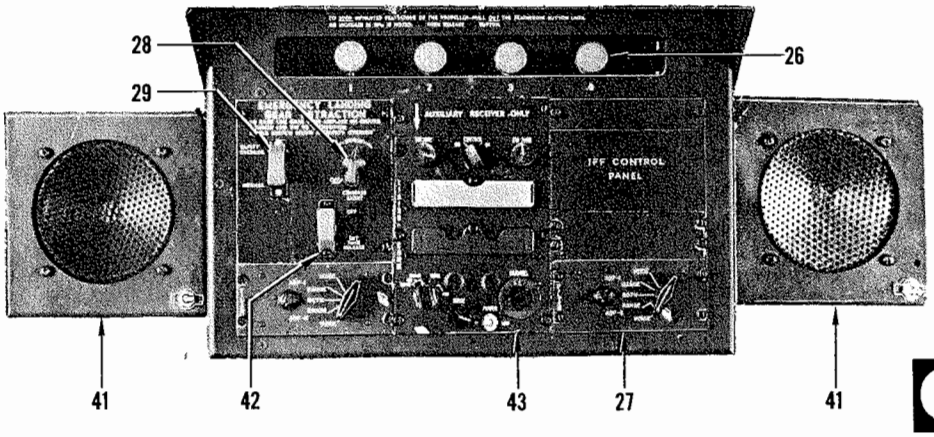
F

Figure 1-12 (Sheet 1 of 2)



30 MISCELLANEOUS LIGHT SWITCHES (2 PLACES)
31 CONTROL CABIN LIGHT SWITCHES (2 PLACES)
32 PITOT HEAT SWITCHES (3 PLACES)
33 CARGO DISCHARGE SIGNAL SWITCH (2 PLACES)
34 FLARE RELEASE SWITCHES (2 PLACES)
35 OVERHEAD PANEL LIGHTS RHEOSTAT (2 PLACES)
36 LEFT WING ANTI-ICING HEATER FIRE GANG SWITCH (2 PLACES)
37 BODY HEATER FIRE SWITCH (2 PLACES)
38 BODY HEATER FIRE DETECTOR LIGHT (2 PLACES)
39 ENGINE STARTING SELECTOR SWITCH (2 PLACES)
40 ELECTRICAL MASTER SWITCH (2 PLACES
41 LOUDSPEAKER (6 PLACES)
42 EXTERNAL TANK RELEASE SWITCH (2 PLACES)
43 LIAISON RECEIVER CONTROL PANEL (AN/ARR-36) LESS TCTO K572

DETAIL III
3142 ▶
PLUS TCTO 292



DETAIL II
2901 ▶

G

Figure 1-12 (Sheet 2 of 2)

Turbosupercharger Automatic Control

The automatic control system (figure 1-13) 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 (37, figure 1-16) and the turbo calibrating knobs (38, figure 1-16) 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 having ▲ TCTO 320 ▶ incorporated (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 1-13). Each control circuit is separately fused with a 2-amp slow blow fuse located in the turboamplifier 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 F G 1243 ▶ 22700 or circuit breaker G 22701 ▶ on the AC power panel (figure 1-35, sheet 3).

Turbosupercharger Manual Control

A manual control system is provided in case of automatic system malfunction. A separate power source, transformer and control switches (figure 1-13) 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 F G 1243 ▶ 22700 or circuit breaker G 22701 ▶ on the AC power panel (figure 1-35, sheet 3).

Turbosupercharger Overboost Limiting System ▲ TCTO 338 ▶

The overboost limiting system is a safety device to protect the powerplant 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 1-13) 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 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 (figure 1-35, sheet 1). 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 TURBO BOOST fuse F G 1243 ▶ 22700 or circuit breaker G 22701 ▶ on the AC power panel (figure 1-35, sheet 1).

TBS Lever

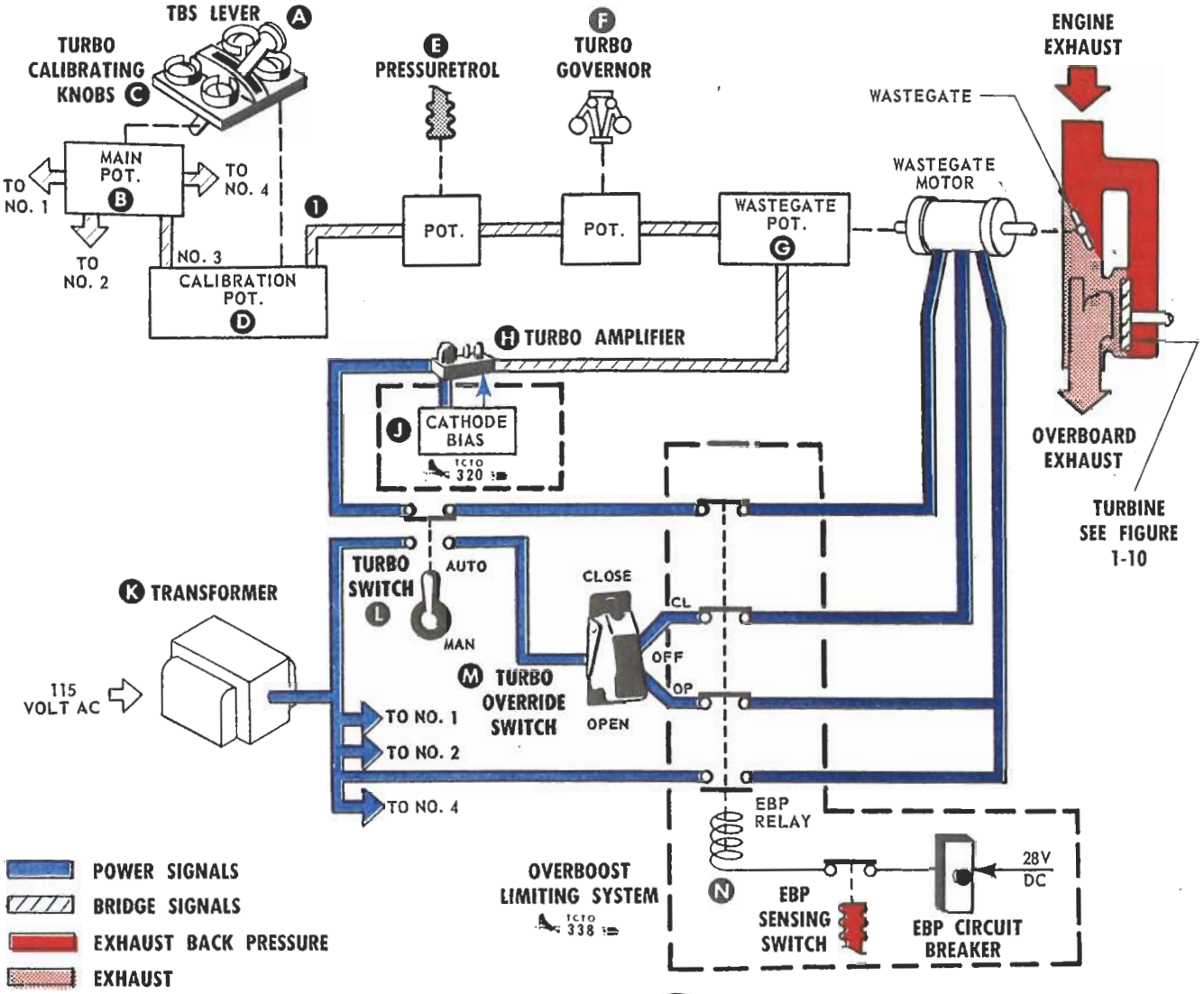
As the TBS lever (37, figure 1-16) is advanced from ZERO toward 10, the wastegate control bridge circuits are unbalanced so that each exhaust wastegate is moved toward the closed position. When the lever is moved toward the zero position the bridge circuits are unbalanced so that the wastegates are driven toward the open position. The output of each compressor is regulated by the automatic control system, once the initial carburetor inlet pressure has been established by positioning the TBS lever.

Turbo Calibrating Knobs

Each of the four calibrating knobs (38, figure 1-16) permits adjustment of its wastegate control 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 1-13). 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 amp fuse located in the junction box in the floor under the engineer's seat.

Turbo Switches

The turbo switches (30, figure 1-16) have AUTO--MAN positions. When these switches are placed in the AUTO position, the turbosuperchargers are controlled by the automatic system. When placed in the MAN position the turbosupercharger wastegate is controlled by means of the manual override switches.



POWER SIGNALS
BRIDGE SIGNALS
EXHAUST BACK PRESSURE
EXHAUST
CARBURETOR INLET PRESSURE
MECHANICAL CONNECTION

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 TCTO 320 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 de-energize 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 de-energize the EBP relay and have the same effect on the control systems as excessive exhaust back pressure

TURBOSUPERCHARGER CONTROL SYSTEM

Figure 1-13

Turbo Override Switches

The turbo override switches (27, figure 1-16) have CLOSE--OFF--OPEN positions. When the turbo switches are at MAN, nudging the override switches to the CLOSE position causes the wastegate to close which results in a rise in manifold pressure. When the turbo switches are on MAN, nudging the override switches to the OPEN position causes the wastegate 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 motor and the lack of governor overspeed control in the manual system. See TURBOSUPERCHARGER SYSTEM OPERATION, MANUAL CONTROL in 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 Gage ▲ TCTO 611

Two dual gages (103, figure 1-22) are installed on the forward side of the engineer's instrument panel. These gages show turbo bearing temperature in degrees centigrade. The gages are operable only for the turbos which have been modified in accordance with TCTO 2RA4-3-508. 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 (figure 1-35, sheet 1).

WATER INJECTION (ADI) SYSTEM

The water injection system (figure 1-14) 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 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 MP. The manifold pressure switch automatically opens the shutoff valve at 45 inches MP, 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 MP. Each water injection tank contains a water-alcohol mixture, described in figure 1-50, and supplies the two engines on that side of the airplane. Duration of the supply at 3500 brake horsepower per engine is approximately 10 minutes.

Water Injection (ADI) Pump Switch

An ADI pump, ON--OFF switch (10, figure 1-16) 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 water shutoff valve. Operation is then initiated by manifold pressure. The circuit is supplied with 28 volt DC through circuit breakers on the overhead circuit breaker panel and the main circuit breaker panel (figure 1-35, sheets 1 and 5).

Water Injection (ADI) Lights

Four amber water injection pressure warning lights (5, figure 1-16) 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 settings above 45 inches manifold pressure, with the water injection pump switch on. The circuit is supplied with 28 volt DC through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

ENGINE COOLING SYSTEM

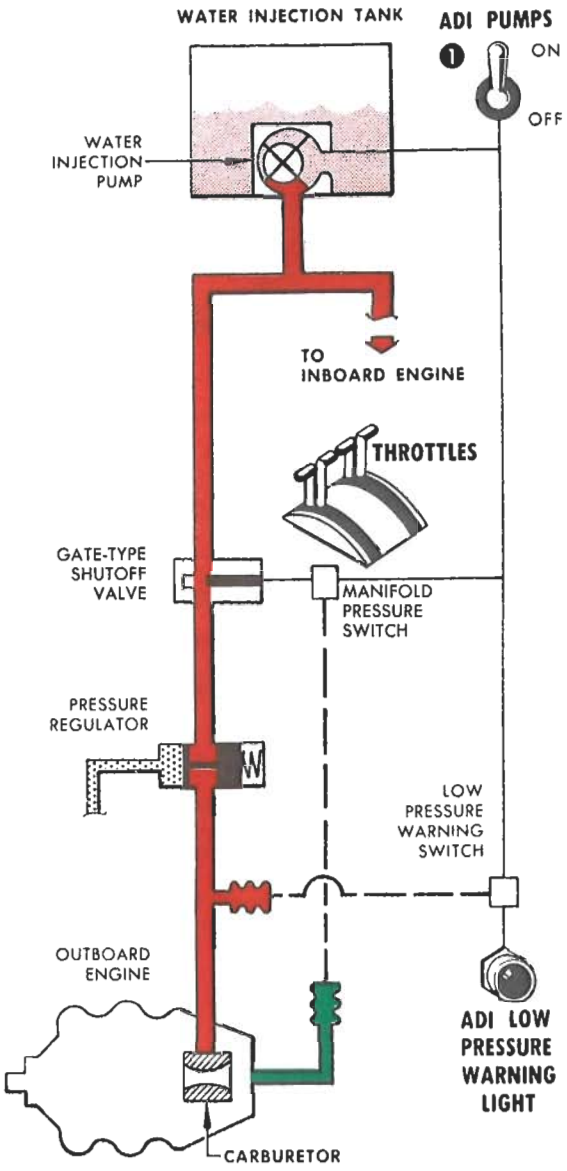
The flow of cooling air for each engine is controlled by two ground-adjustable and seven electrically operated, flight adjustable, cowl flaps. The cowl flaps are actuated by seven jackscrews driven by a single electric motor through a flexible drive shaft system.

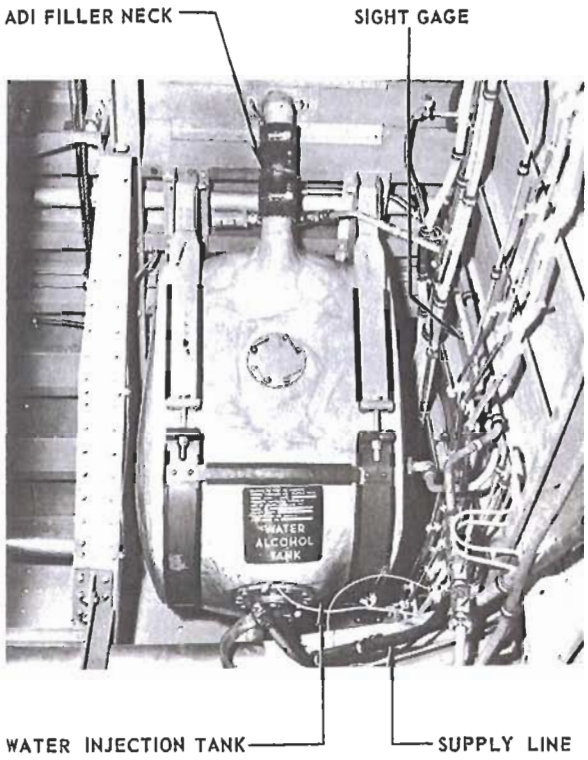
Cowl Flap Switches

Four cowl flap switches (26, figure 1-16) one for each engine, are on the aft end of the engine control stand F, and (92, figure 1-22) on the engineer's instrument panel G. These switches electrically 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 flappers 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 through circuit breakers on the overhead circuit breaker panel and the main circuit breaker panel (figure 1-35, sheets 1 and 5).

Cowl Flap Position Indicators

The position of the cowl flaps is indicated in inches of opening by four cowl flap position indicators (53, figure 1-22) 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 through the four engine instrument fuses on the AC power panel (figure 1-35, sheet 3).





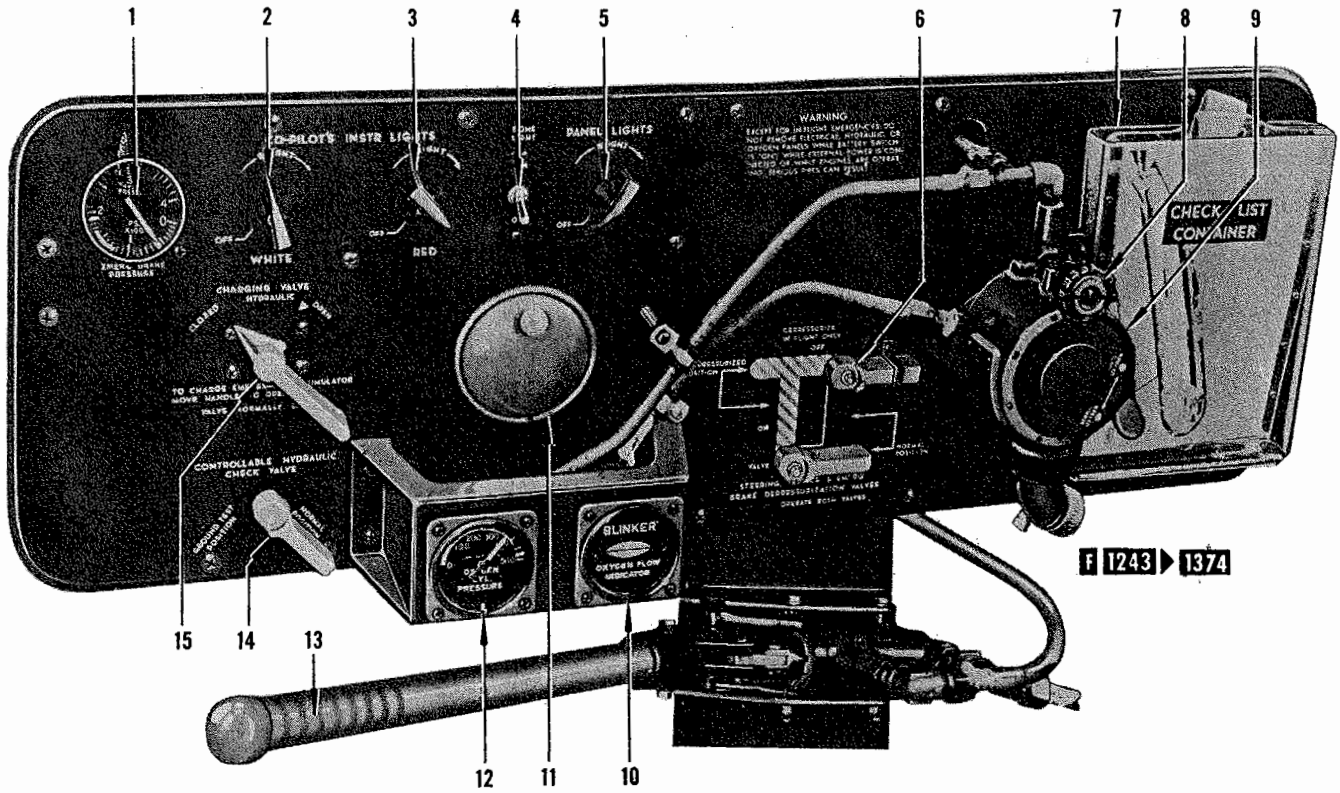
❶ This switch operates ADI system for all engines (one engine shown).

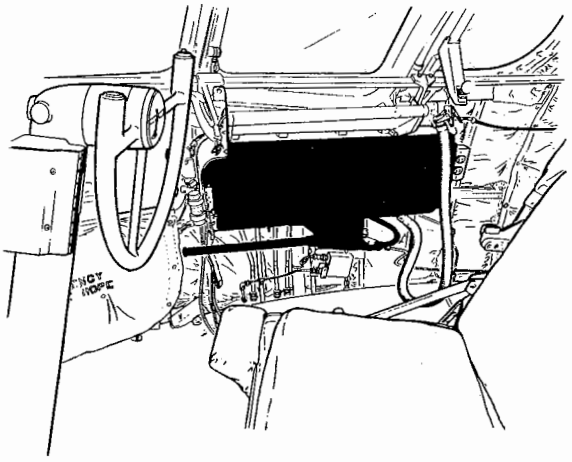
PRESSURE
SUPPLY
CARBURETOR FUEL PRESSURE
MANIFOLD PRESSURE
MECHANICAL
ELECTRICAL

ADI PUMPS SWITCH ON, MANIFOLD PRESSURE ABOVE 45 INCHES

WATER INJECTION SYSTEM

Figure 1-14





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

COPILOT'S AUXILIARY PANEL

Figure 1-15 (Sheet 1 of 2)

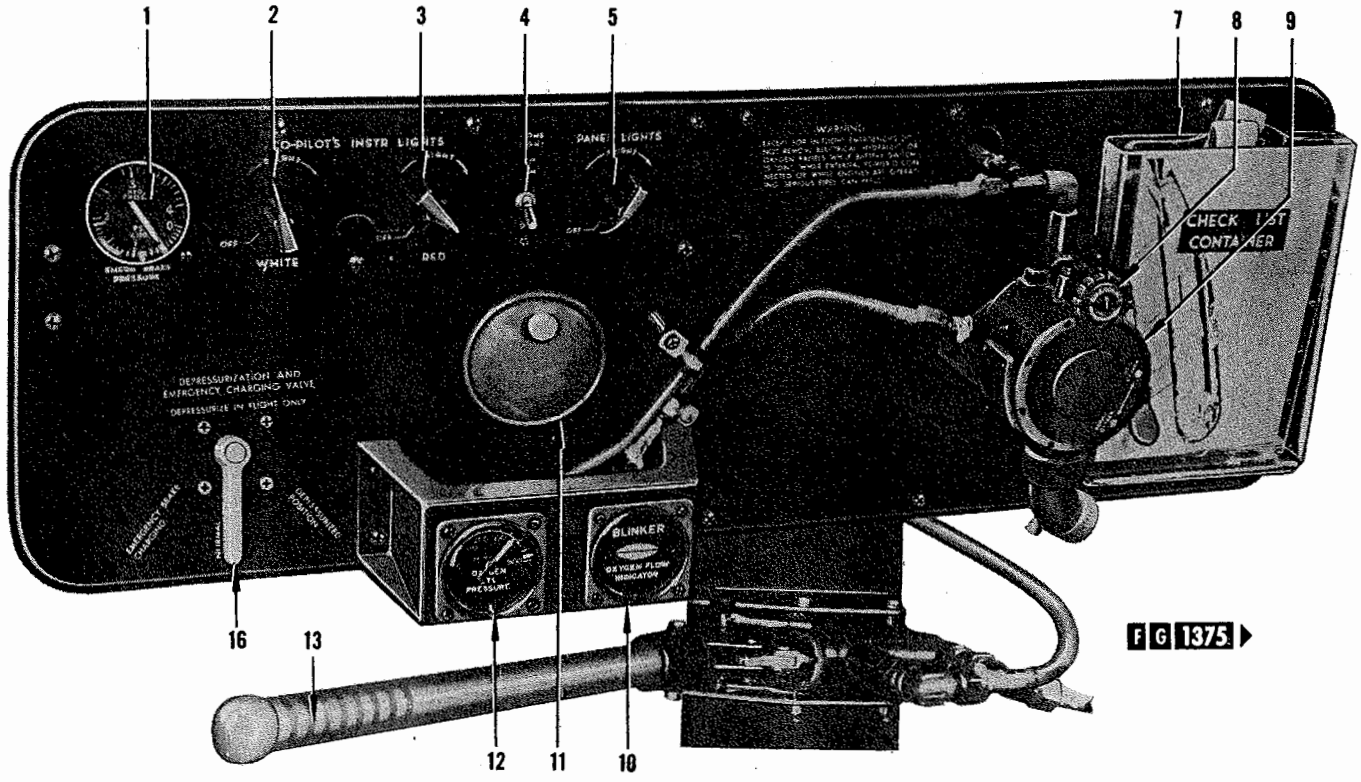


Figure 1-15 (Sheet 2 of 2)

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 intake side of the cylinders and the left spark plugs are on the exhaust side of the cylinders. Cylinder rows are designated A, B, C and D.

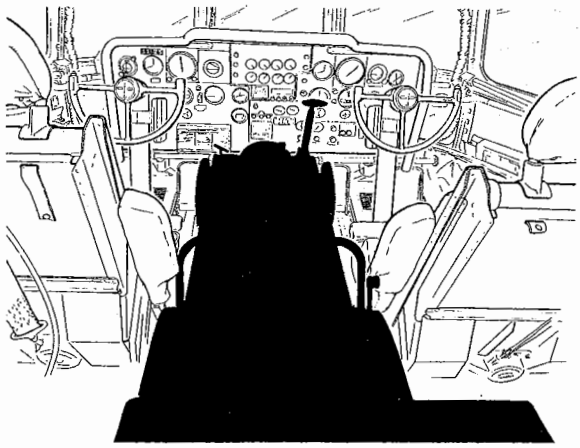
Two starting vibrators are incorporated into each engine ignition circuit to boost magneto input at low starting rpm until the magneto output is sufficient to operate the ignition.

Ignition Switches

Four rotary-type engine ignition switches (2, figure 1-12) 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. See ENGINE STARTING SELECTOR SWITCH in this Section. Once the engine has been selected the starting vibrators are energized by the boost push button switch (5, figure 1-12) 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 through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).



1 AUTOPILOT EMERGENCY DISCONNECT HANDLE (2 PLACES)
2 RUDDER BOOST SWITCH (2 PLACES)
3 AILERON TRIM CONTROL WHEEL (2 PLACES)
4 PROPELLOR REVERSE WARNING FLAG (2 PLACES)
5 WATER INJECTION (ADI) LIGHTS (2 PLACES)
6 SURFACE LOCK HANDLE (2 PLACES)
7 LANDING GEAR WARNING HORN RELEASE SWITCH (2 PLACES)
8 LANDING GEAR SWITCH (2 PLACES)
9 ELEVATOR TRIM CONTROL WHEEL (4 PLACES)
10 WATER INJECTION (ADI) PUMP SWITCH (2 PLACES)
11 LANDING LIGHT RETRACTION SWITCHES (2 PLACES)

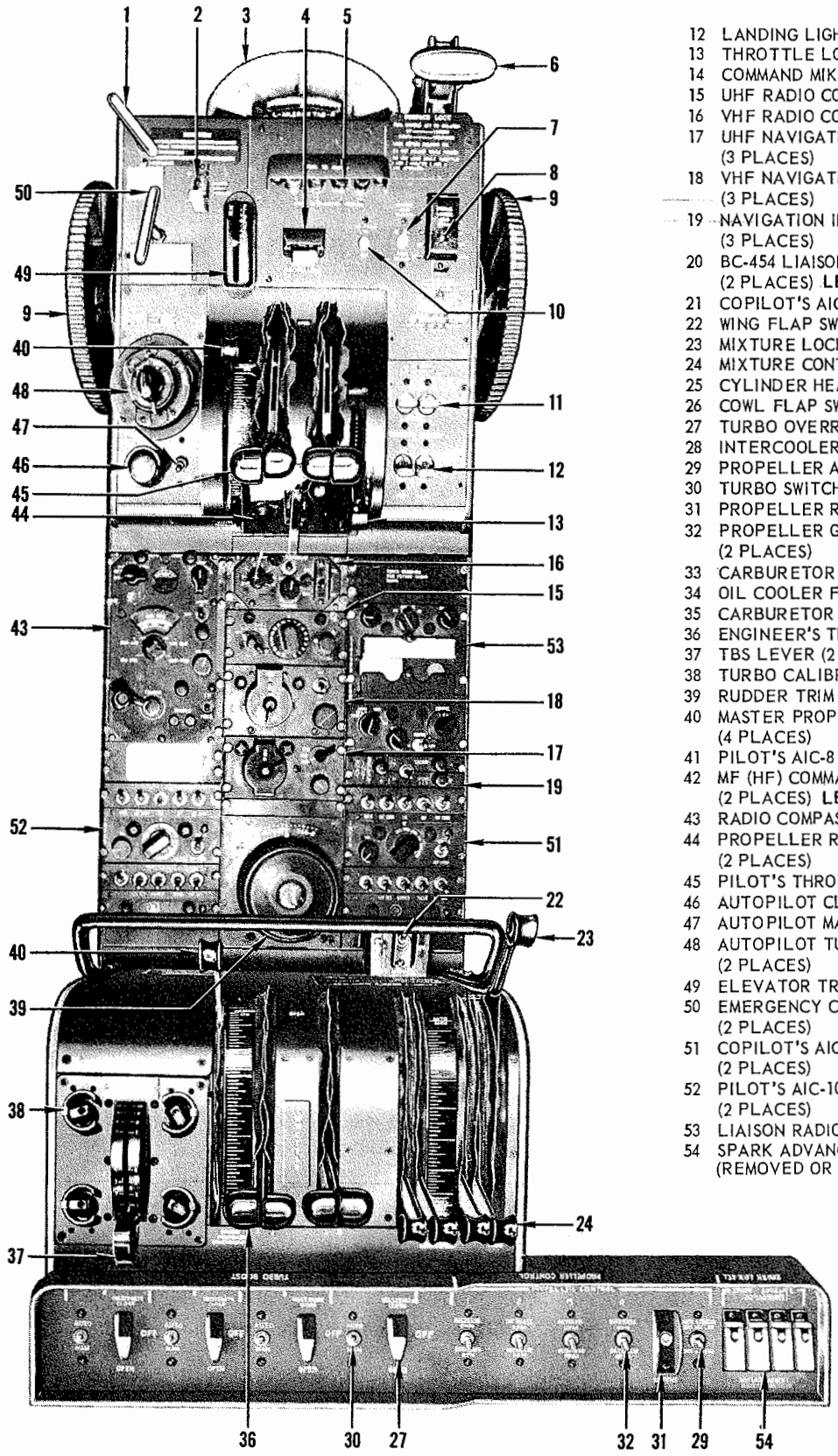
SEE DETAIL I

DETAIL I 1372

CONTROL STAND

F

Figure 1-16 (Sheet 1 of 2)



12 LANDING LIGHT SWITCHES (2 PLACES)
13 THROTTLE LOCK LEVER (2 PLACES)
14 COMMAND MIKE SWITCH
15 UHF RADIO CONTROL PANEL (3 PLACES)
16 VHF RADIO CONTROL PANEL (3 PLACES)
17 UHF NAVIGATION RADIO (TACAN) CONTROL PANEL (3 PLACES)
18 VHF NAVIGATION RADIO (OMNI) CONTROL PANEL (3 PLACES)
19 NAVIGATION INSTRUMENT SELECTOR PANEL (3 PLACES)
20 BC-454 LIAISON RECEIVER CONTROL PANEL (2 PLACES) LESS TCTO K572
21 COPILOT'S AIC-8 INTERPHONE CONTROL PANEL
22 WING FLAP SWITCH (3 PLACES)
23 MIXTURE LOCK LEVER (3 PLACES)
24 MIXTURE CONTROLS (2 PLACES)
25 CYLINDER HEAD TEMPERATURE SELECTOR SWITCH
26 COWL FLAP SWITCHES
27 TURBO OVERRIDE SWITCHES (2 PLACES)
28 INTERCOOLER FLAP SWITCHES
29 PROPELLER AUTO CONTROL SWITCH (2 PLACES)
30 TURBO SWITCHES (2 PLACES)
31 PROPELLER RESYNCHRONIZER SWITCH (2 PLACES)
32 PROPELLER GOVERNOR SELECTOR SWITCHES (2 PLACES)
33 CARBURETOR PREHEAT SWITCHES
34 OIL COOLER FLAP SWITCHES
35 CARBURETOR AIR SWITCHES
36 ENGINEER'S THROTTLES (2 PLACES)
37 TBS LEVER (2 PLACES)
38 TURBO CALIBRATING KNOBS (2 PLACES)
39 RUDDER TRIM CONTROL WHEEL (3 PLACES)
40 MASTER PROPELLER SYNCHRONIZER LEVER (4 PLACES)
41 PILOT'S AIC-8 INTERPHONE CONTROL PANEL
42 MF (HF) COMMAND TRANSMITTER CONTROL PANEL (2 PLACES) LESS TCTO K572
43 RADIO COMPASS CONTROL PANEL (3 PLACES)
44 PROPELLER REVERSE THROTTLE LOCK PLATE (2 PLACES)
45 PILOT'S THROTTLES (2 PLACES)
46 AUTOPILOT CLUTCH SWITCH (2 PLACES)
47 AUTOPILOT MASTER SWITCH (2 PLACES)
48 AUTOPILOT TURN AND PITCH CONTROLLER (2 PLACES)
49 ELEVATOR TRIM TAB INDICATOR (2 PLACES)
50 EMERGENCY CABIN PRESSURE RELEASE HANDLE (2 PLACES)
51 COPILOT'S AIC-10 INTERPHONE CONTROL PANEL (2 PLACES)
52 PILOT'S AIC-10 INTERPHONE CONTROL PANEL (2 PLACES)
53 LIAISON RADIO CONTROL PANEL (AN/ARC-21, -65)
54 SPARK ADVANCE SELECTOR SWITCHES (REMOVED OR DEACTIVATED)

Figure 1-16 (Sheet 2 of 2)

PRIMING SYSTEM

Engine priming is electrically controlled by a push button switch (3, figure 1-12) adjacent to the starter switch. The starter selector switch controls engine selection. Each engine is primed through a solenoid valve located in the fuel line between the heater tank and the carburetor (figure 1-27, sheet 3). 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 booster pumps. The primer circuit is supplied with 28 volt DC through a circuit breaker on the overhead panel (figure 1-35, sheet 1).

Hot Fuel Prime

The airplane is provided with a hot fuel prime feature which reduces engine preheat time during cold weather. The hot fuel prime tank is mounted inside each engine nacelle, and electrical controls are located on the overhead panel (10 & 11, figure 1-12 and figure 1-27, sheet 3). Two heater elements within each hot fuel prime tank, when energized, raise the temperature of the fuel to 105° C (220° F) within three minutes. When only one heater element is energized, the fuel heats to 105° C (220° F) within six minutes (figure 7-2).

HOT FUEL PRIME SWITCHES. Four hot fuel prime toggle switches (11, figure 1-12), one for each engine, are provided on the overhead panel. Each switch has three positions, HIGH--OFF--LOW. When positioned to HIGH, both heater elements are energized using 300 amperes. When the switch is positioned to LOW, only one element will be energized using 150 amperes. When the required temperature is reached, the switch should be placed in the OFF position. If this is not done, a heater control relay on the engine nacelle solenoid panel automatically maintains the temperature until the switch has been positioned to OFF. The circuit is provided with 28 volt DC through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

HOT FUEL PRIME INDICATOR LIGHTS. Four press-to-test lights (10, figure 1-12), are located directly above the four hot fuel prime switches on the overhead panel. Each light will illuminate when it's respective hot fuel prime switch is positioned to HIGH or LOW. The light will automatically go out when the required fuel temperature is reached. The lights are supplied with 28 volt DC through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

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 switch (39, figure 1-12) 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.

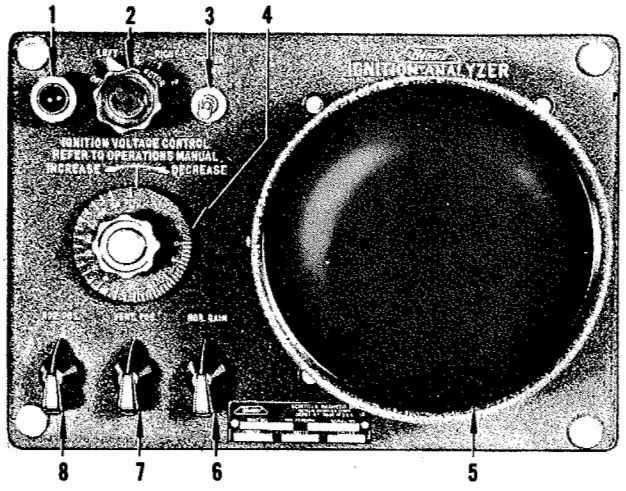
Starter Switch

Direct cranking starters are controlled by a push-button switch (4, figure 1-12) on the overhead panel. The starter, prime and boost switches are grouped on a raised and guarded base. Each switch controls all four engines, through a rotary engine starting selector switch, adjacent to the raised base. The starter control circuit is supplied with 28 volt DC through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

ENGINE INDICATORS

Ignition Analyzer System

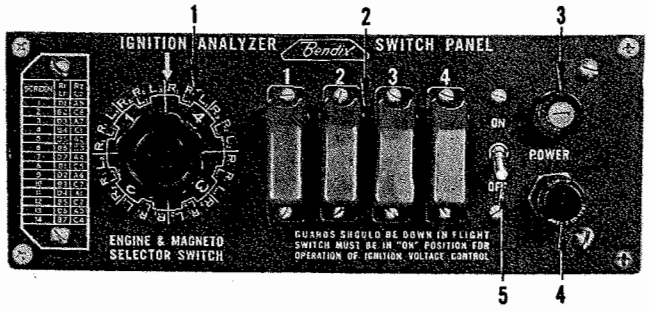
The ignition analyzer system provides a means of detection, identification, and location of engine ignition troubles during both flight and ground operation. This analysis of ignition performance is made by interpreting and comparing the magneto voltage wave patterns of a malfunction system with those produced by a properly operating system, each specific trouble producing a characteristic pattern. The system consists essentially of an ignition analyzer, a switch panel assembly, 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 is mounted above and to the left of the aft end of the engine control stand (1, figure 1-6) F 1243 ▶ 1371, and on the engineer's auxiliary panel (3, figure 1-23) F G 1372 ▶ 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.



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 1-17



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

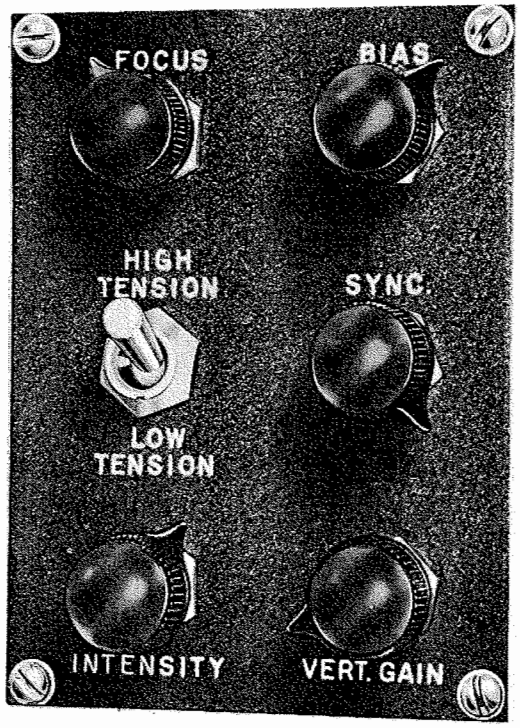
IGNITION ANALYZER SWITCH PANEL

Figure 1-18

ANALYZER POWER SUPPLY. The regulated AC power supply circuit for the ignition analyzer is protected by a fuse or circuit breaker (figure 1-35, sheet 3) on the AC power panel. The DC power supply circuit is protected by a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1). A system fuse on the analyzer switch panel (3, figure 1-18) also protects the AC circuit to the analyzer system.

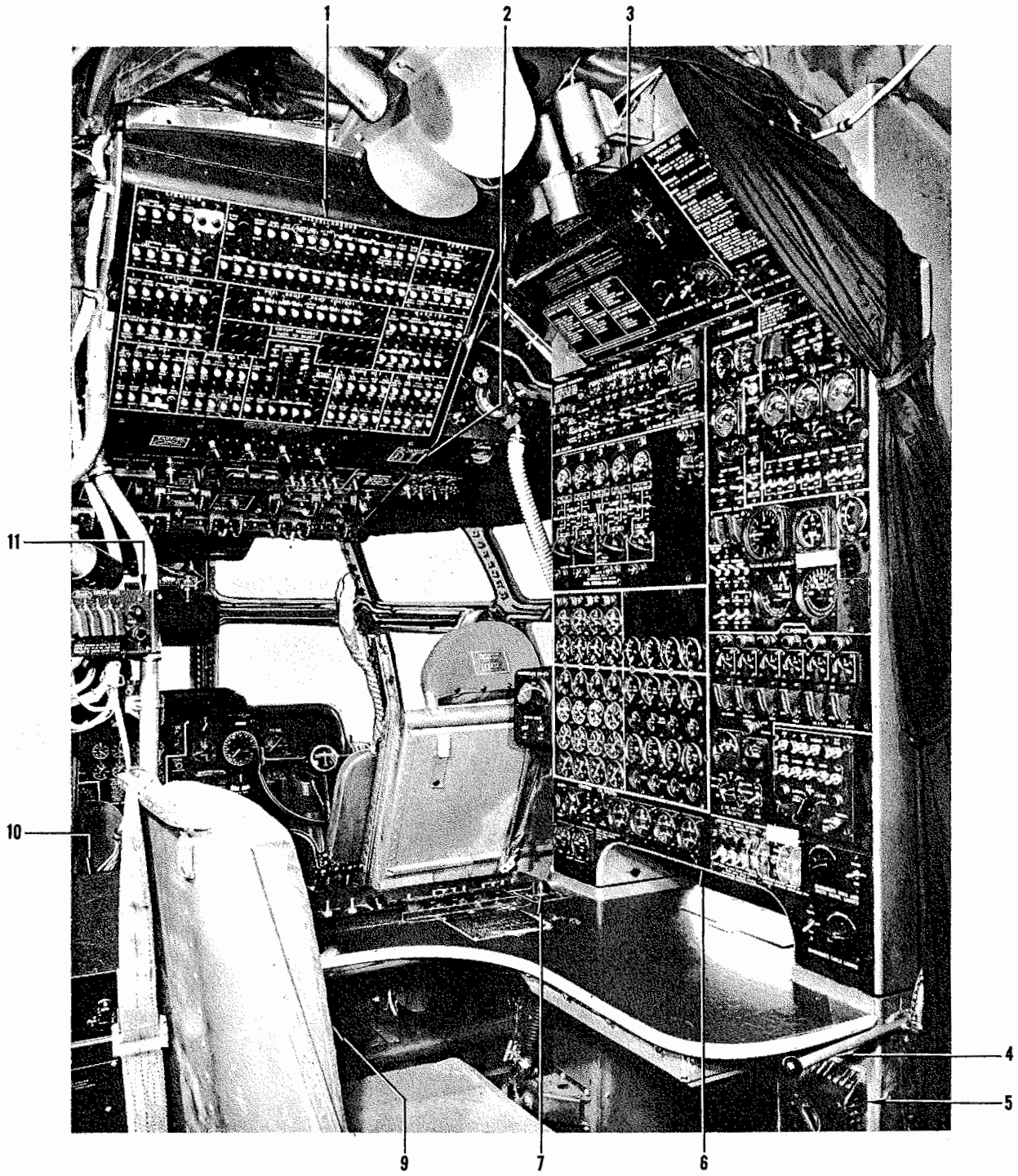
ANALYZER SYSTEM POWER SWITCH. This switch (5, figure 1-18), located on the analyzer switch panel delivers power to the ignition analyzer system. The switch has two positions, ON and OFF. In the ON position the power circuit to the ignition analyzer is closed. In the OFF position this circuit is open.

ANALYZER POWER SWITCH. An ON--OFF switch (3, figure 1-17), on the ignition analyzer, controls power from the 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.



IGNITION ANALYZER INTERNAL CONTROL PANEL

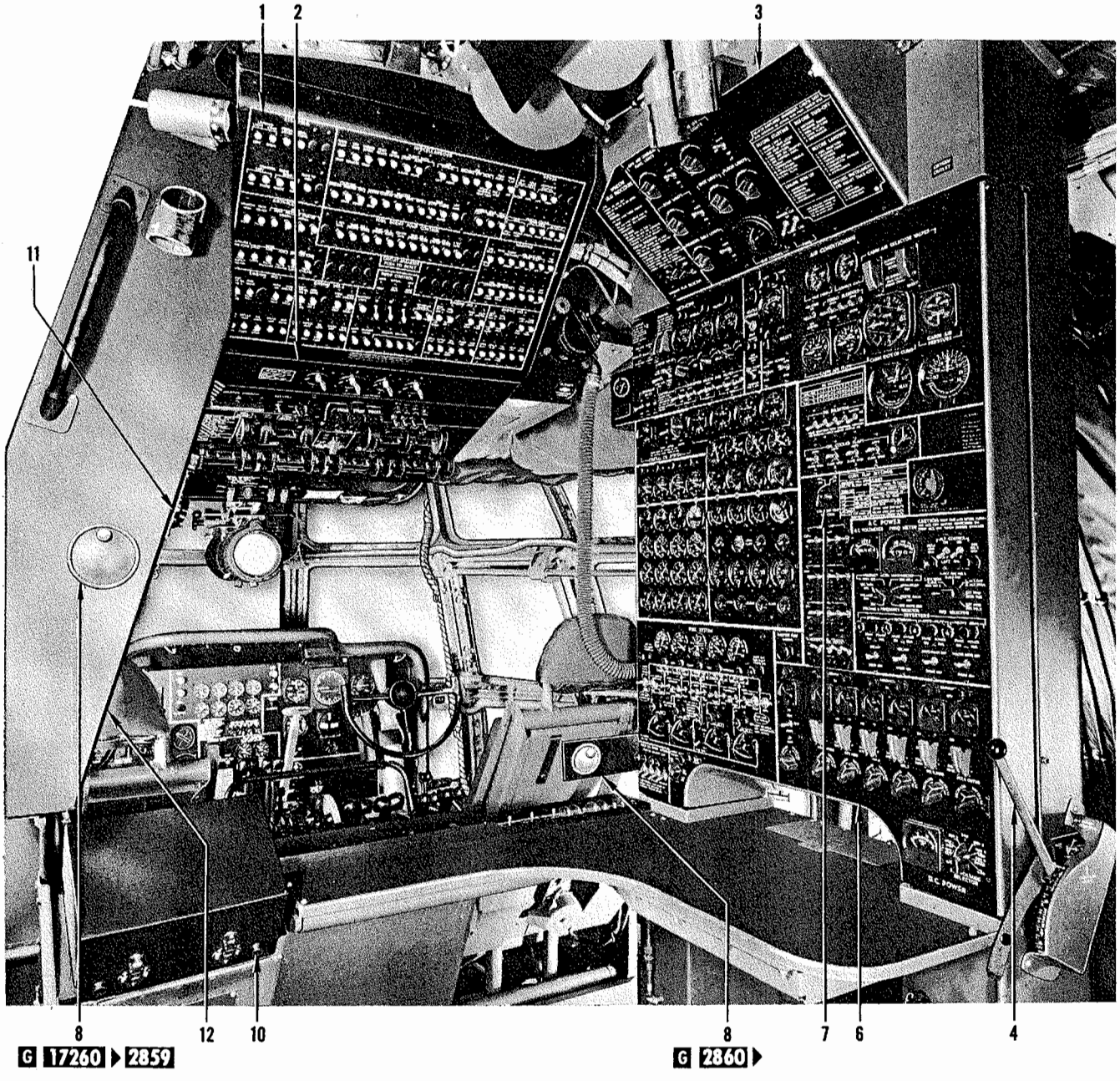
Figure 1-19



1 OVERHEAD CIRCUIT BREAKER PANEL (2 PLACES)
2 OVERHEAD PANEL (2 PLACES)
3 ENGINEER'S AUXILIARY OVERHEAD PANEL (2 PLACES)
▽T 4 ISODRAULIC HANDLE (2 PLACES)
5 ENGINEER'S HEATED SUIT CONTROL PANEL
F G 1243 ▶ 2859
6 ENGINEER'S INSTRUMENT PANEL (2 PLACES)
7 CYLINDER HEAD TEMPERATURE SELECTOR SWITCH (2 PLACES)
8 ENGINEER'S ASH TRAY (2 PLACES)
9 ENGINEER'S SEAT
10 IGNITION ANALYZER (2 PLACES)
11 IGNITION ANALYZER SWITCH PANEL (2 PLACES)
12 ENGINEER'S AUXILIARY PANEL
F G 1372 ▶

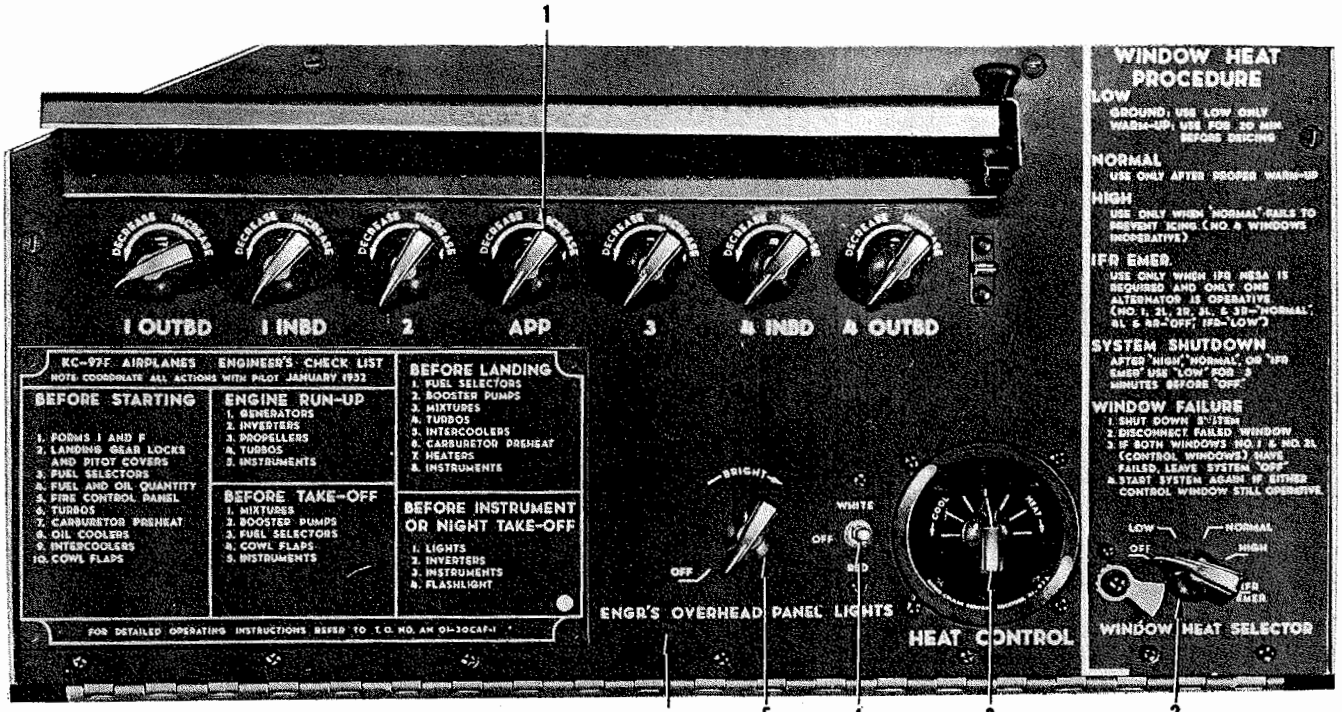
ENGINEER'S STATION F (TYPICAL)

Figure 1-20 (Sheet 1 of 2)



G (TYPICAL)

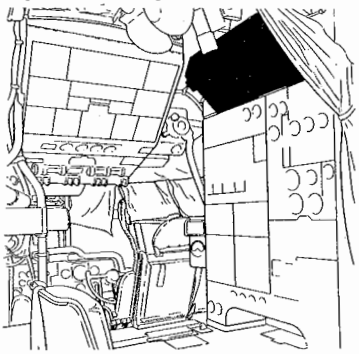
Figure 1-20 (Sheet 2 of 2)



DETAIL I

On Airplanes F 1372 ▶ 17259 this decal reads;

ENGINEER'S INPH AND OVERHEAD PANEL LIGHTS



ENGINEER'S AUXILIARY OVERHEAD PANEL

F

Figure 1-21 (Sheet 1 of 2)

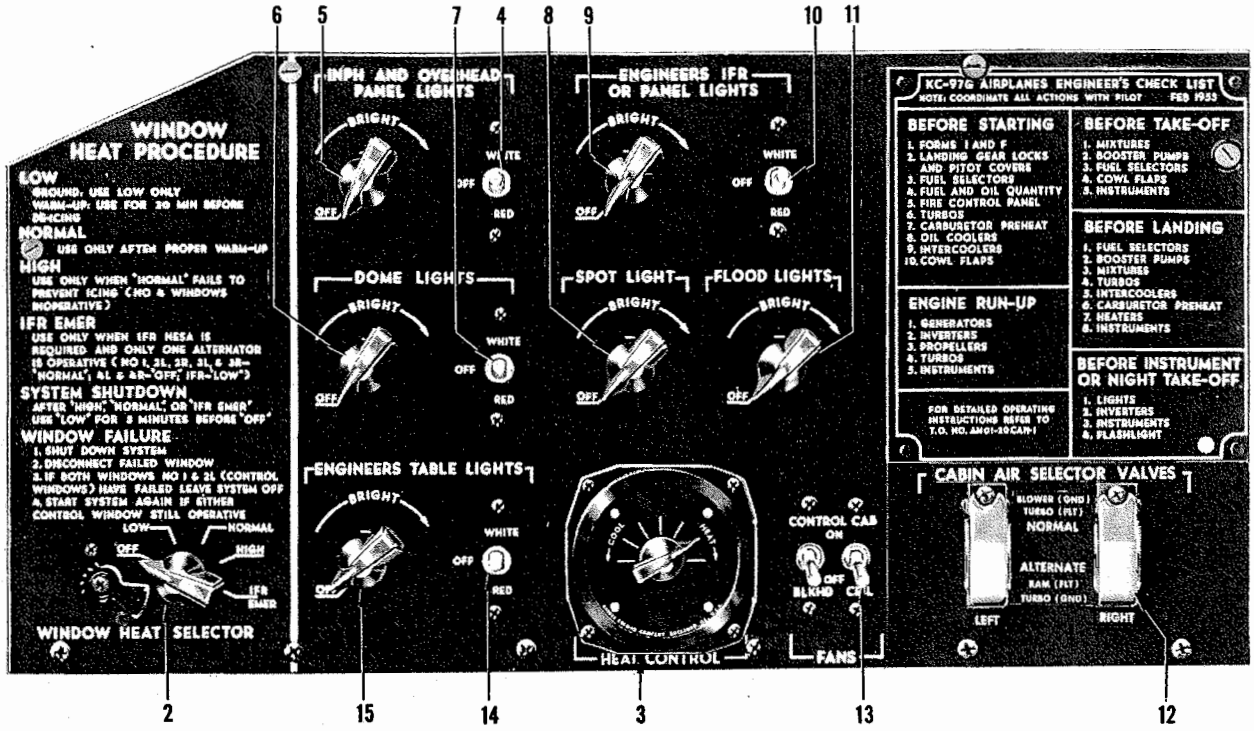
ANALYZER MAGNETO SELECTOR SWITCH. This switch (2, figure 1-17) located on the ignition analyzer, is installed to provide magneto selection when the ignition analyzer is used as a portable unit. The switch in this airborne installation operates in conjunction with the engine and magneto selector switch on the analyzer switch panel and is always positioned to LEFT 1 when the analyzer is being used.

ANALYZER HORIZONTAL POSITION SWITCH. The wave form picture on the analyzer screen is shifted to the left or right by this rotary type switch (8, figure 1-17) on the ignition analyzer.

ANALYZER VERTICAL POSITION SWITCH. The wave form picture on the analyzer is shifted up or down by this rotary type switch (7, figure 1-17) on the ignition analyzer.

ANALYZER HORIZONTAL GAIN CONTROL SWITCH. This rotary type switch (6, figure 1-17), located 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 panel (figure 1-19), 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



1 GENERATOR VOLTAGE RHEOSTATS
2 WINDOW HEAT SELECTOR SWITCH (2 PLACES)
3 HEAT CONTROL RHEOSTAT (2 PLACES)
4 ENGINEER'S TABLE LIGHT CONTROL SWITCH F 1243 ▶ 1371 OR ENGINEER'S INPH AND OVERHEAD PANEL LIGHTS F G 1372 ▶
5 ENGINEER'S TABLE LIGHTS RHEOSTAT F 1243 ▶ 1371 OR ENGINEER'S INPH AND OVERHEAD PANEL LIGHTS CONTROL SWITCH F G 1372 ▶
6 DOME LIGHTS RHEOSTAT
7 DOME LIGHTS CONTROL SWITCH
8 SPOT LIGHT RHEOSTAT
9 ENGINEER'S (A/R) LIGHTS RHEOSTAT
10 ENGINEER'S (A/R) LIGHTS CONTROL SWITCH
11 FLOOD LIGHTS RHEOSTAT
12 CABIN AIR SELECTOR SWITCHES G 3106 ▶
13 CONTROL CABIN FAN SWITCHES
14 ENGINEER'S TABLE LIGHTS CONTROL SWITCH
15 ENGINEER'S TABLE LIGHTS RHEOSTAT

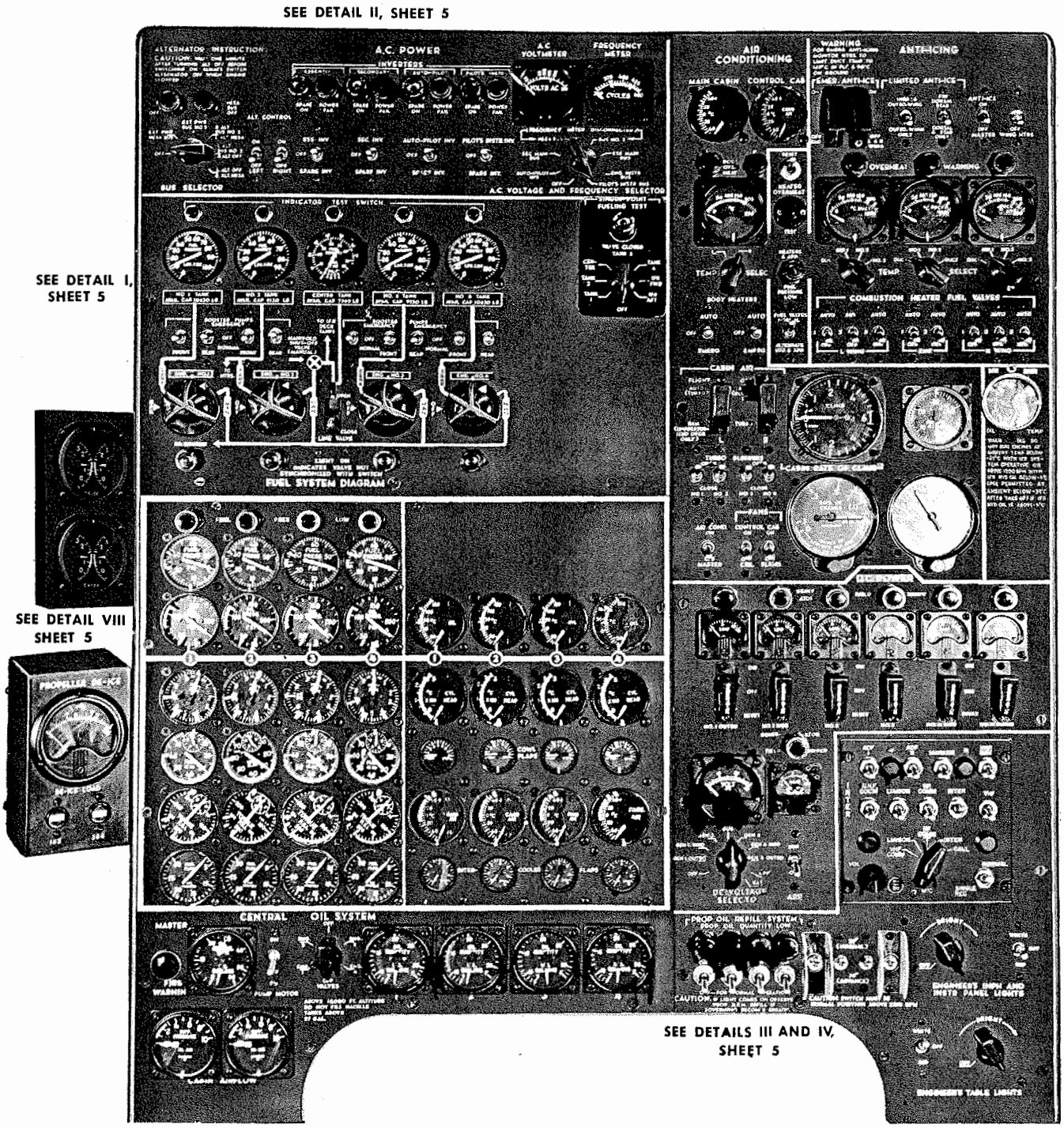
Figure 1-21 (Sheet 2 of 2)

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. This switch (1, figure 1-18), on the analyzer switch panel, provides a means of selecting the engine and each individual ignition circuit to be tested by the ignition analyzer. The selector 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 fourteen cylinders, one position for the magneto firing the right side circuit of the same row of cylinders and one position for both of these magnetos. This makes a total of six positions for each engine and a total of twenty-four positions on the selector switch.

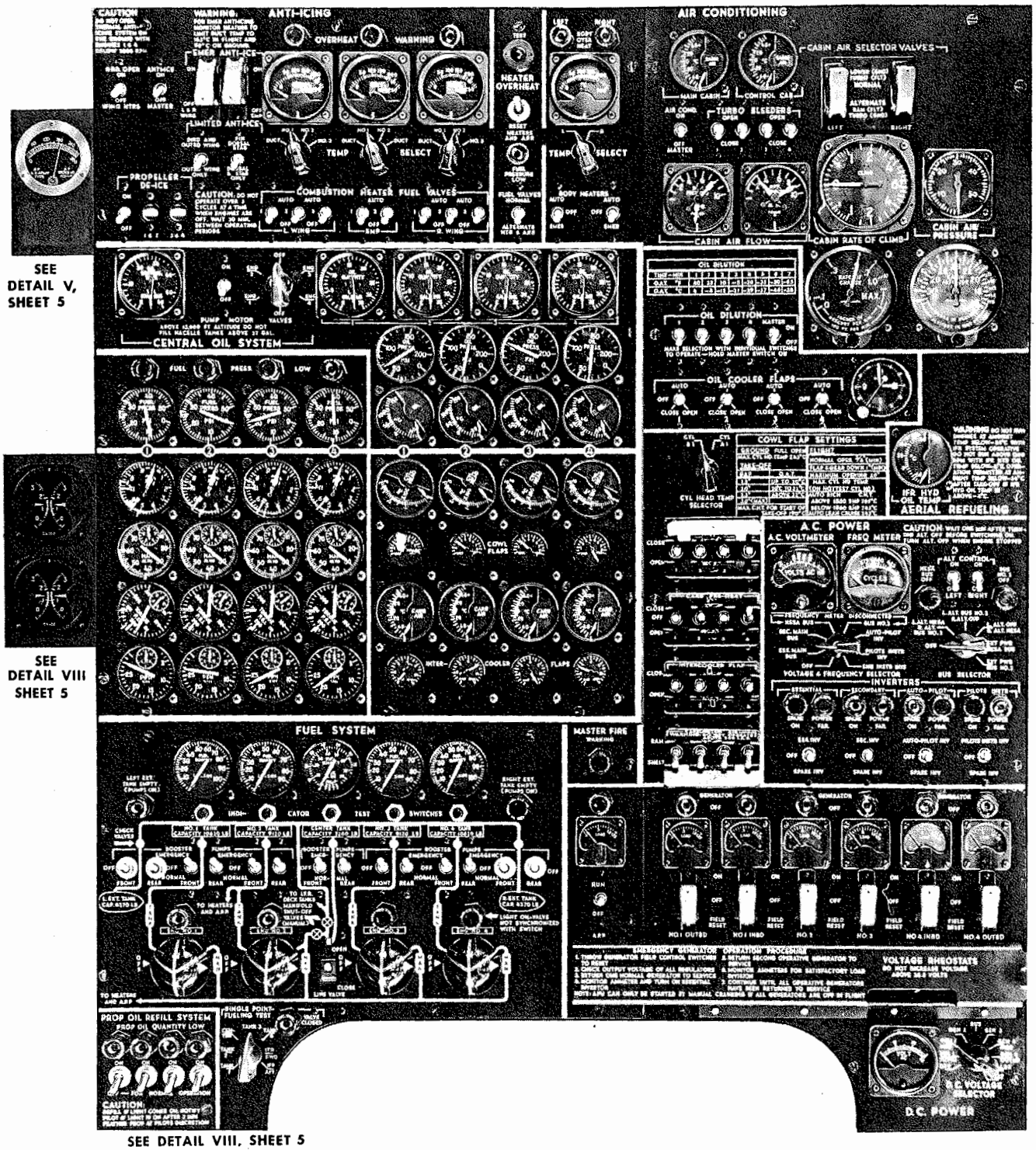


ENGINEER'S INSTRUMENT PANEL

F

Figure 1-22 (Sheet 1 of 5)

SEE DETAILS VI AND VII, SHEET 5

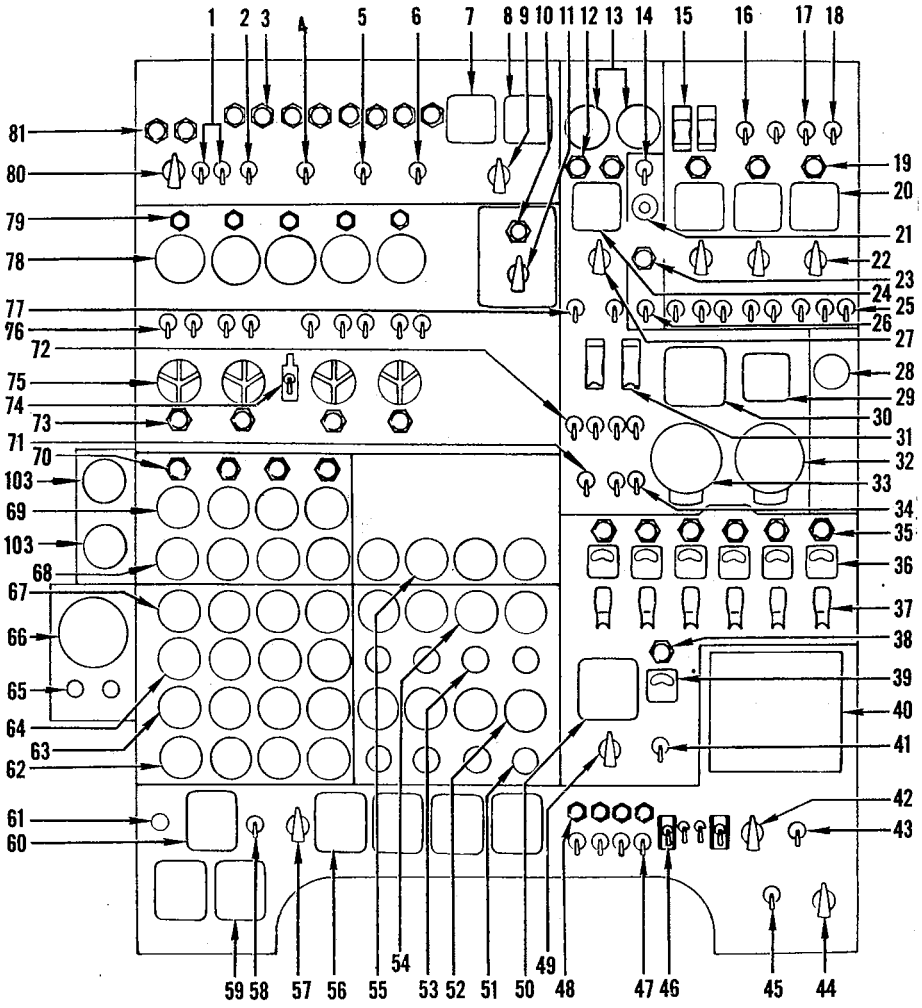


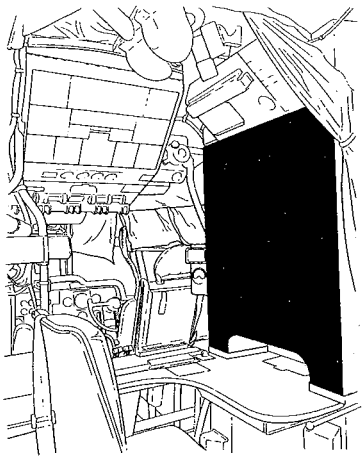
SEE DETAIL V, SHEET 5

SEE DETAIL VIII SHEET 5

SEE DETAIL VIII, SHEET 5

Figure 1-22 (Sheet 2 of 5)



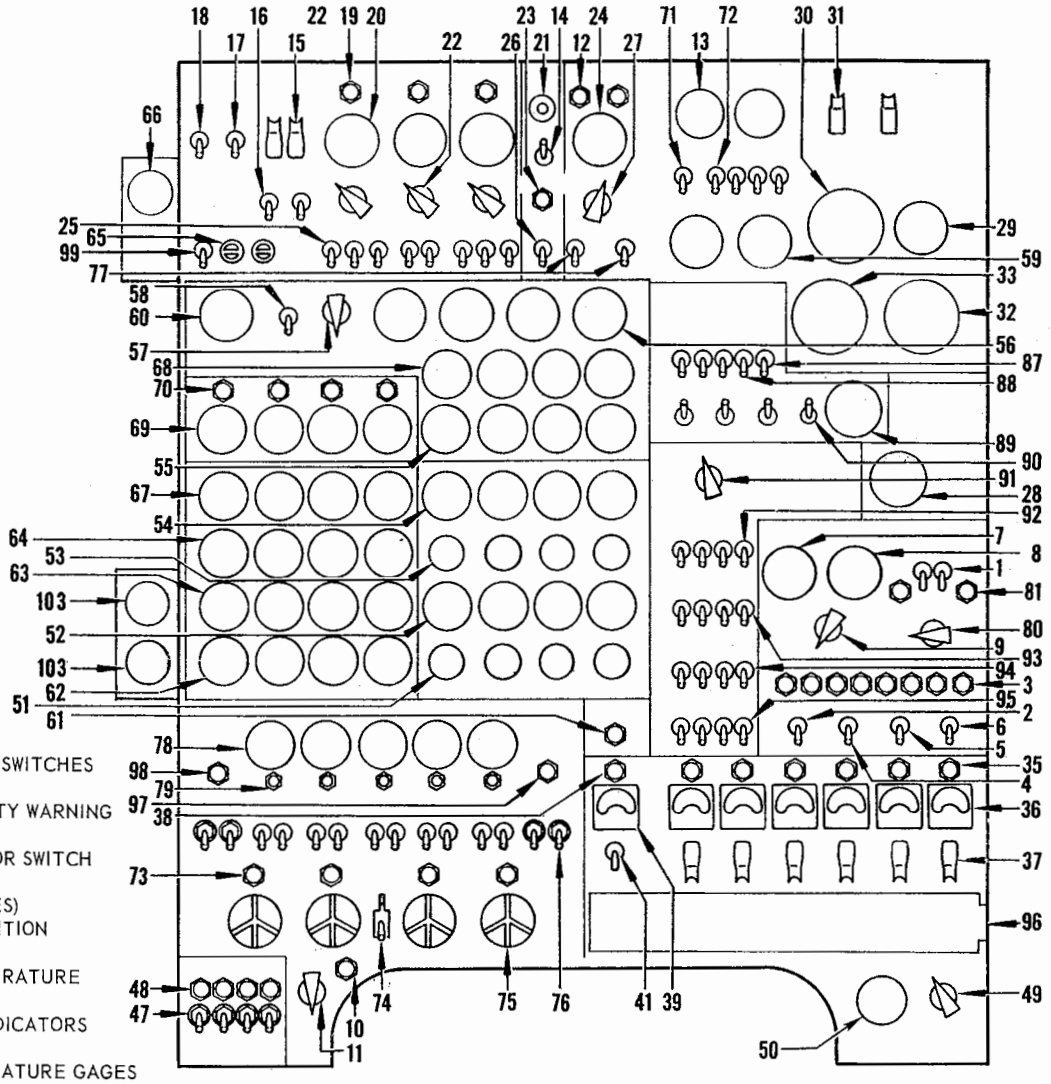


1 ALTERNATOR SWITCHES (2 PLACES)
2 ESSENTIAL INVERTER SWITCH (2 PLACES)
3 INVERTER WARNING LIGHTS (2 PLACES)
4 SECONDARY INVERTER SWITCH (2 PLACES)
5 AUTOPILOT INVERTER SWITCH (2 PLACES)
6 PILOT'S INSTRUMENT INVERTER (2 PLACES)
7 AC VOLTMETER (2 PLACES)
8 FREQUENCY METER (2 PLACES)
9 AC VOLTAGE AND FREQUENCY SELECTOR SWITCH (2 PLACES)
10 SECONDARY VALVE CLOSED LIGHT F G 1255 ▶ (4 PLACES)
11 SINGLE POINT REFUELING TEST SWITCH F G 1255 ▶ (4 PLACES)
12 BODY HEATER OVERHEAT WARNING LIGHTS (2 PLACES)
13 CABIN TEMPERATURE GAGES (4 PLACES)
14 HEATER OVERHEAT RESET SWITCH (2 PLACES)
15 EMERGENCY ANTI-ICE SWITCHES (3 PLACES)
16 LIMITED ANTI-ICE SWITCHES (3 PLACES)
17 ANTI-ICE MASTER SWITCH (3 PLACES)
18 WING HEATER GROUND OPERATION SWITCH LESS TCTO 515 OR BALANCE BYPASS SWITCH PLUS TCTO 515 (3 PLACES)
19 ANTI-ICING OVERHEAT WARNING LIGHTS (2 PLACES)
20 ANTI-ICING HEATER AND DUCT TEMPERATURE GAGES (2 PLACES)
21 HEATER OVERHEAT TEST SWITCH (2 PLACES)
22 TEMPERATURE GAGE SELECTOR SWITCHES (2 PLACES)
23 HEATER FUEL LOW PRESSURE WARNING LIGHT (2 PLACES)
24 BODY HEATER TEMPERATURE GAGE (2 PLACES)
25 ANTI-ICING HEATER FUEL VALVE SWITCHES (2 PLACES)
26 HEATER FUEL VALVE SWITCH (2 PLACES)
27 BODY HEATER TEMPERATURE SELECTOR SWITCH (2 PLACES)
28 AIR REFUELING (IFR) HYDRAULIC OIL TEMPERATURE GAGE (2 PLACES)
29 CABIN AIR PRESSURE INDICATOR (CABIN ALTIMETER) (4 PLACES)
30 CABIN VERTICAL VELOCITY INDICATOR (4 PLACES)
31 CABIN AIR SELECTOR SWITCHES (3 PLACES)
32 CABIN ALTITUDE SELECTOR (2 PLACES)
33 CABIN PRESSURE RATE-OF-CHANGE SELECTOR (2 PLACES)
34 CONTROL CABIN FAN SWITCHES
35 GENERATOR WARNING LIGHTS (2 PLACES)
36 DC LOADMETERS (2 PLACES)
37 GENERATOR SWITCHES (2 PLACES)
38 APU GENERATOR WARNING LIGHT (2 PLACES)
39 APU DC LOADMETER (2 PLACES)
40 ENGINEER'S AIC-8 INTERPHONE CONTROL PANEL (2 PLACES)
41 APU SWITCH (2 PLACES)
42 ENGINEER'S INSTRUMENT PANEL LIGHT RHEOSTAT (2 PLACES)
43 ENGINEER'S INSTRUMENT PANEL LIGHT SWITCH (2 PLACES)
44 ENGINEER'S TABLE LIGHT RHEOSTAT (3 PLACES)
45 ENGINEER'S TABLE LIGHT SWITCH (3 PLACES)
46 SPARK ADVANCE SELECTOR SWITCHES (REMOVED OR DEACTIVATED) (2 PLACES)

ENGINEER'S INSTRUMENT PANEL (CONT)

F

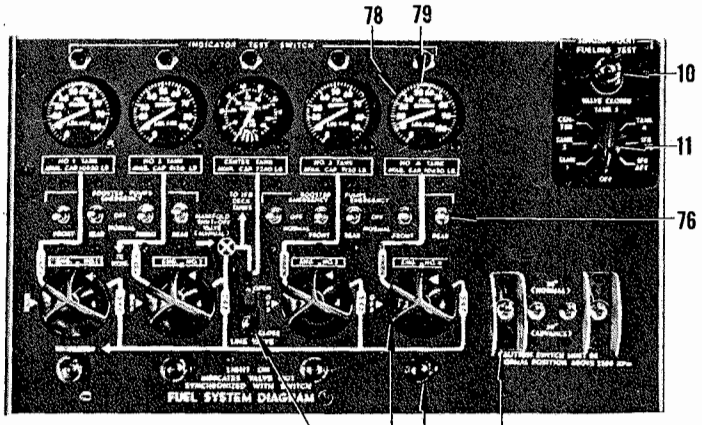
Figure 1-22 (Sheet 3 of 5)



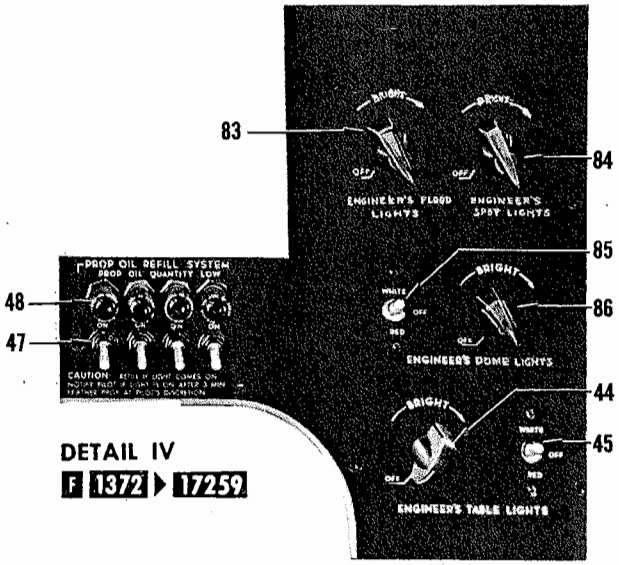
47 PROPELLER OIL REFILL SWITCHES (5 PLACES)
48 PROPELLER OIL QUANTITY WARNING LIGHTS (5 PLACES)
49 DC VOLTMETER SELECTOR SWITCH (2 PLACES)
50 DC VOLTMETER (2 PLACES)
51 INTERCOOLER FLAP POSITION INDICATORS (2 PLACES)
52 CARBURETOR AIR TEMPERATURE GAGES (2 PLACES)
53 COWL FLAP POSITION INDICATORS (2 PLACES)
54 CYLINDER HEAD TEMPERATURE GAGES (2 PLACES)
55 OIL TEMPERATURE GAGES (2 PLACES)
56 OIL QUANTITY GAGES (2 PLACES)
57 OIL TANK SELECTOR SWITCH (2 PLACES)
58 OIL TRANSFER PUMP SWITCH (2 PLACES)
59 CABIN AIR FLOW INDICATORS (4 PLACES)
60 CENTRAL OIL TANK QUANTITY GAGE (2 PLACES)
61 MASTER FIRE WARNING LIGHT (2 PLACES)
62 FUEL FLOWMETERS (2 PLACES)
63 TORQUEMETERS (2 PLACES)
64 MANIFOLD PRESSURE GAGES (2 PLACES)
65 PROPELLER DEICING INDICATORS (3 PLACES)
66 PROPELLER DEICING AMMETER (2 PLACES) TCTO 534
67 TACHOMETERS (2 PLACES)
68 OIL PRESSURE GAGES (2 PLACES)
69 FUEL PRESSURE GAGES (2 PLACES)
70 FUEL LOW PRESSURE WARNING LIGHTS (2 PLACES)
71 AIR CONDITIONING MASTER SWITCH (2 PLACES)
72 TURBO BLEEDER SWITCHES (2 PLACES)
73 FUEL VALVE POSITION WARNING LIGHTS (3 PLACES)
74 CENTER TANK LINE VALVE SWITCH (3 PLACES)
75 FUEL SELECTOR SWITCHES (3 PLACES)
76 BOOST PUMP SWITCHES (3 PLACES)
77 BODY HEATER SWITCHES (2 PLACES)
78 FUEL QUANTITY GAGES (3 PLACES)
79 FUEL QUANTITY GAGE TEST SWITCHES (3 PLACES)
80 ALTERNATOR BUS SELECTOR SWITCH (2 PLACES)
81 NESA BUS OFF WARNING LIGHTS (2 PLACES)
82 ASH TRAY
83 ENGINEER'S FLOOD LIGHT RHEOSTAT
84 ENGINEER'S SPOTLIGHT RHEOSTAT
85 ENGINEER'S DOME LIGHT SWITCH
86 ENGINEER'S DOME LIGHT RHEOSTAT
87 OIL DILUTION MASTER SWITCH
88 OIL DILUTION SELECTOR SWITCHES
89 CLOCK G 22701 ▶
90 OIL COOLER FLAP SWITCHES
91 CYLINDER HEAD TEMPERATURE SELECTOR SWITCH
92 COWL FLAP SWITCHES
93 CARBURETOR PREHEAT SWITCHES
94 INTERCOOLER FLAP SWITCHES
95 CARBURETOR AIR SWITCHES
96 GENERATOR VOLTAGE RHEOSTATS
97 RIGHT EXTERNAL TANK LOW FUEL FLOW WARNING LIGHT
98 LEFT EXTERNAL TANK LOW FUEL FLOW WARNING LIGHT
99 PROPELLER DE-ICING SWITCH
100 PROPELLER DE-ICING LOADMETER G 22629 ▶
101 PRESSURE ALTIMETER G 22737 ▶ (2 PLACES)
102 AIRSPEED INDICATOR G 3106 ▶
103 TURBO BEARING TEMPERATURE GAGE TCTO 611 (5 PLACES)

G

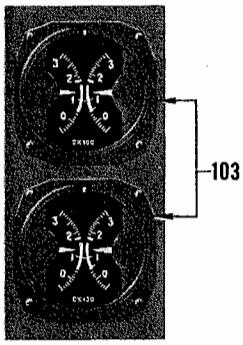
Figure 1-22 (Sheet 4 of 5)



DETAIL I F 1279 ▶ 17259

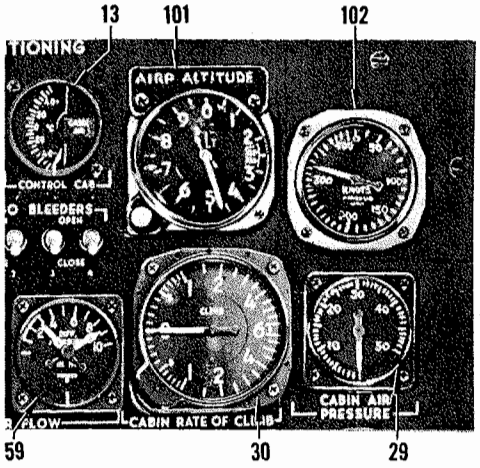


DETAIL IV
F 1372 ▶ 17259

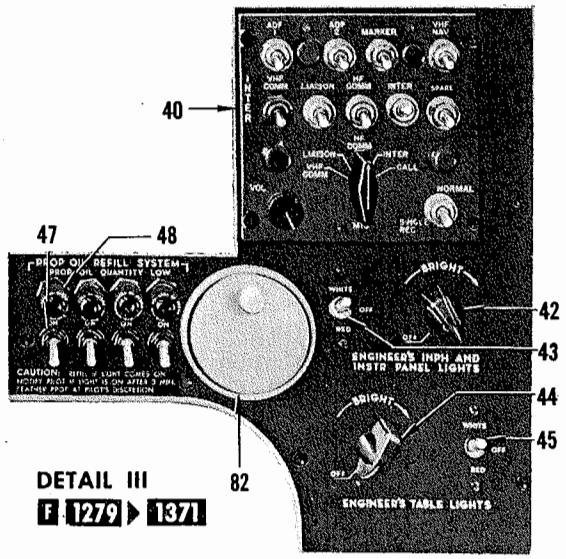


AIRPLANES WITH TCTO 611

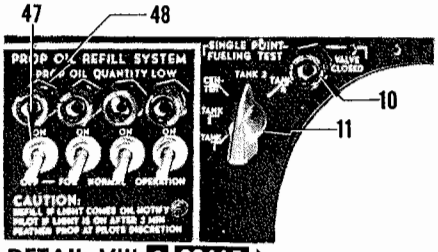
DETAIL VIII



DETAIL VII G 3106 ▶



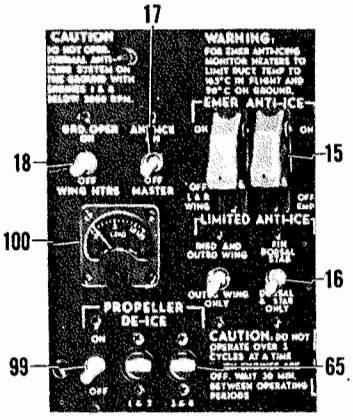
DETAIL III
F 1279 ▶ 1371



DETAIL VIII G 22665 ▶

CAUTION: HOLD IN "OFF" POS. 3 SEC. WHEN SWITCHING FROM ESS. TO SPARE INV.

DETAIL II F 1366 ▶ 17259



DETAIL V G 22629 ▶

DETAIL VI G 22737 ▶ 22806

ENGINEER'S INSTRUMENT PANEL (CONT)

Figure 1-22 (Sheet 5 of 5)

RELAY-RESISTOR SWITCHES. Four guarded switches (2, figure 1-18) 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 by-pass the resistors, thereby allowing the use of the ignition voltage control of the ignition analyzer.

ANALYZER VOLTAGE CONTROL SWITCH. This switch (4, figure 1-17), on the ignition analyzer, enables the flight engineer on a ground check to foresee ignition 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 is a rotary switch marked with an OFF position with 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. This screen (5, figure 1-17), 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 patterns produced by a malfunctioning system with the wave forms produced by a properly operating system. The operation of this screen is regulated by controls located on the ignition analyzer control panel, the internal control panel, and the ignition analyzer.

ANALYZER SYSTEM POWER INDICATOR LIGHT. This light (4, figure 1-18) on the 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. This light (1, figure 1-17), located 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 analyzer switch panel are in the ON position.

Tachometers

Four single-indicating engine tachometers are on both the pilots' and the engineer's instrument panels (10, figure 1-9 and 67, figure 1-22). 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 (63, figure 1-22) are on the engineer's instrument panel. The torquemeters 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 through circuit protection on the AC power panel (figure 1-35, sheet 3).

Manifold Pressure Gages and Purge Valve Buttons

Four manifold pressure gages (9, figure 1-9 and 64, figure 1-22) are on both the pilots' and engineer's instrument panel. The manifold pressure gages give a direct reading of manifold pressure in inches of Hg. Four manifold purge valve buttons (8, figure 1-9) 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.

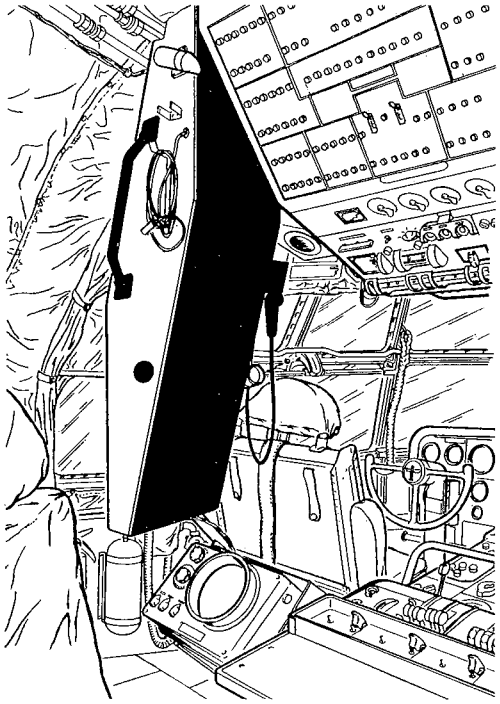
Cylinder Head Temperature Gages

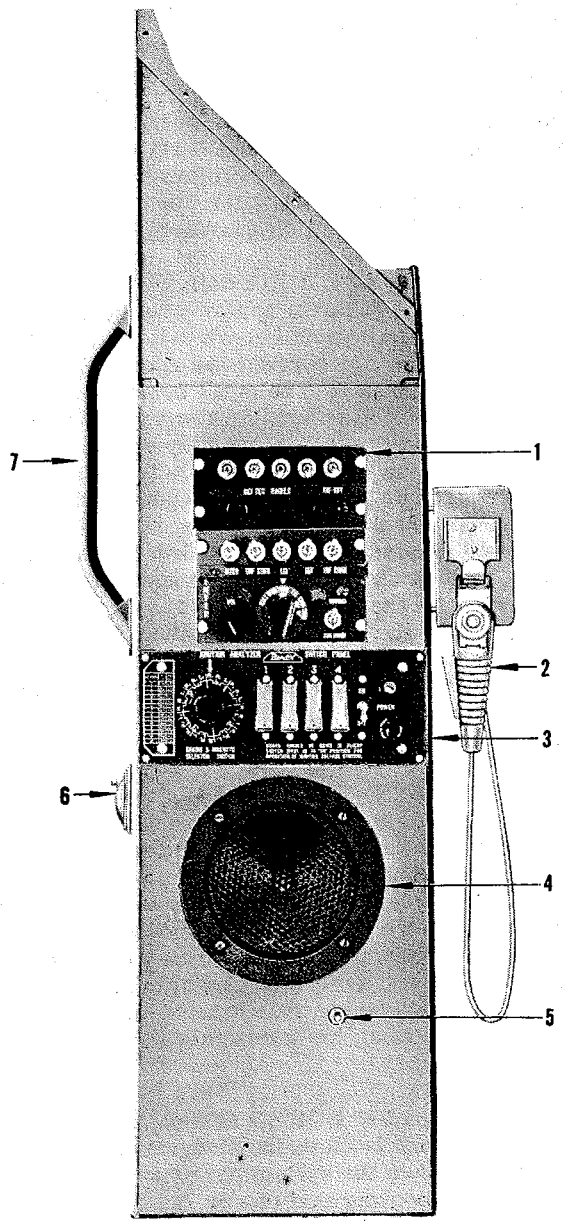
Four cylinder head temperature gages (54, figure 1-22) of the direct current type are on the engineer's instrument panel. The cylinder head temperature gages are resistance bulb type units and indicate cylinder head temperature in degrees Centigrade. There are two resistance bulbs on each engine which are connected to cylinder A_1 and B_1. The circuits are supplied with 28 volt DC through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

Cylinder Head Temperature Selector Switch

A selector switch (25, figure 1-16) on the aft end of the control stand F and (91, figure 1-22) on the engineer's instrument panel G allows selection of the desired set of cylinders for cylinder head temperature indication. The selector switch has A_1--B_1 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 selected 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 (figure 1-35, sheet 1).

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





ENGINEER'S AUXILIARY PANEL F G 1372 ▶

Figure 1-23

Fuel Flowmeters

Each engine has a fuel flowmeter, located on the engineer's instrument panel (62, figure 1-22). The flowmeters show rate of fuel flow in hundreds of pounds per hour. On airplanes F G 1243 ▶ 22700 , the indicator circuits are supplied with 26 volt AC through the engine instrument fuses in the AC power panel (figure 1-35, sheet 3). On airplanes G 22701 ▶, the indicator circuits are supplied with 26 volt AC through individual fuel flow fuses in the AC power panel (figure 1-35, sheet 3).

Fuel Pressure Gages

Four fuel pressure gages (69, figure 1-22) on the engineer's instrument panel indicate fuel pressure in psi for each engine. The indicator circuits are supplied with 26 volt AC through the engine instrument fuse on the AC power panel (figure 1-35, sheet 3).

Fuel Low Pressure Warning Lights

A fuel low pressure warning light (70, figure 1-22), adjacent to each fuel pressure gage, illuminates when fuel pressure is low. The circuit is supplied with 28 volt DC through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

Oil Pressure Gages

Four oil pressure gages (68, figure 1-22) are on the engineer's instrument panel. The gages indicate engine oil pressure in psi. The indicator circuits are supplied with 26 volt AC through the engine instrument fuses on the AC power panel (figure 1-35, sheet 1).

Oil Temperature Gages

A resistance bulb type oil temperature gage for each engine (55, figure 1-22) 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 through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

PROPELLER SYSTEM

The airplane is equipped with Hamilton Standard, hydromatic propellers having four solid aluminum blades. This propeller has a non-rotating control unit, incorporating an independent oil system, mounted between the engine nose section and the propeller. Controls are provided to automatically snychronize 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 oil replenishing system is provided to replace oil lost from the propeller independent oil system with engine nose section oil. See figure 1-24.

NOTE

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

PROPELLER GOVERNOR SELECTOR SWITCHES

Four propeller DECREASE RPM--OFF--INCREASE RPM governor selector switches (32, figure 1-16), 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 through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

PROPELLER AUTO CONTROL SWITCH

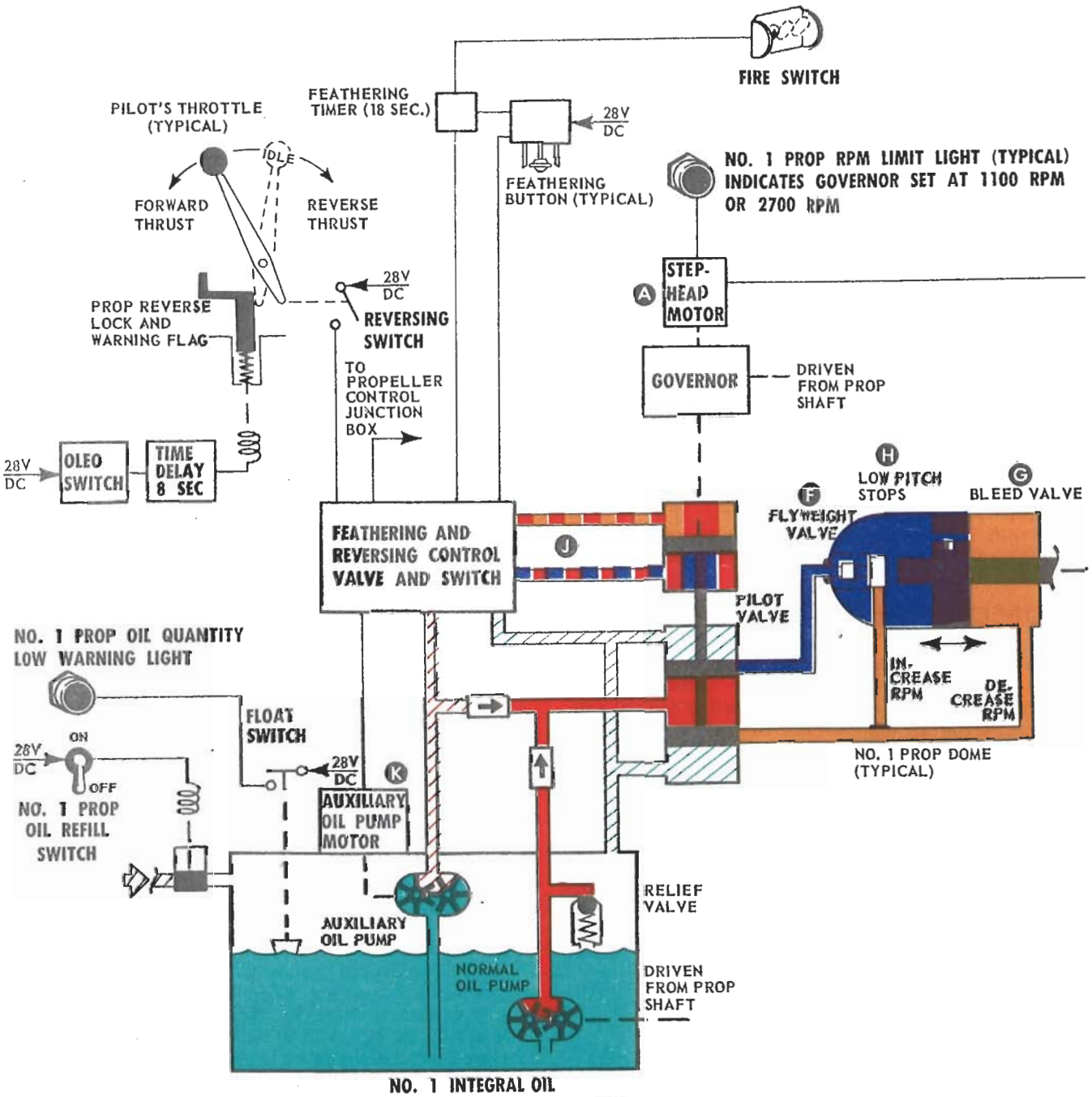
The automatic propeller synchronizing system is referred to No. 1 or No. 2 engine as the master engine by a NO. 1 MASTER--OFF--NO. 2 MASTER switch (29, figure 1-16) on the aft end of the control stand. This switch is used in the propeller synchronizing system to select either engine No. 1 or No. 2 as 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 through an ON--OFF, switch-type circuit breaker on the overhead panel (figure 1-35, sheet 1).

MASTER PROPELLER SYNCHRONIZER LEVER

Two levers (40, figure 1-16) on the control stand, 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 (29, figure 1-16) 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 (figure 1-35, sheet 1).

RESYNCHRONIZER SWITCH

A spring-loaded resync-off switch (31, figure 1-16) on the aft end of the control stand, is used to syn-



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.

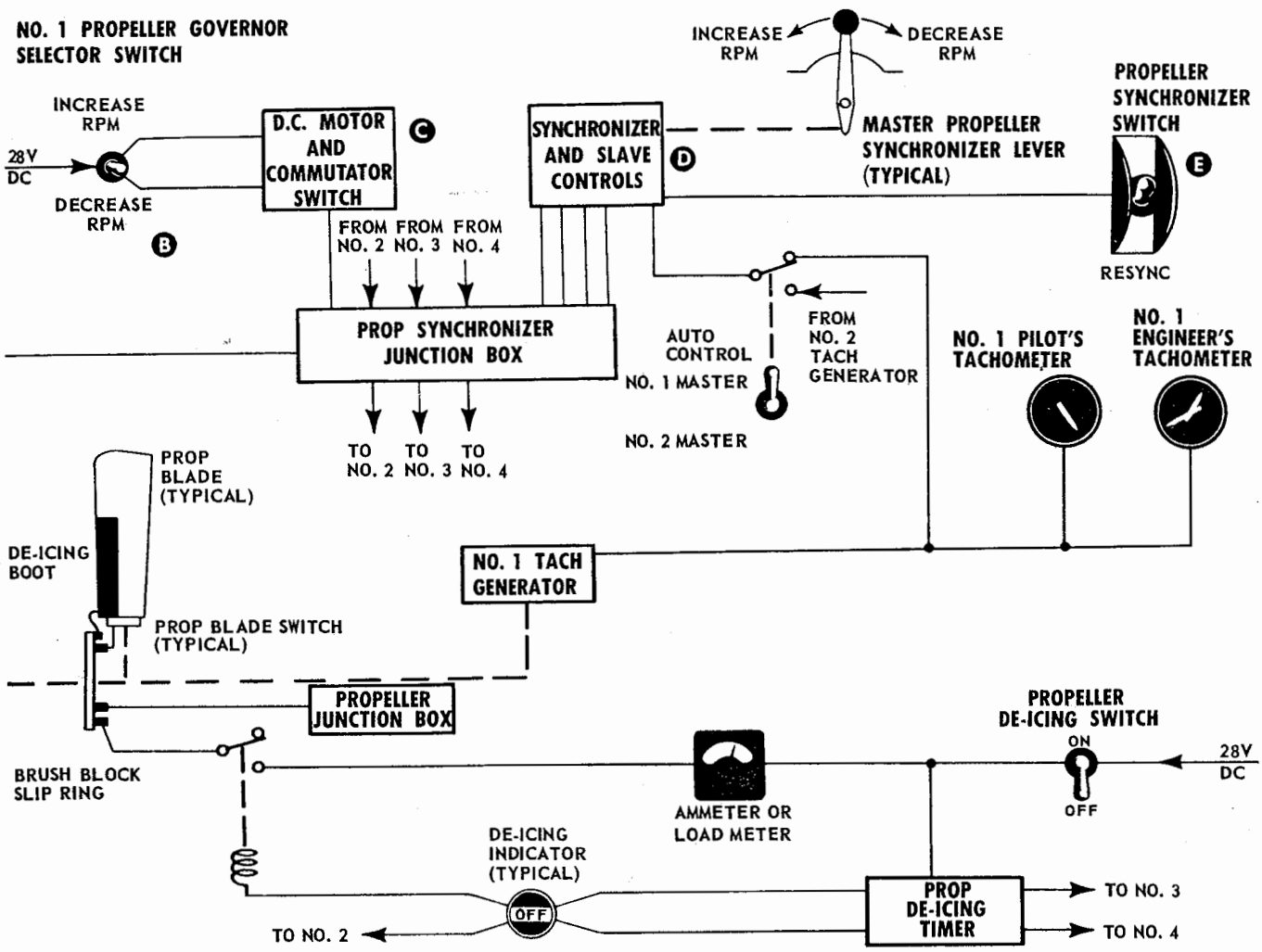
(C) DC motor and commutator switch control stephead motor, so that in the event of electrical power failure, governor remains at last setting.

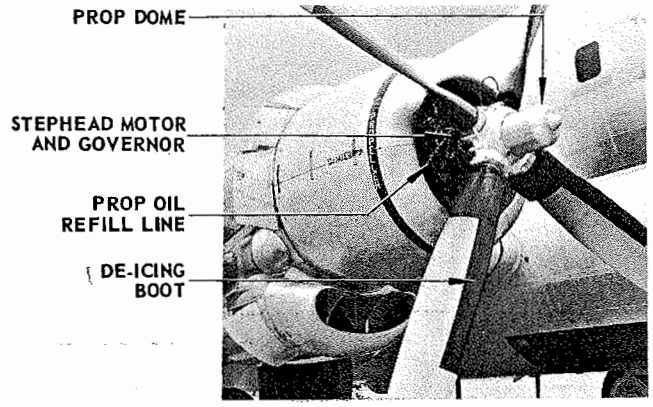
(D) Synchronizer will control slave engines RPM when slave engines are within ±3% of master engine RPM. When master synchronizer lever is at full increase (calibrate) all engines will go to 2700 RPM and the 3% does not apply.

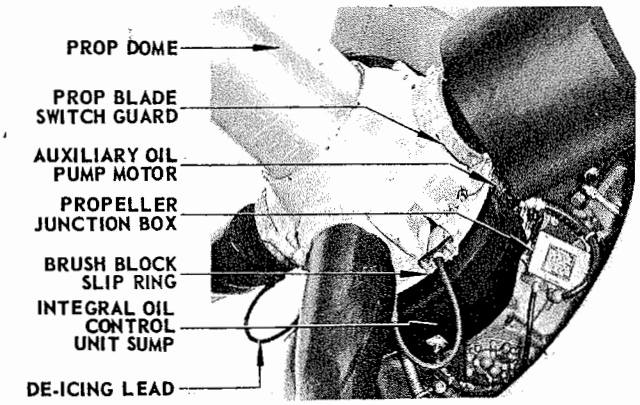
(E) Resynchronizer switch will change slave engine RPM a maximum of 3% of master engine RPM.

PROPELLER SYSTEM

Figure 1-24 (Sheet 1 of 2)







F Flyweight valve closes at 2535 to 2665 RPM and above to prevent over speed 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 - 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 prop oil pressure. When throttles are moved to reverse idle, high pressure oil will retract the low pitch stops and prop 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 1-24 (Sheet 2 of 2)

chronize 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 (figure 1-35, sheet 1).

PROPELLER FEATHERING BUTTONS

Four guarded propeller feathering buttons (26, figure 1-12) 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 in Section III. The circuit is supplied with 28 volt DC through four feathering circuit breakers and one timer circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1). An additional propeller feathering switch for each engine is on the overhead fire panel. See FIRE SWITCHES this Section.

PROPELLER REVERSE THRUST CONTROL

The propeller reverse thrust is controlled by the throttles. See THROTTLES AND THROTTLE LOCK LEVER in this Section.

PROPELLER OIL REFILL SWITCHES

Four ON--OFF switches (47, figure 1-22) on the engineer's instrument panel are used to energize the propeller oil refilling circuit. Placing the switches 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 or less quart level 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 through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1), which protects both oil refill and warning light circuits.

PROPELLER OIL QUANTITY WARNING LIGHTS

Four red warning lights (48, figure 1-22) above the refill switches on the engineer's instrument panel are a part of the propeller oil refill circuit and illuminate whenever the float switch drops to approximately the 2.5 quart level regardless of refill switch position and go off when approximately 1.5 quarts have been added. The circuit is supplied with 28 volt DC through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1) which protects both warning light and emergency oil refill circuits.

RPM LIMIT LIGHTS

Four amber rpm limit lights (33, figure 1-9) 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 through an ON--OFF, switch-type circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

PROPELLER REVERSE WARNING FLAG

A red LOCKED flag (4, figure 1-16) 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 through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

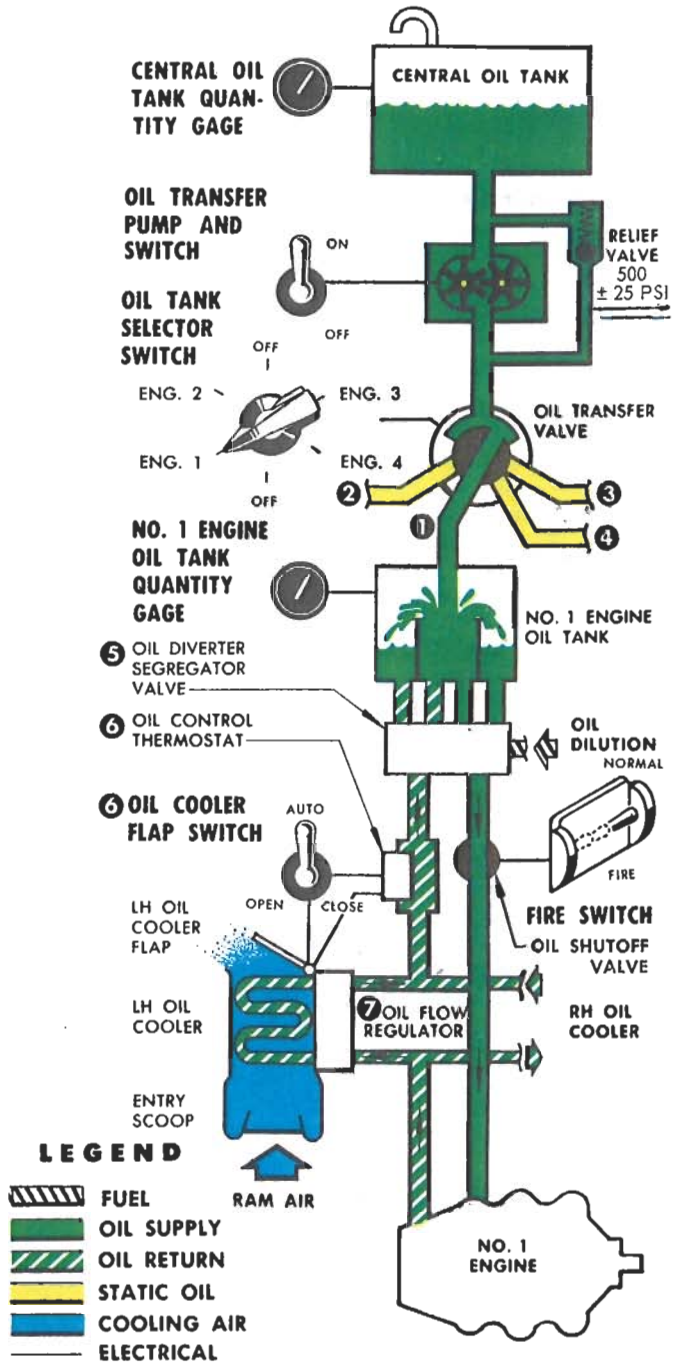
NOTE

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

OIL SYSTEM

CENTRAL OIL SYSTEM

This system (figure 1-25) has a central 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 6 gallons per



NOTES

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. Thermostatically controls oil flow to engine oil tank and tank hopper,
6. Controls RH and LH oil cooler flap
7. Allows the oil to by-pass 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 1-25

minute, and is directed to the desired engine tank by a transfer valve. The circuit is supplied with 28 volt DC through a circuit breaker on the forward power panel (figure 1-35, sheet 4).

Oil Tank Selector Switch

A rotary switch (57, figure 1-22) 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 through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

Oil Transfer Pump Switch

An ON--OFF switch (58, figure 1-22). Spring-loaded from the ON position to the OFF position, and adjacent to the tank selector switch on the engineer's instrument panel, is used to turn on or off the central oil tank transfer pump. The circuit is supplied with 28 volt DC through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

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.

Oil Diverter Segregator

The airplane is provided with an oil diverter segregator system which reduces engine warm-up time. This system employs a thermal and pressure operated valve at the base of each engine oil tank. The diverter segregator valve allows oil to flow from and return to the hopper only when the oil temperature is low. Above 55° C (130° F) the valve permits oil to flow from both the hopper and the engine tank. At 72° C (160° F) oil

will flow from the engine oil tank and from the hopper at a ratio of 75 percent and 25 percent respectively. Fuel for dilution is introduced at the thermal valve to obtain a high dilution percentage in the circulatory system. The tank hopper is independent of the engine oil tank except for spill-over at the top of the hopper. A pull chain valve is used to equalize hopper and tank levels during servicing. See OIL SYSTEM OPERATION, Section VII and oil dilution procedures under SHUTDOWN under COLD WEATHER PROCEDURES in Section IX.

Oil Cooler Flap Switches

The oil cooler flaps for each engine are operated by OPEN--OFF--AUTO--CLOSE switches (34, figure 1-16) on the aft end of the engine control stand F, and (90, figure 1-22) on the engineer's instrument panel G. 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 are 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 through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

Oil Dilution Switches

One master OFF-ON (spring-loaded OFF) switch and four engine selector OFF--ON switches (6, figure 1-12) on the overhead panel F, and (87 and 88, figure 1-22) on the engineer's instrument panel G energize the oil dilution solenoids, allowing fuel to mix with engine oil before the oil enters the engine. The four engine selector switches select the engines to be diluted. Dilution is then accomplished by use of the master dilution switch (figure 1-25 and figure 1-27, sheet 3). The circuits are supplied with 28 volt DC through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

Oil Shutoff Valve

A 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. See FIRE SWITCHES in this Section.

Oil Quantity Gage

Oil quantity gages (56, figure 1-22) for each engine oil tank and central oil tank on the engineer's instrument panel, indicate oil quantity in US gallons. The circuits are supplied with 28 volt DC through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

OIL SPECIFICATION AND GRADE

Refer to figure 1-50 for oil specification and grade.

FUEL SYSTEM

The airplane fuel system (figure 1-27) has four internal main fuel tanks. The main fuel system is arranged so that the engines may be supplied directly from the main fuel tanks, from the main fuel manifold or any combination of tanks. Each main fuel tank contains two submerged fuel boost pumps.

On F airplanes the auxiliary fuel system consists of the center wing tank. The center wing tank contains one submerged fuel boost pump. Flow from the center wing tank is controlled by the center tank line valve and is isolated from the main fuel manifold by a manual fuel-shutoff valve (figure 7-10, sheet 1).

On G airplanes the auxiliary fuel system consists of the center wing tank and two external fuel tanks. These tanks each contain 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 positioning the No. 1 manual fuel-shutoff valve (figure 7-10, sheet 2). The external fuel tanks may be isolated from the center wing tank by positioning the No. 2 manual fuel-shutoff valve. On G 22665 ▶ the external fuel tanks may be completely isolated by positioning the external tank manifold shutoff valve (figure 7-10, sheets 2, 3 and 4).

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. Check valves in the boost pump lines prevent transfer of fuel between tanks. Individual fuel tank capacity is shown in figure 1-26.

SINGLE POINT REFUELING F G 1255 ▶

Two single point refueling receptacles (5 and 6, figure 4-84) 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. On tanker airplanes the air refueling deck tanks are refueled through the aft receptacle. See SINGLE POINT REFUELING, Section IV.

TANK	NO OF TANKS	AIRP USED ON	USABLE FUEL			FULLY SERVICED		
			GAL	JP-4 LB	GAS LB	GAL	JP-4 LB	GAS LB
NO. 1	1	F G	1770		10,354.5	1789.1		10,466.2
NO. 2	1	F G	1520		8892	1539.6		9006.7
NO. 3	1	F G	1520		8892	1539.6		9006.7
NO. 4	1	F G	1770		10,354.5	1789.1		10,466.2
CENTER	1	F G	1210	7744	7078.5	1218.5	7798.4	7128.2
RH EXT.	1	G	675	4320	3948.8	686.8	4395.5	4017.8
LH EXT.	1	G	675	4320	3948.8	686.8	4395.5	4017.8
FWD DECK TANKS	2	F	3600 (Total 2 tanks)	23,040	21,060	3640.7	23,300.5	21,298.1
FWD A/R TANK SYSTEM	7	G	2910.7 (Total 7 tanks)	18,628.5	17,027.6	2953.5	18,902.4	17,278
AFT DECK TANKS	2	F	3600 (Total 2 tanks)	23,040	21,060	3656.8	23,403.5	21,392.3
AFT A/R TANK SYSTEM	8	G	2908.3 (Total 8 tanks)	18,613	17,013.6	2967.5	18,992	17,360

F 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 Deck	7200	46,080	42,120
Tanks FWD and AFT Deck, and Center	8410	53,824	49,198

G 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 No. 1, 2, 3, 4, Center and External	9140		53,469
Tanks Fwd and AFT A/R	5819	37,241.6	34,041
Tanks Fwd and AFT A/R, Center and External	8379	53,625.6	49,017

NOTE

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

TEMP, °F: 0 – 20 — 6.91; 20 – 40 — 6.93; 40 – 60 — 6.85; 60 – 80°F — 6.85; 80 – 100°F — 6.77; 6.69

FUEL QUANTITY DATA

Figure 1-26

AIR REFUELING V

When in the tanker configuration, 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 (22, figure 1-4 and figure 4-77). 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. See AIR REFUELING SYSTEM, Section IV and FUEL SYSTEM OPERATION, Section VII.

FUEL SPECIFICATION AND GRADE

Refer to figure 1-50 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 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 on airplanes G 17260 ▸ 22664 relieves the line between the manual fuel-shutoff valves and the transfer valves to the aft A/R tank system; or on airplanes G 22665 ▸ 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 tank No. 3. Normally the rate of return flow is negligible.

FUEL SELECTOR SWITCHES

Four rotary type selector switches (75, figure 1-22 and figure 7-9) 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. See FIRE SWITCHES in this Section. The selector switches are supplied with 28-volt DC through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

FUEL VALVE POSITION WARNING LIGHTS

Four fuel valve position warning lights (73, figure 1-22), 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 through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

FUEL SYSTEM MANUAL FUEL-SHUTOFF VALVE F

A manual fuel-shutoff valve (figure 1-27) is provided in the fuel system to direct the fuel flow from the center wing tank to the main fuel manifold, control fuel flow between the main fuel manifold and the A/R system, or to isolate the main fuel manifold when contaminated fuel or A/R fuel is carried in the center wing tank. This valve is located just aft of the rear spar in the lower aft compartment. When the manual fuel-shutoff valve and the center wing tank line valve are open fuel is directed to the main fuel manifold. When the manual fuel-shutoff valve and the A/R transfer valves are open fuel may be directed either to or from the main fuel manifold and the A/R system. For operation of the manual fuel-shutoff valve refer to Section IV and Section VII

FUEL SYSTEM MANUAL FUEL-SHUTOFF VALVES G

Two manual fuel-shutoff valves, No. 1 and No. 2, (figure 1-27) are provided in the fuel system to direct the flow of fuel from the auxiliary tanks to either the airplane main fuel manifold or the A/R system, for V airplanes. 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, the external fuel tanks are shut off from the airplane main fuel manifold. When the center wing tank line valve is opened, fuel will be directed from the center wing tank to the main fuel manifold. With both manual fuel-shutoff valves open, and the A/R transfer valve switches at CLOSED, fuel from the external fuel tanks is directed to the airplane main fuel manifold. Fuel from the center wing tank is also directed to the main fuel manifold when the center wing tank line valve is open. With the No. 1 manual fuel-shutoff valve closed, both external fuel tanks and the center wing tank are shut off from the

airplane main fuel manifold. On airplanes with 1C10 KGT507 incorporated, an additional manual fuel-shutoff valve, No. 3 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. See FUEL SYSTEM OPERATION in Section VII.

CENTER TANK LINE VALVE SWITCH F

An OPEN--CLOSE switch on the engineer's instrument panel (74, figure 1-22 and figure 7-9) controls the center wing tank valve. With the switch OPEN, the manual fuel-shutoff valve open, fuel will flow from the tank into the manifold system. On T airplanes if the valve positions are reversed, fuel will flow into the A/R tanks provided the transfer valves are open. With the switch in the CLOSE position fuel cannot be drawn from the center wing tank. The circuit is supplied with 28 volt DC through the center wing tank boost pump circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

CENTER TANK LINE VALVE SWITCH G

An OPEN--CLOSE switch on the engineer's instrument panel (74, figure 1-22 and figure 7-9) 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 manifold system. On T airplanes if the valve positions are reversed, fuel will flow into the A/R tanks provided the transfer valves are open. With the switch in the CLOSE position fuel cannot be drawn from the center wing tank. The circuit is supplied with 28 volt DC through the center wing tank boost pump circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

BOOST PUMP SWITCHES

Each fuel tank has two fuel boost pumps except the center tank on F airplanes which has only one boost pump. These pumps are controlled individually by EMERGENCY--OFF--NORMAL switches (76, figure 1-22 and figure 7-9) on the engineer's instrument panel. When the boost pump switches are on NORMAL with a no-flow condition (engine inoperative), fuel pressure will be 12 to 20 psi. When the boost pump switches are on EMERGENCY with a no-flow condition, fuel pressure will be 24 to 40 psi. When the boost pump switches are on NORMAL with a flow condition (engine operating), fuel pressure will be 23 to 27 psi. When the boost pump switches are on EMERGENCY with a flow condition, fuel pressure will be 24 to 30 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 in 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 through circuit breakers on the overhead circuit breaker panel, (figure 1-35, sheet 1).

FUEL TANK QUANTITY GAGES

Five gages (78, figure 1-22) on the engineer's instrument panel show the quantity of fuel in pounds for the main tanks and the center wing tank. Push-button test switches (79, figure 1-22) adjacent to the gage are used to show circuit continuity of the fuel quantity indicating circuits. The circuits are supplied with 115 volt AC through circuit protection on the AC power panel (figure 1-35, sheet 3).

EXTERNAL FUEL TANK RELEASE SWITCH G

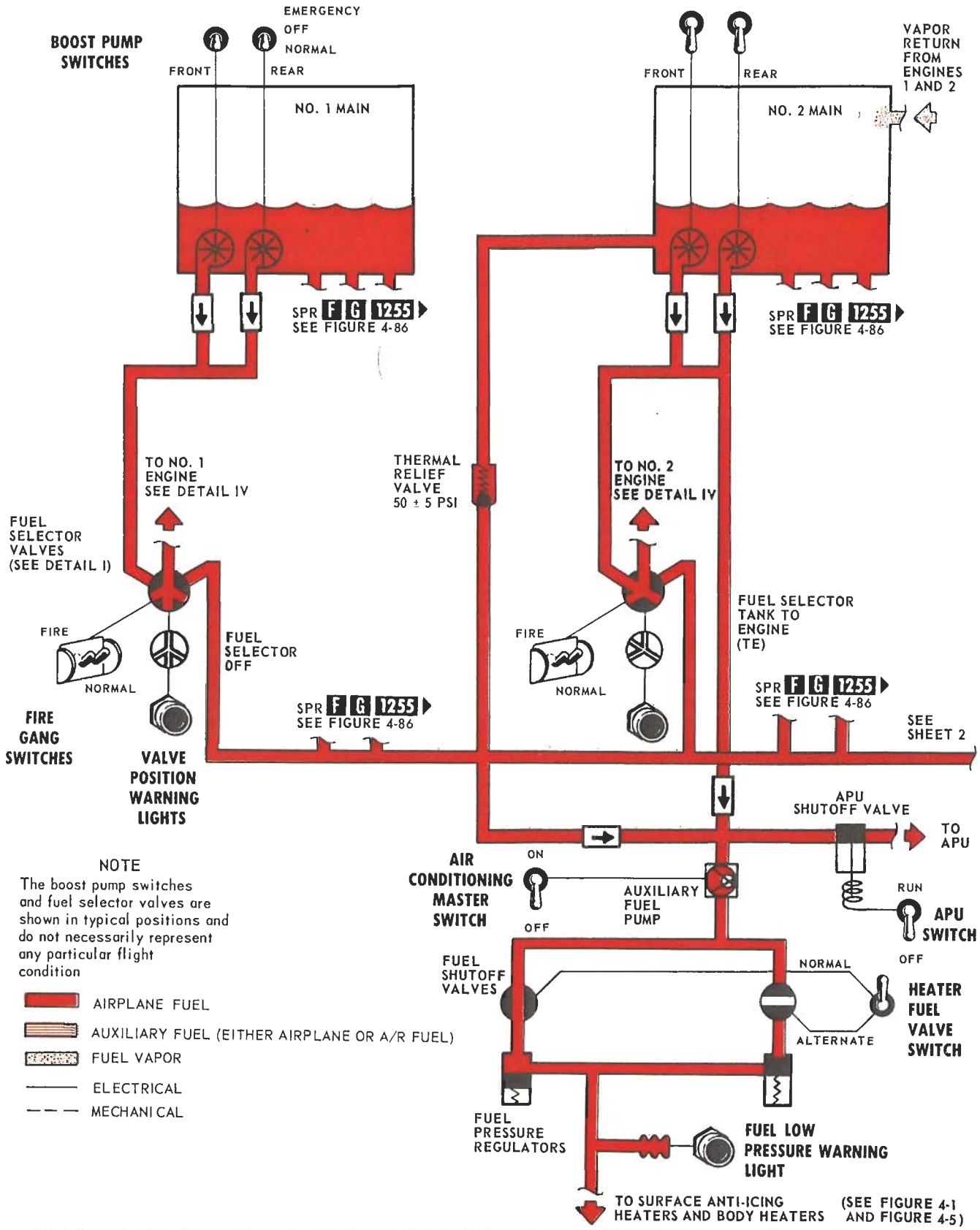
A single switch (42, figure 1-12) guarded to the OFF position, on the overhead panel controls both external fuel tank release mechanisms. When the switch is moved to EXTERNAL TANK RELEASE, both tank release mechanisms are actuated, dropping the tanks. The circuit is supplied with 28 volt DC through a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

WARNING

The external tanks can be jettisoned only with normal electrical power.

EXTERNAL FUEL TANK LOW FLOW WARNING LIGHTS G

Two warning lights (97 and 98, figure 1-22) one for each external fuel tank, are on the engineer's instrument panel adjacent to their respective tank boost pump switches. With either external fuel tank boost pump operating, the light for that tank will illuminate when fuel flow falls below 6 gallons per minute from the tank. Each light is controlled by a flow indicating check valve in each tank supply line. The circuits are supplied with 28-volt DC through the EXT. TANK EMPTY circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).



AIRPLANE FUEL DISTRIBUTION SYSTEM

Figure 1-27 (Sheet 1 of 6)

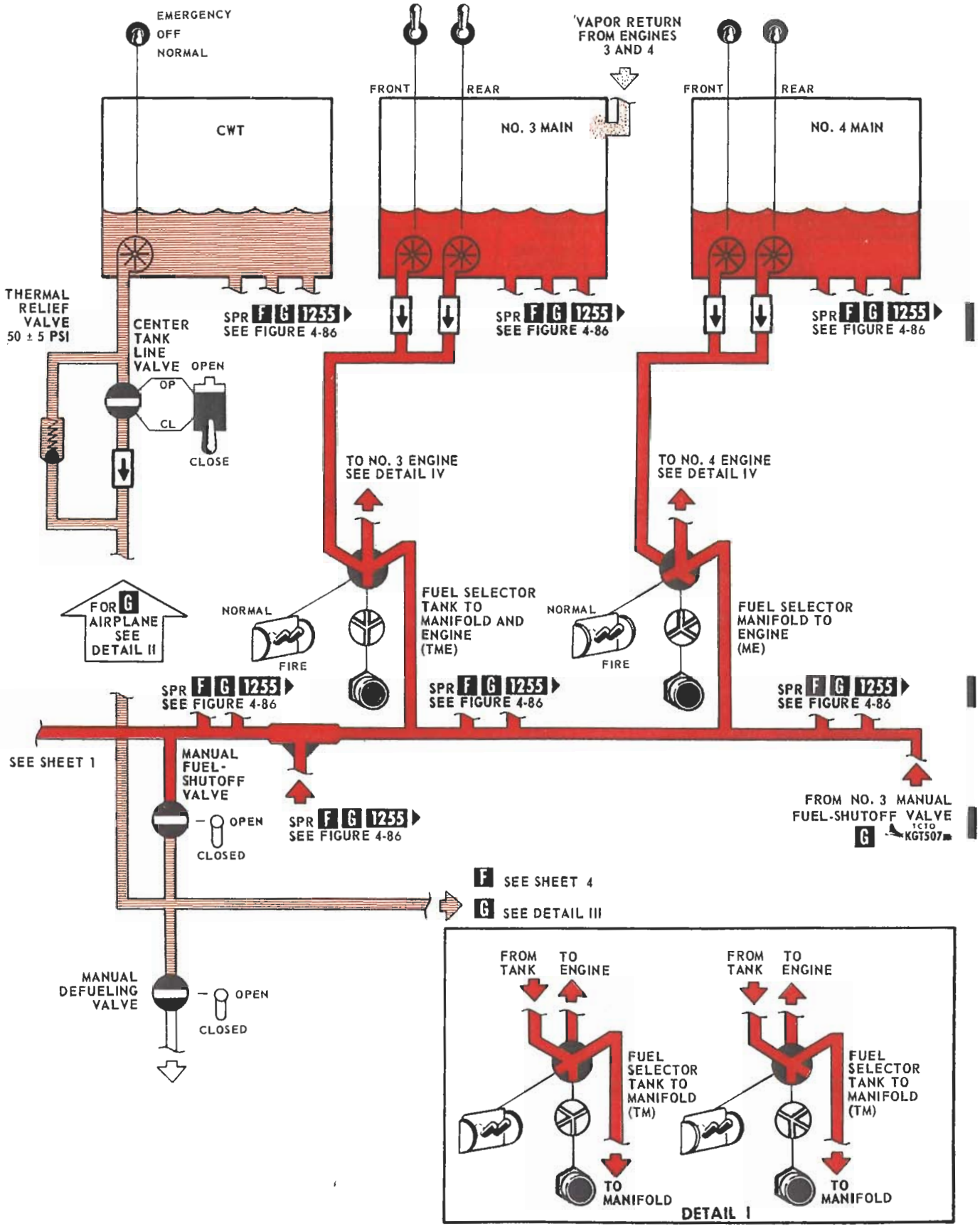
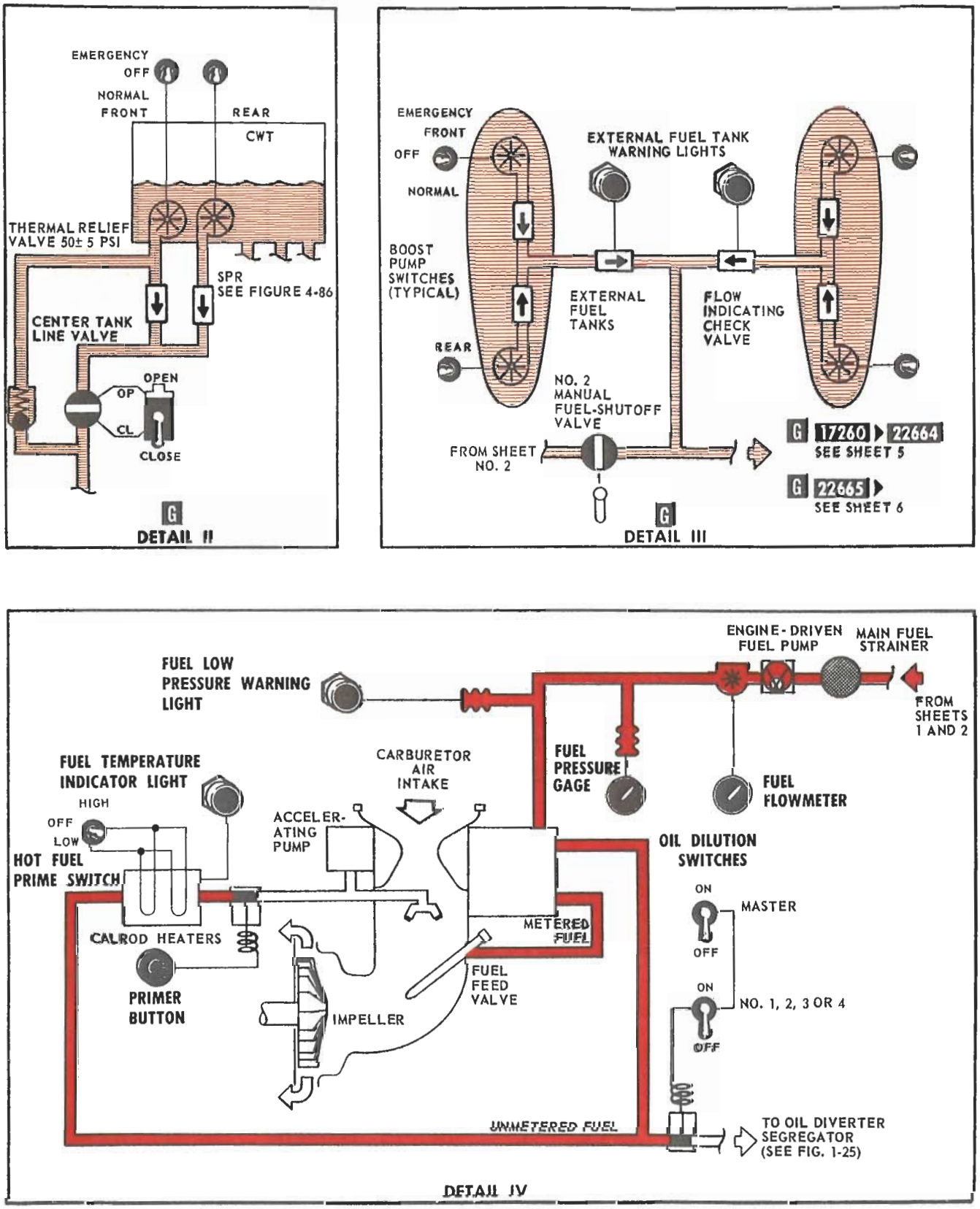


Figure 1-27 (Sheet 2 of 6)



AIRPLANE FUEL DISTRIBUTION SYSTEM (CONT)

Figure 1-27 (Sheet 3 of 6)

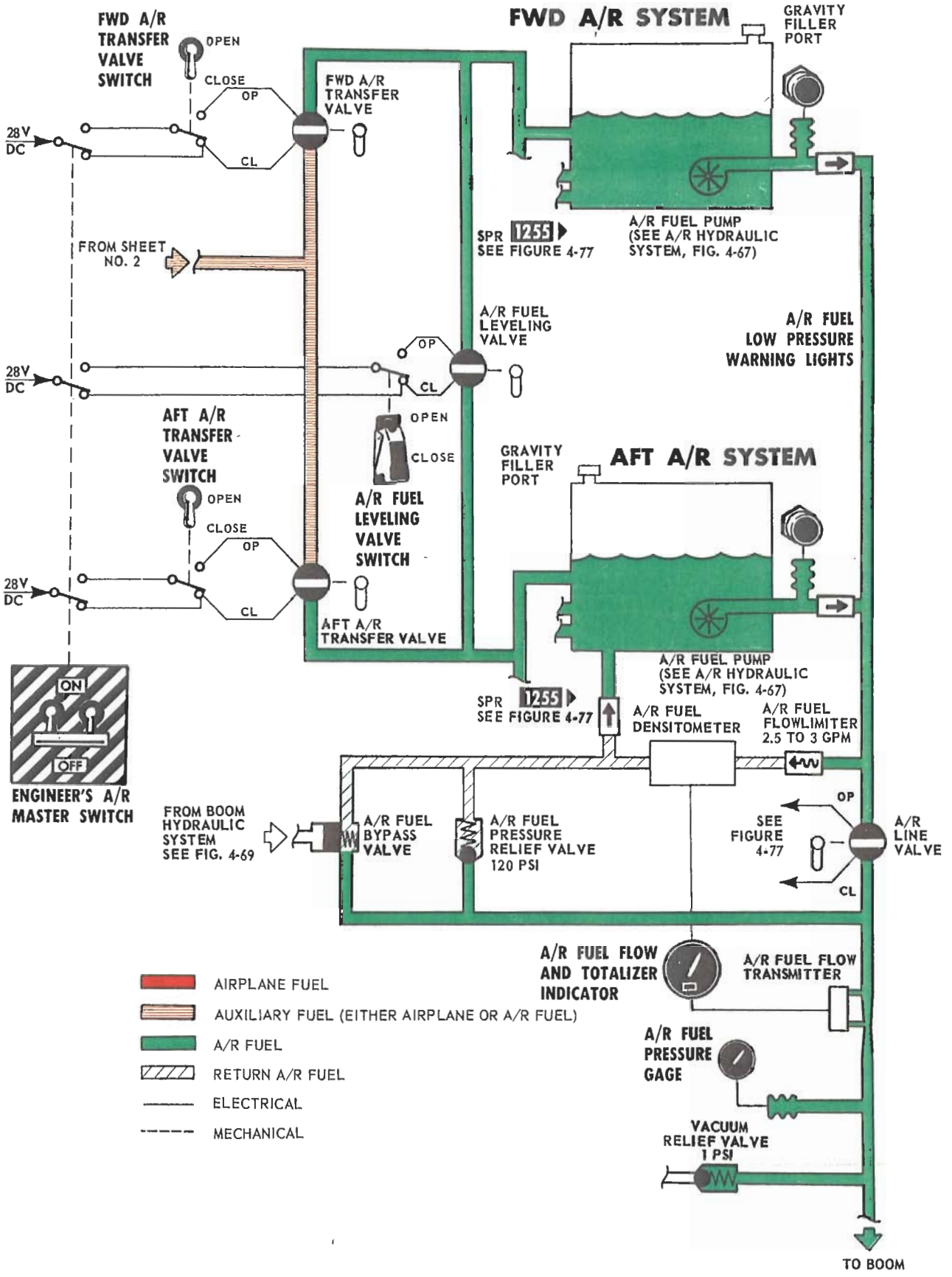


Figure 1-27 (Sheet 4 of 6)

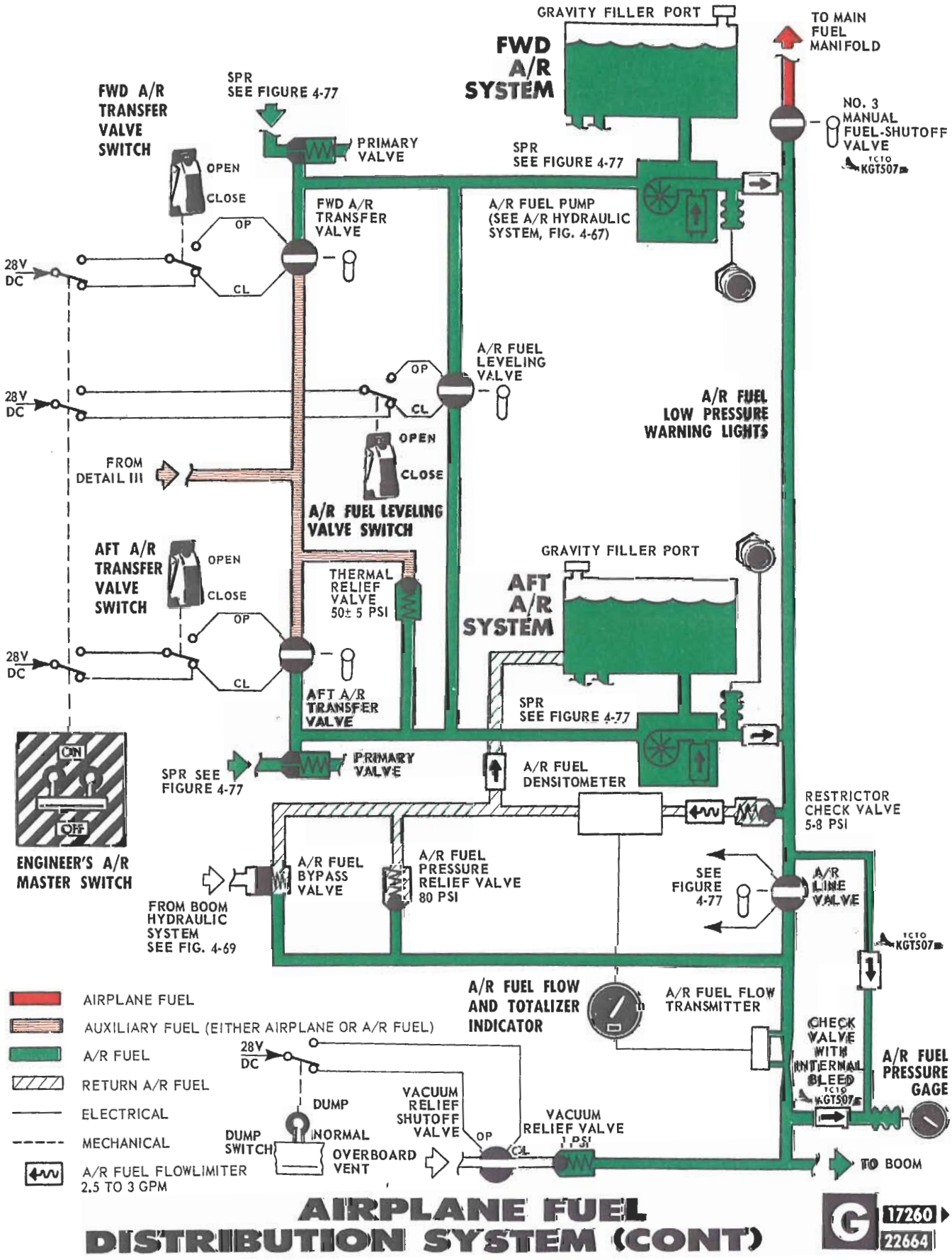


Figure 1-27 (Sheet 5 of 6)

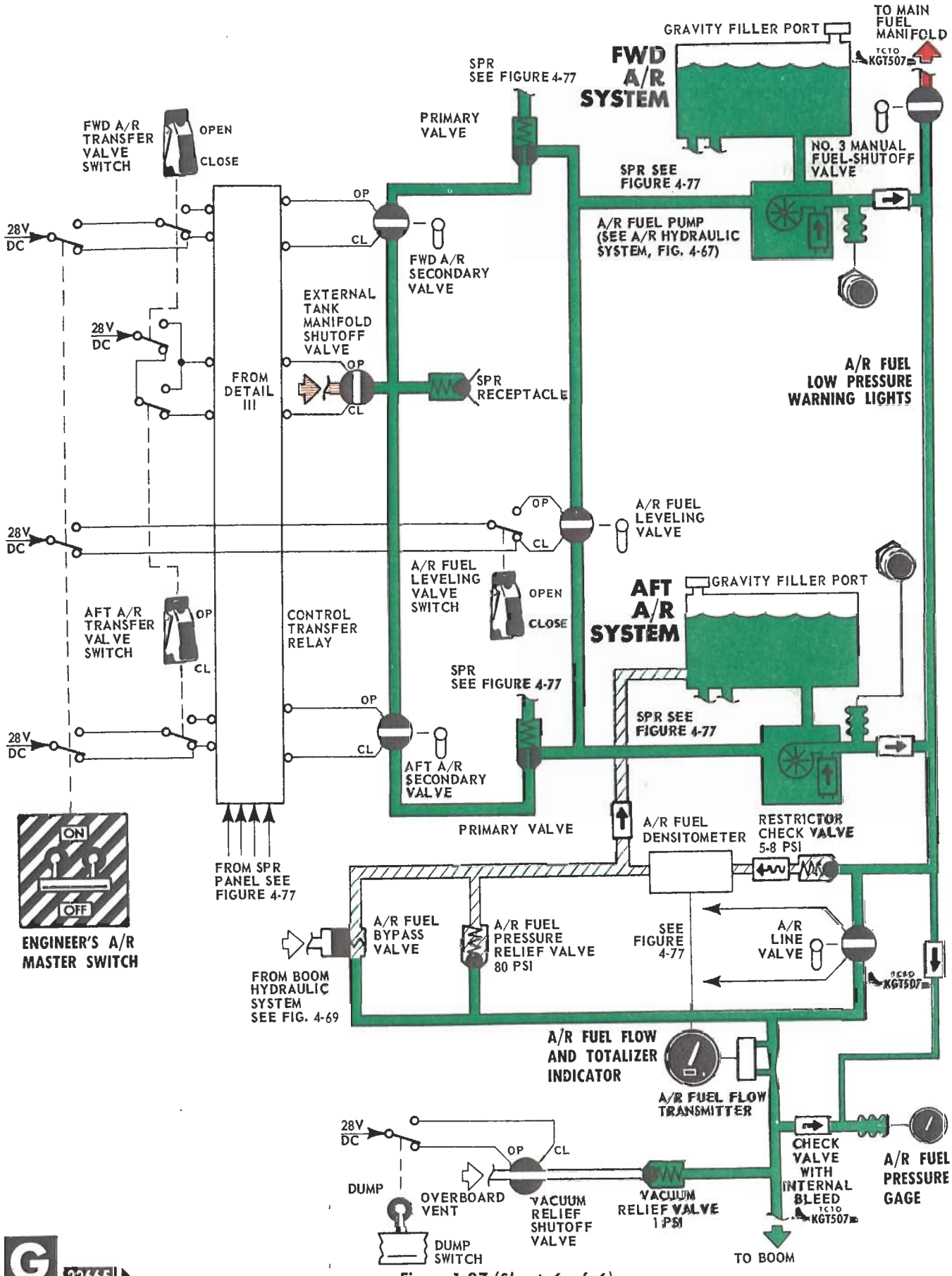


Figure 1-27 (Sheet 6 of 6)

ELECTRICAL SYSTEM

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 distribution system by six engine-driven generators and by an auxiliary power unit. (See Section IV for description and operating instructions for the auxiliary power unit.) Parallel operation on the DC 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 direct current power. An external power supply may be connected to the direct-current distribution system through an external power receptacle. Circuit breakers and fuses (figure 1-34) provide circuit protection for all direct-current operated equipment. See figure 7-12 for listing of major direct current operated equipment loads. See figures 1-28 and 1-29 for schematic diagrams of DC power generation and distribution.

Battery

Airplanes not incorporating TCTO K551 have a 24-volt 34 ampere-hour lead-acid battery. Airplanes incorporating TCTO K551 have 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 1-29 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 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 direct-current 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 direct-current operated equipment in the airplane, and also supply direct-current power to the inverters.

DC External Power Receptacle

An external power receptacle (16, figure 1-50) for DC power is on the bottom of the fuselage near the forward entry door.

Auxiliary Power Unit

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

DC Outlets

Airplanes F G 1243 ▶ 2859 have eleven 28V DC outlets. Five heated suit control panels are located in the control cabin at the pilot's, copilot's, engineer's, navigator's and radio operator's stations. Four casualty blanket outlets are located in the main cargo 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.

Airplanes G 2860 ▶ have five 28V 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 (40, figure 1-12) 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 1-12) is adjacent to the

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 de-energizes 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 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; however the relay is energized by battery power and will not close if the battery voltage is below approximately 18 volts. 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 is protected by a circuit breaker on the forward power panel, emergency bus (figure 1-35, sheet 4).

Generator Switches

Six individual generator switches (37, figure 1-22) 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 over-voltage relay, and the 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 (figure 1-35). Each generator control circuit and each generator field is protected by a circuit breaker on the main circuit breaker panel (figure 1-35, sheet 5).

Generator Voltage Rheostats

Generator voltage rheostats, one for each generator, are behind a hinged cover on the engineer's auxiliary overhead panel F, (1, figure 1-21), and on the engineer's instrument panel G, (96, figure 1-22). 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 switch (49, figure 1-22) and a single direct-current voltmeter (50, figure 1-22) 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--BATTERY. 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 (figure 1-35, sheet 5).

Generator Warning Lights

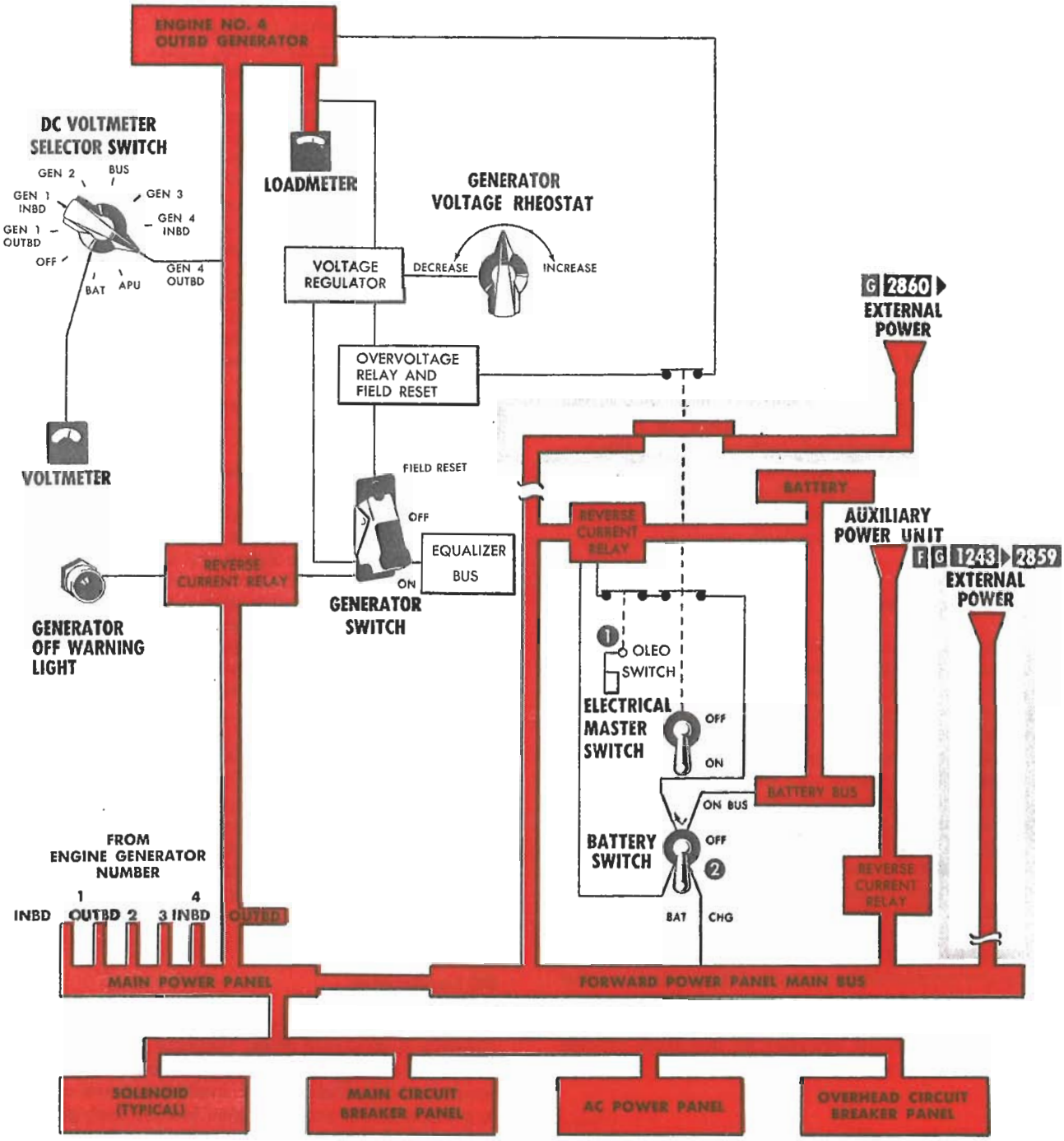
Seven press-to-test generator-off red warning lights (35 and 38, figure 1-22) are on the engineer's instrument panel. Six of the lights are for the engine-driven generators and one is for the auxiliary power unit generator. The generator warning lights are operated by individual relays connected to the 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. On airplanes F 1243 ▶ 1326 , the generator warning light is a generator field trip warning, connected through the controls of the field control relay, and will not light if the generator is off the line for undervoltage, failure of the contactor and etc.

DC Loadmeter

Seven loadmeters (36 and 39, figure 1-22) 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 inverter system, autopilot inverter system, and pilots' instrument inverter system.

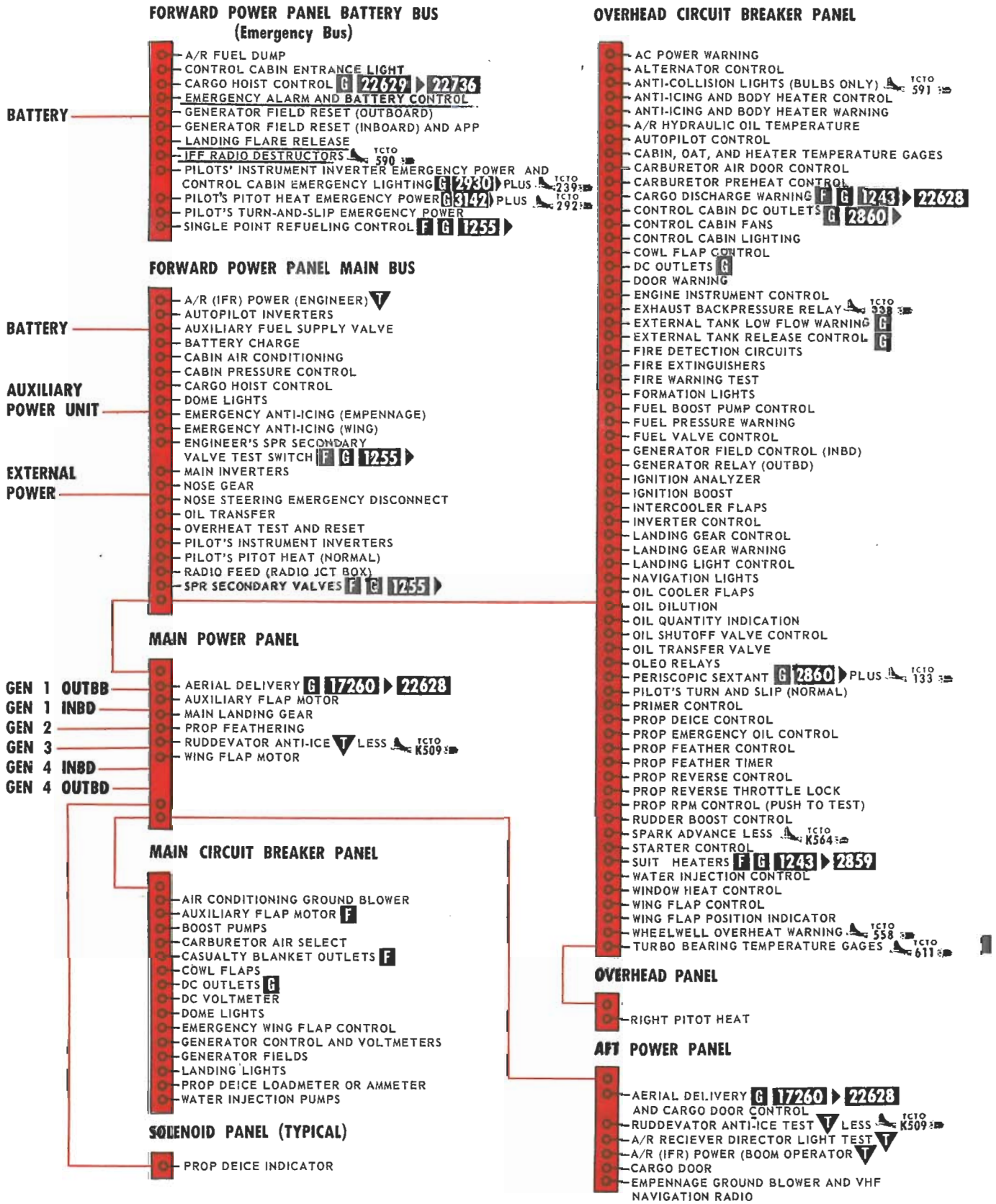


1 When on the ground, all dc electrical circuits can be operated from the battery if the electrical master switch is ON and the battery switch is ON BUS.

2 When in flight, battery bus voltage will be the same as generator voltage (28V) if the battery switch is ON CHG., with the battery switch OFF or ON BUS the battery bus will be at battery voltage (24V).

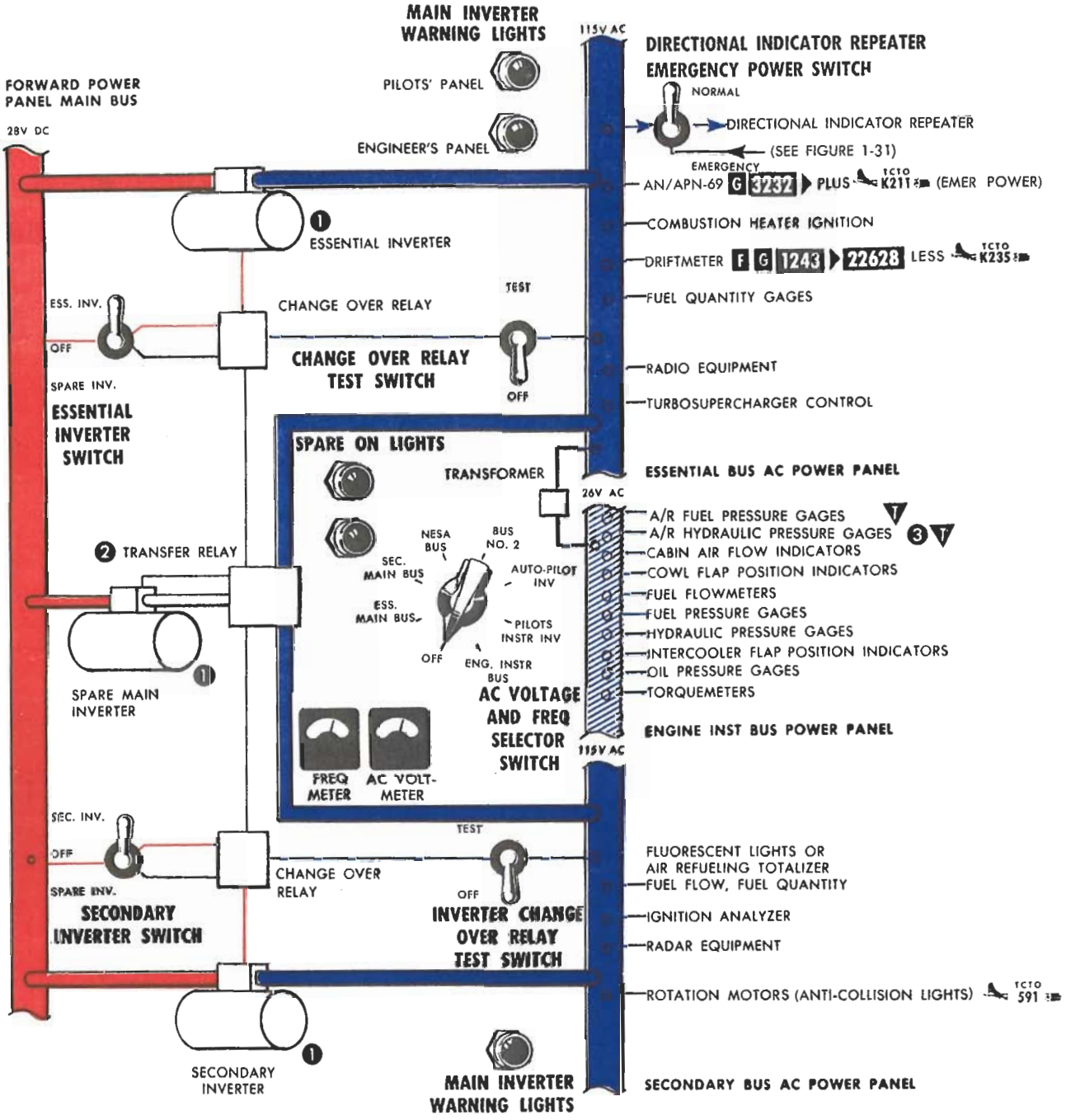
DC POWER GENERATION

Figure 1-28



DC POWER DISTRIBUTION

Figure 1-29



MAIN INVERTER POWER GENERATION AND DISTRIBUTION

Figure 1-30

Main Inverters

2500-VOLT-AMPERE INVERTERS. Three 2500-volt-ampere inverters provide 115-volt, 400-cycle, single phase, alternating current to the essential and secondary AC busses. The inverters are the essential, secondary and spare main. The essential inverter supplies power to the essential bus. The secondary inverter supplies power to the secondary bus.

SPARE MAIN INVERTER. 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 (figure 1-35, sheet 4) through a current limiter. See figure 1-30 for a schematic diagram of the main inverter system.

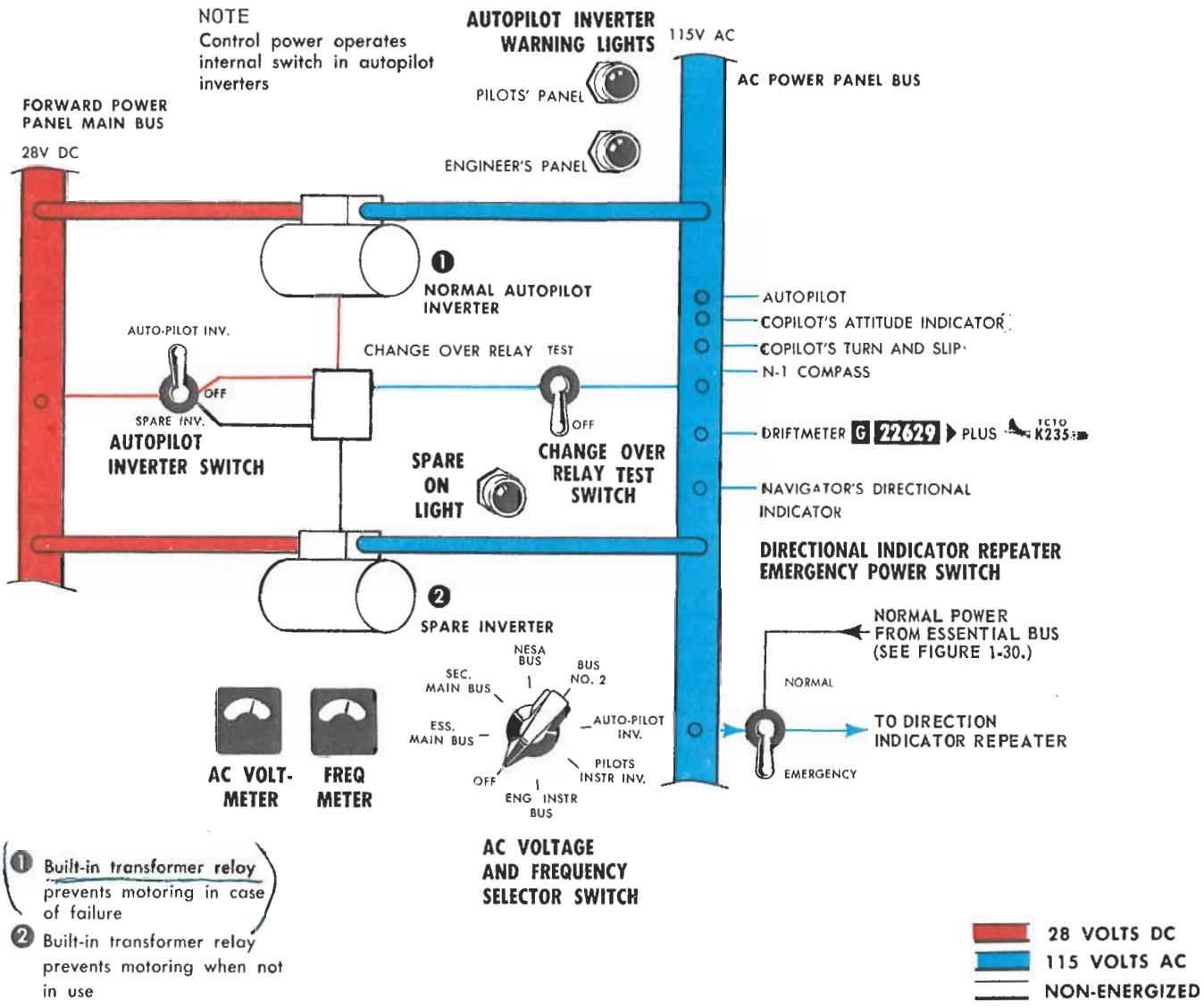
MAIN INVERTER SWITCHES. Two switches (2 and 4, figure 1-22) on the engineer's instrument panel control the three inverters in the main inverter system. One switch with ESS INV--OFF--SPARE INV positions energizes and connects the essential main inverter to the essential bus when in the ESS INV position. The second switch marked SEC INV--OFF--SPARE INV energizes and connects the secondary main inverter to the secondary bus when in the SEC INV position. If the essential main 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 main 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 essentail main 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 main 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 (figure 1-35, sheet 1).

MAIN INVERTER WARNING LIGHTS. There are five press-to-test main inverter warning lights. Two red lights and two amber lights (3, figure 1-22) are on the engineer's instrument panel and one red light (7, figure 1-9) is on the pilots' instrument panel. In event of failure of the essential main 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 main inverter, or when the essential main 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 main inverter, the second red light will illuminate, and the second amber light will illuminate on the engineer's instrument panel 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 alternating current for operation of the autopilot and navigator's directional indicator. 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. Direct-current power for the autopilot inverters is supplied through fuses on the forward power panel (figure 1-35, sheet 4) F G 1243 ▶ 22700 , through thermo-circuit breakers on the forward power panel G 22701 ▶ 3141 , and through thermo-circuit breakers on the autopilot junction shield G 3142 ▶. See figure 1-31 for a schematic diagram of the autopilot inverter system.

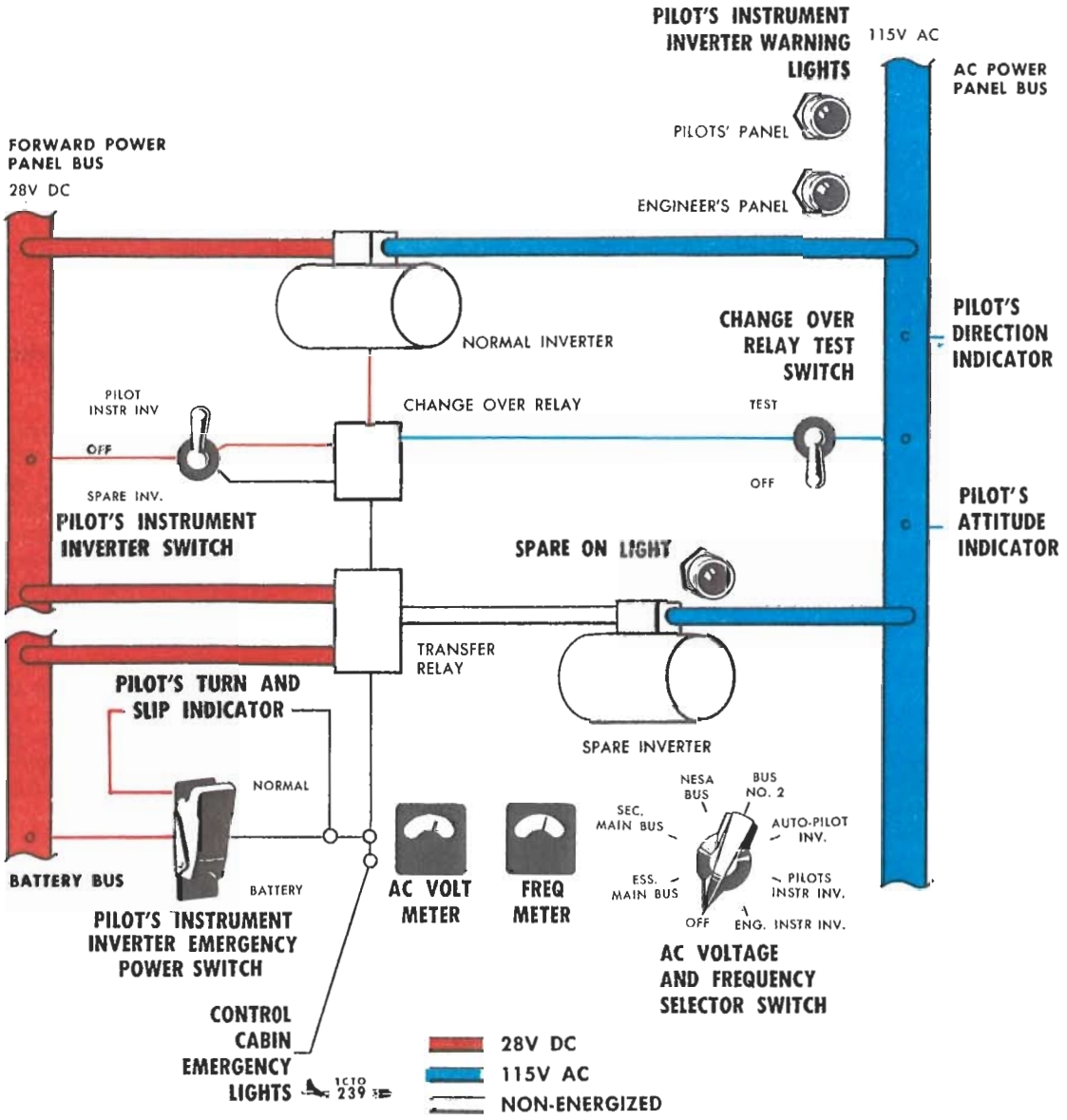
AUTOPILOT INVERTER SWITCH. A switch (5 , figure 1-22) on the engineer's instrument panel, with AUTOPILOT INV--OFF--SPARE INV positions, controls the normal and spare autopilot inverters. When the switch is in the AUTOPILOT INV position, the normal autopilot inverter is energized and supplies power to the autopilot, copilot's attitude indicator, copilot's turn and slip indicator, N-1 compass, the driftmeter on airplanes G 22629 ▶ plus ICTO K235 and the navigator's direction indicator on airplanes F G 1243 ▶ 2859. 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 (figure 1-35, sheet 1).



AUTOPILOT INVERTER AC POWER GENERATION AND DISTRIBUTION

Figure 1-31

AUTOPILOT INVERTER WARNING LIGHTS. There are three press-to-test autopilot inverter warning lights. An amber and a red light (3, figure 1-22) are on the engineer's instrument panel, and a red light (11, figure 1-9) is on the pilots' instrument panel. The red warning 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 1-32

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 alternating current for the operation of the pilot's directional indicator and attitude indicator. Either of the two inverters may be selected for operation, and in the event of failure of the normal instrument inverter, the spare inverter is automatically put into operation. However, the normal instrument inverter will not be put into operation automatically in event of failure of the spare inverter. Each of the two inverters receives DC power from the forward power panel through circuit breakers. In emergencies, the spare inverter may receive power from the battery through a circuit breaker on the forward power panel (figure 1-35, sheet 4). See figure 1-32 for a schematic diagram of the pilots' instrument inverter system.

PILOTS' INSTRUMENT INVERTER SWITCH. A switch (6, figure 1-22) on the engineer's instrument panel with PILOTS' INSTR INV--OFF--SPARE INV positions controls the normal and spare pilots' instrument inverters. When the switch is in the PILOTS' INSTR INV position, the normal inverter is energized and supplies power to the pilot's direction 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 direction indicator or attitude indicator. Each of the two inverter control circuits is protected by a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

PILOTS' INSTRUMENT INVERTER WARNING LIGHTS There are three press-to-test pilots' instrument inverter warning lights. A red and an amber light (3 , figure 1-22) are on the engineer's instrument panel, and a red light (5, figure 1-9) is on the pilots' instrument panel. In event of failure of the normal pilots' instrument inverter, the red lights on the engineer's instrument panel and pilots' instrument panel will illuminate. The amber light on the engineer's instrument panel will illuminate and the red warning lights will go out when the spare pilots' instrument inverter automatically assumes the load of the normal inverter, or when the pilots' instrument inverter switch is positioned to SPARE INV.

Pilots' Instrument Inverter Emergency Power Switch

This switch (39, figure 1-9) on the pilots' instrument panel, with NORMAL--BATTERY positions, connects power from the battery to the spare pilots' 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 on airplanes G 2930 ▶ plus ICTO 239 that can be operated on battery power through the pilot's instrument inverter emergency power switch, see figure 4-42. When the switch is in the NORMAL position, power is supplied to the pilots' instrument inverter by the DC power distributing system. The pilots' instrument emergency power control circuit is protected by a circuit breaker on the forward power panel battery emergency bus (figure 1-35, sheet 4).

Direction Indicator Repeater Emergency Power Switch and Warning Light

This switch (23, figure 1-9) with NORMAL--EMERGENCY positions, is located on the pilots' instrument panel. When the switch is in the NORMAL position, power is supplied to the direction indicator repeater from the essential bus on the AC power panel. When the switch is placed in the EMERGENCY position, power is supplied only to the copilot's compass repeater indicator from the normal or spare autopilot inverter, whichever is operating. The direction indicator (gyro compass) repeater warning light (12. figure 1-9) is located on the pilots' instrument panel directly above the repeater switch. In the event of normal power failure the light will illuminate indicating that emergency power is needed to operate the direction indicator repeater. The repeater power circuit is protected by a fuse on the AC power panel (figure 1-35, sheet 3).

AC Voltage and Frequency Selector Switch, Voltmeter and Frequency Meter

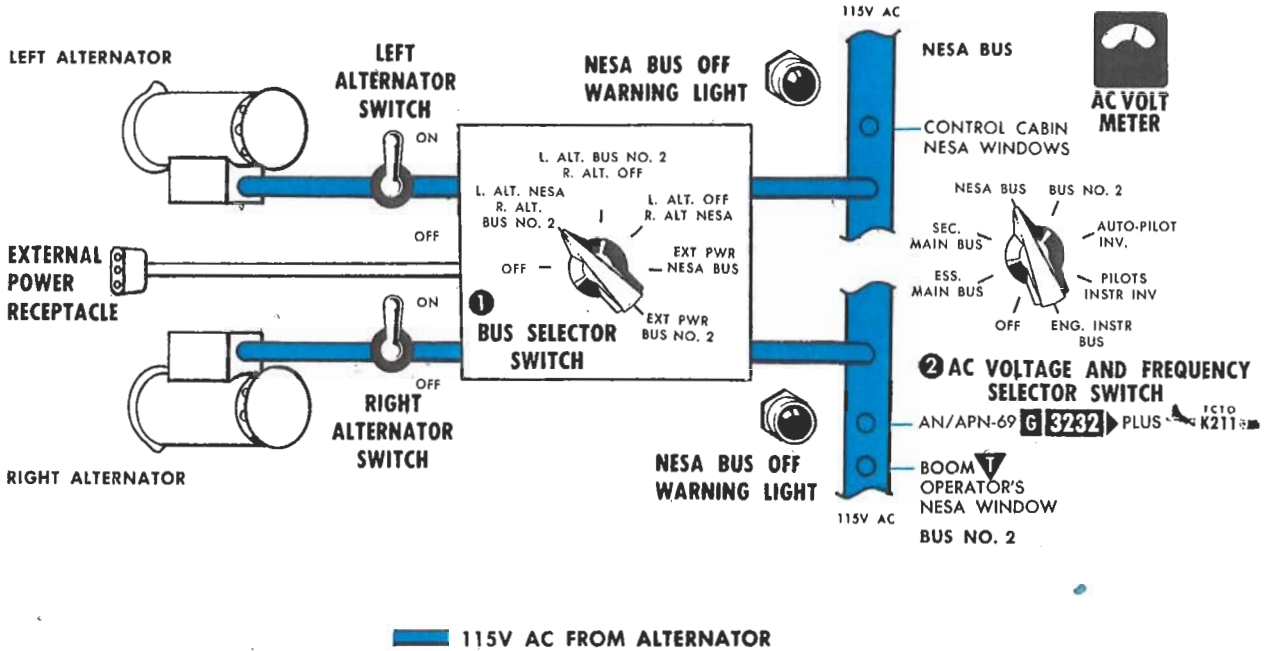
A rotary-type switch (9 , figure 1-22); a single alternating-current voltmeter (7 , figure 1-22) and a single frequency meter (8 , figure 1-22) on the engineer's instrument panel provide a means of reading the output voltage and frequency of each 400 cycle inverter and voltage only of variable frequency alternators, as selected 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 or frequency meter are connected to a power source.

Inverter Changeover Relay Test Switches

These switches (figure 1-35, sheet 3) with TEST--OFF positions, are located on the AC power panel, except on airplanes G 3142 ▶ the autopilot inverter changeover relay test switch is located on the autopilot junction shield. 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 buses 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 volts AC to the AC bus and the switch must be held in the TEST position for four 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 on Code T airplanes in the boom operator's compartment. See figure 1-33 for a schematic diagram of the variable frequency AC power system.



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

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

VARIABLE FREQUENCY AC POWER GENERATION AND DISTRIBUTION

Figure 1-33

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.

ALTERNATOR SWITCHES. The two alternators are controlled by two ON--OFF switches (1, figure 1-22) on the engineer's instrument panel. 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. The control circuit for each alternator is protected by a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

AC External Power Receptacle

An external power receptacle (19, figure 1-50) for variable frequency alternating-current power is in the forward end of the nose wheel well.

Bus Selector Switch

This rotary-type switch (80, figure 1-22), 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 alternating current from the external AC 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 alternator warning lights (81, figure 1-22) 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 hydraulic oil temperature	DC	Overhead circuit breaker panel	Same	
A/R fuel pump control	DC	Engineer's A/R panel	Same	
Receiver director light test			DC	Aft power panel
A/R fuel dump (Emergency)	DC	Forward power panel	Same	
A/R power			DC	Aft power panel
A/R fuel by-pass control valve			DC	Engineer's A/R panel
A/R fuel flow totalizer	AC	Engineer's A/R panel	Same	
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	
Signal amplifier	DC	Aft power panel	DC	Boom operator's panel
Gravity fuel dump G	DC	Engineer's A/R panel	Same	
Hydraulic pressure gages G 2894 ▶			AC	Engineer's A/R 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	
Overheat test	DC	Forward power panel	Same	
Pitot heat (Copilot's)	DC	Overhead panel	Same	
Pitot heat - (Pilot's) Normal & Emergency G 3142 ▶ PLUS TCTO 292	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 G 17260 ▶ 17271		
Window heat (Boom operator's)	DC	Overhead circuit breaker panel	AC	Alternator relay shield
	DC	Boom operator's panel		

CIRCUIT PROTECTION AND LOCATION

Figure 1-34 (Sheet 1 of 4)

CIRCUIT TITLE	CONTROL POWER	CIRCUIT PROTECTION LOCATION	OPERATING POWER	CIRCUIT PROTECTION LOCATION
AUTOPILOT				
Autopilot inverters	DC	Overhead circuit breaker panel	DC	Forward power panel
Autopilot	DC	Overhead circuit breaker panel	AC	AC power panel F G 1243 ▶ 3141
			AC	Autopilot junction shield G 3142 ▶
N-1 compass system		(Uses autopilot circuit protection)		
CABIN HEATING, VENTILATING, AND PRESSURIZING SYSTEMS				
Body heaters	DC	Forward power panel		
Body heater fuel valves	DC	Forward power panel	Same	
Body heater ignition		(Uses body heat control circuit protection)	AC	AC 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				
Aerial delivery motor F G 1243 ▶ 22628	DC	Aft power panel	DC	Main power panel
Cargo door	DC	Aft power panel	DC	Aft power panel
Cargo hoist	DC	Cargo hoist shield	DC	Forward power panel
	DC	Forward power panel G 22629 ▶ 22736		
COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT				
IFF destruction less TCTO 590	DC	Forward power 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 TCTO K211
VHF navigation (omni)	DC	Aft power panel		
		Aft radio rack junction box		
UHF navigation (Tacan) TCTO 572	DC	Radio junction box circuit breaker panel	AC	Radio junction box circuit breaker panel
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	
Generators	DC	Main circuit breaker panel	Same	
Generator field relays	DC	Overhead circuit breaker panel	DC	Overhead circuit breaker panel
			DC	Forward power panel
Inverters	DC	Overhead circuit breaker panel	DC	Forward power panel
Voltmeters	AC	AC power panel and alternator relay shield	Same	
	DC	Main circuit breaker panel	Same	
ENGINES				
Carburetor preheat valve	DC	Overhead circuit breaker panel	Same	
Carburetor sheltered 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 G 3196 ▶ PLUS TCTO 338	DC	Overhead circuit breaker panel	Same	
Ignition analyzer	DC	Overhead circuit breaker panel Control panel and analyzer	AC	AC power panel ✓
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
Turbo superchargers	AC	AC power panel	Same	
Water injection	DC	Overhead circuit breaker panel	DC	Main circuit breaker panel

Figure 1-34 (Sheet 2 of 4)

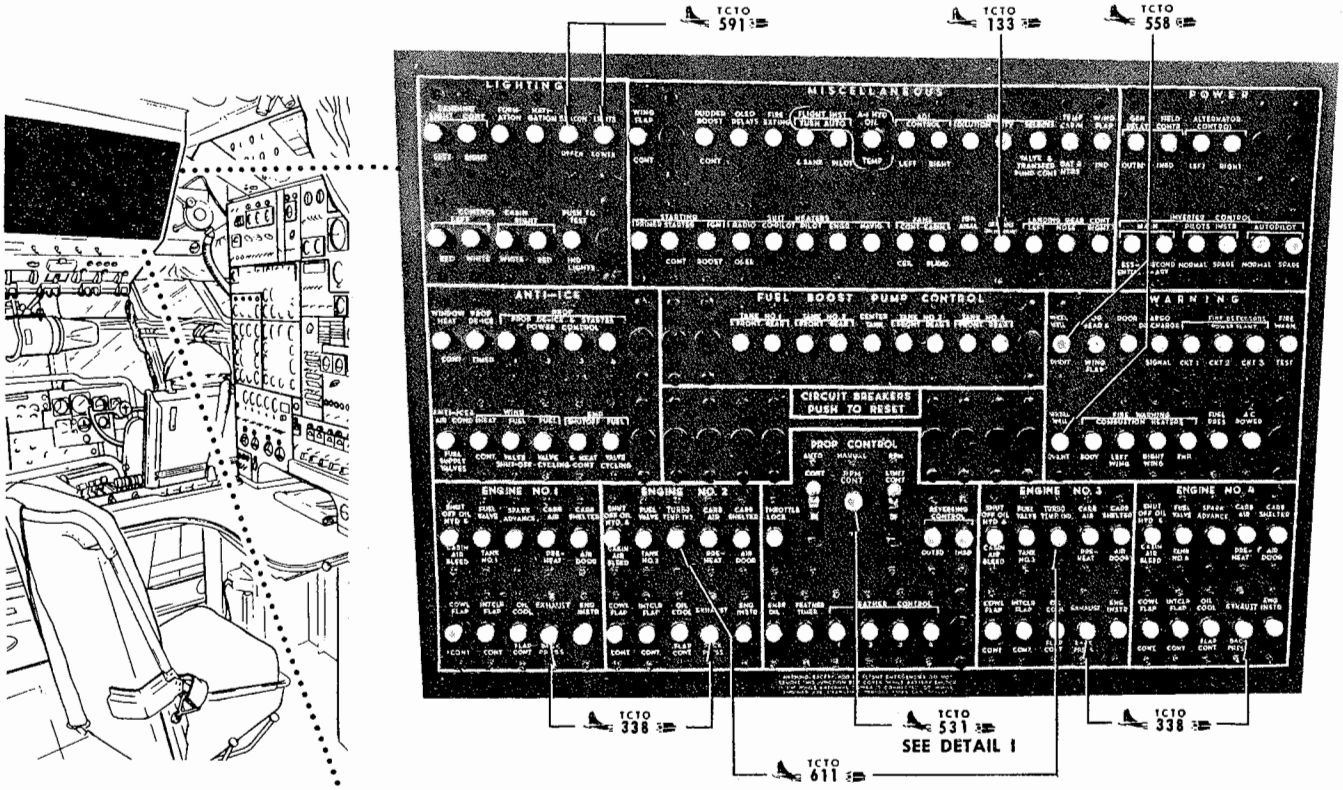
CIRCUIT TITLE	CONTROL POWER	CIRCUIT PROTECTION LOCATION	OPERATING POWER	CIRCUIT PROTECTION LOCATION
FIRE EXTINGUISHING AND FIRE WARNING				
Fire detectors			DC	Overhead circuit breaker panel
Fire extinguishing	DC	Overhead circuit breaker panel		
Fire warning test	DC	Overhead circuit breaker panel	Same	
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				
T 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
T Fuel leveling valve (A/R)	DC	Engineer's A/R panel	Same	
Fuel pressure warning			DC	Overhead panel
T Fuel selector valve	DC	Overhead circuit breaker panel	Same	
T Fuel shutoff valve (Emergency A/R)			DC	Engineer's A/R panel
T Fuel transfer valves (A/R)	DC	Engineer's A/R panel	Same	
Single point refueling F G 1255 ▶	DC	Forward power panel	Same	
Single point refueling secondary valves F G 1255 ▶	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				
T 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 direction indicator			AC	AC power panel
Temperature cabin, OAT and heater			DC	Overhead circuit breaker panel
Turn and slip indicator (Pilot's)			DC	Overhead circuit breaker panel
Turn and slip indicator (Copilot's)			AC	(Uses autopilot circuit protection)
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	

CIRCUIT PROTECTION AND LOCATION (CONT)

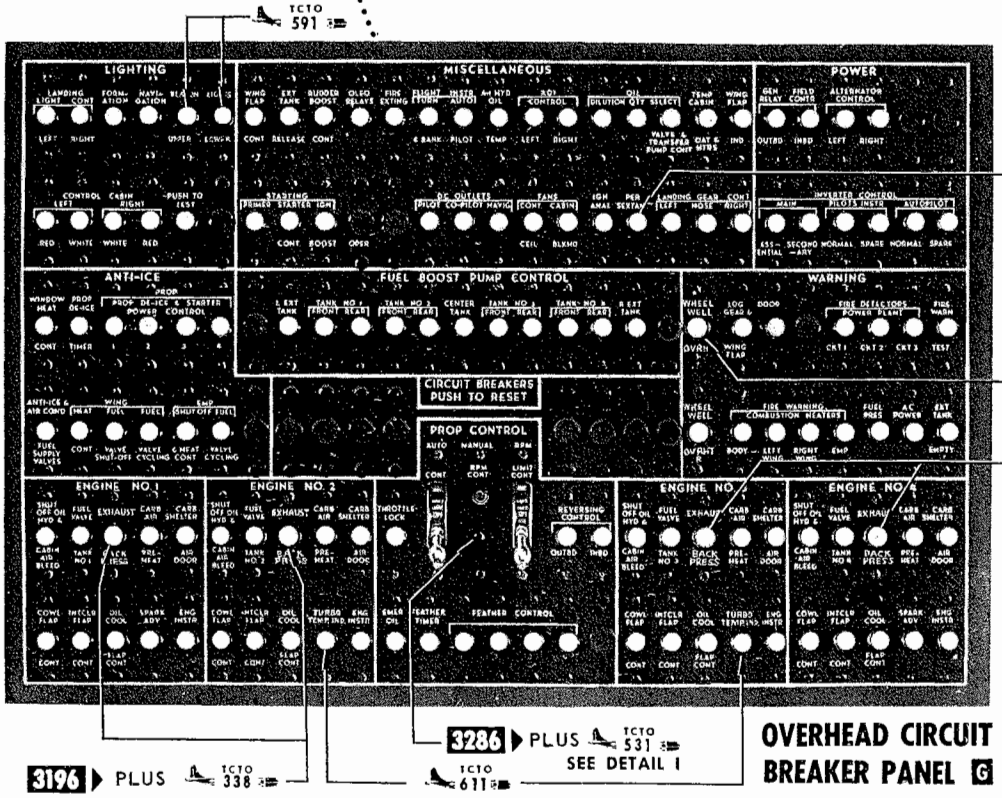
Figure 1-34 (Sheet 3 of 4)

CIRCUIT TITLE	CONTROL POWER	CIRCUIT PROTECTION LOCATION	OPERATING POWER	CIRCUIT PROTECTION LOCATION
LIGHTING				
Anti-collision lights and color control TCTO 591	DC	Overhead circuit breaker panel	Same	
Anti-collision lights rotation motors TCTO 591			AC	AC power panel
T 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	
T Engineer's refueling panel lights	DC	Engineer's A/R panel	Same	
Exterior lights (A/R)	DC	Boom operator's panel	Same	
Fluorescent lights F G 1243 ▶ 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 cargo compartment	DC	Main circuit breaker panel	Same	
Miscellaneous lights	DC	Overhead panel	Same	
Navigation lights	DC	Overhead circuit breaker panel	Same	
T Rendezvous beacon lights	DC	Boom operator's 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 G 2860 ▶ PLUS TCTO 133	DC	Overhead circuit breaker panel	Same	
Suit heaters F G 1243 ▶ 2859	DC	Overhead circuit breaker panel	Same	
NOSE STEERING SYSTEM				
Nose steering emergency valve	DC	Forward power panel	Same	
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 F G 1243 ▶ 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
External Tank Low G	DC	Overhead circuit breaker panel	Same	
Fire detectors			DC	Overhead circuit breaker panel
Fire detector test	DC	Overhead circuit breaker panel	Same	
T Fuel and hydraulic pressure (A/R)			DC	Engineer's A/R panel
Fuel pressure			DC	Overhead circuit breaker panel
T Fuel quantity gage test (A/R)	DC	Engineer's A/R panel	Same	
Landing gear and wing flaps			DC	Overhead circuit breaker panel
Turbo bearing temperature gages TCTO 611	DC	Overhead circuit breaker panel	Same	
Wheel well overheat TCTO 558			DC	Overhead circuit breaker panel

Figure 1-34 (Sheet 4 of 4)

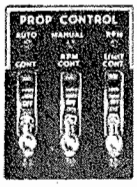


OVERHEAD CIRCUIT BREAKER PANEL F



OVERHEAD CIRCUIT BREAKER PANEL G

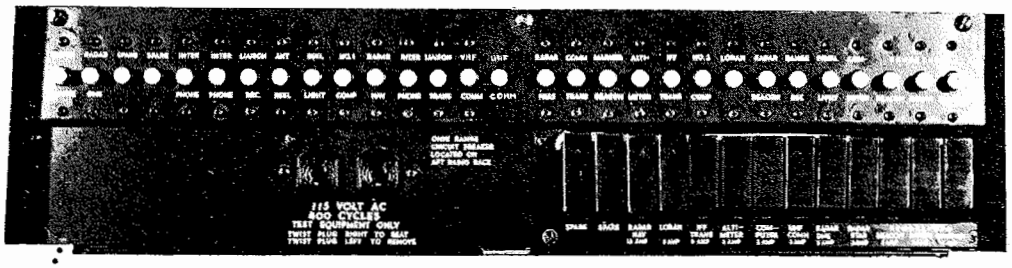
F G 1243 3285 WITHOUT TCTO 531



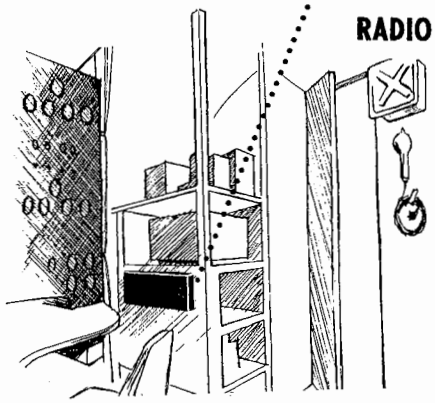
DETAIL 1

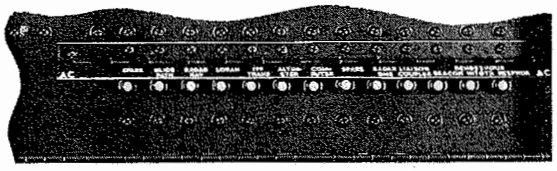
CIRCUIT BREAKER PANELS LOCATION

Figure 1-35 (Sheet 1 of 8)

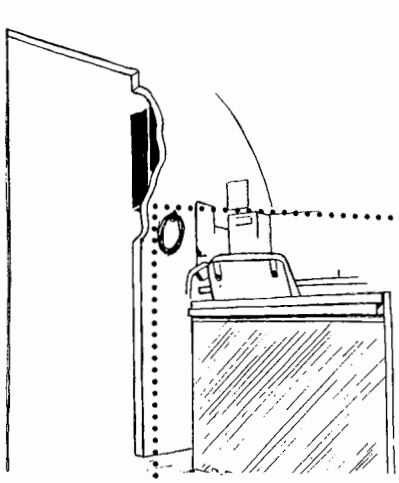


RADIO JUNCTION BOX CIRCUIT BREAKER PANEL (TYPICAL) F G 1243 ▶ 22700
SEE DETAIL II

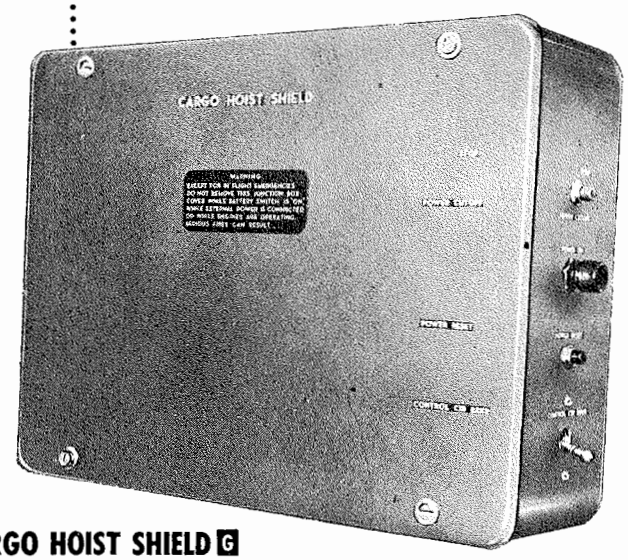




DETAIL II G 22701 ▶

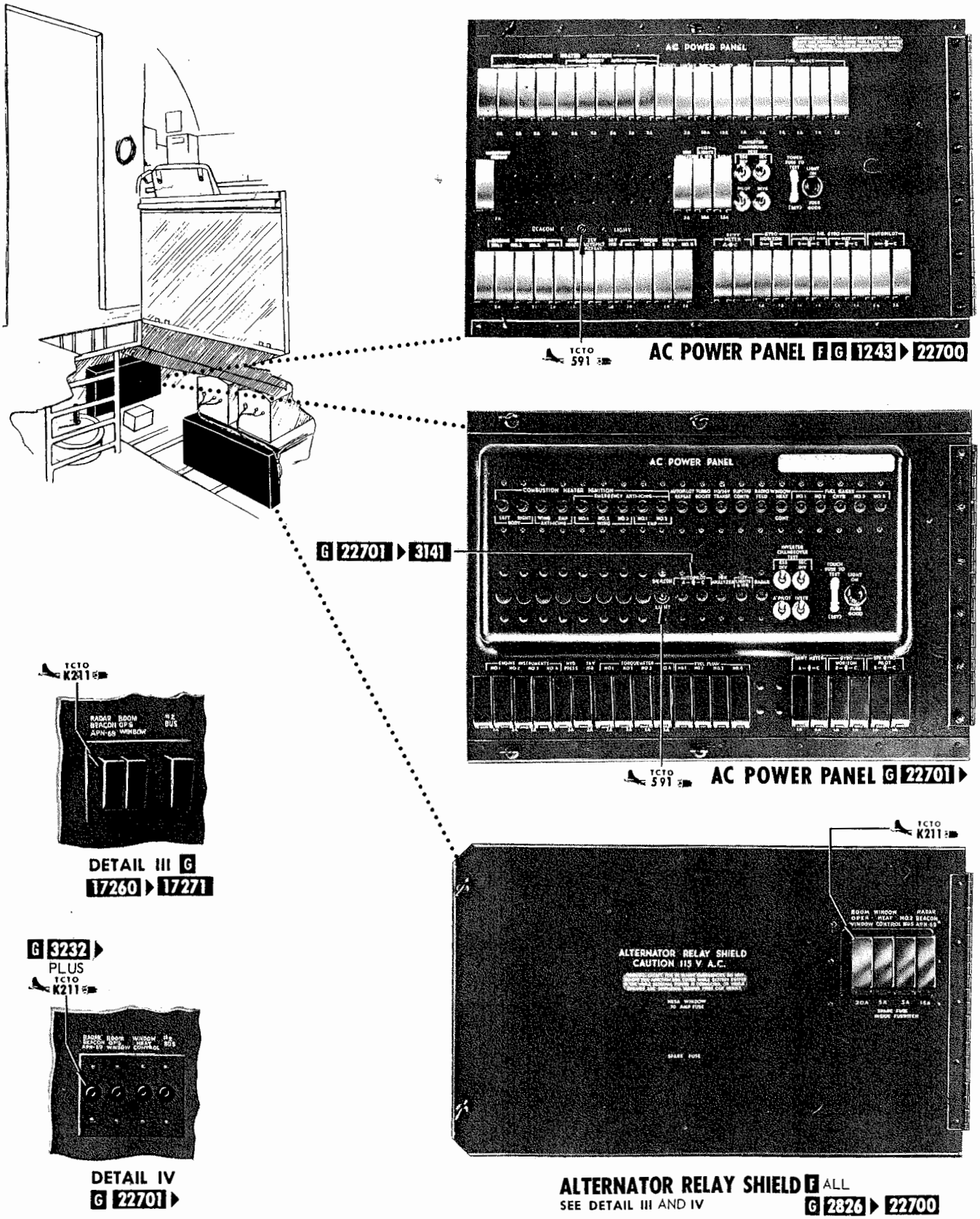


CARGO HOIST SHIELD F



CARGO HOIST SHIELD G

Figure 1-35 (Sheet 2 of 8)



CIRCUIT BREAKER PANELS LOCATION (CONT)

Figure 1-35 (Sheet 3 of 8)

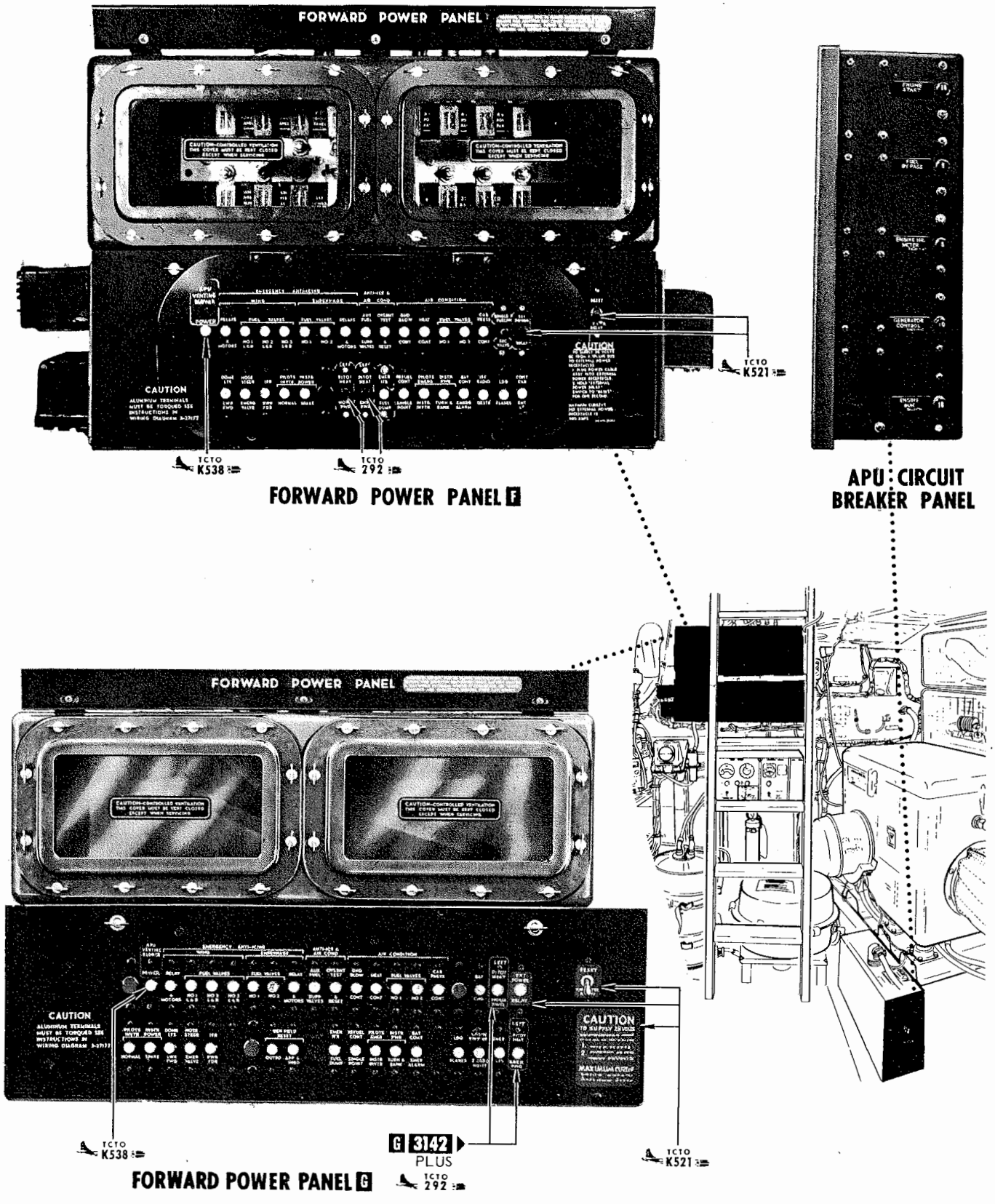
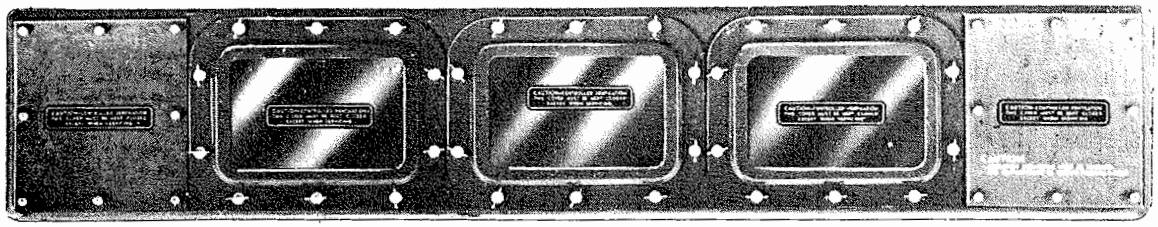
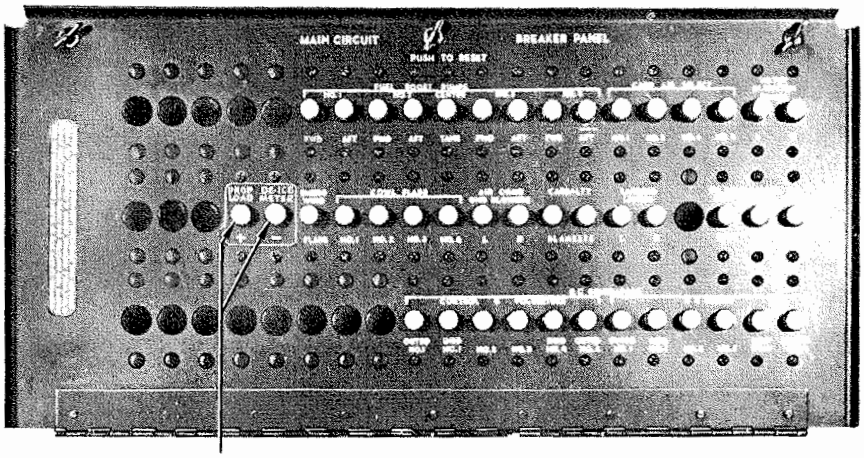


Figure 1-35 (Sheet 4 of 8)

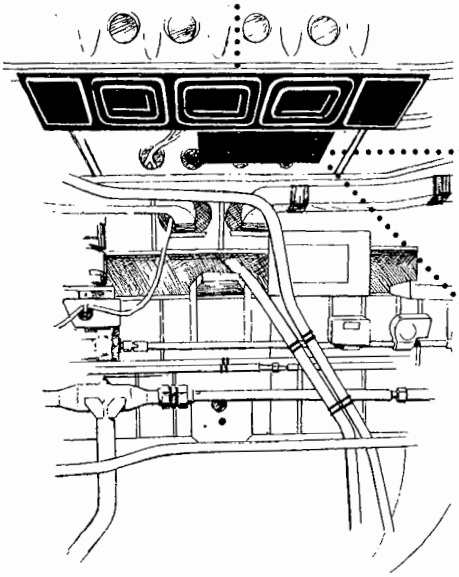


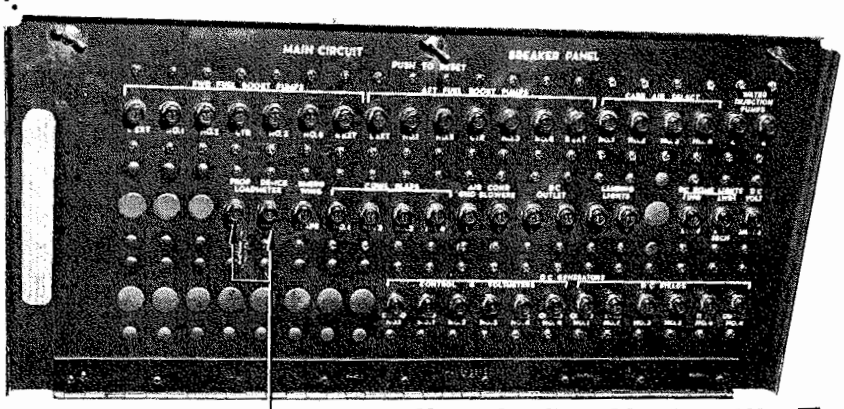
MAIN POWER PANEL



1CTO 534

MAIN CIRCUIT BREAKER PANEL F



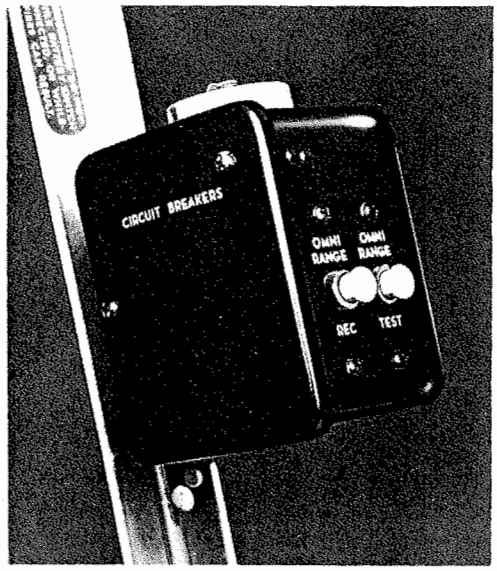


MAIN CIRCUIT BREAKER PANEL G

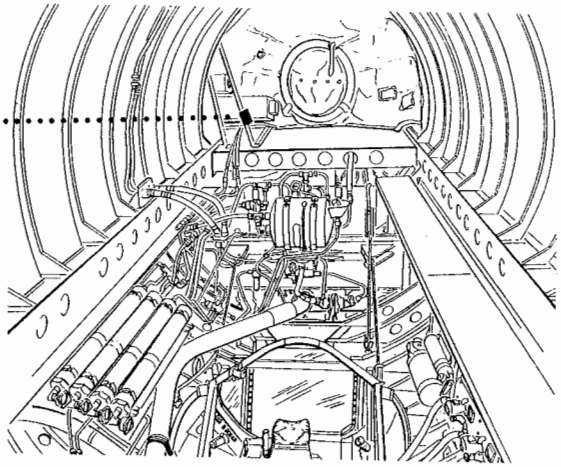
G 22629 PLUS TCTO 534

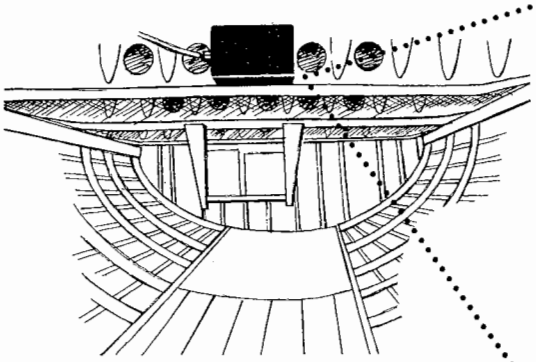
CIRCUIT BREAKER PANELS LOCATION (CONT)

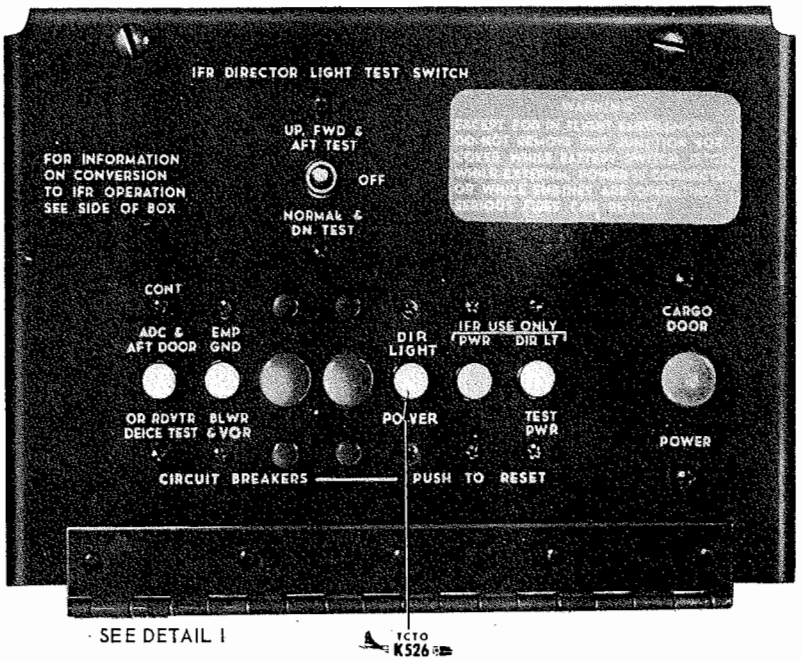
Figure 1-35 (Sheet 5 of 8)



AFT RADIO RACK JUNCTION BOX

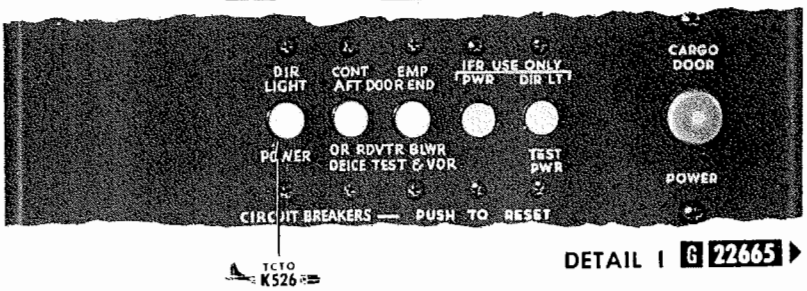






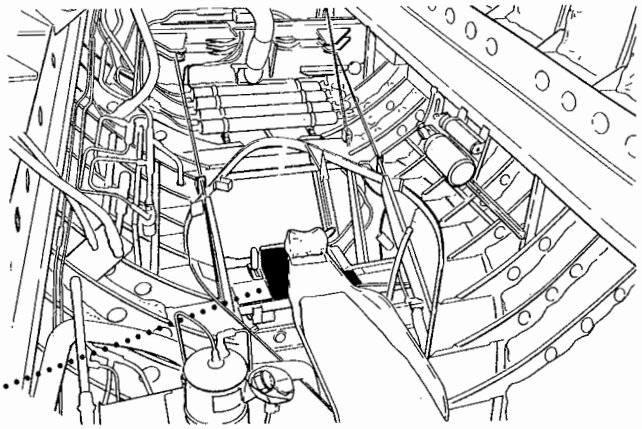
AFT POWER PANEL

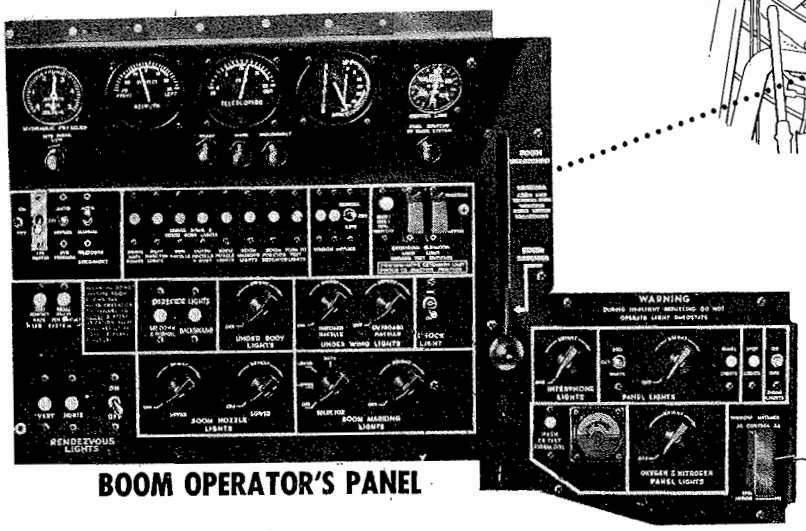
F G 1243 ▶ 22664



DETAIL I G 22665 ▶

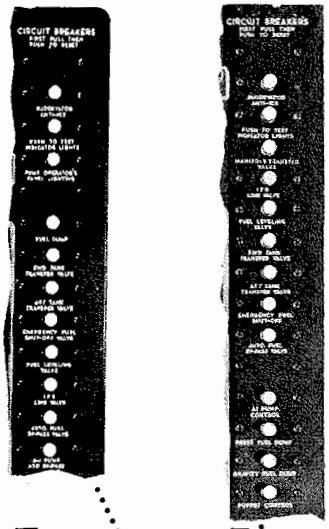
Figure 1-35 (Sheet 6 of 8)





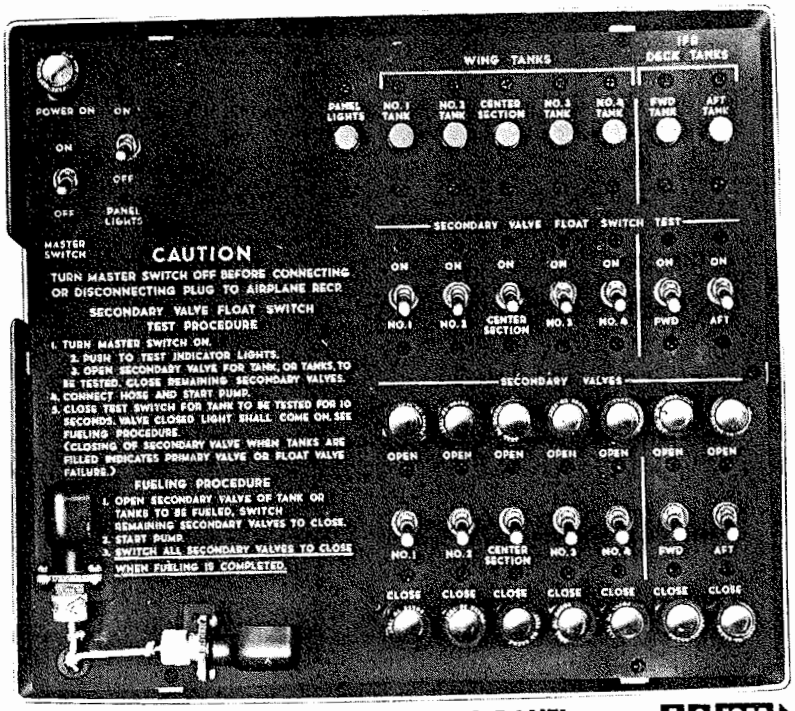
BOOM OPERATOR'S PANEL

F G 1243 ▶ 22700



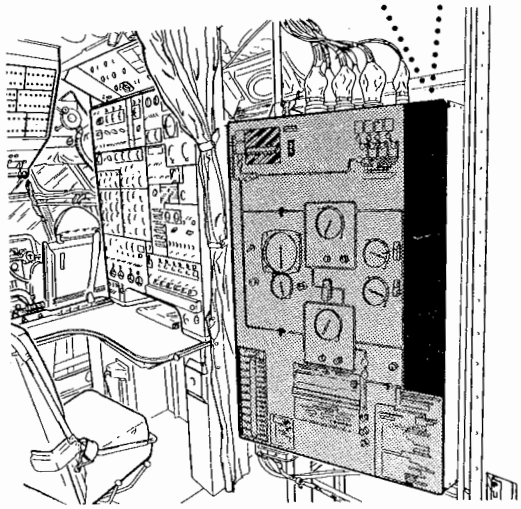
F G

ENGINEER'S A/R PANEL



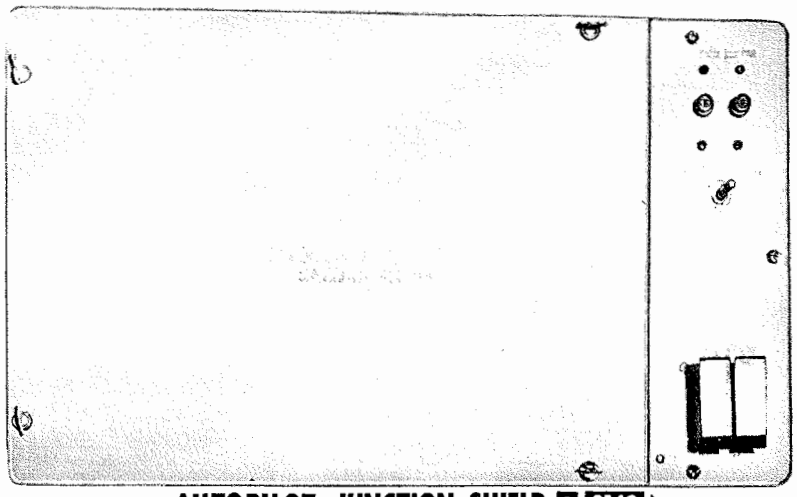
SINGLE POINT REFUELING PANEL

F G 1255 ▶

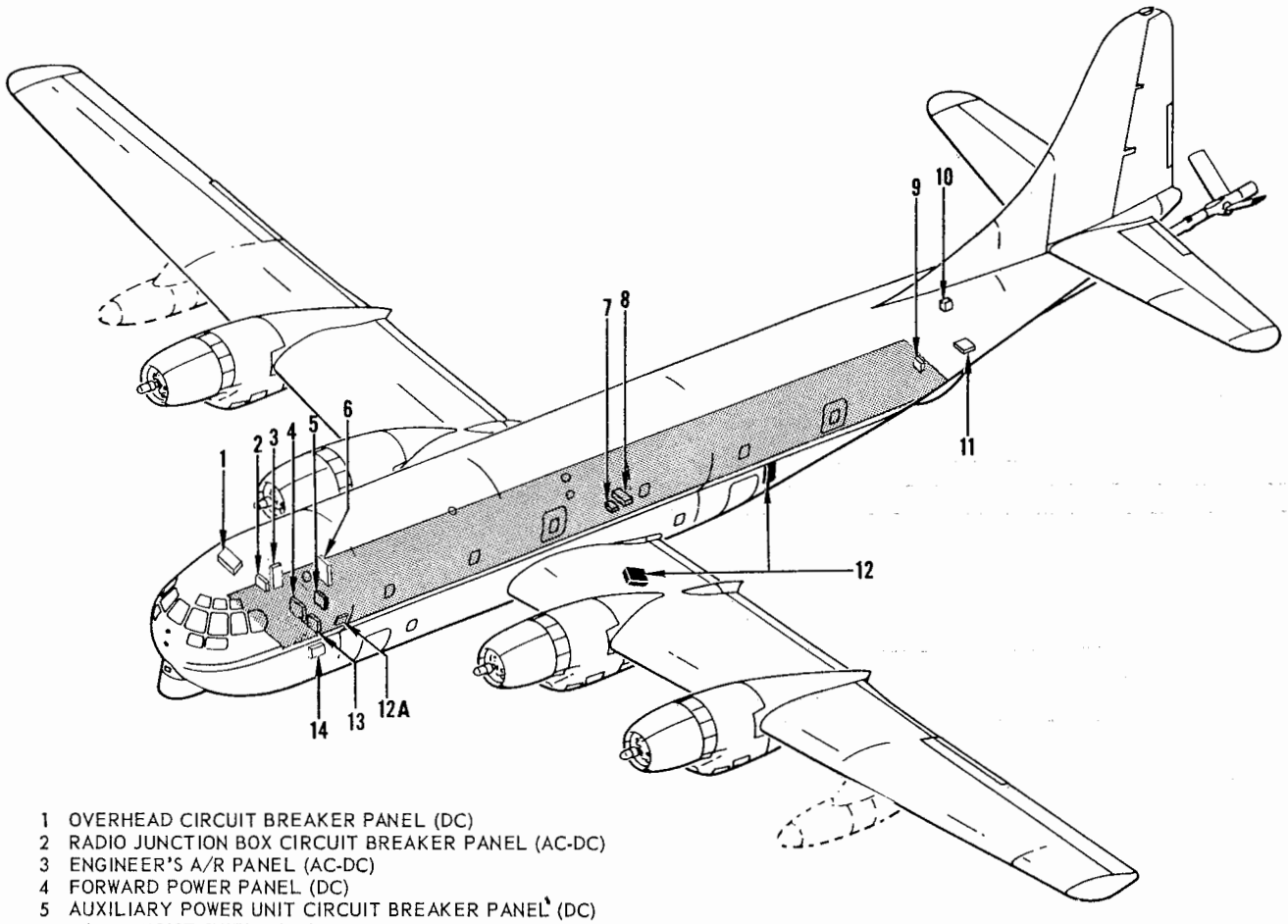


CIRCUIT BREAKER PANELS LOCATION (CONT)

Figure 1-35 (Sheet 7 of 8)



AUTOPILOT JUNCTION SHIELD G 3142 ▶



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

Figure 1-35 (Sheet 8 of 8)

HYDRAULIC SYSTEM

Both the tanker and cargo airplanes are 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
T Air Refueling Hydraulic Systems (See Section IV)	Pressure System Boom System Fuel Pump System Isodraulic System
Forward Cargo Door Hydraulic System (See Section IV)	Cargo Door
G Aft Cargo Door Hydraulic System (See Section IV)	Cargo Door

MAIN HYDRAULIC SYSTEM

The main hydraulic system supplies 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 airplanes G 22737 ▶ 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 pumps, one each on No. 2 and No. 3 engines. The pumps are set to maintain 1500-1650 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 hand pump. A hand pump is provided to supply pressure to the service brake system in the event of failure of both engine-driven pumps. The hand pump can also be used to recharge the emergency brake system. On F 1243 ▶ 1374 a controllable check valve is provided to ground test the entire hydraulic system with the hand pump. During inflight 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.

Controllable Hydraulic Check Valve Handle F 1243 ▶ 1374

A controllable check valve handle (14, figure 1-15) on the copilot's auxiliary panel controls a check valve in the main system pressure lines. When the handle is in the GROUND TEST POSITION, the check valve is opened and pressure from the hand pump can be applied to the nose wheel steering, windshield wipers, rudder boost, and brake systems. When the handle is in the NORMAL POSITION the check valve allows pressure to flow in one direction, the engine-driven pumps provide pressure to the entire system, while the hand pump can pressurize only the service brake system.

Depressurization Handles F 1243 ▶ 1374

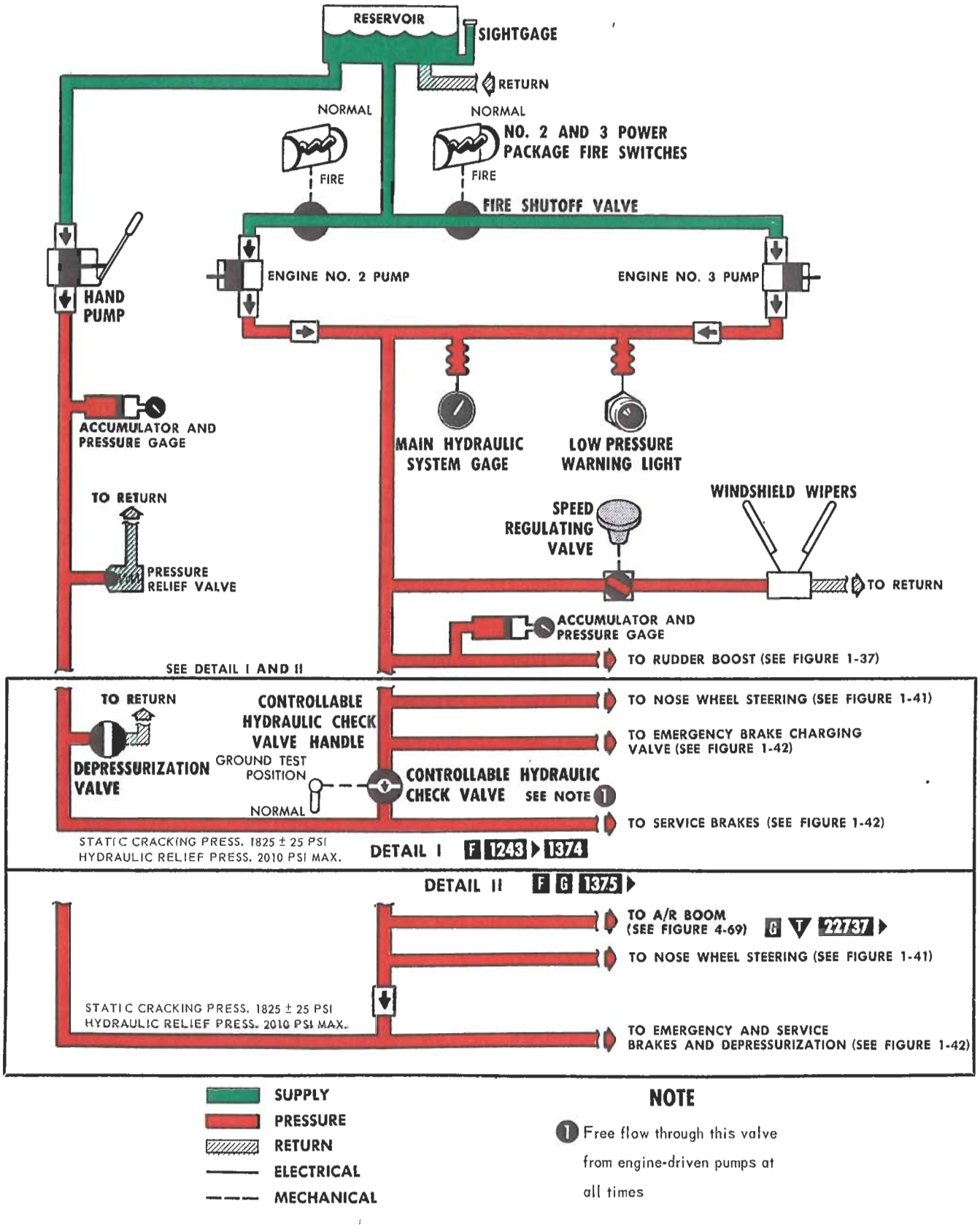
Two handles (6, figure 1-15) on the copilot's auxiliary panel, control shutoff valves; one valve is in the main pressure line and the other between the pressure lines and reservoir. The valve controlling the main pressure line is locked in the open position and is rendered inoperative. The other depressurization valve handle has ON, DEPRESSURIZATION POSITION--OFF, NORMAL POSITION. When this valve handle is turned to the ON, DEPRESSURIZATION POSITION, the shutoff valve leading to the reservoir is opened and the airplane hydraulic system, with the exception of the emergency brake system, is depressurized.

Depressurization And Emergency Charging Valve Handle F G 1375 ▶

This is a three position valve handle (16, figure 1-15) on the copilot's auxiliary panel and is mechanically linked to a control valve. The three positions are: NORMAL--EMERGENCY BRAKE CHARGING--DEPRESSUIRZED 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.

Hand Pump

A hand pump (13, figure 1-15) below the copilot's auxiliary panel is provided to supply pressure to the service brakes in the event of failure of both engine-driven pumps. On F 1243 ▶ 1374 hand pump can be used to recharge the entire hydraulic system by placing the controllable hydraulic check valve handle in the GROUND TEST POSITION, and the depressurization valve handle in the OFF, NORMAL POSITION. On F G 1375 ▶ the hand pump can be used to recharge the emergency brake system by first placing the depressurization and emergency charging valve handle in EMERGENCY BRAKE CHARGING position.



MAIN HYDRAULIC SUPPLY SYSTEM

Figure 1-36

Hydraulic System Pressure Gages

Three gages are provided. Two are on the pilots' instrument panel: one indicates main system pressure (29, figure 1-9) and the other indicates service brake system pressure (26, figure 1-9). A gage (1, figure 1-15) 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 (figure 1-35, sheet 3).

Hydraulic System Low Pressure Warning Lights

An amber light (28, figure 1-9), adjacent to the main hydraulic system pressure gage will illuminate whenever system pressure falls below 900 psi. Two other lights in the hydraulic system are described in BRAKE SYSTEM in this Section. The warning light is operated by 28 volt DC power from a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

HYDRAULIC FLUID SPECIFICATION

Refer to Servicing Diagram (figure 1-50) 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 (figure 1-35, sheet 1).

SURFACE LOCK HANDLE

This red handle (6, figure 1-16) 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 surface lock 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 fifty 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 surface lock handle is in the DOWN-UNLOCKED position the surfaces are unlocked, throttle movement is unrestricted, and rudder boost can be turned on.

CONTROL COLUMN AND WHEEL

The dual control columns and wheels for elevator and aileron control are conventional. Each control column wheel contains an autopilot release switch and microphone switch (4, 5, figure 1-7) and (2, 3, figure 1-8) on the outboard side of the control column wheels.

TRIM CONTROL WHEELS AND INDICATORS

Trim control wheels and indicators (3, 9, 39, and 49, figure 1-16) are on the control stand.

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

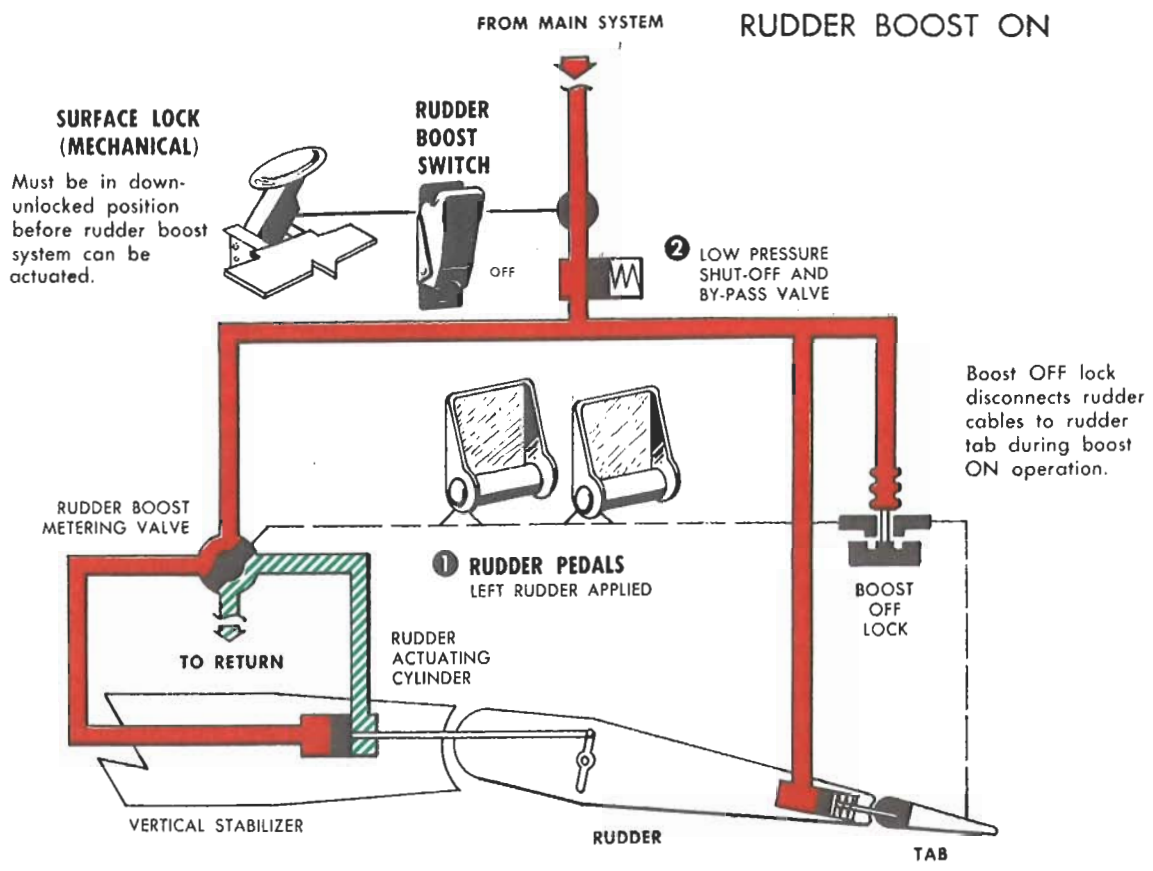
The primary purpose of the rudder boost system (figure 1-37) is to provide effective rudder control at low airspeeds with unsymmetrical power as would occur if an engine failed during takeoff or landing. The main hydraulic system (figure 1-36) provides pressure to operate the rudder boost system. With 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 system to the rudder boost systems falls below 800 psi, a shutoff and bypass valve (figure 1-37) 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 pressure switch (2, figure 1-16) 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 system pressure line leading to rudder boost actuating units. The rudder boost switch is wired in series with a switch



RUDDER HYDRAULIC BOOST SYSTEM

Figure 1-37

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 tab is then cable operated. Power and circuit protection is through the overhead circuit breaker panel (figure 1-35, sheet 1).

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 motor (figure 1-38) mechanically connected to the normal wing flap motor (figure 1-38) 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% 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 (figure 1-35, sheet 5). Control circuit protection is through the overhead circuit breaker panel (figure 1-35, sheet 1) for the normal wing flap motor and through a circuit breaker on the main circuit breaker panel for the auxiliary wing flap motor.

WING FLAP SWITCH

The wing flaps are normally controlled by a switch (22, figure 1-16) 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 (figure 1-35, sheet 1).

EMERGENCY WING FLAP SWITCH

A guarded DOWN--OFF-UP switch (20, figure 1-12) on the overhead panel controls the wing flap auxiliary 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 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 auxiliary 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 (figure 1-35, sheet 5).

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 POSITION INDICATORS

Two wing flap position indicators (32, figure 1-9) 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 (figure 1-35, sheet 1).

WING FLAP POSITION MARKINGS

There are three orange color stripes painted on the top side of each wing flap, outboard of the inboard nacelles (figure 1-38). These stripes provide a means for visually checking the amount of wing flap travel from the scanners position in the main compartment during flight operation. Each stripe is marked with corresponding numerals indicating the % 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 gear. Three ground safety locks, one for each landing gear (figure 1-40) are provided to prevent accidental collapse of the landing gear while on the ground. 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 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 flap motor (figure 1-38) mounted above the normal wing flap motor, can be removed and used for emergency operation of the main gear; however, the hand crank 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 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 flap motor is on the main circuit breaker panel (figure 1-35, sheet 5).

LANDING GEAR SWITCH

A DOWN--OFF--UP switch (8, figure 1-16) 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 de-energized. Three circuit breakers, on the overhead circuit breaker panel (figure 1-35, sheet 1) 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 (figure 1-35, sheet 5). The nose gear motor receives power through a circuit breaker on the forward power panel (figure 1-35, sheet 4).

EMERGENCY RETRACTION SWITCH

TCTO 299

The landing gear emergency retraction switch (29, figure 1-12) 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 (figure 1-35, sheet 1).

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 1/5 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% with the weight of the airplane on the landing gear. A NORMAL--HORN RELEASE switch (7, figure 1-16), 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 (figure 1-35, sheet 1).

EMERGENCY HAND CRANKS

In an emergency, the landing gear can be operated manually by hand cranks. The nose gear crank (figure 1-39) is on the underside of the lower nose compartment hatch. The main gear cranks (figure 1-39) 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 1-39) 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 1-39) 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 indicators (35, figure 1-9) on the pilots' instrument panel show, by interchangeable tabs, the positions of the main and nose 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 (figure 1-35, sheet 1).

LANDING GEAR WARNING LIGHT

A red warning light (36, figure 1-9) 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 1/5 open. Power and circuit protection is through the overhead circuit breaker panel (figure 1-35, sheet 1).

WHEEL WELL OVERHEAT WARNING LIGHTS

TCTO 558

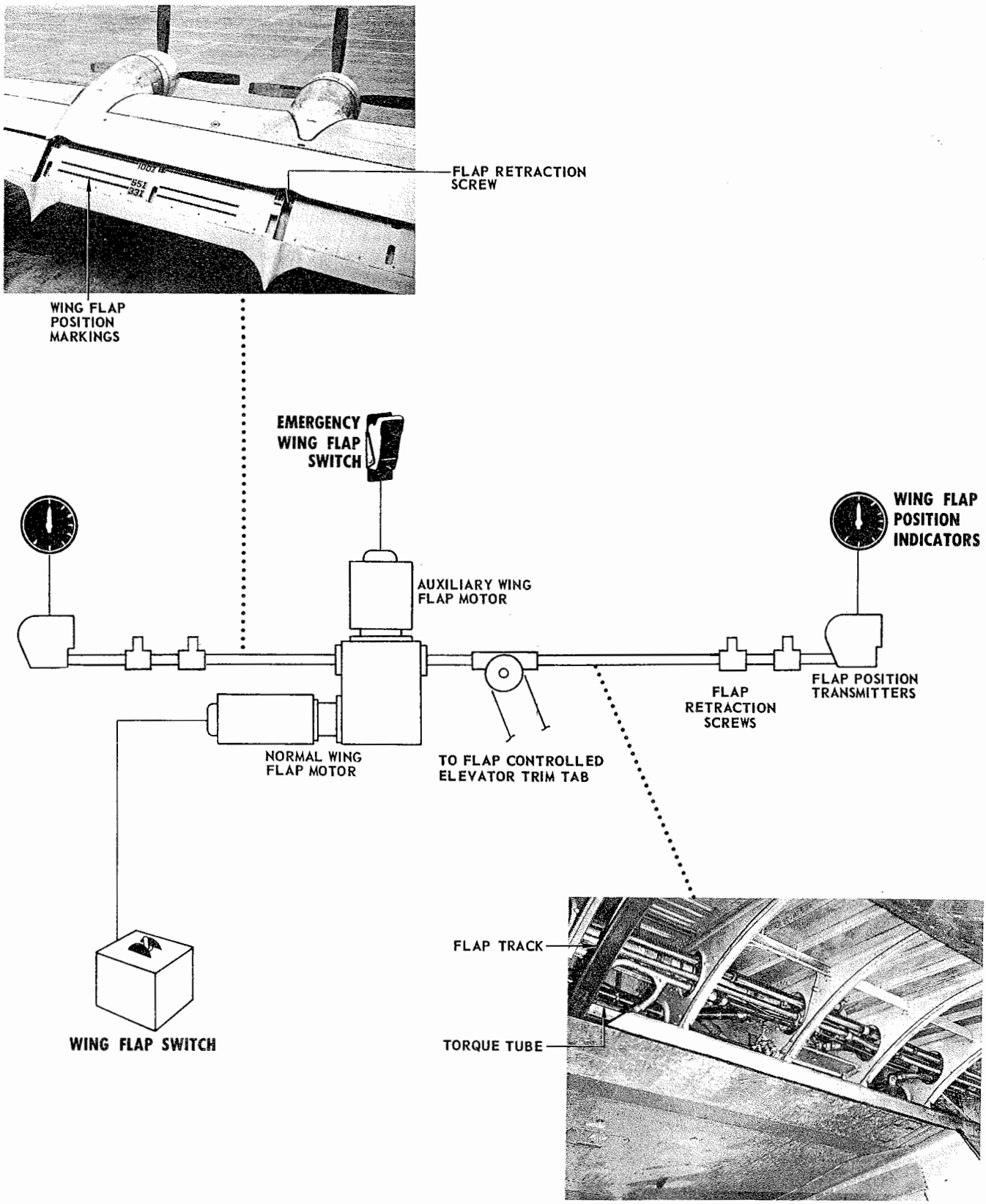
Two wheel well overheat warning lights (20, figure 1-9) located on the pilots' instrument panel, will illuminate if the brakes or tires are overheated when retracted. The overheat condition is sensed by two adjustable detector switches in each main wheel well. These switches are set to close at 200°F. Circuit protection is through the overhead circuit breaker panel (figure 1-35, sheet 1).

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. 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. See figure 1-41.

NOSE STEERING WHEEL

Nose gear steering is controlled by a steering wheel (10, figure 1-7) mounted on a pedestal forward and



WING FLAP SYSTEM

Figure 1-38

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 follow-up system will return the nose wheel to its original course should the wheel be deflected momentarily by some obstacle. Nose wheel must be centered before 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.

EMERGENCY DISCONNECT BUTTON

When manually depressed, the push-pull button on the steering pedestal (3, figure 1-7) electrically actuates the bypass valve, bypasses hydraulic fluid pressure past the steering 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 re-engage the steering mechanism. Power and circuit protection is through the forward power panel (figure 1-35, sheet 4).

NOTE

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

BRAKE SYSTEMS

SERVICE BRAKE SYSTEM

Main hydraulic system pressure is used to operate the service brakes. See figure 1-42. Toe pressure on the pilot's or copilot's rudder pedals will actuate 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. Whenever 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.

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.

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.

Hydraulic Fuses

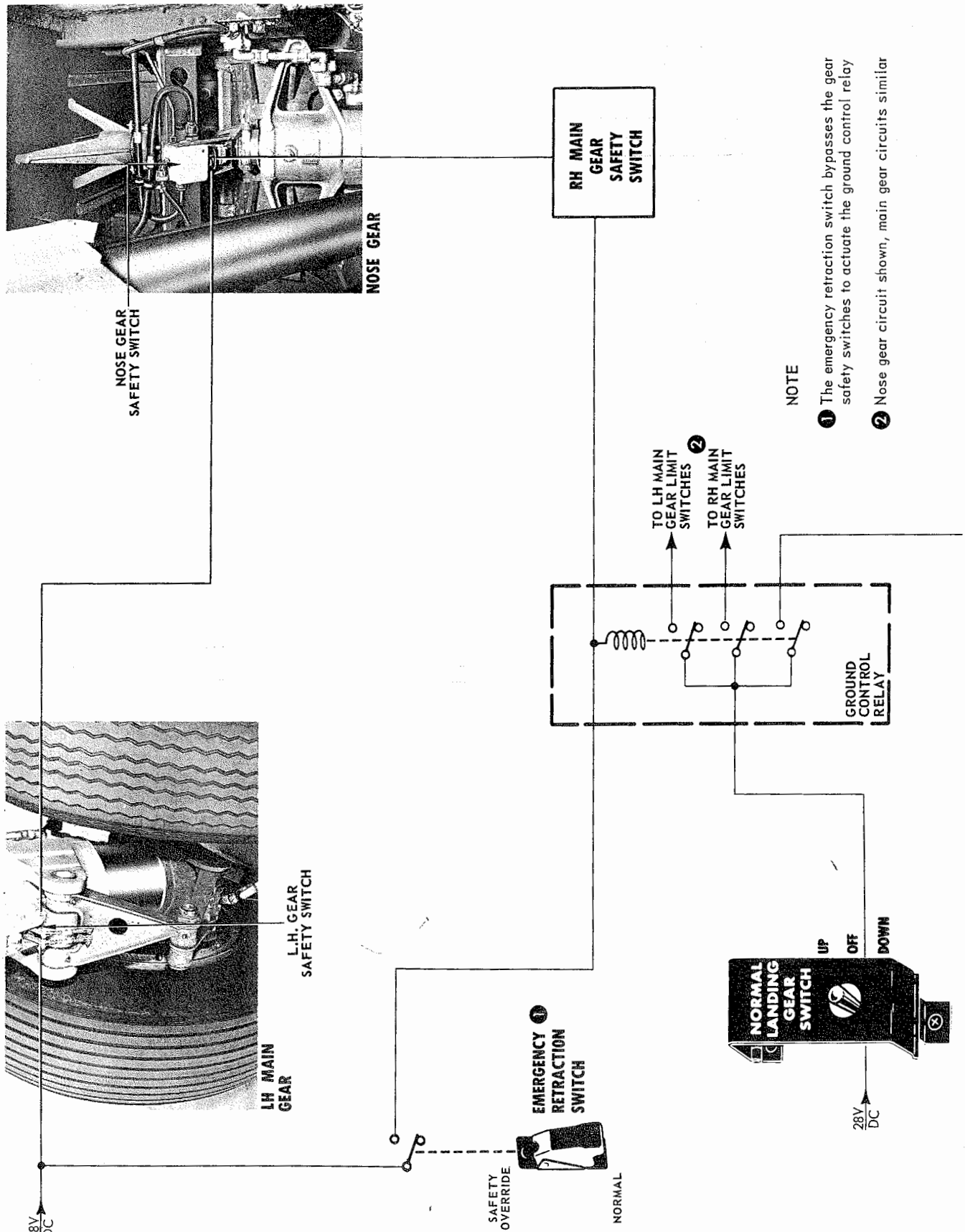
A hydraulic fuse in the brake line to each wheel is designed to shut off the flow of fluid after a quantity of fluid somewhat in excess of that required to operate the brakes has passed the fuse. See figure 1-42. Should a brake line rupture, the fuse will close and stop the flow of fluid through the 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 1-7) 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 1-42) stores pressure in an accumulator for emergency operation of the service brakes. With TCTO K555 incorporated only two applications of emergency brakes are available.



LANDING GEAR CONTROL SYSTEM

Figure 1-39 (Sheet 1 of 2)

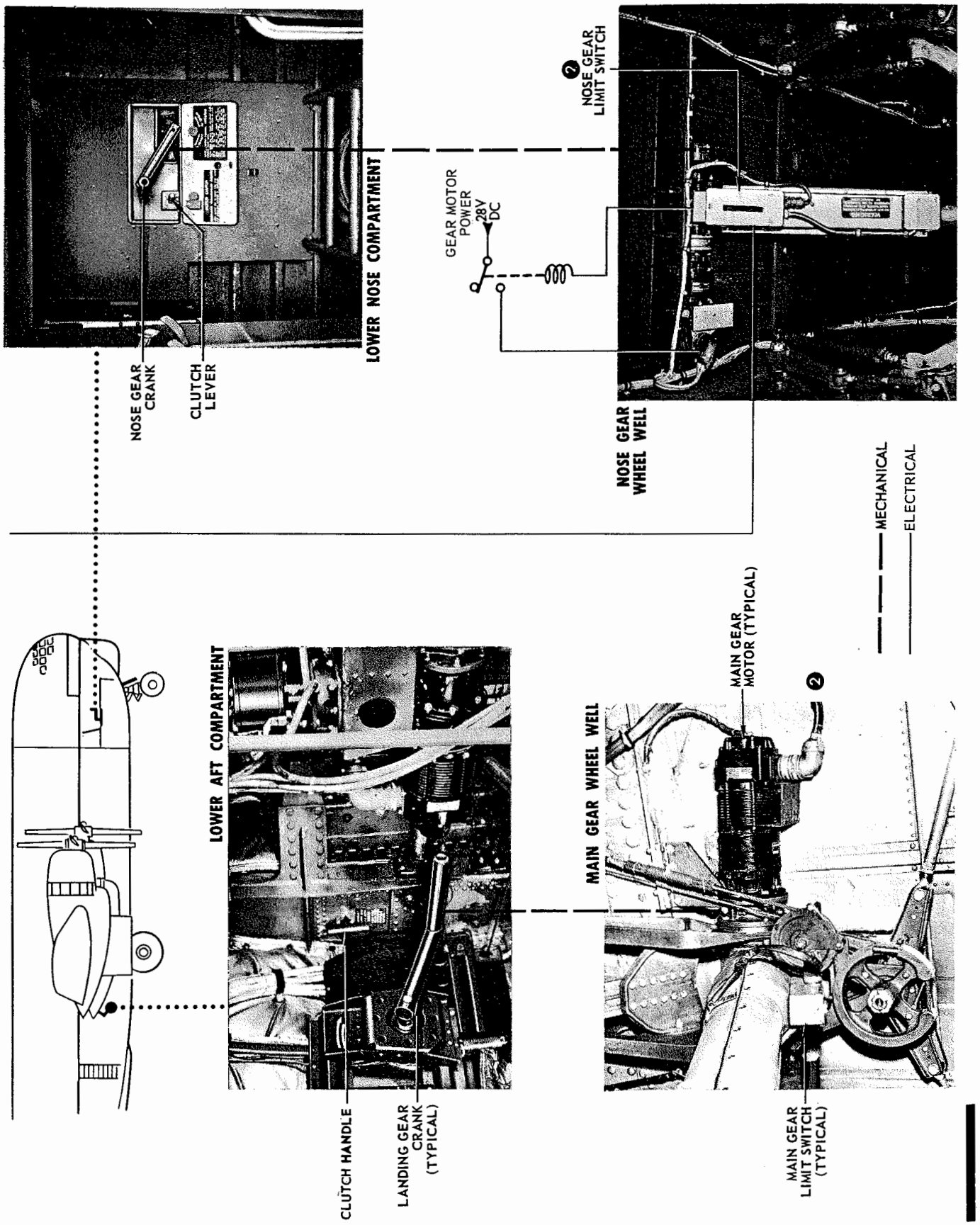
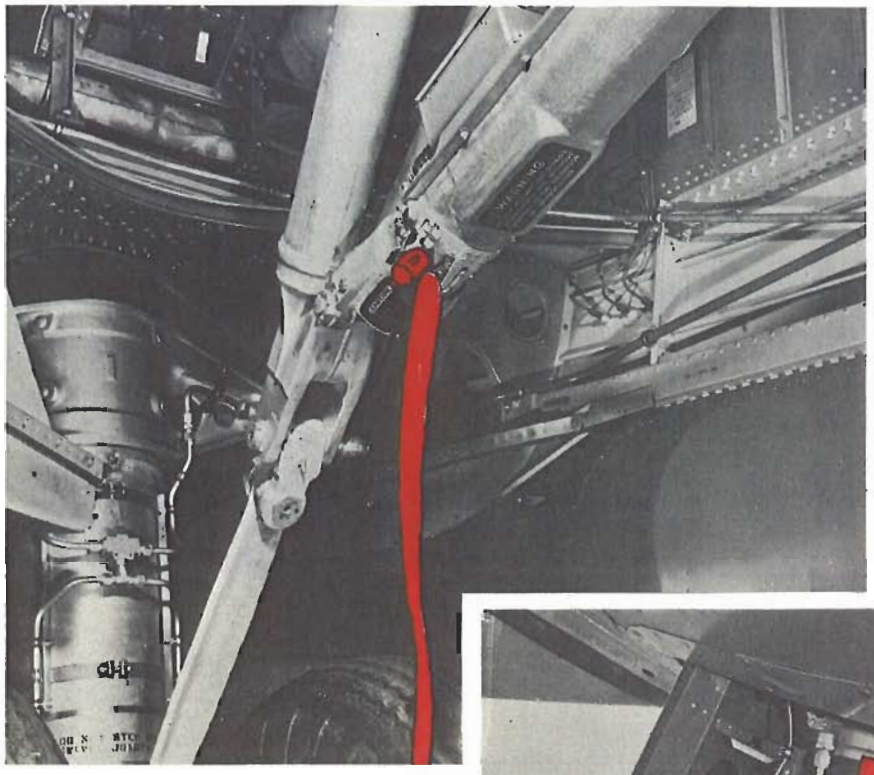
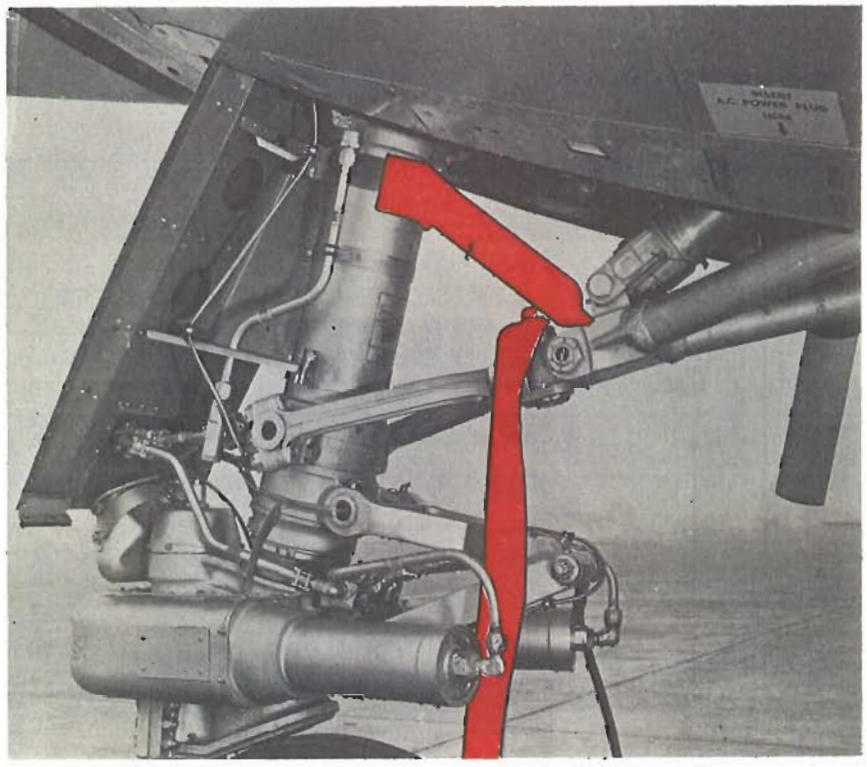


Figure 1-39 (Sheet 2 of 2)



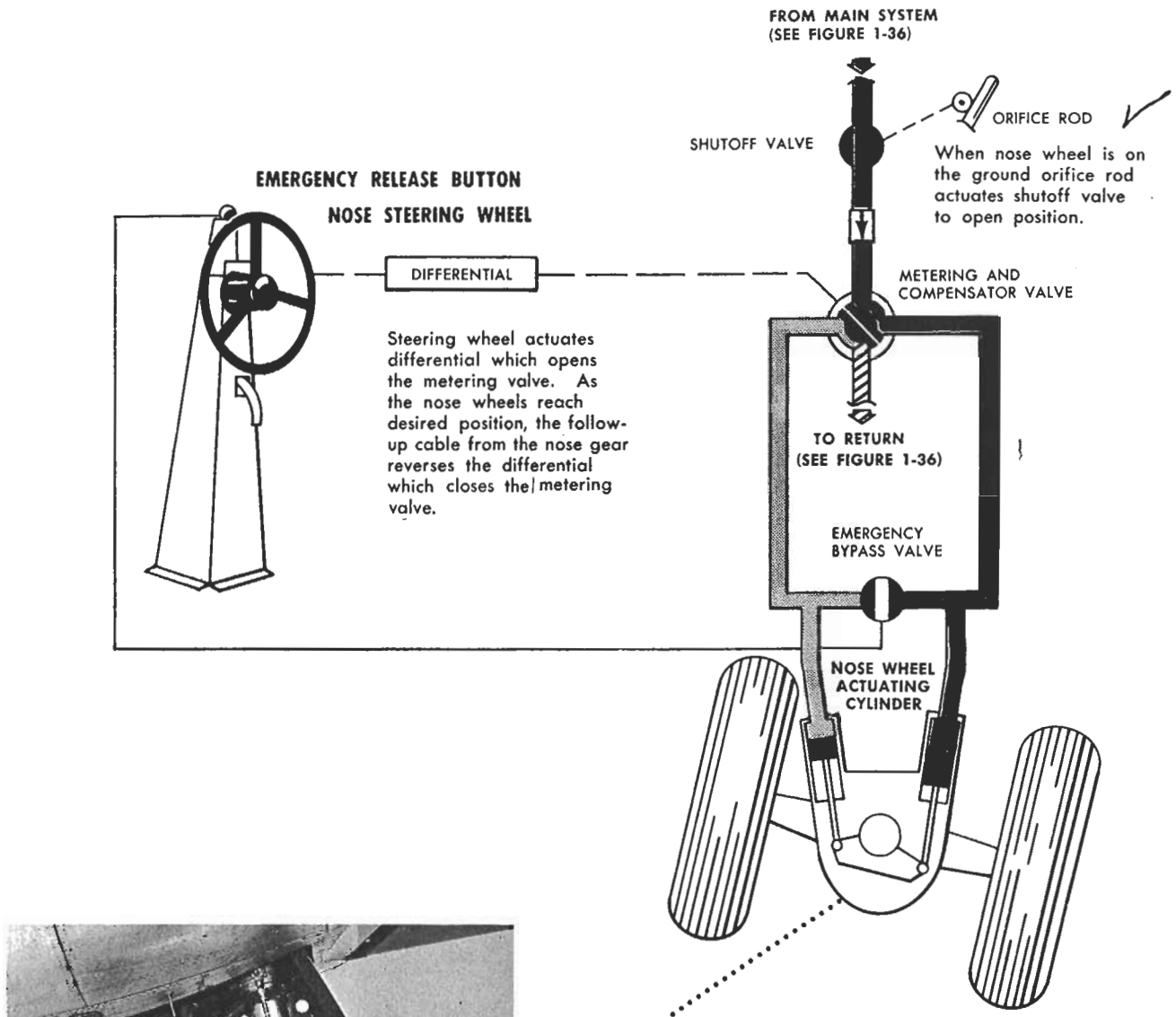
MAIN LANDING GEAR GROUND LOCK

NOSE GEAR GROUND LOCK



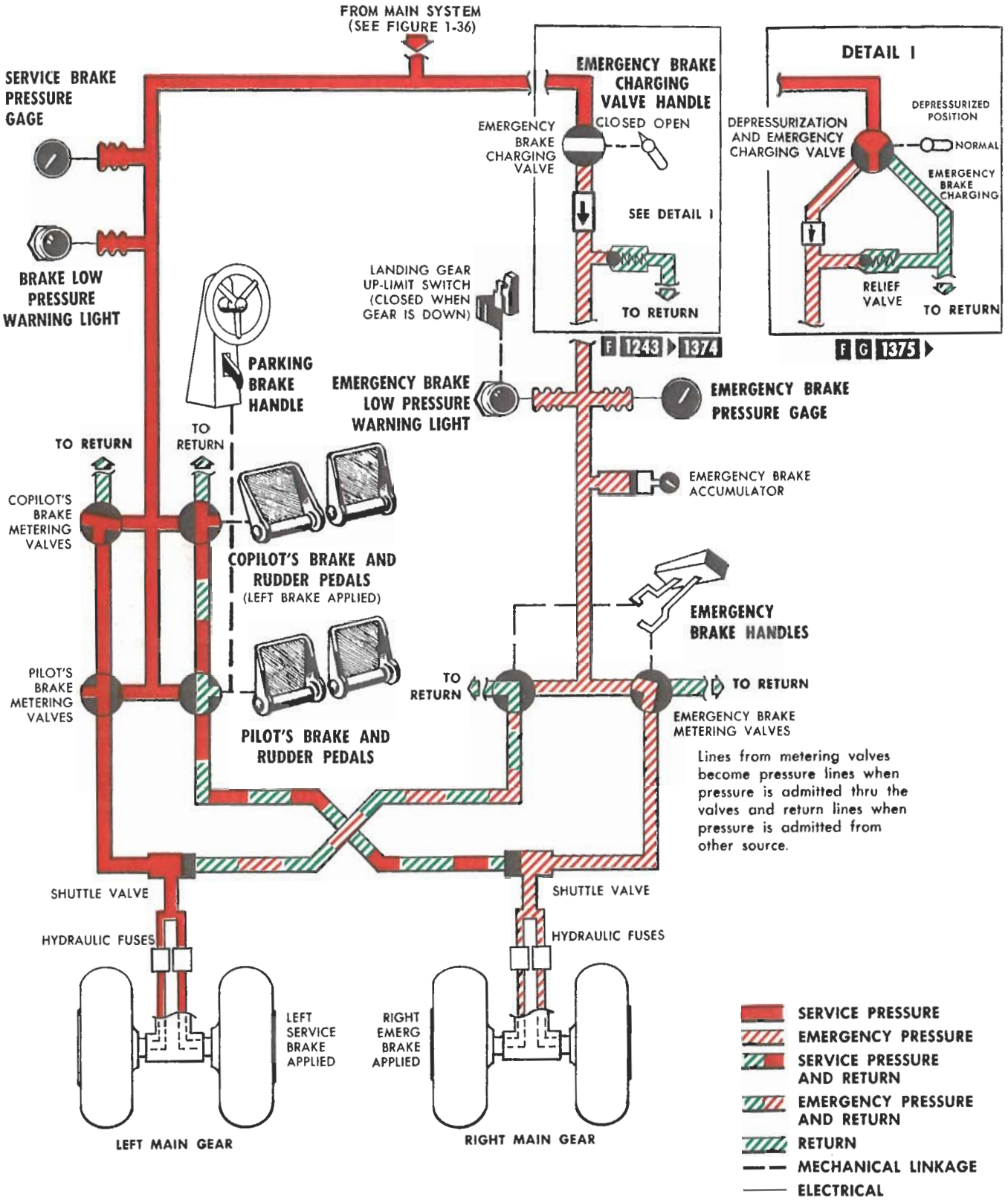
LANDING GEAR GROUND SAFETY LOCKS

Figure 1-40



NOSE WHEEL HYDRAULIC STEERING SYSTEM

Figure 1-41



SERVICE AND EMERGENCY BRAKE SYSTEM

Figure 1-42

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 together.

EMERGENCY BRAKE SYSTEM CHARGING VALVE HANDLE F 1243 ▶ 1374

A charging valve handle (15, figure 1-15) on the copilot's auxiliary panel provides a means of charging the emergency brake system. The handle has OPEN--CLOSED positions. When the handle is placed in the OPEN position, a shutoff valve between the main and emergency systems is opened, and the emergency system is charged by main system pressure. Positioning the handle to CLOSED isolates the emergency brake system from the main hydraulic system.

DEPRESSURIZATION AND EMERGENCY CHARGING VALVE HANDLE F G 1375 ▶

This is a three position handle, with EMERGENCY BRAKE CHARGING--NORMAL--DEPRESSURIZED positions (16, figure 1-15). Moving this handle to the EMERGENCY BRAKE CHARGING position, allows main system pressure to charge the emergency brake accumulator. With the valve handle in this position system pressure will continue to be maintained. For NORMAL--DEPRESSURIZED position operation see MAIN HYDRAULIC SYSTEM this Section.

BRAKE SYSTEM PRESSURE GAGE

A pressure gage for the service brake system (26, figure 1-9) is on the pilots' instrument panel, and a gage for emergency brake system pressure (1, figure 1-15) is on the copilot's auxiliary panel. The gages are marked in psi. Circuit protection and 26 volts AC power is through the AC power panel (figure 1-35).

BRAKE SYSTEM LOW PRESSURE WARNING LIGHTS

Two amber warning lights (22 and 25, figure 1-9) on the pilots' instrument panel are provided for the service and emergency brake systems. The service brake system warning light will illuminate whenever hydraulic pressure is below 900 psi, and the emergency brake system warning light will illuminate whenever emergency brake 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 (figure 1-35, sheet 1).

INSTRUMENT	OPERATING POWER	POWER SOURCE	CIRCUIT PROTECTION LOCATION
Airspeed Indicators	Pitot and Static Systems	Pitot and Static Systems	None
Altimeters	Static System	Static System	None
Vertical Velocity Indicators	Static System	Static System	None
❶❷❸ Pilot's Turn and Slip Indicator	DC Electric Emergency Power	DC Power Distribution System	Overhead Circuit Breaker Panel DC Power Panel
❶❸ Pilot's Direction Indicator	AC Electric	Pilots' Instrument Inverter	AC Power Panel
❶❸ Pilots Attitude Indicator	AC Electric	Pilots' Instrument Inverter	AC Power Panel
Outside Air Temperature Gages	DC Electric	DC Power Distribution System	Overhead Circuit Breaker Panel

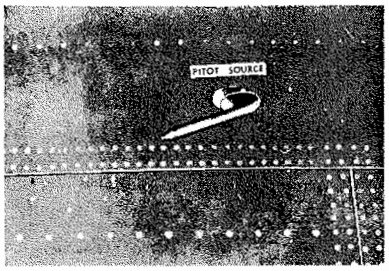
❶ These instruments can be operated by battery power in case of DC power failure if the pilot's instrument inverter emergency power switch is positioned to battery. See figure 1-32.

❷ Pilot's turn-and-slip indicator is calibrated for four minute turns. Copilot's turn-and-slip indicator is calibrated for two minute turns.

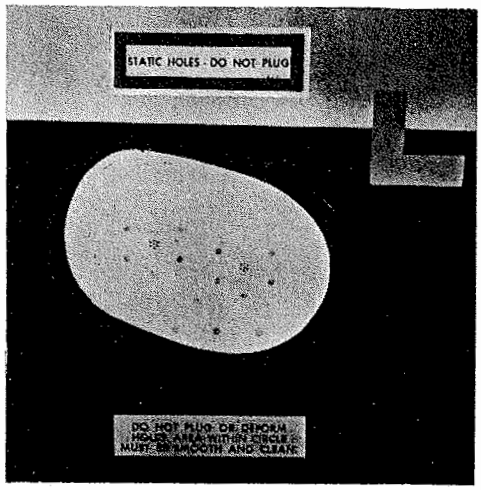
❸ For copilot's instruments see figure 1-31 and Autopilot Section IV.

INSTRUMENTS

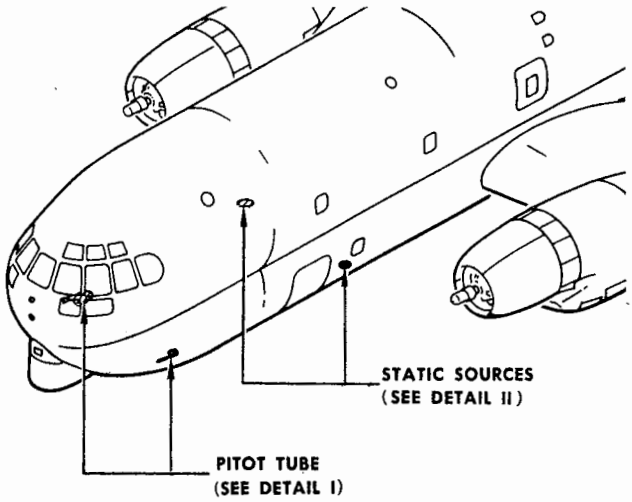
Figure 1-43



DETAIL I



DETAIL II



PITOT AND STATIC SOURCES

Figure 1-44

INSTRUMENTS

Only those instruments which are not properly a part of a complete system such as fuel system are listed in figure 1-43. The instruments listed include pitot and static operated instruments, alternating current operated instruments, and direct current operated instruments.

PILOT'S ATTITUDE INDICATORS

The pilot's attitude indicator is installed on the left side of the pilots' instrument panel and is supplied with power from the 115 volt AC pilots' instrument inverters through circuit protection on the AC power panel (figure 1-43). The power-off warning flag becomes visible if power from any phase is cut; however, it does not indicate incorrect readings 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.

On airplanes not incorporating TCTO 563, a type J-8 attitude indicator is installed. The instrument has 360 degrees of freedom in roll and a minimum of ± 80 degrees in pitch. The horizon bar and attitude sphere indicate the degree of climb or dive in reference to a miniature airplane. Maximum horizon bar deflection in climb or dive is approximately 27 degrees. The attitude sphere shows no markings in level flight but CLIMB or DIVE markings appear if the airplane is climbed or dived over 27 degrees. Concentric lines and circles on the top and bottom of the sphere indicate 70, 80 and 85 degrees of climb and dive. 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.

On airplanes incorporating TCTO 563, 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.

NOTE

After applying power to the type J-8 and MF-2 attitude indicators, a period of 30 seconds should be allowed for the gyro to attain speed. The instrument should then be caged immediately to prevent unnecessary torque stresses on the instrument mechanism.

CAUTION

- Caging of the J-8 and MF-2 attitude indicators 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.
- It is possible for the J-8 attitude indicator to erect in the inverted position; therefore, after the J-8 attitude indicator has been energized at least 30 seconds, cage the attitude prior to takeoff to insure proper erection.

WARNING

A slight amount of pitch error in the indication of the J-8 and MF-2 attitude indicators will result from accelerations or decelerations. It will appear as a slight climb indication after a forward acceleration and as a slight dive indication after deceleration when the 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 will generally be approximately 1 1/2 bar widths. The erection system will automatically remove the error after the acceleration ceases.

PILOT'S INSTRUMENT INVERTER EMERGENCY POWER SWITCH

For a description of this switch, see AC POWER SYSTEM in this Section.

ALTIMETER

Altimeters are provided, one each, for the pilot, copilot (24, figure 1-9) 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 long pointer (4, figure 1-45) indicates hundreds of feet altitude; the broad pointer (2, figure 1-45) indicates thousands of feet, and the narrow pointer with the triangular index marker on the outer edge of the dial (1, figure 1-45) indicates tens of thousands of feet. The Kollsman window (3, figure 1-45) and the set knob (6, figure 1-45) are interconnected to allow the altimeter to be set to station barometric pressure corrected to sea level pressure. The low altitude warning indicator (5, figure 1-45) is a cross hatched area that comes into view below 16,000 feet.

WARNING

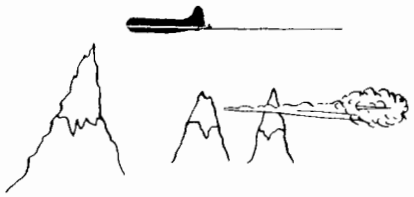
It is possible to misset an altimeter by 10,000 foot increments and still have the proper pressure setting in the Kollsman window. Check all three pointers to be sure the altimeter indicates the proper field elevation before takeoff.

NOTE

Reset altimeter to 29.92 in Hg when climbing through 23,500 feet. Reset altimeter to current setting when descending through 24,000 feet.

EMERGENCY EQUIPMENT

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

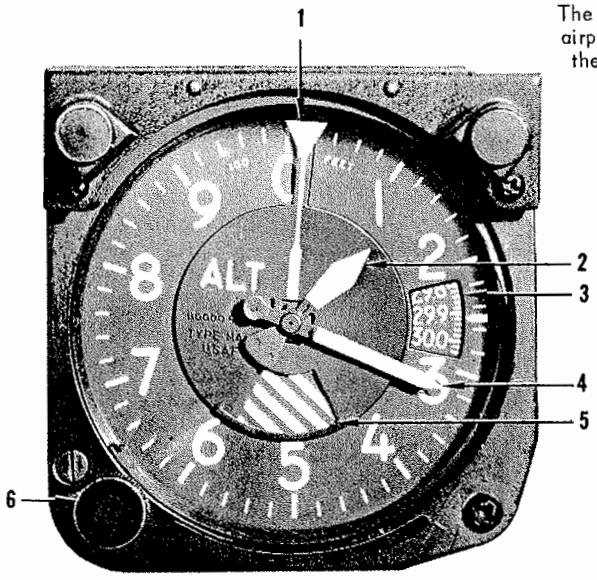


CORRECT READING ALTIMETER

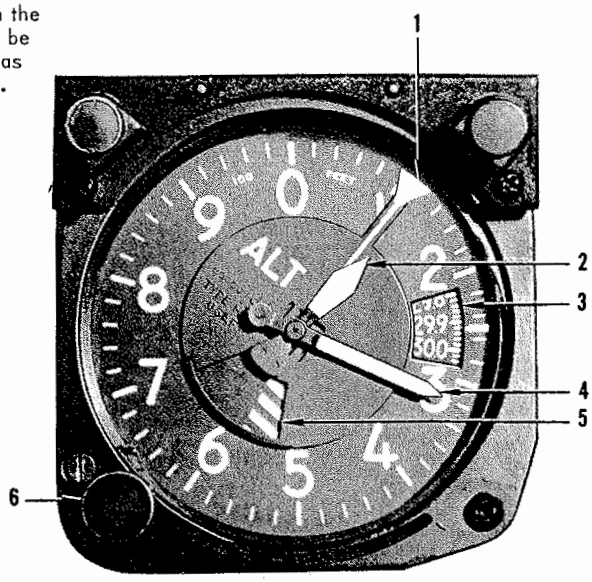
NOTE

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

ERRONEOUS READING ALTIMETER



SETTING – 29.92 IN. HG
ALTITUDE – 1320 FEET



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 THOUSAND FOOT POINTER (INDICATES THOUSANDS OF FEET)
3 KOLLSMAN WINDOW
4 HUNDRED FOOT POINTER (INDICATES HUNDREDS OF FEET)
5 LOW ALTITUDE WARNING INDICATOR
6 SET KNOB

ALTIMETER SETTINGS

Figure 1-45

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 by fire warning lights located on the overhead panel (8, 9, 17 and 38, figure 1-12), and on airplanes incorporating ICTO 558 on the pilots' instrument panel (20, figure 1-9). 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 on airplanes incorporating ICTO 558 in the main landing gear 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. 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 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 fire detector system push-to-test buttons (13, figure 1-12) 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 and 2 buttons 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 on airplanes incorporating TCTO 558 the main landing gear wheel well warning lights. The test circuits are operated from 28 volt DC through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

Master Fire Warning Lights

Two red push-to-test master fire warning lights are provided; one (30, figure 1-9) on the pilots' instrument panel and the other (61, figure 1-22) 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 (figure 1-35, sheet 1).

FIRE EXTINGUISHER SYSTEM

A CO_2 fire extinguisher system (figure 1-46) 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 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 two 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 (12, figure 1-12) will discharge the entire bottle into the turbine cover. These control switches are located on the fire section of the overhead panel (figure 1-12). All controls are powered by 28-volt DC through circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

Fire Switches

FIRE SWITCH GANG PLATES. A switch gang plate (figure 1-12) is located aft of each group of power package and surface anti-icing heater fire switches on the overhead panel. When a power package switch gang plate 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 surface anti-icing heater switch gang plate is positioned to FIRE, it will actuate the surface anti-icing heater select direction valve fire switch and the heater shutoff switch. Each gang plate is spring-loaded from the FIRE position to the NORMAL position.

SELECT DIRECTION VALVE SWITCHES. These switches (18, figure 1-12) with NORMAL--FIRE positions are located on the fire section of the overhead panel. One switch is provided for each power package. When the CO_2 release switch is placed in FIRE, the select direction valve will open, allowing the charge of CO_2 to enter the power package selected.

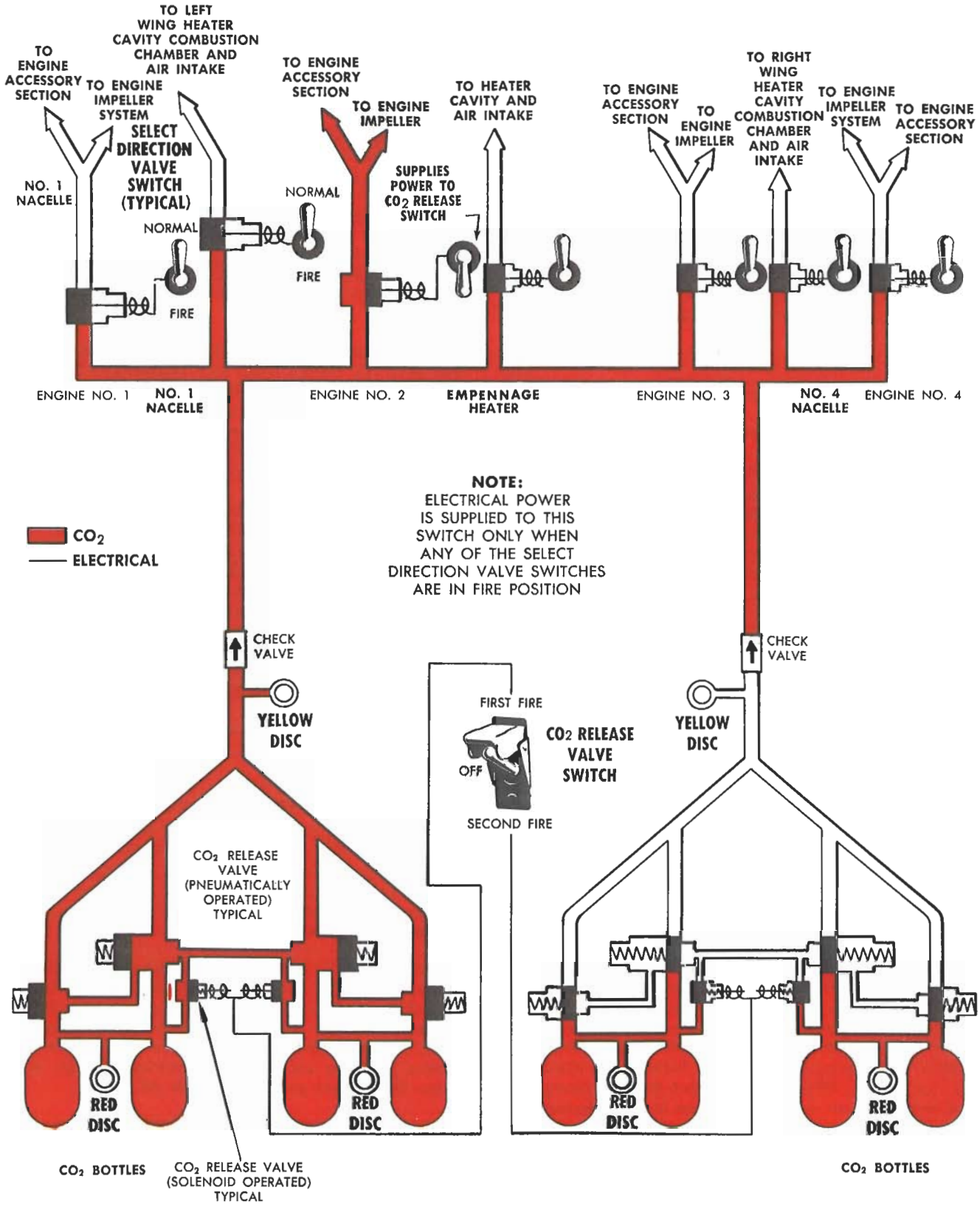
APU CO_2 RELEASE SWITCH. An on-off toggle switch marked AUX POWER UNIT CO_2 RELEASE (12, figure 1-12), when positioned to ON will release the contents of a CO_2 bottle into turbine cover. The switch is spring-loaded and guarded to the OFF position, and when operated, must be held ON for five seconds.

SHELTERED AIR DOOR SWITCHES. The NORMAL--FIRE positions of these switches (18, figure 1-12) control the operation of the sheltered air door. When the switch is placed in FIRE, the sheltered air door stops ram air from entering the induction system. One switch is provided for each power package.

FUEL VALVE SWITCHES. A fuel valve switch (18, figure 1-12) with NORMAL--FIRE positions is provided for each power package. When the switch is placed in FIRE, the fuel selector valve is turned to the OFF position F 1243 ▶ 1290, and the TANK TO MANIFOLD position F G 1291 ▶. 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 (18, figure 1-12), with NORMAL--FIRE positions, is provided for each power package. When the switch is placed in 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 (18, figure 1-12) control the propellers. When the switch is placed in 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.



FIRE EXTINGUISHER SYSTEM

Figure 1-46 (Sheet 1 of 2)

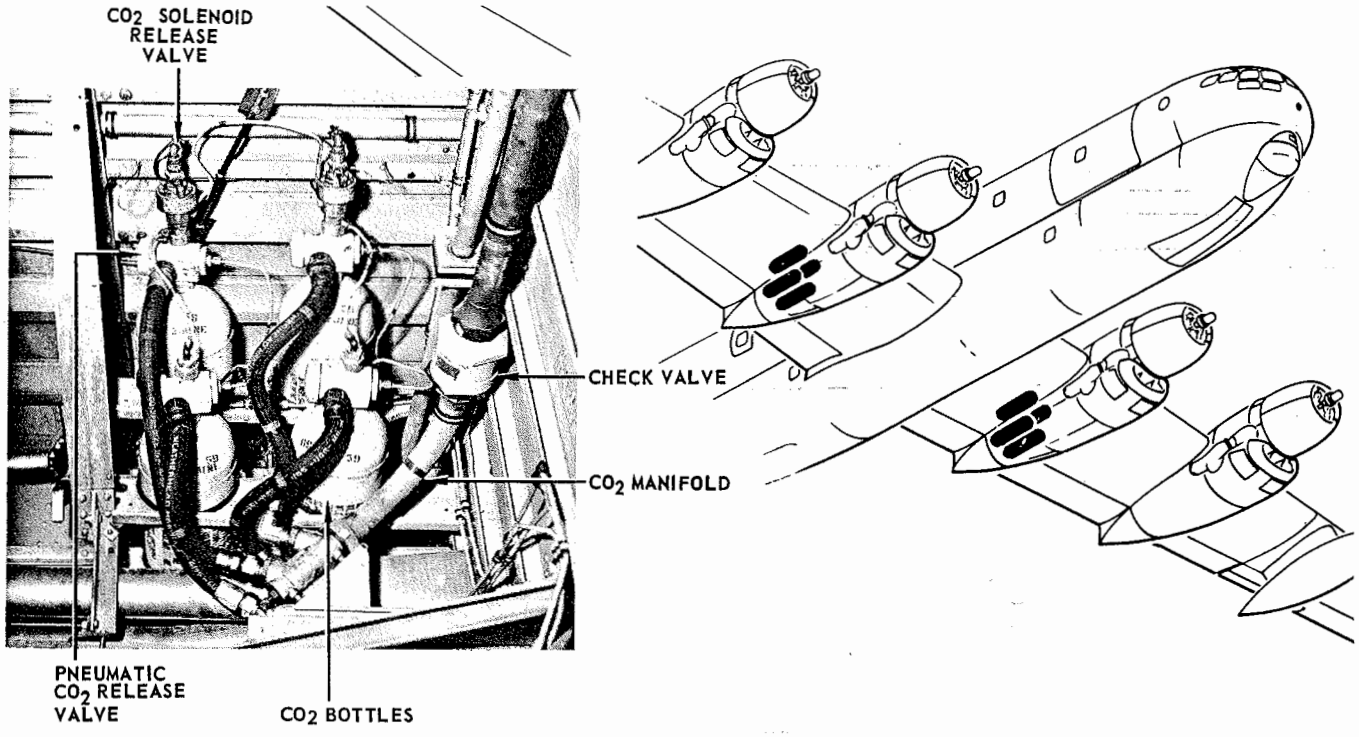


Figure 1-46 (Sheet 2 of 2)

ANTI-ICING HEATER SELECT DIRECTION VALVE SWITCHES. These switches (14, 15, 36, figure 1-12) one for each set of anti-icing heaters, are on the fire section of the overhead panel. When the CO_2 release valve switch is placed in FIRE position, it actuates the directional control valve to allow CO_2 charge to enter the heater area from the fire extinguisher system manifold.

ANTI-ICING HEATER SHUTOFF SWITCH. These switches (14, 15, 36, figure 1-12), one for each set of anti-icing heaters, are on the fire section of the overhead panel. The switch, when actuated to FIRE, discontinues heater operation by stopping intake air flow and fuel supply to the heaters and de-energizes the heater ignition circuit.

BODY HEATER FIRE SWITCH. One body heater switch (37, figure 1-12) 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 position it will shut off the fuel supply to the body heaters besides de-energizing 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

This guarded switch (16, figure 1-12) 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. It 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 directional 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 gear must be extended and contacting the ground so the oleo switch is actuated.

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 nine hand fire extinguishers (5, figure 3-1), located throughout the airplane. F 1243 ▶ 1278 have CO_2 extinguishers and F G 1279 ▶ have bromochloromethane extinguishers, both which are effective in combating all types of fires. The effective range of the extinguishers is 25 feet, when operated vertically to within 15 degrees from horizontal. One extinguisher is on the pilot's auxiliary panel in the control cabin. In the main compartment, two extinguishers are mounted near the toilet compartment and another is mounted on the right side of the fuselage just aft of the forward cargo door; another is mounted on the emergency equipment panel at the aft end of the compartment, and a sixth is mounted on the right side of the fuselage across from the emergency equipment panel. A seventh extinguisher is mounted on an emergency equipment panel just forward of the aft entrance door F and on the aft entry door G; an eight is mounted on the left side of the fuselage above and forward of the aft entrance door, and the ninth is mounted on the fuselage above and forward of the leading edge of the wing.

On airplanes incorporating TCTO 566 the lower forward compartment fire extinguisher is mounted on the fire fighters panel on the aft side of the radio rack in the lower forward compartment.

WARNING

Prolonged exposure (5 minutes or more) to high concentrations (pronounced irritation of eye and nose) of Bromochloromethane (CB) or its decomposition products should be avoided. CB is an anesthetic agent of moderate intensity. It is safer to use than previous fire extinguishing agents (carbon-tetrachloride, methylbromide). However, especially in confined spaces, adequate respiratory and eye protection from excessive exposure, including the use of oxygen when available, should be sought as soon as the primary fire emergency will permit.

EMERGENCY ALARM BELL

The emergency alarm bells in the airplane are controlled by a single ON-OFF switch (19, figure 1-12) 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; another is located in the control cabin near the pilot's control column. On Code V airplanes, a fifth alarm bell is located aft of the boom operator's station. On Code C airplanes, the fifth alarm bell is located aft of the aft cargo doors. 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 (figure 1-35, sheet 4).

AXES

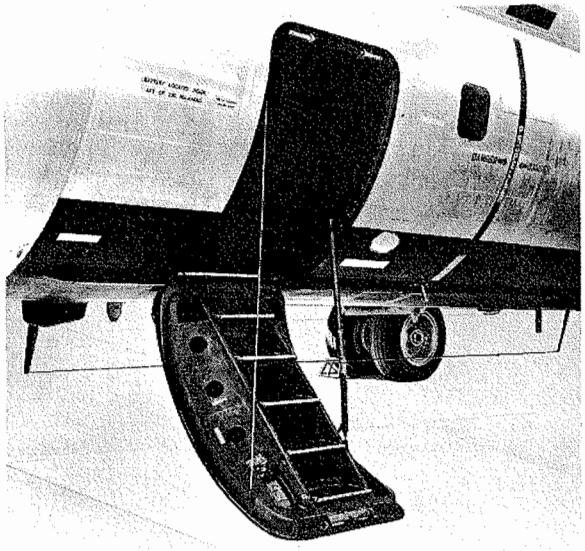
There are two hand crash axes. One is located on the pilot's auxiliary panel (18, figure 1-11) and one is located on the miscellaneous equipment panel (12, figure 3-1) at the left side of the main compartment in the rear of the airplane.

EMERGENCY EXITS

Two emergency escape hatches (figure 3-7) are provided on each side of the fuselage. On Code V F airplanes the right aft hatch is blocked by the A/R tank and cannot be used. On airplanes not incorporating TCTO 529 the escape hatches are opened inboard by pulling a bar on the lower part of each hatch. On airplanes incorporating TCTO 529 , the escape hatches are opened inboard by pulling a lever marked PULL, located on the upper section of each hatch. See Section III for escape hatch operation. The pilot and copilot are each provided with an emergency exit window. These windows can be opened by pulling a handle inboard and sliding the window aft along a set of tracks. The aft entry door 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.

ESCAPE ROPES

Three escape ropes, stowed in bags (1, figure 3-1) are provided for use of crew members 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.



FORWARD ENTRY DOOR

Figure 1-47

SIGNAL LAMPS

An interairplane (aldis) signal lamp (19, figure 4-16) 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 on G 1366 ▶. The signal lamp may be plugged into any convenient DC outlet receptacle (casualty blanket or suit heater).

LIFE RAFTS

On airplanes incorporating ICTO K512 four twenty man life rafts (9, figure 3-1) are located throughout the main compartment over the A/R tanks. The rafts 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.

DINGHY RADIOS

There are two dinghy radios (6, figure 3-1) located on the top left side of the fuselage opposite the aft edge of the forward cargo door. The radios are held in place by straps. To remove the radios, unhook the straps and lower radios.

FIRST AID KITS

F

There are positions for eleven 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 outside of the toilet compartment. Nine first aid kits are in the main compartment. Two are on the right side of the fuselage near the excape hatch and three others are directly opposite on the left side of the fuselage. An eighth first aid kit is in the aft end of the airplane on the right side of the fuselage and a ninth directly opposite on the emergency panel. The tenth first aid kit is on the emergency panel just aft of the wing trailing edge and the eleventh is mounted on the left side of the fuselage in the lower forward compartment just aft of the main entrance door. G 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 miscellaneous equipment panel. G 22629 ▶

There are positions for fifteen 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 twelve first aid kits in the main compartment: one is on the left side of the forward bulkhead, two are located just aft of the forward cargo door, three are located on the right hand side of the fuselage over the wing center section, and two are on the left hand side of the fuselage above the escape hatch over the wing center section, two are located over the aft escape hatch on the right hand side, one is located over the aft escape hatch on the left hand side, and one is on the miscellaneous equipment 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 flare tubes (7, figure 3-1) each containing provisions for one three-minute night landing parachute flare, are provided in the tail compartment. The flares are released electrically by actuating two flare release switches (34, figure 1-12) on the overhead panel.

PYROTECHNIC PISTOL

A single-shot breech-loading double-action, pyrotechnic pistol (11, figure 3-1) and various colored flares are stowed in containers 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

Two sets of oxygen equipment, for use in fighting in-flight fires, are installed in the airplane. One is located on the aft side of the main compartment bulkhead to the right of the doorway, and the other on the aft side of the radio rack in the lower forward compartment. Each set consists of a portable oxygen cylinder equipped 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.

ENTRY DOORS

Entrance to the airplane is gained through the two entry doors on the left side of the fuselage. The forward entry door 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

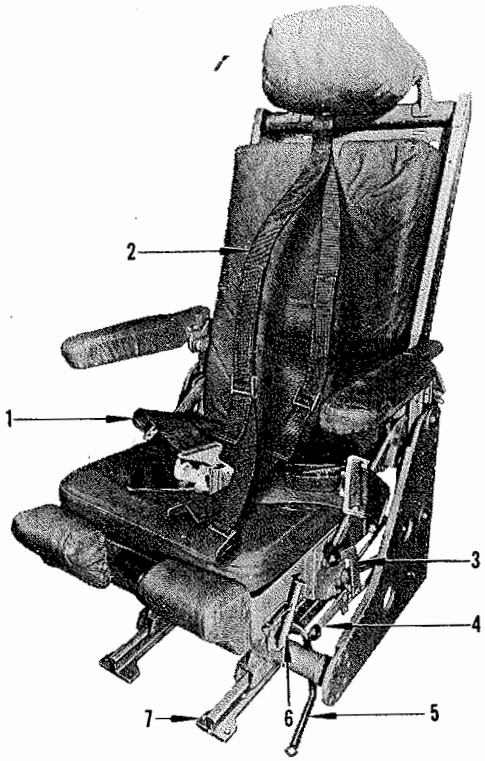
The pilot and copilot are provided with identical seats except that the seat controls for the pilot are on the left and for the copilot are on the right. These seats are fully adjustable for height and fore-and-aft-movement (figure 1-48). The engineer's, navigator's and radio operator's seats are adjustable for vertical, and radial movements only. (See figure 1-49.) On ▶FG 375◀ the engineer's seat is also adjustable for fore and aft movement. These seats are provided with safety belts. The pilot's, copilot's and engineer's seat are also provided with a shoulder harness and inertia reel lock. See Section IV for other seats.

SHOULDER HARNESS INERTIA REEL LOCK HANDLE

A handle with LOCKED and RELEASED positions is located on the left side of the pilots' 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 crew member 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 crew member is prevented from bending forward. This position provides an added safety precaution over and above that of the automatic safety lock.

NOTE

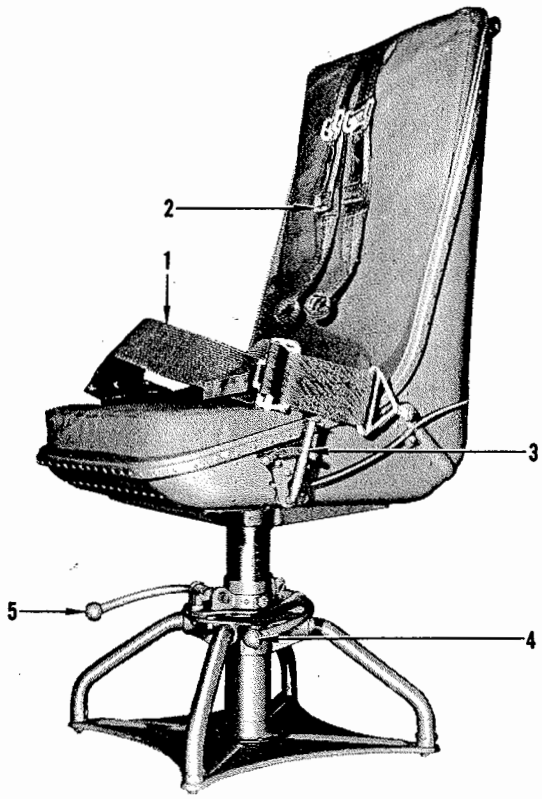
It is recommended that the shoulder harness be manually locked during maneuvers and flight in rough air or as an added precaution in event of a forced landing.



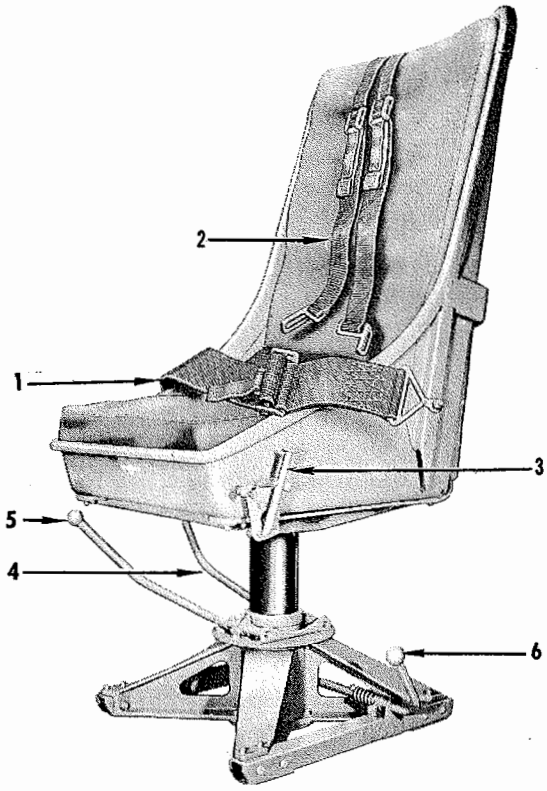
1 SAFETY BELT
2 SHOULDER HARNESS
3 SEAT BACK ADJUSTMENT LEVER
4 SEAT ELEVATION LEVER
5 SEAT FORE AND AFT ADJUSTMENT LEVER
6 INERTIA REEL LOCK HANDLE
7 SEAT TRACKS

PILOT'S SEAT

Figure 1-48



TYPICAL FOR:
ENGINEER'S SEAT F 1243 ▶ 1374
NAVIGATOR'S SEAT F
RADIO OPERATOR'S SEAT F



TYPICAL FOR:

ENGINEER'S SEAT F G 1375 ▶
NAVIGATOR'S SEAT G 17260 ▶

1 SAFETY BELT
2 SHOULDER HARNESS (ENGINEER'S SEAT) F 1243 ▶, NAVIGATOR'S SEAT G
3 INERTIA REEL LOCK HANDLE (ENGINEER'S SEAT F 1243 ▶, NAVIGATOR'S SEAT G
4 SEAT ELEVATION LEVER
5 SEAT RADIAL ADJUSTMENT LEVER
6 SEAT FORE AND AFT ADJUSTMENT LEVER

ENGINEER'S, NAVIGATOR'S AND RADIO OPERATOR'S SEAT

Figure 1-49

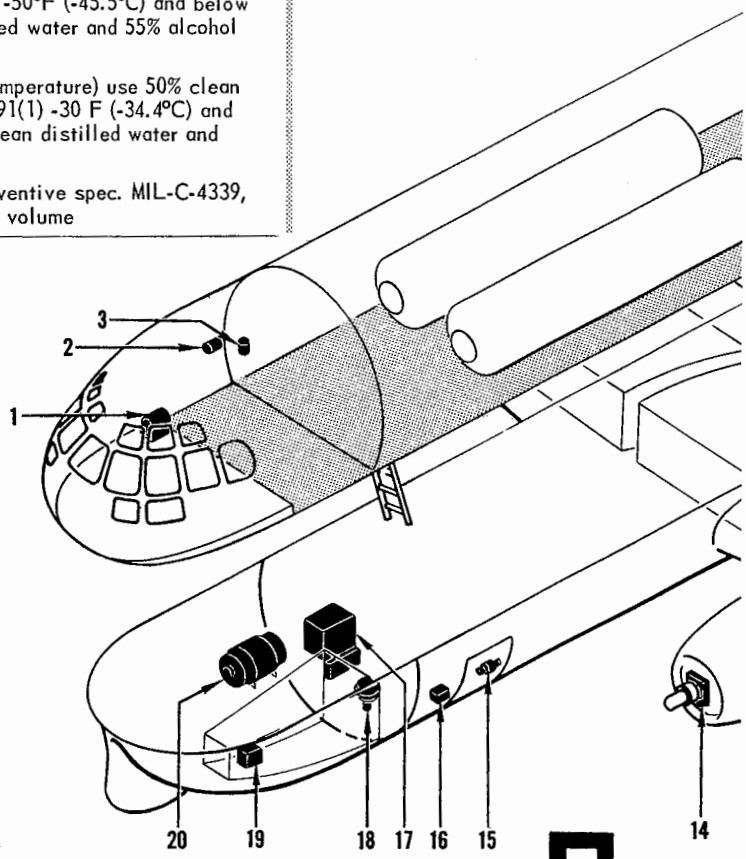
AUXILIARY EQUIPMENT

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

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 1255 ▶
10. Cargo Loading Equipment
11. Troop Carrying Equipment
12. Air Refueling
13. Miscellaneous Equipment

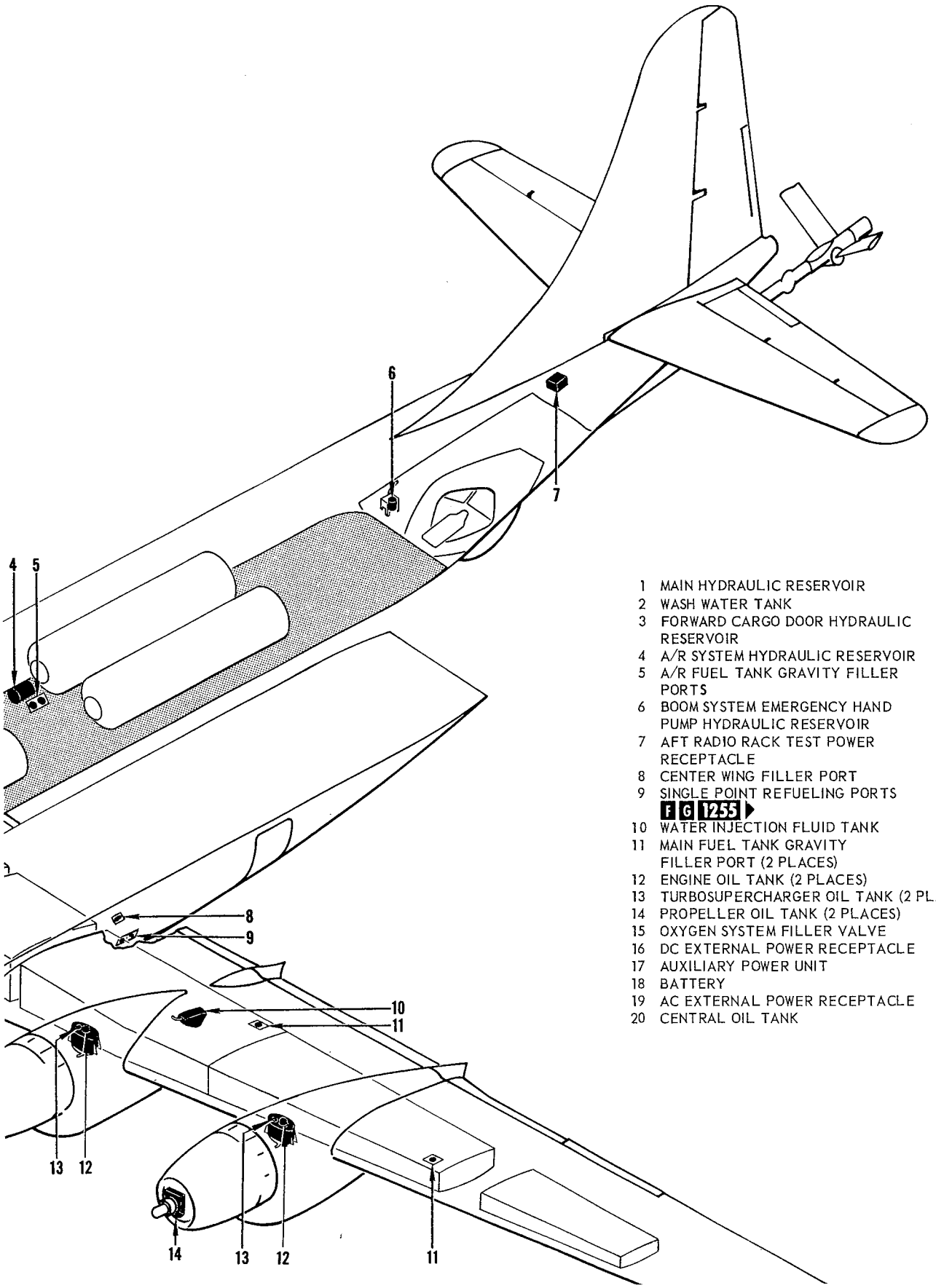
FLUID SPECIFICATIONS

FLUID	SPECIFICATION	NUMBER OF FILLER POINTS
FUEL	MIL-F-5572, recommended grade 115/145; alternate grade 100/130	1 center wing tank 4 main fuel tanks 1 single point for main tanks F G 1255 ▶ 1 A/R single point F G 1255 ▶ 2 A/R gravity
ENGINE OIL	MIL-L-6082, Grade 1100 Before servicing insure that the engines have been properly scavenged	4 engine oil tanks 1 central oil tank
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-6082, Grade 1100) Cold temperatures 60% hydraulic oil MIL-H-5606 40% rust inhibitor MIL-H-6083, Type I	4
TURBO OIL	Above -9.4°C (15°F) (ground temperature) use MIL-L-6082, Grade 1065 Below -9.4°C (15°F) (ground temperature) use MIL-O-6081, Grade 1010	4
AUXILIARY POWER UNIT OIL	MIL-L-7808 (turbine)	1 (in APU)
HYDRAULIC FLUID	MIL-H-5606 (red)	1 main hydraulic tank 1 A/R system hydraulic reservoir 1 boom system emergency hand pump hydraulic reservoir 1 forward cargo door tank 1 rear cargo door tank C
OXYGEN	BB-O-925	1
WATER INJECTION	Above -50°F (-45.5°C) (ground temperature) use 50% clean distilled water and 50% alcohol (O-M-232, Grade A) -50°F (-45.5°C) and below (ground temperature) use 45% clean distilled water and 55% alcohol (O-M-232, Grade A) Alternate: Above -30°F (-34.4°C) (ground temperature) use 50% clean distilled water and 50% alcohol (MIL-A-6091(1) -30 F (-34.4°C) and below (ground temperature) use 33-1/3% clean distilled water and 66-2/3% alcohol (MIL-A-6091(1) For inclusion of oil-emulsive, corrosion preventive spec. MIL-C-4339, use in the amount of 2/3 of 1% of the total volume	2



SERVICING F

Figure 1-50 (Sheet 1 of 4)

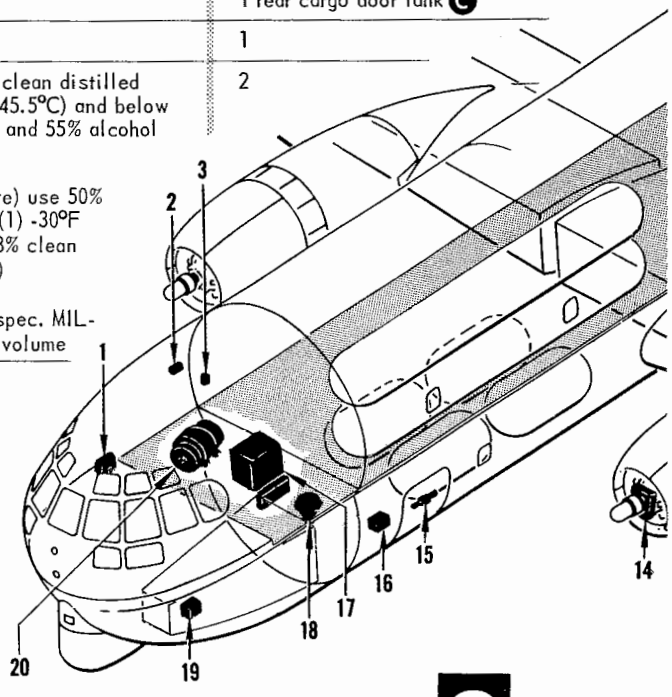


1 MAIN HYDRAULIC RESERVOIR
2 WASH WATER TANK
3 FORWARD CARGO DOOR HYDRAULIC RESERVOIR
4 A/R SYSTEM HYDRAULIC RESERVOIR
5 A/R FUEL TANK GRAVITY FILLER PORTS
6 BOOM SYSTEM EMERGENCY HAND PUMP HYDRAULIC RESERVOIR
7 AFT RADIO RACK TEST POWER RECEPTACLE
8 CENTER WING FILLER PORT
9 SINGLE POINT REFUELING PORTS
F G 1255 ▶
10 WATER INJECTION FLUID TANK
11 MAIN FUEL TANK GRAVITY FILLER PORT (2 PLACES)
12 ENGINE OIL TANK (2 PLACES)
13 TURBOSUPERCHARGER OIL TANK (2 PLACES)
14 PROPELLER OIL TANK (2 PLACES)
15 OXYGEN SYSTEM FILLER VALVE
16 DC EXTERNAL POWER RECEPTACLE
17 AUXILIARY POWER UNIT
18 BATTERY
19 AC EXTERNAL POWER RECEPTACLE
20 CENTRAL OIL TANK

Figure 1-50 (Sheet 2 of 4)

FLUID SPECIFICATIONS

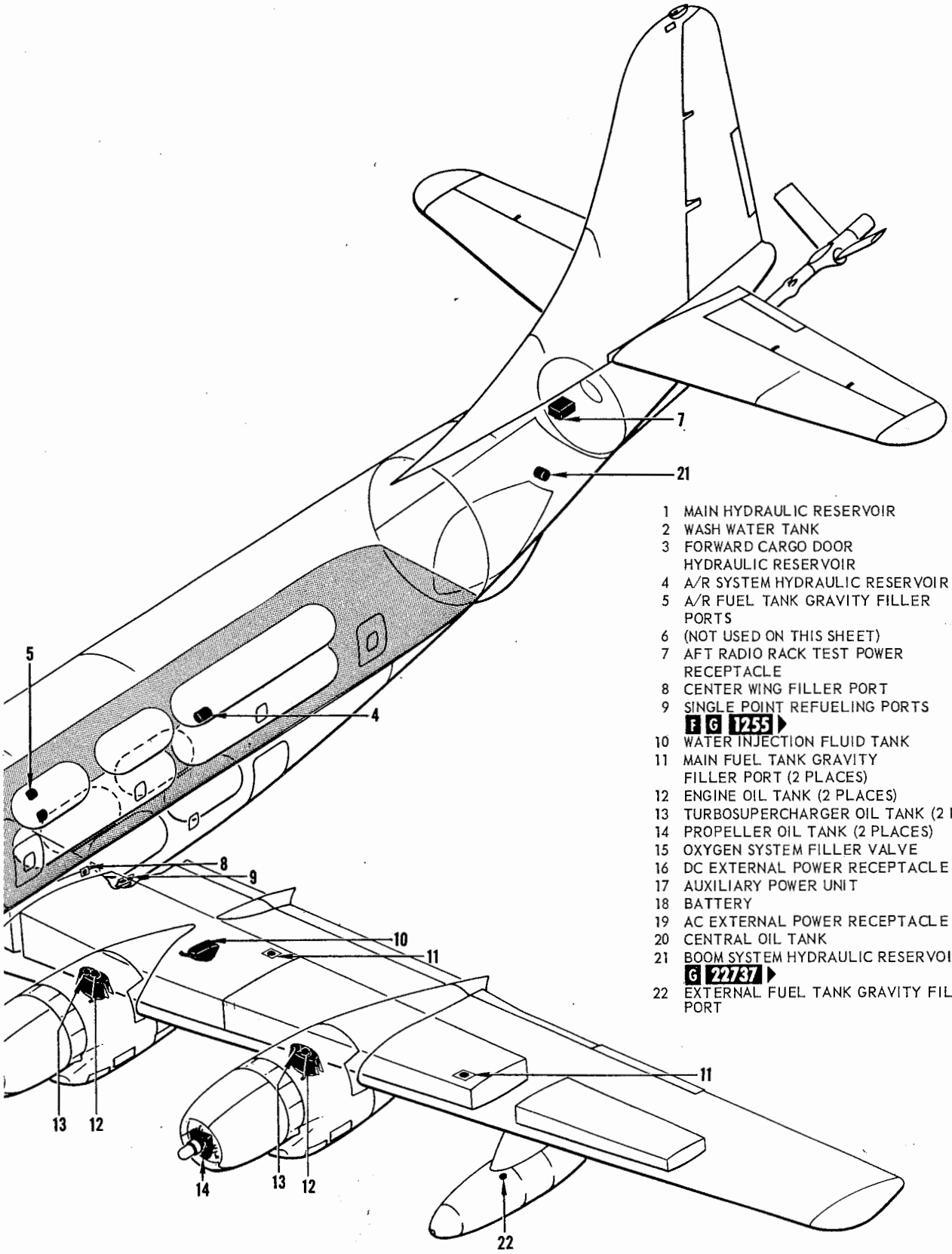
FLUID	SPECIFICATION			NUMBER OF FILLER POINTS
	MIL – SPEC AND OCTANE RATING	NATO SYMBOL	COMMERCIAL GRADE	
FUEL	RECOMMENDED MIL-G-5572 Grade 115/145	F-22	Av Gas 115/145	2 external tanks 1 center wing tank 4 main fuel tanks 1 single point for main tanks 1 A/R single point 2 A/R gravity
	FIRST ALTERNATE Grade None	None	Av Gas 108/145	
	SECOND ALTERNATE MIL-G-5572 Grade 108/135	F-18	Av Gas 100/130	
ENGINE OIL	MIL-L-6082, Grade 1100	Before servicing insure that the engines have been properly scavenged		4 engine oil tanks 1 central oil tank
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-6082, Grade 1100) Cold temperatures 60% hydraulic oil MIL-H-5606 40% rust inhibitor MIL-H-6083, Type I			4
TURBO OIL	Above -9.4°C (15°F) (ground temperature) use MIL-L-6082, Grade 1065 Below -9.4°C (15°F) (ground temperature) use MIL-O-6081, Grade 1010			4
AUXILIARY POWER UNIT OIL	MIL-L-7808 (turbine)			1 (in APU)
HYDRAULIC FLUID	MIL-H-5606 (red)			1 main hydraulic tank 1 A/R system hydraulic reservoir 1 boom system reservoir G 22737 1 forward cargo door tank 1 rear cargo door tank C
OXYGEN	BB-O-925			1
WATER INJECTION	Above -50°F (-45.5°C) (ground temperature) use 50% clean distilled water and 50% alcohol (O-M-232, Grade A) -50°F (-45.5°C) and below (ground temperature) use 45% clean distilled water and 55% alcohol (O-M-232, Grade A) Alternate: Above -30°F (-34.4°C) (ground temperature) use 50% clean distilled water and 50% alcohol (MIL-A-6091(1) -30°F (34.4°C) and below (ground temperature) use 33-1/3% clean distilled water and 66-2/3% alcohol (MIL-A-6091(1) For inclusion of oil-emulsive, corrosion preventive spec. MIL-C-4339 use in the amount of 2/3 of 1% of the total volume			2



SERVICING (CONT)

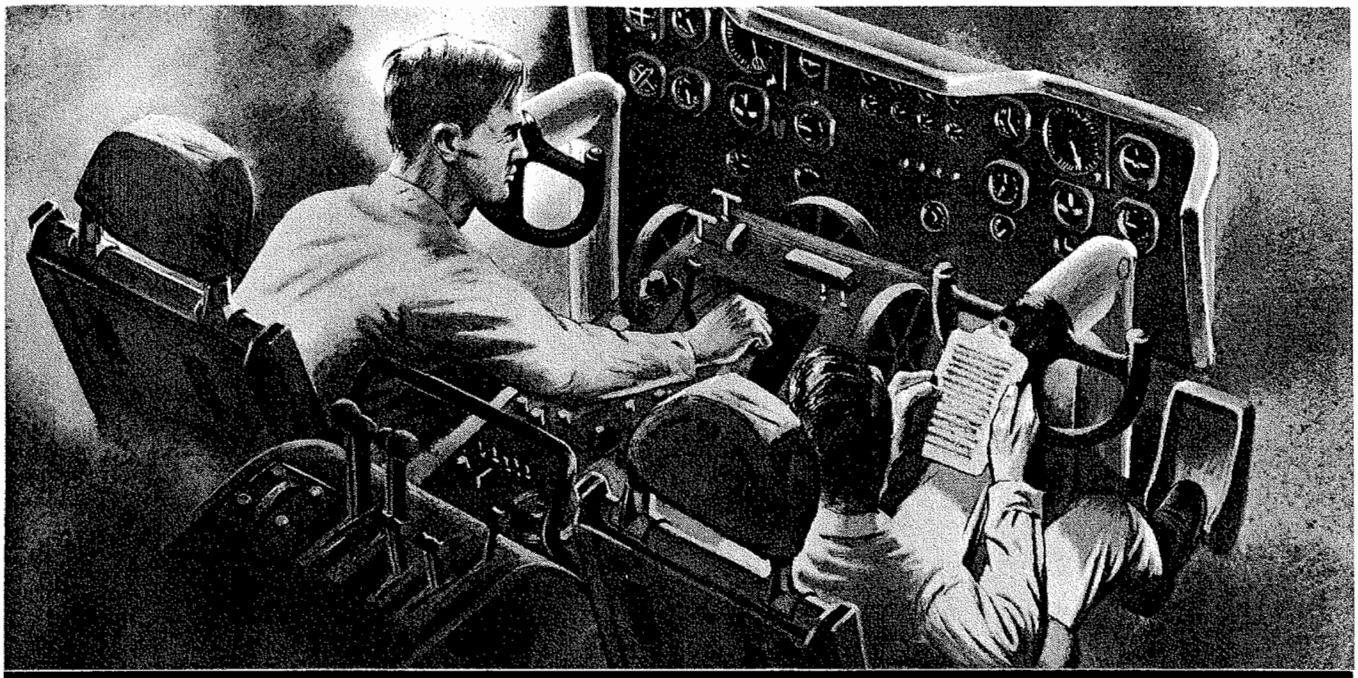
G

Figure 1-50 (Sheet 3 of 4).



1 MAIN HYDRAULIC RESERVOIR
2 WASH WATER TANK
3 FORWARD CARGO DOOR HYDRAULIC RESERVOIR
4 A/R SYSTEM HYDRAULIC RESERVOIR
5 A/R FUEL TANK GRAVITY FILLER PORTS
6 (NOT USED ON THIS SHEET)
7 AFT RADIO RACK TEST POWER RECEPTACLE
8 CENTER WING FILLER PORT
9 SINGLE POINT REFUELING PORTS F G 1255 ▶
10 WATER INJECTION FLUID TANK
11 MAIN FUEL TANK GRAVITY FILLER PORT (2 PLACES)
12 ENGINE OIL TANK (2 PLACES)
13 TURBOSUPERCHARGER OIL TANK (2 PLACES)
14 PROPELLER OIL TANK (2 PLACES)
15 OXYGEN SYSTEM FILLER VALVE
16 DC EXTERNAL POWER RECEPTACLE
17 AUXILIARY POWER UNIT
18 BATTERY
19 AC EXTERNAL POWER RECEPTACLE
20 CENTRAL OIL TANK
21 BOOM SYSTEM HYDRAULIC RESERVOIR G 22737 ▶
22 EXTERNAL FUEL TANK GRAVITY FILLER PORT

Figure 1-50 (Sheet 4 of 4)



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 flight 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 condensed 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, (RO) Radio Operator and (GC) Ground Crewman. The amplified checklist explains the condensed checklist to be used during airplane operation. A circle around a number denotes that coordination is required between crew members or between crew members and ground crewman.

To avoid undue complication of this Section, it will include only normal procedures applicable to the pilot, copilot and flight engineer. Procedures for other crew members will be given only when coordination is required to properly execute a particular function. For specific crew duties of other aircrew members, see Sections IV and VIII.

VISUAL INSPECTION

The aircrew visual inspection procedures outlined in this Section are predicated on the assumption that maintenance personnel have completed all the requirements of the Manual of Inspection Requirements, T.O. 1C-97(K)E(C)-6, for preflight or postflight; therefore, duplicate inspections and operational checks of systems by aircrew members have been eliminated, except for certain items required in the interest of safety of flight. To afford maintenance personnel full opportunity to perform the required maintenance, postflight and preflight inspections and to develop sound practices, close adherence to the typical time schedule below is recommended.

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

See Section V, OPERATING LIMITATIONS, 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 the Appendix to this manual, T.O. 1C-97(K)F-1-1. See Sections IV and VIII for additional flight planning requirements.

TYPICAL TIME SCHEDULE

1. Before Interior Inspection..... 1:10 Before Takeoff Time.
2. Starting Engines Time..... Engine start will be timed to have all engines started 20 minutes before takeoff time.
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.
- Except during alert execution the BEFORE STARTING ENGINES checklist will be accomplished immediately prior to starting engines.

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 the Appendix (see Appendix, Part 10, T.O. 1C-97(K)F-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 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 weight 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. See Section V, OPERATING LIMITATIONS, 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

BEFORE INTERIOR INSPECTION

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 T.O. 1C-97(K)E(C)-6 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, heater access cavity doors open and small maintenance stands available.

- Upon arrival at the airplane, the pilot will review the Form 781 with the ground crew while the other crew members load and stow all personal and professional equipment. The pilot will then assemble the crew to accomplish the Before Interior Inspection and provide any special instructions not previously covered. Any preflight discrepancies or irregularities should be reported immediately in order to preclude unnecessary delays.

1. Assemble Crew - Assembled (P)

   a. Form 781 - Read (as applicable) (P)

      Read discrepancies pertinent to the various crew positions.

   b. Mission and Weather Briefing - Complete (P)

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

   c. Instructions and Questions - Cleared (P)

      Insure that the boom operator will brief all personnel who will not occupy a crew position for takeoff, on safety procedures and responsibilities. This briefing will be commensurate with the experience of the applicable personnel and will be accomplished prior to Starting Engines Time.

   d. Starting Engines Time - Announced (P)

      All crew members will don life vests, if applicable, parachute harness and be in position at their respective crew stations in time to have all engines started 20 minutes before takeoff time with the exception of the navigator and boom operator. The navigator will be in the lower forward compartment to receive the three landing gear ground locks and boom pin from the GC. The navigator will then close and lock the forward entry door and start the APU if requested by the engineer. Boom operator will close and lock the aft entry door.

   e. Preflight - Initiated (P)

      Instruct the crew to initiate preflight inspection.

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 crew member. These duties, when so assigned, are performed under the pilot's supervision. Normally the pilot will accomplish the exterior and the interior preflight check.

NOTE

The pilot and copilot begin the interior inspection check of the control cabin. The copilot will complete the radio preflight inspection (when a radio operator is not assigned) and then assist the pilot with the remainder of the preflight inspection. The ground crewman will assume position on the ground headset at the nose wheel and assist the engineer with the engine hydraulic lock check and in clearing the wing flaps which will be lowered to the full down position. Upon completion of these checks the ground crewman will be released to assist the pilot in determining the fuel quantity in the external fuel tanks on G airplanes. The sequence of events allows the engineer sufficient time to pressurize the main fuel manifold for subsequent inspection by the pilot. At the completion of the exterior preflight inspection, the pilot will advise the engineer that the main fuel manifold inspection is completed. 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.

Interior Inspection

CONTROL CABIN

1. Oxygen Equipment Check - Checked and stowed (P, CP)

   Pilot and copilot check station oxygen pressure for at least 400 psi. For oxygen equipment check, see Section IV.

2. Gear Switch - DOWN, guard down (CP)

3. Direction Indicator Repeater Emergency Power Switch - NORMAL (CP)

4. Emergency Lights (if applicable) - Checked (P)

   On airplanes G 2930 ▶ plus those incorporating VC10 239, to assure that power is available when the pilot's instrument inverter power switch is on BATTERY, the pilot will check any emergency cabin light for proper operation.

5. Rudder Boost - ON (P)

6. Reverse Warning Flag - Down (CP)

7. APS-42 Aux Indicator Controls - Full CCW (CP)

8. Gear Emergency Retraction Switch - NORMAL and safetied (P)

9. Ready for Power - Report received (P, E)

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

CONTROL CABIN (Cont)

(10) Alarm Bell Check - Checked (P, N, E, GC)

When the engineer reports "Ready for power," 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 navigator to start the APU. If external power is to be used, this is the signal for the ground crew to plug in external power.

(11) Check Flight Controls - Checked (P, CP)

Copilot will unlock controls, visually checking the aileron, elevators, and rudder for full travel, trim tabs for opposite travel. The copilot will wear headset and lip microphone while checking flight controls. Lip microphone may be keyed using the hand microphone inside the airplane. The pilot will check the left aileron. (Without speakers installed): Pilot will hold copilot's selector switch to CALL position to allow copilot to transmit. Lock flight controls.

12. Throttle Lock Lever - UNLOCK (P)

13. Flap Warning Horn - Checked (P)

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

CAUTION

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

(14) Radios - ON (P, CP)

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

(15) Trim Control Wheels - Free movement and zeroed (P, CP)

(16) Instrument Flight Manuals: (P, CP)

a. Enroute Charts

b. Enroute Supplements

c. Terminal Charts

WARNING

Personnel will not leave or enter the airplane through the forward entrance door during the engine hydraulic lock check. The pilots will not start the Exterior Inspection until the engine hydraulic lock check is completed by the engineer.

(17) Main Fuel Manifold - Pressurized (P, E)

Prior to departing control cabin for exterior inspection, insure that main fuel manifold is pressurized.

Exterior Inspection

FORWARD FUSELAGE AND NOSE SECTION

1. Left Pitot Tube - Pitot cover removed, tube unobstructed (P)
2. Right Pitot Tube - Pitot cover removed, tube 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.) External Fuel Tank Quantity - Checked (P, GC) G

   After GC removes filler cap, determine fuel quantity. GC will then secure the filler cap.

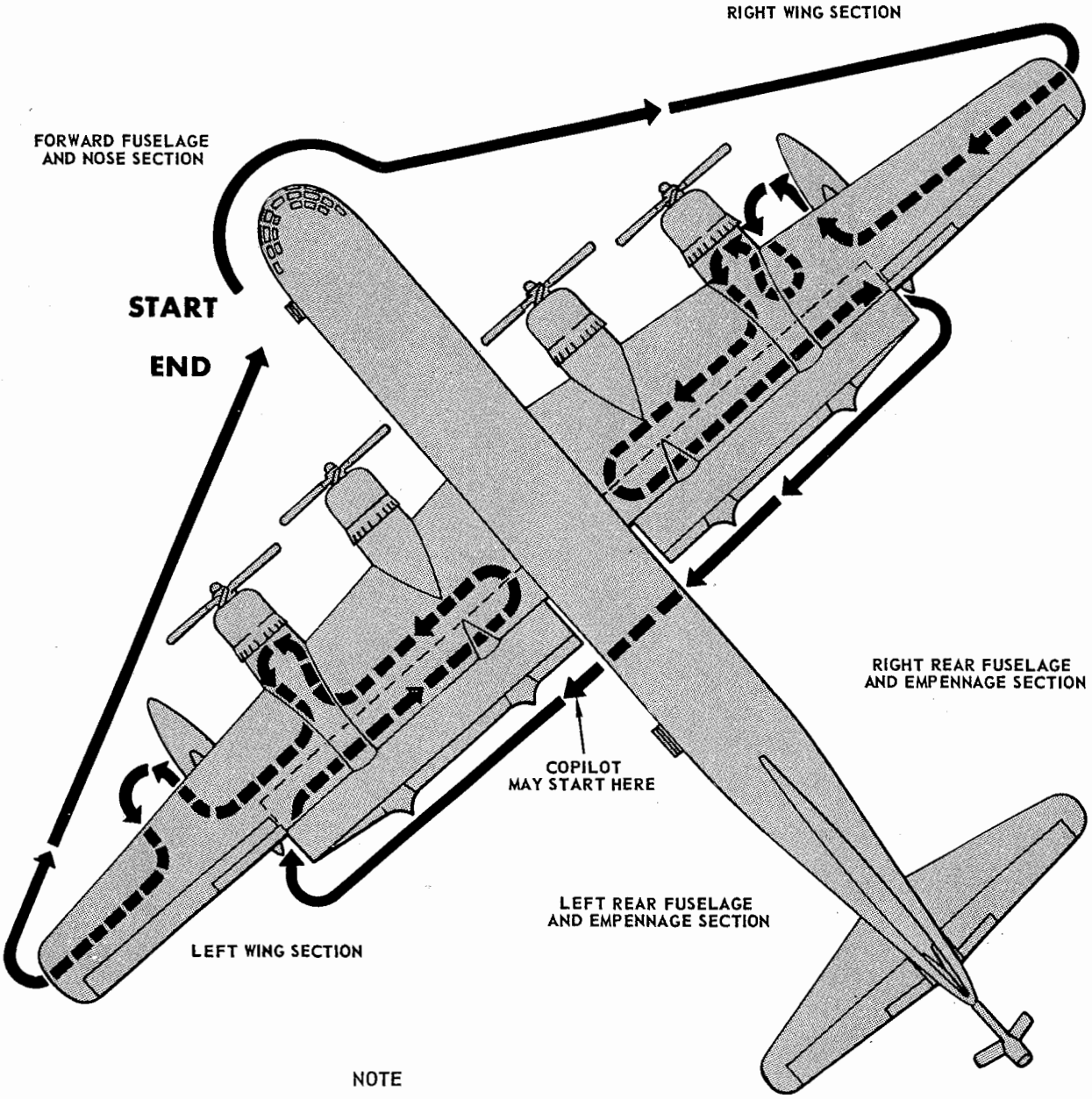
3. Anti-Syphon Scoop - Unobstructed (P)
4. No. 4 Nacelle Heater Cavity - Condition (P)

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

5. Anti-Syphon Scoop - Unobstructed (P)

6. Wing Flap Well - Condition (P)

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



NOTE

- The exterior preflight inspection is arranged in the sequence shown.
- Inspection of external fuel tanks applies to G airplanes.
- 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, see ALL WEATHER OPERATION, Section IX.

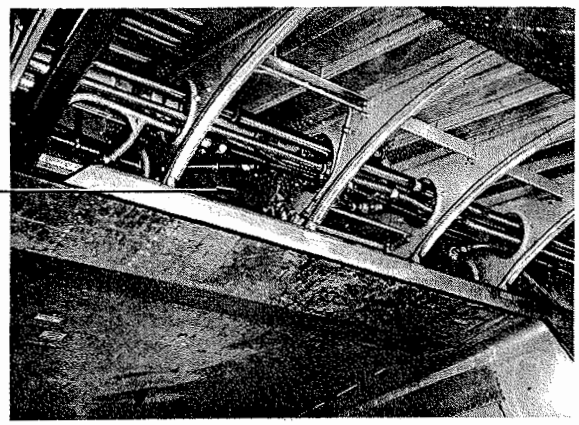
THE EXTERIOR INSPECTION

Figure 2-1

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, fuel and hydraulic lines for leaks. Check wiring and bonding for condition.

2. SPR F G 1255 ▶ and Defueling Cock - Security (P or CP)

   Check single point port caps installed securely and defueling cock closed.

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.

4. Anti-Syphon Scoop - Unobstructed (P or CP)

5. No. 1 Nacelle Heater Cavity - Condition (P or CP)

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

6. Anti-Syphon Scoop - Unobstructed (P or CP)

(7.) External Fuel Tank Quantity - Checked (P or CP, GC) G

   After GC removes filler cap, determine fuel quantity, GC will then secure the filler cap.

(8.) Boost Pumps OFF - OFF (P or CP, E)

   Notify engineer that fuel manifold check is complete.

Interior Inspection - Power On (To be accomplished by copilot if radio operator not aboard)

1. VHF Channelization - Set as required

   Check for proper crystals and thumbwheel settings.

2. UHF Channelization - Set as required F G less TCIO 600

3. UHF LOCAL/REMOTE Switch - REMOTE F G less TCIO 600

4. Radio Compass - Check

   Check reception, nulls, and ADF bearing indicator for proper homing. Leave tuned to desired station.

5. VOR Receiver

   a. Instrument Select Switch - VOR-ILS TCIO 572

   b. Local Station - Tune

   c. RMI No. 2 Bearing Indicator - Check for homing

   d. TO/FROM Flags - Check

      Set the reading indicated by the pointer of the No. 2 bearing indicator into the course set window. Check the course deviation indicator on the pilot's course indicator for centering and the TO/FROM window for a TO indication. Set the reciprocal reading indicated by the No. 2 bearing indicator into the course set window. Check the course deviation indicator on the pilot's course indicator for centering and the TO/FROM window for FROM indication. Leave tuned to desired station.

6. TACAN TCIO 572

   a. Instrument Select Switch - TACAN

   b. Local Station - Tune

   c. No. 1 Bearing Indicator - Check for homing

   d. Range Indicator - Check

   e. Pilot's Course Indicator - Check

   f. Instrument Select Switch - VOR-ILS

      Place the instrument select switch to TACAN. Tune in the station by selecting the proper channel on the TACAN control panel. Check the No. 1 bearing indicator on the pilot's TACAN/VOR RMI for proper homing. Place the function selector switch to T/R and check the range indicator. Check the Course Direction Indicator for proper indication. Return the instrument select switch to VOR/ILS. Leave tuned to desired station.

7. VHF Radio - Check

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

8. 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.

9. Liaison Radio (ARC-21) G less TCTO H-666 (ARC-65) G plus TCTO H-666

a. Channelization Card - Check

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

b. Operation - Check

c. Time Signal - Tune (if required)

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

d. Liaison Radio - OFF

ENGINEER'S PREFLIGHT INSPECTION

The following action will be required in complying with the response portion of the preflight inspection checklists:

Condition - A visual check only is required.

Checked - An operational check is required.

Before Interior Inspection

Upon arrival at the airplane, stow personal equipment and check oxygen equipment as outlined in Section IV. When the pilot directs, the crew will assemble and the Form 781 will be read and discrepancies pertaining to each crew position will be discussed with the crew member concerned. Prior to dismissing the crew the pilot will announce a Starting Engines time, which is the time the engineer will be at his crew station with life vest (if applicable) and parachute harness donned. During ALERT PROCEDURES, if time does not permit, the takeoff may be made without wearing the applicable emergency equipment. When dismissed, the preflight inspection will be started.

Interior Inspection

CONTROL CABIN - POWER OFF

1. Circuit Breakers - Set

All circuit breakers on overhead, A/R T, and radio circuit breaker panels set.

2. All Switches - OFF or NORMAL

Check that inverter and boost pump switches are OFF and all other switches are OFF or in NORMAL position prior to applying power.

3. Instruments - Condition

Check for proper position of instruments with power off.

CONTROL CABIN - POWER OFF (Cont)

④ 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, the electrical master switch will be turned ON and the battery switch to ON BUS. If external power is to be used, the electrical master switch will be turned ON and the battery switch will be left OFF.

2. External Power or Auxiliary Power Unit - Started and on the line

3. Bus Voltage - Checked

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

④ Inverters (essential, secondary and autopilot) - ON (E, N)

   Place essential, secondary and autopilot inverter switches on normal switch positions, checking voltage and frequency at each then give power clearance to navigator.

5. SPR Test - Valves closed F G 1255 ▶

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

⑥ Interphone - Contact ground crewman (E, GC)

   Have ground crewman insure and report lower forward entrance door is closed.

⑦ Engine Hydraulic Lock Check - Crank 8 blades (E, GC)

   Have ground crewman insure and report all four props are clear prior to turning each prop. Upon completion of this check, turn the starter selector switch to the OFF position.

⑧ Wing Flaps - Check full down (E, GC)

   Have ground crewman clear the wing flaps prior to lowering to the full down position using normal wing flap switch.

   a. Ground Crewman - Released

      Instruct ground crewman to position manual fuel-shutoff valve(s) for external fuel tank G or CWT boost pump operation, if required, and notify him that checks are completed.

9. Normal Fuel System:

   Perform fuel pressure leak test on all engines as follows:

   a. Fuel Selector Switches (all positions) - Check (counterclockwise and OFF)

      Fuel selector switches in a counterclockwise direction for cycling of valves on all positions.

b. Boost Pump Switches Main Wing Tanks - NORMAL (no pressure rise)

Fuel selector switches OFF, turn both boost pump switches for each wing tank to NORMAL; check for zero fuel pressure rise.

CAUTION

Carburetor will be subjected to one minute NORMAL boost pressure prior to EMERGENCY boost operation. Do not change fuel selector switches with boost pumps on EMERGENCY, except as outlined in Section III.

c. Fuel Selector Switches - TE (note pressure rise)

d. Fuel Selector Switches - OFF

e. Boost Pump Switches - OFF (pressure holds 10 to 14 psi approximately 10 seconds)

f. Fuel Selector Switches - TE

(1) Main Wing Tank Boost Pumps - Checked

Check each boost pump individually on NORMAL. Turn all eight boost pumps on NORMAL for one minute. Turn one boost pump per tank to EMERGENCY and note that warning lights go out. Turn boost pumps from EMERGENCY to OFF. Note fuel low pressure warning lights on at 22 to 20 psi. Turn remaining boost pumps to EMERGENCY. Note fuel pressure. Turn all boost pumps OFF.

g. External Fuel Tank Boost Pumps - Checked (if required) G

Turn forward boost pump to NORMAL in each external tank. Open forward A/R transfer valve T or otherwise provide path of flow. The A/R master switch must be ON to operate the A/R transfer valves. Turn forward boost pumps to EMERGENCY. If boost pumps operate, the fuel tank empty warning light will go out. Return forward boost pump switches to NORMAL. Close forward A/R transfer valve T or other valve opened, when the check is complete. Turn forward boost pumps OFF. Repeat above steps using aft boost pumps and aft transfer valve.

CAUTION

Do not close transfer valves with external boost pumps on EMERGENCY, as sudden flow stoppage may cause external tank O ring seals to pop out.

h. Fuel Selector Switches - TME

CONTROL CABIN - POWER ON (Cont)

i. CWT Boost Pumps - Checked (if required)

If fuel suitable for R-4360 engines is carried in the CWT the No. 1 manual fuel-shutoff valve should be OPEN. With this configuration, open the CWT line valve and turn CWT boost pump switches separately to NORMAL and EMERGENCY. Fuel pressure should rise on all engine fuel pressure gages.

(j.) Boost Pump Switches - One on EMERGENCY, all others NORMAL (E, P)

Turn one boost pump switch on EMERGENCY and all others to NORMAL. Leave in this position for pilot's and boom operator's visual check of the fuel system.

T.O. 10. A/R Panel - Checked:

a. Turn A/R master switch ON and check A/R fuel quantity. Level fuel as required.

b. All other switches OFF or NORMAL position.

c. Push-to-test lights.

d. Hydraulic oil supply valve switches OPEN.

11. Instruments - Condition

Check power on indication of all instruments. On airplanes incorporating TCTO K565, check A1 and B1 head temperature with cylinder head temperature selector switch. On airplanes not incorporating TCTO K565, check A2 and B2 head temperature. Record manifold pressure gage readings for reference during engine runup.

12. All Fuel and Oil Quantities - Checked

All fuel and oil quantities will be determined and entered on the flight engineer's log at this time.

13. Cabin Pressure Relief Valve Crank - Full INCREASE

14. All Switches - As required

15. Takeoff and Landing Data Cards - Check

BEFORE STARTING ENGINES

PILOTS

NOTE

From this point on through the engine shutdown checklist, all checklists will be announced on interphone. 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.

(1.) Wing Flaps UP - 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.

(2.) Lights as Required - As required (P, CP)

3. Gear Switch DOWN - DOWN (CP)

Copilot rechecks landing gear switch is in DOWN position and closes safety cover

4. Check Gear Indicator and Warning Light - Checked (P)

Press landing gear warning light for indication that light is operating. Check indicators for down indication.

5. Check Nose Steering Disconnect Button - Checked (P)

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

6. Open Reverse Lock Plate - Opened (CP)

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

ENGINEER

FOR AN AIRPLANE NOT ON ALERT ITEMS 15 THROUGH 18 WILL BE OMITTED.

1. Electrical Master and Battery Switches - As required

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

(2.) APU or External Power - Started and on line, voltage checked (E, N or GC)

3. Essential Inverter Switch - ESS INV

Check voltage and frequency.

4. Cowl Flap Switches - As required (1 to 2 inches for COCKING)

Cowl flaps open except during cold weather when they will be left in position set.

5. Cabin Pressure Rate-of-Change Selector - MAX

6. Cabin Altitude Selector - Set

Set to desired altitude at which airplane is to be pressurized during flight.

7. Mixtures - FUEL CUTOFF

Check and unlock.

BEFORE STARTING ENGINES (Cont)

PILOTS

7. Check Hydraulic Controls - Checked (CP)

   a. Depressurization and Controllable Check Valve Handles - NORMAL F 1243 ▶ 1374

   b. Emergency Brake Charging Valve Handle - CLOSED F 1243 ▶ 1374

   c. Depressurization and Emergency Charging Valve Handle NORMAL - NORMAL F G 1375 ▶

8. Set Radios - Set (P or CP)

   a. VHF - ON, set on desired frequency

   b. UHF - ON, set on desired frequency

   c. Liaison Radio (ARC-21) G less 1C10 1-1-666, (ARC-65) G plus 1-1-666 - Set on desired frequency (OFF for COCKING)

   d. VOR Receiver - Set on desired frequency (OFF for COCKING)

   e. Radio Compass - Set on desired frequency (OFF for COCKING)

   f. TACAN - Set on desired frequency (OFF for COCKING)

9. Set Parking Brakes - Set (P)

   Copilot checks hydraulic pressure in service brake system. If pressure is below 520 psi, the hand pump will be operated until pressure reaches 520 psi to insure parking brakes being set. Check that the essential inverter warning light is not illuminated.

10. Check Form 781, TOLD Cards - Checked (P)

    Form 781 aboard and takeoff data card available for reference.

(11) Receive Engineer's Report - "Before starting engines checklist complete" (P, E)

ENGINEER

8. Throttles - Cracked

   Throttles cracked (approximately 1 inch for 1000 rpm).

   CAUTION

   Position throttle prior to raising fuel pressure to preclude possibility of the accelerator pump discharging fuel into the engine which could result in a liquid lock.

9. Prop Synch Lever - Full INCREASE RPM

10. TBS Lever - 0

11. Turbo Switches - AUTO

12. Turbo Override Switches - OPEN, guards down

13. Prop Governor Selector Switches - Full INCREASE RPM (lights on)

14. Prop Auto Control Switch - No. 1 or No. 2 MASTER

15. Essential Inverter Switch - OFF

16. Interphone, VHF, UHF Circuit Breakers - Pulled

17. Electrical Master and Battery Switches - OFF

18. Takeoff and Landing Data Cards - Check

(19) Report to Pilot - "Before starting engines checklist complete" (E, P)

STARTING ENGINES

Normally personal equipment will be donned prior to initiating this checklist, however during alert procedures, if time does not permit, the takeoff may be made without wearing the applicable emergency equipment.

PILOTS

FOR AIRPLANES NOT ON ALERT, ITEMS 1 THROUGH 8 WILL BE OMITTED AND THE CHECKLIST WILL BE STARTED WITH ITEM 9.

(1) Remove Ground Heating Equipment and Covers - Removed (ALL)

Each crew member and ground crewman will remove ground heating equipment, ducting, wing and empennage covers as briefed by pilot or as per local directives.

(2) Remove and Stow Tail Jack - Removed and stowed (P or RO, BO)

Assist boom operator if radio operator not assigned.

(3) Down Locks - Removed and stowed (P, N, BO)

Receive down locks from navigator and boom operator. Remove nose gear lock. Stow all down locks in the lower forward compartment.

(4) Start APU - Started (CP, E)

5. Remove Pitot Covers - Removed (P)

(6) Remove Ground Power Unit - Removed (if applicable) (P or RO, GC)

Assist ground crew if radio operator not assigned.

7. Lock Forward Entrance Door - Locked (P)

After boarding airplane, check all downlocks aboard and close and lock forward entrance door.

8. Monitor Radio - Monitored (CP)

Monitor for instructions and type of alert.

9. Check Parking Brakes Set - Checked (pressure up) (P)

10. Radio Call - Monitor or complete (as applicable) (P or CP)

Contact tower, advise airplane location and request taxi and takeoff information.

ENGINEER

FOR AIRPLANES NOT ON ALERT, ITEMS 1 THROUGH 6 WILL BE OMITTED AND THE CHECKLIST WILL BE STARTED WITH ITEM 7.

1. Ground Heating Equipment and Covers - Removed

Remove ground heating equipment and covers as briefed.

2. Electrical Master and Battery Switches - As required

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

(3) APU or External Power - Started and on line, voltage checked (E, CP or GC)

4. Interphone, VHF, UHF Circuit Breakers - Set

5. Essential Inverter Switch - ESS INV

Check voltage and frequency.

6. Turn and Slip Circuit Breaker - Set

7. Boost Pump Switches (one per main tank) - NORMAL

8. Hot Fuel Prime Switches - Climatic (normally HIGH, then OFF)

Place switch to OFF after hot fuel prime indicator light goes out. (Refer to Sections VII and IX for alternate hot fuel prime starting procedures).

CAUTION

If indicator light fails to go out in about three minutes at HIGH, or in about six minutes at LOW, place hot fuel prime switch OFF. Check hot fuel prime tank for overheat condition.

9. Engine Starting Selector Switch - No. 3

STARTING ENGINES (Cont)

PILOTS

(11) Start Engines - Direct engineer to start engines (P, E)

(12) Check Hydraulic Pressure - Checked (P, CP)

With No. 3 engine running, copilot checks No. 3 hydraulic pump by observing rise in pressure. Turn the emergency brake charging valve to OPEN, check emergency pressure, then return to CLOSED and report to pilot - Hydraulic pressure normal. F 1243 ▶ 1374

With No. 3 engine running, copilot checks No. 3 hydraulic pump by observing rise in pressure. Turn the (13) pressurization and emergency charging valve to EMERGENCY brake charging, check emergency pressure, return to NORMAL and report to pilot - Hydraulic pressure normal. F G 1375 ▶

13. Radios - (P or CP)

a. VOR Receiver - ON

b. Radio Compass - ON

c. TACAN - As required

d. Liaison Radio (ARC-21) G less ICTO 1-1-666, (ARC-65) G plus 1-1-666 - As required

e. IFF - STANDBY (if applicable) (CP)

(14) Dismiss Ground Crewman - Dismissed (P, GC)

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

(15) Crosscheck Altimeters - Checked (P, CP, N)

Pilot will announce the altimeter setting, received from the tower, over the interphone. The crew members will then set altimeters and compare readings over interphone. Crew members will check all three pointers on their respective altimeters to assure proper readings. Particular attention will be directed to the position of the 10,000 foot pointer.

(16) Set and Uncage Instruments - Set and uncaged (P, CP)

Check that instrument inverter warning light is not illuminated. Pilot and copilot will reset and uncage all flight instruments, cross check B-16 compass reading with N-1 compass repeaters, cage and uncage J-8 attitude indicator.

17. Door Warning Light Off -Off (CP)

ENGINEER

(10) Start Engines - Climatic (E, P, GC)

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 props clear, fire guard standing by on No. 3, clear on No. 3." Engineer states: "Turning No. 3," press starter switch; after 20 blades, ignition switch BOTH, ignition boost and prime. The ground crewman will count 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.

Ignition switch may be turned on after eight blades propeller rotation, with the following qualifications. Oil dilution must have been accomplished in accordance with the current instructions in COLD WEATHER PROCEDURES, Section IX. Engines must have been preheated to a temperature range of 0° to 10° C on the cylinder head temperature gage by application of preheat in both the nose section and the accessory section.

NOTE

- All normal starts will be made on prime. See SYSTEMS OPERATION, Section VII, for starting procedures.
- Twenty blades are required for any start made after a 1-hour shutdown except when the criteria for an alert cold weather eight blade start is complied with. Eight blades will insure detection of hydraulic lock and are sufficient for engine starts made within 1 hour of last shutdown.
- For hot fuel prime start procedure refer to ENGINE OPERATION, Section VII.

11. Oil Pressure - Check

Oil pressure indication immediately and at least 50 psi within 30 seconds or shutdown engine. On interphone state, "Oil pressure up on No. 3." If oil pressure exceeds 200 psi for more than 30 seconds dilute intermittently to reduce oil pressure. If the procedure fails to reduce excessive pressure within 30 seconds discontinue dilution.

PILOTS

ENGINEER

12. Mixture - AUTO RICH, release primer

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

CAUTION

Be ready to return mixture 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 one minute before repeating starting procedure; if engine fails to start after second attempt, check engine completely and prepare for new start.

(13) Repeat on Remaining Engines as Ground Crewman Clears Each Engine in Turn - Above Steps 9, 10, 11 and 12 (E, GC)

14. Starter Selector Switch - OFF

15. All Boost Pump Switches - OFF

16. Fuel Pressures - Checked

Check pressure from engine fuel pumps.

17. Generators - Checked

Generators on the line and taking load.

18. Inverters - ON

Place secondary, autopilot and pilot's instrument inverter switches on normal switch positions, checking voltage and frequency of each, then report over interphone "Inverters on."

(19) Battery Switch and APU - ON BUS, started (E,N)

Place battery switch to ON BUS and advise navigator to start the APU after external power is removed, if used.

18. Taxi Report - Complete (ALL)

Copilot sounds the alarm bell, pilot announces "Taxi report," Crew reports in the following order: Boom Operator, Navigator and Engineer. These crew members will respond "Ready to taxi." The boom operator will also report "Alarm bell checked, rear entry door locked." (If duties require, the boom operator may visually signal the navigator who will also report for the boom operator). The navigator's report will also include "Ground locks and boom pin stowed, front entry door locked." If aircraft is on alert, report "Navigator ready to taxi."

(20) Report to Pilot - "Ready to taxi" (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 shutdown when possible during a prolonged check of another engine, to prevent running unnecessarily. Prolonged ground running causes fouling of the spark plugs. Face 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 with the prop synch lever in full INCREASE RPM, for a period of one minute, 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. Also, when it is necessary to run an engine on the ground for extended periods, the turbosupercharger shall be operated for a period of one minute out of every ten minutes. This will insure priming of the turbo oil pump and proper lubrication of the bearings during ground run windmilling. Refer to Section VII, SYSTEMS OPERATION, for the procedure to be followed for turbosupercharger operation and the procedure to be followed when spark plug fouling conditions are evident.

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. 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.

NOTE

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.

TAXI

CAUTION

If prop low oil quantity warning light comes on during taxi, runup or before takeoff, cut engine, return to line and have it checked and re-serviced. This should be accomplished in order to prevent possible prop oil starvation.

PILOTS

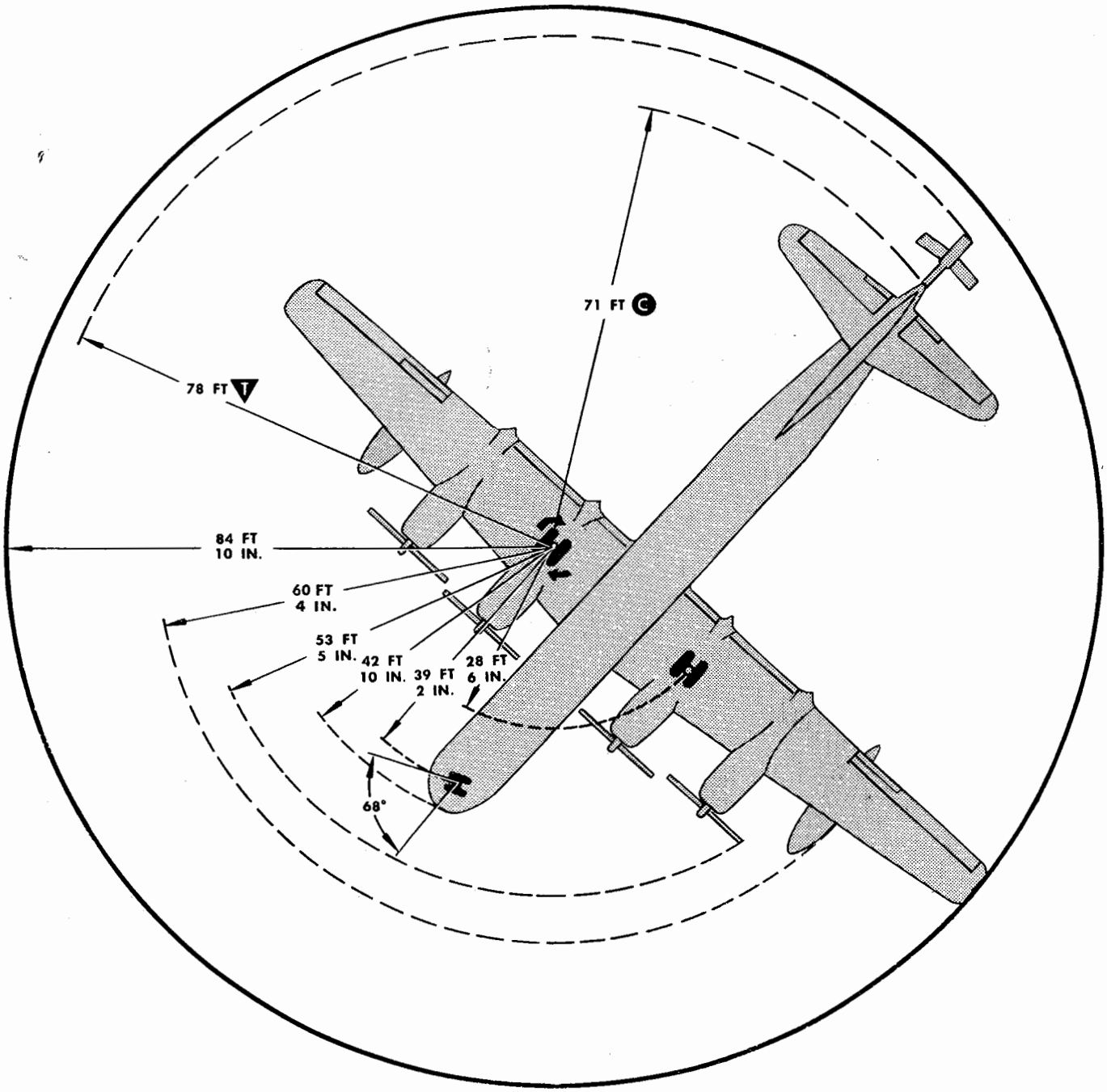
After receiving taxi clearance and visual signal from ground crewman, release parking brake. Advance the throttles to start initial roll.

CAUTION

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

If the brakes still seem to be locked, momentarily depress the copilot's pedals. After the airplane starts rolling, retard throttles to keep engines at a low power adequate for taxiing. When the airplane is clear of congested parking areas and wing walkers are no longer required, the pilot will check the emergency brakes prior to reaching normal taxi speed. Use the brakes to control the speed but do not ride

ENGINEER



NOTE

AVERAGE GROUND CLEARANCE

INBOARD PROPELLERS	1 FOOT 5 INCHES
OUTBOARD PROPELLERS	2 FEET 7 INCHES
EXTERNAL FUEL TANKS G	4 FEET
FUSELAGE	2 FEET 9 INCHES

MINIMUM TURNING RADIUS (TYPICAL)

Figure 2-2

TAXI (Cont)

PILOTS

the brakes. 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. 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.

CAUTION

- Thrust reversal, except in cases of emergency, will not be used at any time to back the airplane on the ground.
- In the event an engine stops during taxiing, the engine should not be restarted until a fire guard is posted, except in emergencies.

(1.) Check Normal Brakes - Checked (P, CP)

As soon as the airplane begins to roll, the pilot will check normal braking action; copilot will check hydraulic pressures.

(2.) Check Emergency Brakes - Checked, system recharged (P, CP)

When the airplane is clear of congested parking areas and wing walkers are no longer required, the pilot will check the emergency brakes prior to reaching normal taxi speed and then direct the copilot to recharge the emergency brake system.

(3.) Check Instruments - Checked (P, CP)

Pilot and copilot will check turn and slip indicators, directional indicators, ADF indicators, and VOR bearing indicator (tracking) for correct operation.

4. Check Hydraulic Pressure - Checked normal (CP)

5. Purge Manifold Pressure Lines - Purged 30 seconds (CP)

Copilot will purge manifold pressure lines 30 seconds.

ENGINEER

1. Mixtures - Manual lean

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. Throttle movement in this range will be made slowly and with caution. Any time 1200 rpm is exceeded the mixtures will be placed in AUTO RICH position.

2. Analyzer Power Switches - ON

(The secondary inverter must be operating to supply power to the analyzer.)

3. Oil Transfer System - As required

Transfer one gallon of oil to each tank using engine oil tank quantity gage as a reference. Do not accomplish after airplane has been placed on alert status.

4. Air Conditioning Master Switch - ON

5. Cabin Pressure Rate-of-Change Selector - Set (as desired for mission)

6. Alternator Control Switches - ON

This allows exciter regulators to warm up. Leave alternator bus selector switch OFF.

7. Carburetor Air Switches - Climatic

During periods of dust or high atmospheric humidity and CAT below plus 7° C use SHELT air.

8. Intercooler Flap Switches - Climatic

Normally CLOSED, then OFF. (When using sheltered air with filters installed, open the intercooler flaps two inches to allow bypass in case of a clogged filter.)

9. Oil Cooler Flap Switches - AUTO

10. Boost Pump Switches (main tanks) - NORMAL

Turn both boost pumps in each tank on NORMAL, CWT boost pumps OFF and CWT line valve CLOSED.

NOTE

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

PILOTS	ENGINEER
	11. Fuel Selector Switches - TE See FUEL SYSTEM OPERATION, Section VII.
	▼12. A/R Hydraulic Pressure - Checked A/R hydraulic pressure on No. 1 and No. 4 hydraulic pumps checked for pressure indication.
	▼13. A/R System - As required If deck fuel is carried check: a. Engineer's A/R Panel in Operating Position. b. A/R Panel Master Switch - ON c. Fuel Dump Switches Cover Open. d. Isodraulic Handle Strap Unfastened. e. A/R System Fuel Level - Checked f. A/R Leveling and Transfer Valve Switches - CLOSED and switch guards down (if installed)
(6) Receive Engineer's Report - "Taxi checklist complete" (P, E)	(14) Report to Pilot - "Taxi checklist complete" (E, P)

ENGINE RUNUP

PILOTS	ENGINEER
1. Center Nose Wheel - Centered (P) Park the airplane with nose into the wind and center nose wheel.	1. Fire Detection Systems - Test Advise pilot - "Checking fire detection." Check all fire detection systems with engines operating to get a test of the relays with vibration.
2. Check Hydraulic Pressure - Checked normal (CP)	2. Mixtures - AUTO RICH
3. Set Parking Brakes - Set (P) NOTE A physical inspection of the brakes will be made after an aborted takeoff or at any time after excessive braking has been used. See USE OF LANDING WHEEL BRAKES, Section VII.	3. Magneto Grounding (800-1000 rpm) - L, R, OFF, BOTH

ENGINE RUNUP (Cont)

PILOTS

④ Receive Runup Report - "Airplane clear for runup" (P, CP, 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. Aft compartment crew member will visually clear the area to the rear of the airplane and report this over interphone. When ready for runup, the pilot will notify the engineer "Clear for runup." During darkness or poor visibility exterior lights will be utilized to aid in detecting any movement of the airplane.

ENGINEER

④ Alternator Voltages - Check (E, P)

Accomplish after pilot notifies "Clear for runup." Set all engines at 1850 rpm. Turn alternator bus selector to L. ALT NESA R. ALT BUS No. 2 and check voltages on both buses. Turn selector OFF when not required. Leave all engines at 1850 rpm for prop operation check.

5. Prop Operation - Check

During cold weather operation turn the auto control switch to No. 1 MASTER and move the synch lever so that the props are exercised between 1850 and 1100 rpm.

a. Manual Controls - Check

(1) Throttles - 1850 rpm

(2) Prop Synch Lever - Full INCREASE RPM

(3) Auto Control Switch - ON

(4) Governor Selector Switches - Full DECREASE RPM

(5) Prop Rpm Lmit Lights (4) - ON (tachometer should indicate 1100 ± 50 rpm)

(6) Governor Selector Switches - Full INCREASE RPM

(7) Prop Rpm Limit Lights (4) - ON

NOTE

Operation in either direction requires 8 to 15 seconds.

b. Auto Master Synchronizer - Check

(1) Throttles - 1850 rpm

(2) Prop Synch Lever - Full INCREASE RPM

(3) Auto Control Switch - OFF

(4) Prop Synch Lever - Retard about one inch from full INCREASE RPM toward DECREASE RPM. Check 4 prop limit lights on, then return lever to full INCREASE RPM.

(5) Auto Control Switch - No. 2 MASTER

(6) Prop Synch Lever - Full DECREASE RPM

Tachometers should indicate 1100 ± 50 rpm.

PILOTS

ENGINEER

(7) Prop Synch Lever - Advance to 1850 rpm, and reset throttles to 30 inches Hg.

(8) Resynchronizer Switch - RESYNC momentarily

Repeat if necessary. Tachometer should indicate 1850 rpm.

(9) No. 2 Throttle - 1000 rpm

(10) Tachometers - 175 rpm maximum drop

No. 1, 3, 4 engines

(11) No. 2 Throttle - 30 inches Hg.

(12) Resynchronizer Switch - RESYNC momentarily

Repeat if necessary. Tachometers should stabilize at 1850 rpm.

(13) Auto Control Switch - No. 1 MASTER

Repeat above 4 steps, using throttle for No. 1 engine.

(14) Throttles - 1000 rpm

(15) Prop Synch Lever - Full INCREASE RPM

(16) Governor Selector Switches (4) - DECREASE RPM for approximately 3 or 4 seconds. Check all rpm limit lights out.

Wait 3 or 4 seconds before retarding prop synch lever.

(17) Prop Synch Lever - Toward DECREASE RPM approximately 2 inches. Then advance to full INCREASE RPM. Check all rpm limit lights on.

CAUTION

If rpm limit lights do not illuminate, calibrate switch is probably faulty.

ENGINE RUNUP (Cont)

PILOTS

(5.) Prop Operation - Checked (P, E, CP)

After the engineer completes the prop operational check the pilot will check thrust reversal. The pilot will reverse the throttles in pairs, e.g., numbers 1 and 4 simultaneously and numbers 2 and 3 simultaneously. Hold thrust reversal to an absolute minimum of time to prevent overheating the engines. Open the throttles to approximately 1000 rpm and allow to stabilize. Depress number 1 feathering button momentarily and watch for initial rpm rise. This is positive indication that the thrust has reversed. Receive engineer's report of load indication on his loadmeter. Repeat on other engines. Upon completion of reversal check, return to forward thrust rpm of approximately 1000 rpm.

CAUTION

If a prop sticks in reverse thrust, immediately have engineer cut the engine and investigate, as the engine may overheat.

Upon completion of the reversal check the engineer will set rpm on all engines at 1200. Adjust throttle friction brake. Check that blade switch operation is normal by pulling out on each feathering button and hold for 3 to 4 seconds. Check that respective engine rpm does not change while feathering button is held out, and then release to neutral. Upon completion of the blade switch check, and with all engines set at 1200 rpm, the pilot will check feathering action. Starting with number 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 prop has returned to forward thrust. During the feathering check of number 1 engine only, the copilot will check that all prop limit lights remain on. This is to check that the prop 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."

(6.) Receive Engineer's Report - "Engine runup complete" (P, E)

ENGINEER

(6.) Reversal - Check (E, P)

a. Throttles - 1000 rpm

b. Report "Ready to Reverse"

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

(7.) Prop Feathering - Check (E, P)

a. Throttles - 1200 rpm

b. Report "Ready for feathering check."

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

8. Engine Power and Ignition System - Check

a. Throttle (one at a time) - 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 prop 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 45-50 rpm; maximum allowable 80 rpm. Maximum allowable difference between right and left magneto is 20 rpm.

CAUTION

Do not exceed maximum allowable CHT for ground operation.

(9.) Report to Pilot - "Engine runup complete" (E, P)

10. Mixtures - Manual lean (if time permits)

BEFORE TAKEOFF

UNDER SCRAMBLE CONDITIONS, ACCOMPLISH THIS CHECKLIST WHILE TAXIING.

PILOTS

1. Set Trim Control Wheels - Set (P)

   Set all trim control wheels neutral or as desired for takeoff.

2. Autopilot Switch OFF - OFF (P)

3. Rudder Boost ON - ON (P)

4. ADI Switch Climatic - Climatic (CP)

   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.

5. Set Throttle Lock Lever - Set (P)

   Adjust throttle lock as desired for takeoff.

6. Set Wing Flaps - Set 33% (P, CP, BO)

   In freezing weather operate wing flaps through one complete cycle before setting flaps for takeoff. Wing flap switch DOWN until indicators read 33%. At this time aft compartment crew member will report, "Both flaps_____%."

   NOTE

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

ENGINEER

1. Body Heater Switches - OFF

   CAUTION

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

2. Turbo Switches - MAN

3. Turbo Override Switches - OPEN, 10 seconds then OFF, guards up

BEFORE TAKEOFF (Cont)

PILOTS

(7.) Takeoff Data - Reviewed (P, CP, N, E)

When the engineer reports "Ready for briefing" the pilot will brief the copilot, navigator and engineer on necessary items on the TOLD card. S_1/S_2 takeoff performance monitoring procedures will be reviewed as necessary. Emergency considerations will be reviewed with the copilot. 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 crew member change occurs at the navigator's position, acceleration check time will be reviewed with the replacement navigator.

NOTE

Under scramble conditions review minimum performance torque with copilot and engineer. Review of other takeoff procedures and considerations will be at discretion of the pilot.

8. Set TACAN - Set as required (P or CP)

WARNING

If departure is to be made on VOR, then turn the TACAN off. This will prevent the automatic switchover to TACAN in event of VOR power failure. This switchover may occur without being noticed by the pilot, since there will be no warning flag indicating the VOR failure.

(9.) Anti-Icing Equipment Climatic - Climatic (P, E)

Direct the engineer to turn on anti-icing equipment as desired. Turn on windshield wipers, if required.

10. Fasten Safety Belt and Shoulder Harness - Fastened (P, CP)

11. Check Reverse Lock Plate Open - Opened (CP)

(12.) Unlock Flight Controls - Unlocked and checked (P, CP)

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

(13.) Set Direction Indicators - Set (P, CP)

Pilot and copilot set direction indicator cards with runway heading under the index at the top of

ENGINEER

(4.) Report to Pilot - "Ready for briefing" (E, P)

5. Exercise Props - Climatic (ALERT only)

Advise pilot "Exercising props" and receive clearance prior to exercising props during cold weather operation. Move the master synchronizer lever so that the props are exercised between 1850 and 1100 rpm.

6. Prop Synch Lever - Full INCREASE RPM

(7.) Prop Deicing Switch - As required (E, P)

Turn prop deicing switch ON at direction of the pilot whenever icing is anticipated.

(8.) Window Heat - As required (E, P)

No higher than necessary, normally LOW.

9. Safety Belt and Shoulder Harness - Fastened

10. Engine Pressures and Temperatures - Checked (within takeoff limits)

See 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.

PILOTS

the dial. Pilot sets direction indicator pointer to agree with copilot's N-1 compass repeater heading pointer.

14. Tower Call - Completed (CP)

Obtain clearance to take the active runway for takeoff. Remaining items of the checklist will be completed after takeoff clearance has been obtained.

(15) Power Staging - Climatic (P, E)

See COLD WEATHER PROCEDURES, Section IX.

(16) Set 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. Windows Closed - Closed (P, CP)

18. Pitot Heat Switches ON - ON (P)

19. Anti-Collision Lights ON - ON (CP) TCTO 591

CAUTION

Do not operate anti-collision lights over five minutes during ground operation.

20. IFF Master Switch - NORMAL (if applicable) (CP)

(21) Landing Lights ON - ON (if required) (P, CP)

Normally the right landing light will be set at a 45 degree angle with the left light and taxi lights used at the discretion of the pilot. Under conditions of restricted visibility, such as haze, fog, snow, or rain, and when pilot is of the opinion that the use of landing lights is a hindrance rather than an aid to visibility, the use of landing lights is not mandatory. Copilot will maintain visual contact with the ground insofar as possible during night and/or weather conditions until a safe altitude has been reached.

(22) Crew Takeoff Report - Received (ALL)

Pilot will announce over interphone, "Takeoff report." Aft compartment crew member will report, "Cowl flaps set, ready for takeoff." Navigator and engineer report "Ready for takeoff."

ENGINEER

11. Mixtures - AUTO RICH (locked)

(12) Power Staging - Climatic (E, P)

Receive pilot approval prior to starting power staging procedures. See COLD WEATHER PROCEDURES, Section IX.

(13) Cowl Flap Switches - Set (when directed) (E, P)

Set position as required by OAT.

(14) Report to Pilot - "Ready for takeoff" (E, P)

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 the Appendix, T.O. 1C-97(K)F-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. During light gross weight takeoffs, where climbout performance and/or terrain clearance is not critical, the pilot may find it advisable to climb out to flap retraction altitude at higher airspeeds and accomplish flap retraction in an accelerated climb profile. This technique will avoid exaggerated nose-high attitudes which may be objectionable .

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

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.

NOTE

For takeoff from a static position on the runway, the pilot will advance power slowly to field barometric pressure and release the brakes. While maintaining directional control with nose wheel steering, gradually advance the throttles to maximum power. The copilot holds the controls and monitors the airspeed.

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 -24°C or colder, see TPSI limitations in Section V.) As the airplane accelerates to approximately 55 knots, the copilot will announce over interphone "60 knots ----------" and at 60 knots will state "NOW." When the copilot calls "NOW" the pilot will check his indicated airspeed. This is a check for gross error in the airspeed indicating systems. If the pilot's airspeed indicator reads other than 60 knots, this difference will be applied at the end of the acceleration check to determine if satisfactory acceleration has been attained. At the exact instant of the call at 60 knots, the navigator will start the acceleration check timing. A stop watch, with either the master or hack watch as a back-up will be utilized. At 60 knots, the pilot will take over the controls and release nose wheel steering if definite rudder control has been attained. Approximately 4 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.

WARNING

In the event of different indicated airspeeds, between pilot's and copilot's indicators, or if indicated airspeeds are erratic during minimum interval takeoff procedures, the pilot must be prepared to decide whether to continue or abort the takeoff. Differences in indicated airspeeds may be apparent at 60 knots, thereby alerting the pilot for possible further non-comparison at the end of the acceleration check.

As the airplane continues to accelerate, at approximately 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. (At light gross weights S_1 and S_2 speeds may be the same.) Lift off 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.
- For airplane weights not in excess of 120,000 pounds actual or 130,000 pounds equivalent,

the takeoff performance acceleration check may be deleted, provided runway available is equal to or greater than total acceleration stop distance. S_1 and S_2 speeds will be computed and applicable procedures outlined under NORMAL TAKEOFF TECHNIQUE will apply.

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.

NOTE

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 three engine 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 of 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 Section VII under ELIMINATION OF CARBURETOR ICE, as this may cause detonation.

Minimum Roll Takeoff Technique

Use of 55% wing flaps instead of 33% decreases takeoff ground roll by 8 to 16% (see the Appendix, T.O. 1C-97(K)F-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. When possible allow the airplane to continue roll when taxiing onto runway. Increase power on all engines during the turn, leading with the engines on the outside of the turn. At the time the airplane is lined up with the runway, all engines should be at or near maximum power. Do not use brakes during the turn; gain as much speed as possible during the turn. Any speed that can be gained while taxiing onto the runway will improve initial acceleration and shorten the takeoff roll.

Obstacle Clearance Takeoff Technique

Use minimum roll takeoff technique outlined above, 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 climb-out speed, maximum power and takeoff flap setting until obstacles have been cleared. In general, obstacles more than a mile distant from takeoff point are best cleared with 33% flaps, while closer obstacles can be cleared with greater margins using 55% flaps. With 33% flaps, the flaps may be retracted upon reaching 500 feet but no improvement in climb path slope will be achieved. With 55% flaps the acceleration necessary to reach flap retraction speed impairs the climbout path unless the obstacles to be cleared are over 1000 feet high or over 10 miles from takeoff point. For such distant or high obstacles allow the airplane to accelerate while still maintaining some vertical velocity to the recommended flap retraction speed. The flaps should then be started up and allowed to retract to the desired climb position in one continuous operation without loss of altitude. Have scanners report flap action during retraction. The minimum recommended altitude for flap retraction is an indicated 500 feet above the terrain. However, the above minimum should not apply under emergency conditions when obstacle clearance can be observed visually.

Transition Flying

NOTE

For brake cooling requirements and subsequent takeoff restrictions, refer to figure 5-4.

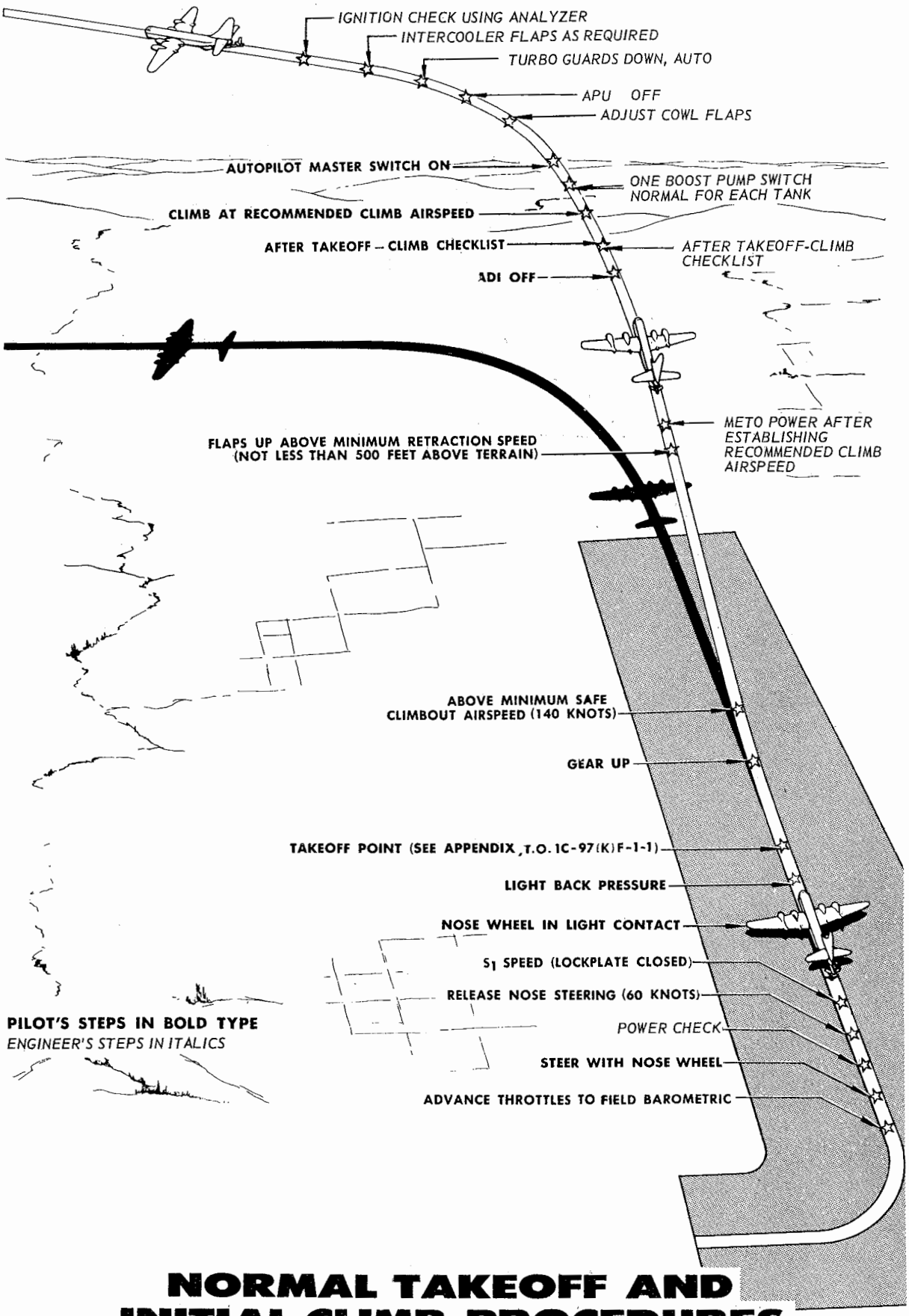
See 4 and 3 ENGINE TAKEOFF FLIGHT PATHS in the Appendix, T.O. 1C-97(K)F-1-1, for accurate information on possible takeoff flight paths.

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, figure 1A1-6, T.O. 1C-97(K)F-1-1, to obtain the runway wind component for crosswind takeoffs.

Night Takeoff Technique

See NIGHT FLYING, Section IX.



NORMAL TAKEOFF AND INITIAL CLIMB PROCEDURES

Figure 2-3

TAKEOFF

PILOTS

1. Enter Runway (P)

2. 60 Knots - NOW (P,CP,N) or (P,CP) as applicable

   At approximately 55 knots the copilot announces over interphone, "60 knots ----," and at 60 knots states "NOW." The navigator, or copilot if the navigator is not flying, will start the acceleration timing at this time. The pilot will check his indicated airspeed and if rudder control has been attained, release nose wheel steering.

3. Time - HACK (P,CP,N) or (P,CP) as applicable

   Approximately four seconds before the end of the computed time, the navigator, or copilot if navigator is not flying, announces over interphone, "Time -----," and at the end of the computed time will state, "HACK." At this time the pilot and copilot will check their respective airspeed indicators. The copilot will call out (not over interphone) the airspeed indicated on the copilot's indicator.

4. S_1 - NOW (P,CP)

   At approximately five knots below S_1 speed the copilot will call (not over interphone) "S_1 -----," and at S_1 speed will state "NOW." If takeoff is to be continued the copilot will close the throttle reverse lock plate.

5. S_2 - NOW (P,CP)

   Copilot will notify the pilot when S_2 speed has been reached.

ENGINEER

AFTER TAKEOFF — CLIMB

NOTE

If backfiring is encountered during flight, power on the malfunctioning engine shall be reduced, and CAT and CHT 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 **ENGINEER**

(1) Gear Switch UP - UP (P, CP)

When the airplane is definitely airborne, the pilot will brake wheels then call and visually signal "gear up." The copilot will raise the gear. The pilot will not level off, but will continue to climb at a reduced rate until the minimum flap retraction speed or 140 knots is reached, whichever is higher, until 500 feet above the terrain. The copilot will check that the landing gear indicators indicate *DOWN*, *INTERMEDIATE* and *UP* during the gear retraction cycle and advise the pilot "gear up" when the indicators indicate up.

CAUTION

To preclude possible landing gear damage and/or wheel well fire which may be incurred shortly after takeoff as a result of spinning wheels within the wheel well, the following normal operating instructions shall be performed. After takeoff and immediately prior to moving the landing gear switch from DOWN to UP position, the pilot shall apply normal brake action to stop the spinning of the landing gear wheels. If the pilot should inadvertently move the landing gear switch to the UP position without first braking the wheels, normal brake action should be applied as soon as possible. However, this latter action should not be performed as normal operating procedure due to undesirable impact loads on the landing gear and its associated structural components, introduced through brake application during landing gear retraction.

PILOTS	ENGINEER
2. Check Reverse Warning Flag Up - Checked (flag up) (CP) After the gear switch has been actuated, the co-pilot will check the prop reverse lock warning flag for the up position indicating that the props cannot be inadvertently reversed. The lock is timed to actuate approximately eight seconds after the oleo struts have been extended.	
(3.) Engineer's Throttles - Notify (P, E) Notify engineer that he has the throttles. Engineer will acknowledge.	(1.) Engineer's Throttles - Acknowledge (E, P)
(4.) Wing Flaps Up - Full up (P, CP, BO) At 500 feet above the terrain and upon reaching flap retraction speed, decrease rate of climb and retract flaps to 20%, then 10% and then to the full up position while accelerating to the recommended climb speed.	
WARNING To preclude flying into the ground, maintain a positive rate of climb at all times during flap retraction. Minimum flap retraction altitude is 500 feet unless an emergency exists.	
NOTE The copilot will monitor the dual flap indicators for any indication of unbalanced wing flap movement. In event unusual roll attitude of the air-plane is encountered during flap op-eration immediately correct with aileron and rudder control and sim-ultaneously return the flaps to a symmetrical position.	

AFTER TAKEOFF — CLIMB (Cont)

PILOTS

(5.) METO Power - Set (P, E)

When wing flaps are full up and recommended climb speed has been reached, the pilot will call for METO power.

(6.) Landing Lights OFF - OFF (P, CP)

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

7. ADI Switch OFF - OFF (CP)

After METO power is set, turn ADI OFF and pilot will call for AFTER TAKEOFF-CLIMB checklist.

(8.) Pilot Monitors Desired Radio - Monitored (P, CP)

9. Autopilot - As desired (P)

10. Gear Switch OFF - OFF (CP)

WARNING

The landing gear will be extended for inflight 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. No. 2 or No. 3 Engine Instruments - Erratic readings

b. Loadmeter - No indication

c. Low Fuel Pressure Warning Light - On

d. Engine rpm - Fluctuating

e. No. 2 or No. 3 Fire Warning Light - On

ENGINEER

(2.) METO Power - Set (E, P)

Set METO power when requested by pilot. Do not exceed 198 psi torque pressure.

3. Boost Pump Switches - NORMAL (one per tank)

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

4. Cylinder Head Temperature - Checked (position selector switch to hottest cylinder)

5. Cowl Flaps - As required

Set minimum cowl flap opening to obtain desired CHT.

6. Generators, Inverters and Alternators (if on) - Checked for proper voltage and power output

7. APU - OFF, exhaust valve closed (if required)

8. Carburetor Air Switches - As required

PILOTS

11. Wheel Well Light Switches OFF - OFF (CP)

ENGINEER

9. 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.)

a. TBS Lever - 0

b. Turbo Override Switches - OPEN, guards down

NOTE

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

c. Turbo Switches - AUTO (one at a time)

Monitor MP closely to prevent inadvertent overboost.

d. Intercoolers - Open to 2 inches (or as desired)

(Accomplish before advancing TBS lever to anticipate CAT rise when turbo is added.)

e. TBS Lever - Carefully advance as desired

CAUTION

Do not exceed CAT 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 in Section III.

NOTE

It may not always be possible to maintain 53 inches 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 manifold pressure fluctuation. This will also be observed during hot day operations, however, if only one or two engines are deficient, a malfunction could be suspected.

f. CAT - Control with intercooler flap switches

AFTER TAKEOFF — CLIMB (Cont)

PILOTS

ENGINEER

10. Cabin Pressurization - As desired

    Advise crew and begin pressurization after maximum throttle is set for climb. For cold weather operation, maintain a minimum of 2 inches Hg. cabin air flow throughout flight to warm the oil transfer line.

▼11. Engineer's A/R Panel (if deck fuel is carried)

    a. Fuel Dump Switches Cover Closed

    b. A/R Master Switch - OFF

    c. Engineer's A/R Panel in Stowed Position

12. Analyzer Check - Accomplish

(12) Anti-Icing Equipment Climatic - Climatic (P,E)

Direct engineer to turn on anti-icing equipment as desired.

(13) Prop Deicing Switch - As required (E, P)

Turn prop deicing switch ON at direction of the pilot whenever icing is anticipated.

(14) Window Heat - As required (E, P)

No higher than necessary, normally LOW.

(15) Surface Anti-Icing Heaters - As required (E, P)

Turn wing and empennage heaters ON as required and monitor temperatures. Check individual heater temperatures periodically while heaters are in operation.

(13) Receive Engineer's Report - "After takeoff-climb checklist complete" (P, E)

Receive engineer's report.

(16) Report to Pilot - "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 speed. 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 flap retraction speed or 140 knots, whichever is greater. At 500 feet above terrain, flaps are retracted in increments to the full up position. When recommended climb speed has been reached, power is reduced to METO power. These speeds and the corresponding flaps up climb performance are shown in the Appendix climb prediction charts, T.O. 1C-97(K)F-1-1.

CRUISE

PILOTS

1. Set Cruise Power - Set (P, E)

   Upon reaching cruise altitude, allow airplane to accelerate to cruise airspeed or slightly above and direct engineer to set cruise power. Trim airplane as required.

2. Engage Autopilot - Engaged (if desired) (P)

ENGINEER

1. Power Setting - As required (when directed) (E,P)

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

   NOTE

   For prop operation during flight, see Section VII.

2. Intercoolers and Carburetor Air Switches - As required

3. Turbo - As required

4. Cowl Flaps - As required

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

5. Fuel Selector Switches and Boost Pumps - As required

6. 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 INFLIGHT FOULING PROTECTION, Section VII.

7. Mixtures - As required

8. 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.

CRUISE (Cont)

PILOTS

(3.) Anti-Icing Equipment Climatic - Climatic (P,E)

Direct engineer to turn on anti-icing equipment as desired.

(4.) Set SIF Mode Settings - Set (P, N)

Check that SIF settings for cruise altitude are as outlined in current directives.

(5.) Receive Engineer's Report - "Cruise checklist complete" (P, E)

Receive engineer's report.

NOTE

Copilot will crosscheck the copilot's direction indicator and repeater compasses against the magnetic compass every 30 minutes during magnetic slaved operation of the N-1 compass system. Advise navigator if any variation exists.

ENGINEER

(9.) Prop Deicing Switch - As required (E, P)

Turn prop deicing switch ON at direction of the pilot whenever icing is anticipated.

(10.) Window Heat - As required (E, P)

No higher than necessary, normally LOW.

(11.) Surface Anti-Icing Heaters - As required (E, P)

Turn wing and empennage heaters ON as required and monitor temperatures. Check individual heater temperatures periodically while heaters are in operation.

(12.) Report to Pilot - "Cruise checklist complete" (E, P)

FLIGHT CHARACTERISTICS

Refer to Section VI for information regarding airplane flight characteristics. See Section IV for a discussion of pilot technique and airplane characteristics during the air refueling operation, as applying to tanker airplanes.

SYSTEMS OPERATION

Refer to Section VII for detailed information regarding the operation of the following:

1. Engine operation including:
   a. Manual leaning
   b. Spark plug defouling
2. Carburetor anti-icing
3. Turbosuperchargers
4. Cowl flaps
5. Ignition analyzer
6. Propellers
7. Oil system
8. Fuel system
9. Electrical system
10. Refer to Section IV for detailed information regarding the operation of the air refueling system.

SECONDARY CLIMB

PILOTS	ENGINEER
(1) Notify Engineer - "Start secondary climb checklist" (P, E)	1. Mixtures - AUTO RICH 2. Boost Pump Switches - 4 on NORMAL When 4 tanks are selected one fuel boost pump on NORMAL for each tank selected or as required. 3. Fuel Selector Switches - As required 4. METO Power - Set 5. Intercoolers - As required 6. Turbo - As required 7. Cowl Flaps - As required
(2) Anti-Icing Equipment Climatic - Climatic (P, E) Direct engineer to turn on anti-icing equipment as desired.	(8) Prop Deicing Switch - As required (E, P) Turn prop deicing switch ON at direction of the pilot whenever icing is anticipated. (9) Window Heat - As required (E, P) No higher than necessary, normally LOW. (10) Surface Anti-Icing Heaters - As required (E, P) Turn wing and empennage heaters ON as required and monitor temperatures. Check individual heater temperatures periodically while heaters are in operation.
(3) Receive Engineer's Report - "Secondary climb checklist complete" (P, E)	(11) Report to Pilot - "Secondary climb checklist complete" (E, P)

DESCENT

DESCENT TECHNIQUE

Analysis shows that, compared to level flight, the energy derived from descent while maintaining long range cruising speeds 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 speeds are maintained. Refer to the Appendix, T.O. 1C-97(K)F-1-1, for discussion.

RAPID DESCENTS

At long range cruising speeds 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 speeds appreciably higher than long range cruising are used. When descending at speeds other than long range cruising speeds the factor of 2.2 nautical miles per 1000 feet is not correct. It is apparent that descending at very high speeds would reduce this factor considerably.

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 one inch Hg. manifold pressure. For example, 23 in. Hg at 2300 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.

PILOTS

(1.) Complete Radio Call - Completed (P, CP)

Request and receive letdown instructions from ARTC if flying on instrument flight rules. Obtain and notify engineer of landing ETA, runway temperature, dew point and pressure altitude. Compare forecast altimeter setting with the setting obtained from FAA facilities.

(2.) Set Altimeters - Set (P, CP, N)

Pilot will announce altimeter setting over interphone. Crew members will set altimeters.

ENGINEER

1. Mixtures - As required

PILOTS

3. Set TACAN - Set (as required) (P or CP) ISUE 572

WARNING

While making a VOR instrument or ILS approach on airplanes equipped with both VOR and TACAN equipment turn the TACAN equipment off. This will prevent the automatic switchover to TACAN, in event of VOR-ILS localizer power failure. This switchover may occur without being noticed by the pilot, since there will be no warning flag indicating the VOR failure.

(4.) Anti-Icing Equipment Climatic - Climatic (P,E)

Direct engineer to turn on anti-icing equipment as desired.

5. Notify Crew - "Prepare for landing" (P)

6. Fasten Safety Belt and Shoulder Harness - Fastened (P, CP)

Pilot and copilot fasten safety belt and shoulder harness.

(7.) Set Power - Set (P, E)

Direct engineer to establish power for descent as desired.

8. Check Hydraulic Controls - Checked (CP)

a. Depressurization and Controllable Check Valve Handles - NORMAL F 1243 ▶ 1374

b. Emergency Brake Charging Valve Handle - Closed F 1243 ▶ 1374

c. Depressurization and Emergency Charging Valve Handle - NORMAL F G 1375 ▶

ENGINEER

(2.) Prop Deicing Switch - As required (E, P)

Turn prop deicing switch ON at direction of the pilot whenever icing is anticipated.

(3.) Window Heat - As required (E, P)

No higher than necessary, normally LOW.

(4.) Surface Anti-Icing Heaters - As required (E, P)

Turn wing and empennage heaters ON as required and monitor temperatures. Check individual heater temperatures periodically while heaters are in operation.

(5.) Descent Power - Set (when directed) (E, P)

CAUTION

- During descent transfer oil only in accordance with Section VII, OIL SYSTEM OPERATION, 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 MP, or master rod bearing failures may result.

DESCENT (Cont)

PILOTS	ENGINEER
9. Check Nose Steering Engaged - Engaged (P)	6. Turbo and Intercoolers - As required Maintain CAT outside of icing range.
(10) Check Instruments - Checked (P, CP)	7. Cabin Altitude and Rate-of-Change Selector - As required Refer to Section IV.
	8. Cowl Flaps - As required
	9. Overhead Panel Circuit Breakers - Checked set
	10. Oil Cooler Flap Switches - AUTO
	11. Carburetor Air Switches - As required
	▼12. Engineer's A/R Panel: a. Unstow Panel and Turn A/R Master Switch - ON b. A/R Fuel Quantity Gages - Checked c. Turn A/R Master Switch OFF and Stow Panel
(11) Review Landing, Go-Around, Landing Data Card - Reviewed (P, CP) Review landing and go-around procedures and review all information on landing data card prior to landing and check appropriate stall speeds according to stall speed placard.	(13) Landing Data Card - Present to pilot (E, P) 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) Receive Engineer's Report - "Descent checklist complete" (P, E)	(14) Report to Pilot - "Descent checklist complete" (E, P)

BEFORE LANDING

PILOTS

NOTE

- 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 2-5, enter the downwind leg at 1500 feet above the runway. 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 roll out, to wings level attitude on base leg, will be of sufficient duration to allow for visual clearance of aircraft in all directions. At the halfway point on the base leg, the altitude should be approximately 1000 feet. A 90 degree descending turn to final approach will be initiated to roll out on final approach at a minimum altitude of 800 feet.

1. Autopilot OFF - 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. Rudder Boost ON - ON (P)

   NOTE

   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.

(3.) Anti-Icing Equipment Climatic - Climatic (P,E)

Direct engineer to turn on anti-icing equipment as desired.

ENGINEER

(1.) Prop Deicing Switch - As required (E, P)

Turn prop deicing switch ON at direction of the pilot whenever icing is anticipated.

(2.) Window Heat - As required (E, P)

No higher than necessary, normally LOW.

BEFORE LANDING (Cont)

PILOTS

④ Mixtures RICH - RICH (P, E)

The pilot will direct the engineer to set mixtures RICH; the engineer will report on completion of this action "Mixtures AUTO RICH and locked."

⑤ Rpm - Call for 2350 rpm (use 2550 or 2700 if required with one or more engines inoperative) (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. (2550 or 2700 if required with one or more engines inoperative).

⑥ Gear Switch DOWN - DOWN (four engine operation) (P, CP, E)

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. A crew member will visually check the main gear and nose gear down, and report checks to engineer. The copilot will check that the landing gear indicators indicate ***UP***, ***INTERMEDIATE*** and ***DOWN*** during the gear extension cycle and check the warning light. The pilot checks landing gear position indicators for down and locked condition. With one or more engines inoperative, gear will be lowered on final approach when certain that the field can be reached.

CAUTION

If any landing gear fails to extend by use of the normal system, the affected gear will be extended manually. Whenever there is any indication that the landing gear position indicators (Selsyn) and/or warning light indicate a gear position different from the known position, the landing gear will be extended manually. This is to insure that the 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 gear unless the manual system has failed.

ENGINEER

③ Surface Anti-Icing Heater Switches - As required (E, P)

④ Mixtures - Check AUTO RICH (locked) and report to pilot (E, P)

⑤ Rpm - Set 2350 rpm or as directed and report to pilot (E, P)

6. Cowl Flaps - Set (1 to 3 inches)

7. APU - Started and on line

Engineer will direct a crew member to start the APU for final full stop landing. For transition flying, where the airplane remains in traffic pattern, operation of the APU is not mandatory and may be operated at pilot's discretion if there is one operational generator per engine.

NOTE

In case the APU is not operational, the APU exhaust door will be opened. This will prevent any accidental cabin pressurization while on the ground.

CAUTION

On airplanes not incorporating TCTO 538 do not operate APU during flight with cabin pressure release valve opened.

8. Safety Belt and Shoulder Harness - Fastened

9. Airplane Fuel Quantity Gages - Checked

10. Boost Pump Switches - Main, NORMAL, external G and center, OFF

All boost pump switches except external G or center wing tank on NORMAL.

11. CWT Line Valve Switch - CLOSE

PILOTS

(7.) Set Wing Flaps - Set 55% (as required with one or more engines inoperative) (P, CP, BO)

Direct copilot, "Set flaps 55%." Aft crew member will report flap movement and position.

CAUTION

With one or more engines inoperative, set wing flaps as required but do not extend flaps over 55% until certain that the field can be reached without increasing power.

8. Check Hydraulic Pressure and Supply - Checked (CP)

Copilot checks hydraulic supply for proper level (approximately 3.5 gallons) and all three hydraulic pressure gages for normal pressure.

9. ADI ON - ON (CP)

To be turned on by copilot, if ADI is available. Advise engineer if ADI is not to be used.

10. Check Reverse Lock Plate Closed - Closed (CP)

11. Fasten Safety Belt and Shoulder Harness - Fastened (P, CP)

(12.) Landing Lights Extended - Extended (as required) (P, CP)

The pilot will direct the copilot to check the landing lights. Landing lights will be extended and turned 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.

(13.) State Reversing Intentions - State as desired (P, E)

Pilot announces reversing intentions and engineer will acknowledge; normally props will be reversed.

ENGINEER

12. Fuel Selector Switches - TE

13. TBS Lever - Climatic

14. Turbo Switches - Climatic

Leave switches in AUTO if TBS is being used.

15. Turbo Override Switches - Climatic

OPEN 10 seconds, (after TBS lever is placed at zero) OFF, guards up.

16. Carburetor Air Switches - Climatic

17. Intercooler Flap Switches - Climatic

With filters installed open 2 inches if sheltered air doors in SHELT position.

18. Battery Switch - ON BUS

19. Body Heater Switches - OFF

BEFORE LANDING (Cont)

PILOTS

(14) Gear Switch DOWN - DOWN (on final if one or more engines inoperative) (request and receive visual check) (P, CP, E)

Extend landing gear on final approach when certain the field can be reached.

(15) Receive Engineer's Report - "Before landing checklist complete" (P, E)

(16) Set Final Flaps as Required - Set as required (P, CP, BO)

When final flaps are lowered the airspeed will be reduced to the desired final approach speed (use 55 to 80% if snow conditions require, to prevent flap damage).

CAUTION

At a gross weight less than 105,000 pounds, and at 15 to 18.5% MAC, flaps must be limited to 80% throughout the approach to touchdown.

(17) Landing Lights ON - ON (if required) (P, CP)

After turn on final approach if required.

ENGINEER

(20) Report to Pilot - "Gear checked down visually, before landing checklist complete" (E, P)

21. Surface Anti-Icing Heater Switches - OFF

Place switches OFF when airplane approaches the flare point.

22. TBS Lever - 0

Place TBS lever to zero when airplane approaches the flare point.

GO-AROUND

PILOTS

1. Notify Crew - Notified (P)

(2) Set Rpm 2700 - Set (P, E)

Direct engineer to increase rpm to 2700.

(3) Simultaneously: (P, E)

a. Advance Throttles - Advanced (P)

Advance throttles evenly and smoothly to maximum power.

(b) Set Wing Flaps - Set 55% (P, CP, BO)

Direct copilot to raise wing flaps to 55 percent in one movement.

ENGINEER

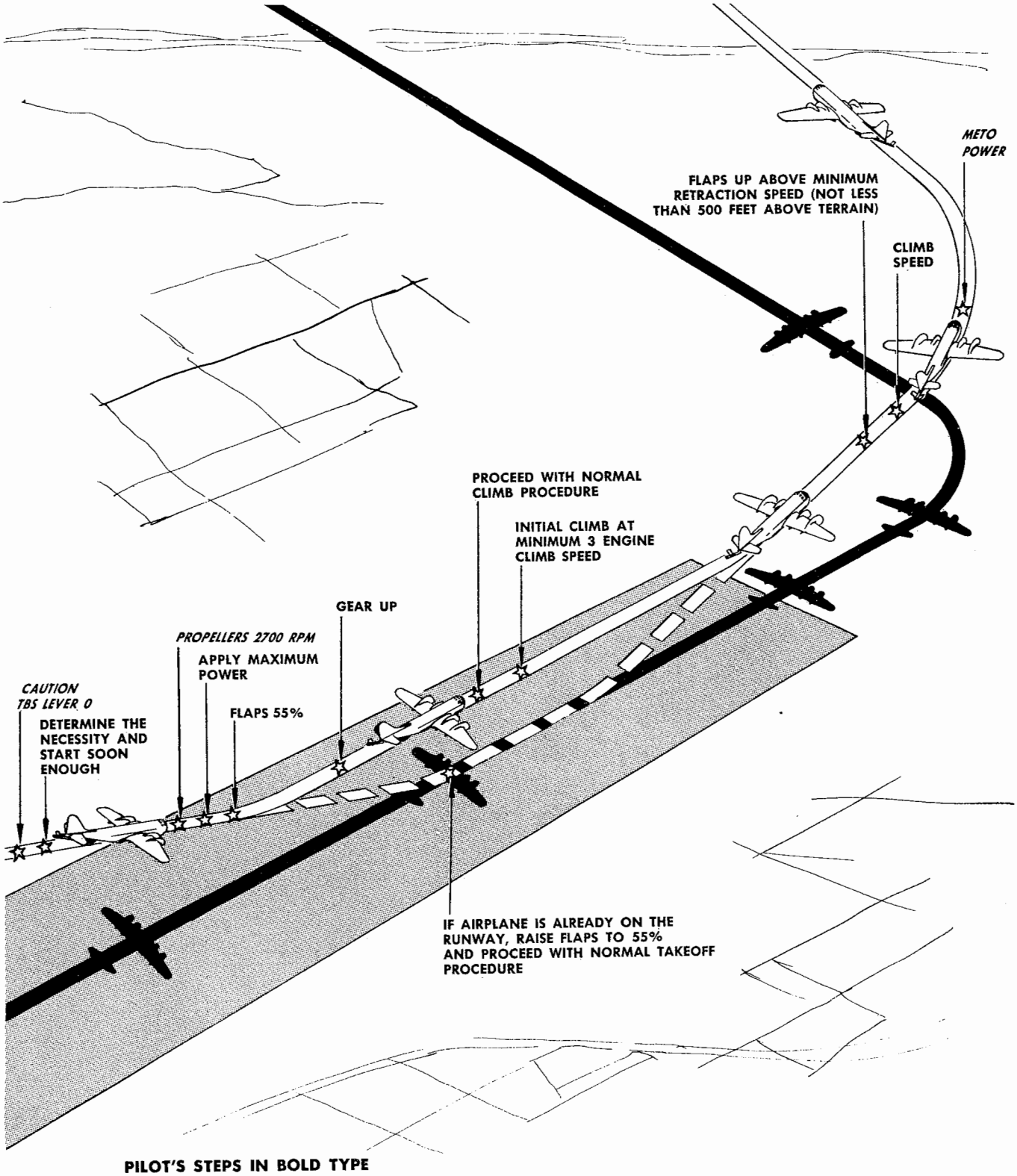
1. TBS Lever - 0

(2) Rpm - Increase to 2700 (E, P)

When directed by pilot, advance prop synch lever to 2700 rpm.

(3) Power - Even up at maximum power (E, P)

4. Pressures and Temperatures - Checked within limits.



GO-AROUND PROCEDURE

Figure 2-4

GO-AROUND (Cont)

PILOTS	ENGINEER
(4.) Gear Switch UP - UP (P, CP)	
Signal copilot gear switch UP when it is evident that contact with the runway will not be made.	
WARNING	
The retraction of the landing gear must be started the instant it is certain that the airplane will not touch down. To delay the retraction of the landing gear unnecessarily may result in prolonged operation at near-stall conditions, and the inability to clear obstructions. If a touchdown is inevitable, leave wing flaps at 55% and maximum power on, and touch down as lightly as possible. Then proceed as nearly as possible in accordance with takeoff procedures, depending upon the length of runway available, obstructions, etc.	
NOTE	
In an emergency, the landing gear and wing flaps can be raised simultaneously if three or more generators are operative.	
(5.) Engineer's Throttles - Notified (P, E)	(5.) Engineer's Throttles - Acknowledge (E, P)
Notify the engineer that he has the throttles and he will acknowledge.	6. Cowl Flap Switches - Adjust as required
(6.) Wing Flaps UP - Full UP (P, CP, BO)	
Direct copilot to retract wing flaps when reaching minimum flap retraction speed, a safe altitude is reached and obstacles are cleared.	
(7.) Power as Required - As required (P, E)	(7.) Power - Set as called for by pilot (E, P)
When a safe go-around altitude and airspeed are obtained, call for power as required, and the after takeoff - climb checklist.	

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.

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 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 the procedure in conjunction with item 13, reversing intentions, of the before landing checklist. The scanner(s) will report all 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.) Notify Crew - "Touch and go rpm 2700" (P, E)

When ground contact is made, the pilot will notify the crew on interphone as soon as he has made the decision to continue the touch and go and simultaneously request rpm 2700.

2. Set Power - Set (approximately 30 inches Hg.) (P)

Pilot will advance power to approximately 30 inches Hg. to preclude too rapid deceleration of the airplane.

3. Set Elevator Trim - Set for takeoff (CP)

(4.) Set Wing Flaps - Set 33% (P, CP, BO)

Direct copilot to adjust wing flaps to 33% in one movement.

NOTE

Pilot not flying airplane will reset elevator trim and flaps to takeoff setting. Gear will remain down for touch and go landings.

ENGINEER

(1.) Prop Synch Lever - 'Full INCREASE RPM" (4 lights on) (E, P)

On initial touchdown, advance prop synch 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.

TOUCH AND GO LANDING (Cont)

PILOTS

(5.) Set Maximum Power - Set (P, E)

Advance throttles to maximum power. Engineer will even up at maximum power.

6. Call Out Airspeeds - Called out (CP)

Copilot reports airspeeds up to and including takeoff airspeed.

7. Check Reverse Warning Flag Up - Checked (flag up) (CP)

Copilot will check the prop reverse lock warning flag for the up position.

8. Wheel Well Light Switches OFF - OFF (CP)

(9.) Engineer's Throttles - Notify (P, E)

Notify engineer that he has the throttles. Engineer will acknowledge.

(10) Wing Flaps UP - UP (P, CP, BO)

At 500 feet above the terrain and upon reaching flap retraction speed, decrease rate of climb and retract flaps to 20%, then 10% and then to the full up position while accelerating to the recommended climb speed.

WARNING

To preclude flying into the ground, maintain a positive rate of climb at all times during flap retraction. Minimum flap retraction altitude is 500 feet unless an emergency exists.

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 flap operation immediately correct with aileron and rudder control and simultaneously return the flaps to a symmetrical position.
- Wing flaps may be left extended at 33% at pilot's discretion until the 55% flap setting is required on downwind leg.

ENGINEER

(3.) Power - Even up at maximum power (E, P)

4. Pressures and Temperatures - Checked within limits

(5.) Engineer's Throttles - Acknowledge (E, P)

Engineer acknowledges he has taken control of throttles.

6. Cowl Flap Switches - Adjust as required

PILOTS

(11) Set METO Power - Set (P, E)

When remaining in closed traffic after touch and go landing, direct engineer to set "METO power" when traffic pattern airspeed has been established.

12. ADI OFF - OFF (CP)

After METO power is set.

(13) Power as Required - As required (P, E)

Upon reaching traffic altitude direct engineer to set MP and rpm as desired or call "pilots throttles", reduce manifold pressure, and then call for 2350 rpm.

ENGINEER

(7) METO Power - Set (E, P)

Set power when directed by pilot. Report to pilot when power has been set.

8. Boost Pump Switches - NORMAL (one per tank)

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

(9) Power - Set (E, P)

Set power as directed by the pilot and report to pilot when set.

LANDING

Refer to Part 7 of the Appendix, T.O. 1C-97(K)F-1-1.

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 dropping of the airplane may result.

When final flaps are lowered, the airspeed will be reduced to the desired final approach airspeed (25 knots 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 whenever the angle of bank exceeds 30 degrees, airspeed falls below computed traffic pattern or final approach speeds, and/or when the airplane appears to be dangerously low to the ground or other obstructions (visual and altimeter cross check). 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 airplane has slowed to 50 knots, use normal braking action. Slow 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% wing flap setting. This 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% 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% wing flaps on final approach and touchdown, and increasing the approach speed to a minimum of 30 knots above full flap power off stall speeds. Minimum power must be maintained at 15 inches manifold pressure on final approach 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.

WARNING

Do not chop throttles during approach as a 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, power and 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. Caution should be observed at these heavy weights, to make the field on the first pass since go-around performance is marginal even with all engines operating. If over 153,000 pounds gross weight, 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 speed, plus 15 knots. Extend the final approach and come in lower with power on and full 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

1. 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

2. There are three methods of making crosswind approaches:

   a. Lower the up-wind wing

   b. Crab into the wind

   c. Combination of the first two methods

3. A 55% wing flap setting is recommended for best control. This flap setting and an approach airspeed 25 knots above stall 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 flaps as soon as the main 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 up-wind 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. MP 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 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 a slippery 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

1. Thrust reversing will be utilized immediately after all wheels are definitely on the ground. 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. Reverse thrust is most effective during the initial part of the landing roll. Normally, only the reverse thrust idle position will be used to decelerate the airplane to 50 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 to allow the prop 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 props are in reverse. If an engine starts to die during prop reversal, the engineer will notify the pilot and try to keep the engine running by moving the mixture 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.

2. 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.

CAUTION

- If a prop 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 50 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. The reversed throttles will be brought to the forward thrust position.
  c. Outboard engines may be used for forward thrust to aid in returning the airplane to the desired track, if necessary.
  d. Apply brakes as necessary.

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. The engineer will move the prop synch lever to full INCREASE RPM and check that all four rpm limit lights are illuminated in anticipation of a possible go-around. The mixtures 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 copilot will then check the hydraulic pressure and report to the pilot "Hydraulic pressure checks OK," or cite exceptions. Normally the pilot will begin braking the airplane at 50 knots indicated airspeed, 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.
- Brake action normally should be applied by the pilot. If it becomes necessary for the copilot to apply the brakes, the pilot must first release his brake pedals. This is necessary to allow the copilot's braking action to be effective through the pilot's brake metering valves.

LANDING

PILOTS

1. Unlock Throttles - Unlocked (CP)

   Copilot unlocks throttle friction lock upon touchdown.

2. Open Reverse Lock Plate - Opened (CP)

   Copilot opens lock plate upon touchdown.

3. Apply Reverse Thrust - Applied (P)

   Reverse thrust idle normally will be used after all wheels are definitely on the ground and airplane is rolling straight down the runway. Normally return throttles to forward thrust idle at 50 knots and utilize nose wheel steering.

(4.) Check Hydraulic Pressure - Checked (P, CP)

   The copilot will check the hydraulic pressure and report to pilot - Hydraulic pressure checks OK.

5. Apply Brakes - Applied (P)

   Normally begin braking at 50 knots.

ENGINEER

1. Prop Synch Lever - Full INCREASE RPM

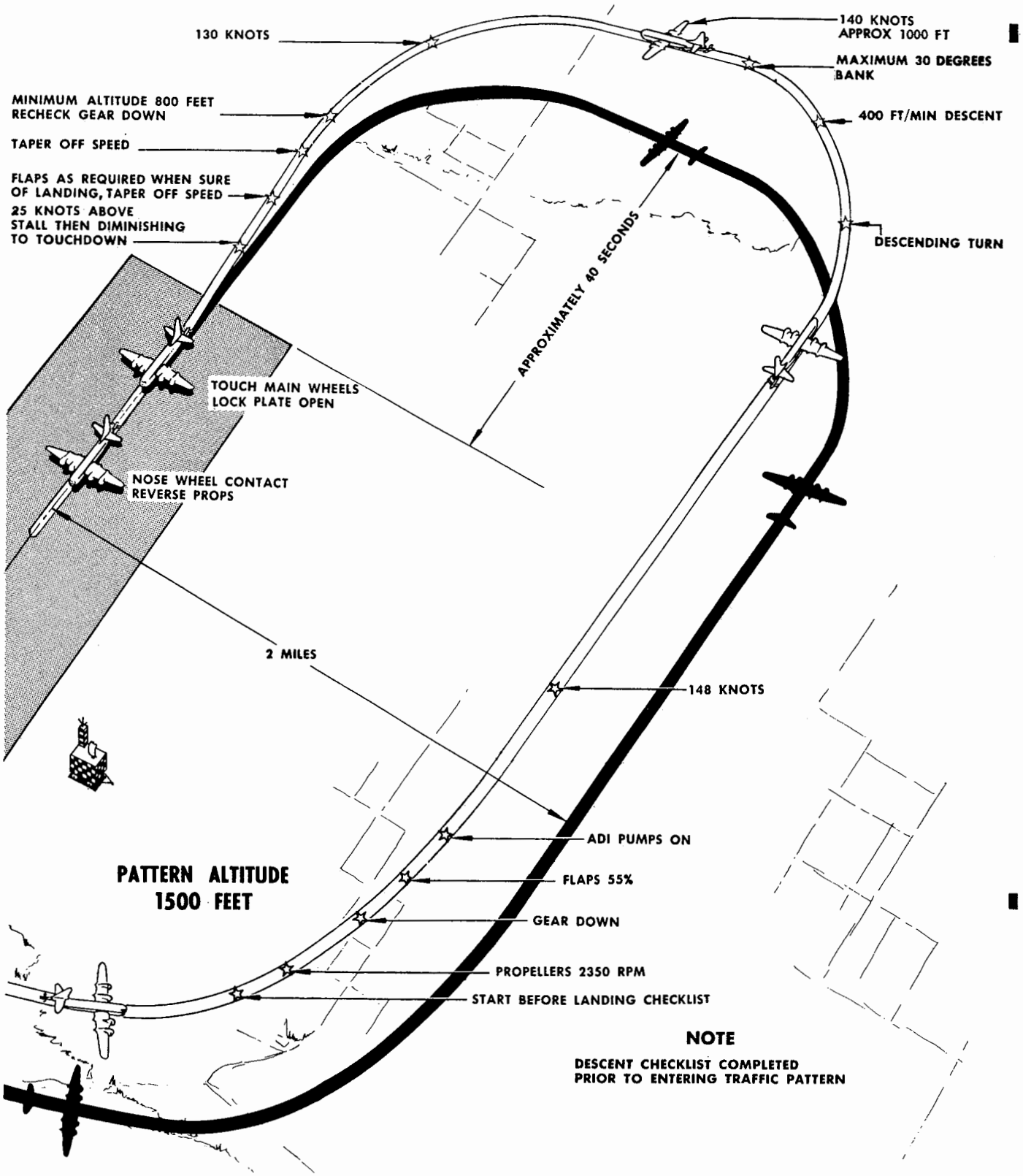
   Advance prop synch lever to full INCREASE RPM upon touchdown.

2. Mixtures - Unlocked

   Unlock mixture levers upon touchdown.

3. Cowl Flaps - Open

   Open cowl flaps if reverse thrust will not be used or after reverse thrust is completed.



NORMAL APPROACH AND LANDING PATTERN

Figure 2-5

AFTER LANDING

PILOTS

(To be performed after airplane is clear of runway and stopped)

1. Set Parking Brakes - Set (P)
2. IFF Master Switch - STANDBY (if applicable) (CP)
3. ADI OFF - OFF (CP)
4. Landing Lights OFF - OFF (if applicable) (CP)

   Landing lights may be used for taxiing as required.

5. Anti-Collision Lights OFF - OFF (CP)

CAUTION

Do not operate anti-collision lights over five minutes on the ground.

6. Flaps UP - UP (CP)

   Flaps may be retracted to 33% if another takeoff is to be accomplished.

7. Pitot Heat OFF - OFF (P)
8. Trim Tabs Centered - Centered (P, 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.

(9.) Check Forward Thrust - Checked (if required) (P, E)

Direct engineer to check forward thrust if reverse thrust was used.

ENGINEER

DURING TRANSITION FLYING, ONLY ITEMS 8, 9, AND 10 NEED BE ACCOMPLISHED.

1. Boost Pump Switches - OFF
2. Oil Cooler Flap Switches - Climatic

   Normally AUTO, during cold weather OPEN, then OFF.

3. Turbo Switches - AUTO
4. Turbo Override Switches - OPEN, guards down
5. Window Heat Selector Switch - OFF
6. Alternator Switches - OFF

   Use following sequence:

   a. Alternator Bus Selector Switch - OFF

   b. Alternator Switches - OFF

7. Prop Deicing Switch - OFF

(8.) Forward Thrust - Check, if required (when directed by pilot) (E, P)

a. Prop Synch Lever - Full DECREASE RPM (4 lights on)

   Advance throttles to 25 inches Hg; observe rpm governs to approximately 1100 indicating props are in forward thrust and assisting low pitch stops to reseat, then retard throttles.

b. Prop Synch Lever - Full INCREASE RPM (4 lights on)

   Check four prop rpm limit lights illuminated.

PILOTS	ENGINEER
10. Lock Controls - Locked (CP)	
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.	
(11) Receive Engineer's Report - "After landing checklist complete" (P, E) Receive engineer's report.	9. Mixtures - Manual lean (if immediate takeoff is not anticipated) 10. Report to Pilot - "After landing checklist complete" (E, P)
(12) Accomplish Postflight Check - Accomplished (if required) (P, E) Direct engineer to accomplish postflight engine check at completion of flight. Outboard engines may be shut down at pilot's discretion.	

POSTFLIGHT ENGINE CHECK

PILOTS	ENGINEER
	1. Prop Deicing - Check a. Prop Deicing Switch - ON b. Prop Deicing Loadmeter and Indicators - Monitor c. Prop Deicing Switch - OFF after one complete cycle. NOTE This check may be accomplished during taxi. 2. Mixtures - AUTO RICH 3. Prop Auto Control Switch - OFF 4. Magneto Ground Check (800-1000 rpm) - L, R, OFF, BOTH Adjust rpm between 800 and 1000 and check L, R and OFF, watch for drop, turn switch back to BOTH.

POSTFLIGHT ENGINE CHECK (Cont)

PILOTS

ENGINEER

5. Idle Mixture - Checked

With engines set in 800-1000 rpm range and CHT between 175°C and 200°C, move each mixture slowly and evenly toward FUEL CUT-OFF. "Slowly" may be defined as the rate of movement which would require 12 to 15 seconds to move the mixtures 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 rapid decrease in rpm indicates too lean 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 the home station the idle mixture should not be reported.

6. Mixtures - Manual lean (if immediate shutdown is not anticipated)

(7.) Report to Pilot - "Postflight engine check complete" (E, P)

ENGINE SHUTDOWN

PILOTS

1. Set Parking Brakes - Set (P)

2. Release Cabin Pressure - Released (CP)

   Copilot will open cabin window to insure that all cabin pressure has been released.

(3.) Shutdown Engines - Shutdown No. 1, No. 3, No. 4 (P, E)

Pilot directs engineer to shutdown numbers 1, 3, and 4 engines.

(4.) Check No. 2 Hydraulic Pump - Checked and shutdown No. 2 Engine (P, E)

With number two engine running, pilot depresses wheel 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 shutdown No. 2 engine.

(5.) All Switches OFF or NORMAL - OFF or NORMAL (P and CP)

Retract landing lights.

6. Gear Switch DOWN - DOWN (CP)

Gear switch will be left in the DOWN position and cover in place.

ENGINEER

1. Analyzer Switches - OFF

2. Secondary, Autopilot and Flight Instrument Inverter Switches - OFF

3. Air Conditioning Master Switch - OFF

4. Oil Dilution - Completed cold weather

   See Section IX to accomplish oil dilution for the purpose of aiding next engine start when expected OAT is 15°F (-9°C) or below. Enter time period of dilution in Form 781.

CAUTION

After CHT stabilizes below 180°C set throttle to maintain 1000-1200 rpm for a period of one minute to accomplish engine scavenging.

(5.) Engines No. 1, No. 3 and No. 4 - Shutdown (when directed)(E, P)

Shutdown by placing mixtures in FUEL CUTOFF.

(6.) After Hydraulic Pump Check - Shutdown No. 2 engine (when directed) (E, P)

With mixture in FUEL CUTOFF.

7. Generator Switches - ON

8. Essential Inverter Switch - OFF

9. Oil Cooler Flap Switches - CLOSE and OFF

10. Carburetor Air Switches - SHELT (if required)

ENGINE SHUTDOWN (Cont)

PILOTS

7. Close Reverse Lock Plate - Closed (CP)

8. Release Parking Brakes - Released (P)

   Release parking brakes after assuring that chocks are in place.

(9) Receive Engineer's Report - "Shutdown checklist complete" (P, E)

Receive engineer's report.

ENGINEER

11. Fuel Selector Switches - TE

    This prevents fuel gravity leveling which could possibly cause overfilling inboard tank.

12. Ignition Switches - OFF

13. All Switches - OFF or NORMAL

14. Circuit Breakers:

    a. Turn and Slip - Pulled

    b. Interphone - Pulled

(15) Report to Pilot - "Shutdown checklist complete (E, P)

NOTE

Cowl flaps need not be shut below 2 inches after engine shutdown.

POSTFLIGHT INSPECTION

The pilots will make an exterior check for any obvious airplane damage. Insure Form 781 entries are completed.

NOTE

The pilots' and flight engineer's normal procedures also appear in T.O. 1C-97(K)F-(CL)1-1 and T.O. 1C-97(K)F-(CL)1-3 respectively, which are condensed checklists. The condensed checklists have each numbered step (and some sub-steps) of the normal, air refueling, alert, and emergency procedures.

ALERT PROCEDURES

Generally, the procedures and techniques used in an alert and scramble situation are the same as those used during normal operation of the airplane. The time element involved demands certain differences in order to be able to accomplish the scramble in minimum time without sacrificing safety of flight.

PROCEDURES AND TECHNIQUES

The checklist procedures contained in this manual have been arranged to permit their use for normal training missions or EWO conditions including ground alert. Integrating the pilot's normal and alert checklist procedures necessitated repeating some items. Repeated items do not necessarily have to be reaccomplished, but will be read, and a not applicable or not required response given. This may seem objectionable for normal training missions; however, it is felt that many advantages are to be gained by integrating the normal and alert checklists. To obtain the most effective results, it is necessary for aircrew members to be thoroughly familiar with these checklists and the proper use of same.

AIRPLANE ACCEPTANCE

After maintenance has declared an airplane ready for alert the airplane is then ready for an initial acceptance check by the aircrew. This acceptance check will consist of completing the following checklists:

Before interior inspection
Interior inspection
Before starting engines
Starting engines
Taxi
Engine runup

ALERT STATUS

When the aircrew declares the airplane ready for alert, the airplane will be placed in the alert line.

GOING ON ALERT

The airplane will be placed in a cocked configuration by the aircrew using the appropriate checklists up to and including before starting engines checklist. Cocking procedures are a coordinated crew effort and crew members will remain at the airplane until the pilot has ascertained that all crew members have completed their checklists. Ground crew will accomplish the GC's cocking checklist.

NOTE

When a new alert crew takes over an airplane already in alert status, a recheck of airplane cocking will be accomplished.

SECURITY

When the airplane is cocked, no one will enter the airplane except aircrew members assigned to that airplane for alert. All hatches will be closed except the crew entry doors, which may be left open, weather permitting. The entry doors will be placarded "Aircraft cocked, entry prohibited."

DAILY PREFLIGHT WHILE AIRPLANE IS ON ALERT

At a predesignated time each 24 hours, the aircrew will accomplish the daily preflight checklists. Upon completion of the daily preflight checklists, the pilots and engineer will recheck all items of the before starting engines checklist. The boom operator will recheck all applicable items of the interior inspection checklist.

ENGINE PRESERVATION

Airplane engines must be rotated or run up each 72 hours while the airplane is on alert. Engine rotation of 20 blades with the starter concurrent with the liquid lock check is required at 72 hour intervals to maintain oil film protection within the engine and also maintain pre-oiled protection for the bearings. Engine runup for lubrication purpose only will not be accomplished. However, when an engine is run up for other than lubrication, a 20 blade rotation for lubrication is not required until a 72 hour interval has elapsed.

ENGINE RUNUP

During periods of cold weather when engine oil has been diluted and engine operation is required, the ground run, when practicable, will consist of operating engines at 800-1200 rpm for approximately five minutes. Engine operation in excess of five minutes will require redilution in accordance with instructions and limitations for oil dilution and redilution contained in Section IX, COLD WEATHER OPERATION.

MAINTENANCE WHILE ON ALERT

At any time while the airplane is in the alert line, if a requirement exists to refuel or perform maintenance, it will not be necessary to uncock the airplane. After maintenance has been completed, the pilots and engineer will check all items of the before starting engines checklist to insure that the airplane is cocked for alert. The boom operator will recheck applicable items of the interior inspection checklist. The ground crew will recheck all items on GC's cocking checklist.

SCRAMBLE

When the execution order is given all crew members will utilize the normal checklists. Checklist items which require the flight crew to assist the ground crew in removal of various airplane equipment have been included as initial items of the starting engines checklist. These items will be accomplished on an "if required" basis. The before takeoff checklist will be completed as a continuation of the taxi checklist without stopping the airplane prior to taking the runway.

TAXI BACK

If a practice scramble has been executed where a takeoff is not accomplished, slowly advance the throttles to field barometric pressure. Hold this power for one minute but do not exceed maximum CHT for ground operation. Utilize the after landing and engine shutdown checklists.

UNCOCKING

No uncocking is required for either the pilots or engineer. When the airplane leaves alert status the ground locks will be installed.

NOTE

The pilots' and flight engineer's daily preflight procedures also appear in T.O. 1C-97(K)F-(CL)1-1 and T.O. 1C-97(K)F-(CL)1-3 respectively, which are condensed checklists. The condensed checklists have each numbered step (and some sub-steps) of the normal, air refueling, alert, and emergency procedures.

PILOTS' DAILY PREFLIGHT

While the airplane is in alert status, a daily preflight will be accomplished using this checklist unless the initial preflight is required. Navigator will start APU if required. Also see GC daily preflight condensed checklist.

1. Check Oxygen Pressure - Checked (P, CP)

   Pilot and copilot check station oxygen pressure for at least 400 psi.

2. Trim Tab Control Wheels - Free movement and zeroed (P, CP)

3. Windows - Condition (P, CP)

4. Wing Flaps DOWN - DOWN (P, CP, GC)

RADIO PREFLIGHT CHECK

To be accomplished by the copilot if radio operator not assigned. Only a check of the operational frequency is required.

1. VHF - Checked

2. UHF - Checked

3. VOR Receiver - Checked

4. Radio Compass - Checked

5. TACAN - Checked

EXTERIOR INSPECTION

Right and Left Wing Sections

1. Lower Wing Surfaces and Ailerons - Condition (P)

   Check hinges clear of foreign material. Trim tab should have approximately one inch droop with controls locked. Check for any evidence of fuel leaks around access panels and condition of landing light.

2. Flaps and Flap Wells - Condition (P)

   With flaps full down check flap surfaces for general condition. Check fuel valves, fuel and hydraulic lines for leaks. Check wiring and bonding for condition. Check jackscrews and tracks. Insure manifold is pressurized.

3. Defueling Cock - Check closed (Left side only) (P)

ENGINEER'S DAILY PREFLIGHT

1. Electrical Master and Battery Switches - As required

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

(2.) APU or External Power - Started and on line, voltage checked (E, N or GC)

3. Interphone, VHF, UHF Circuit Breakers - Set

(4.) Inverters - ON (E, RO or CP)

Check inverters in both spare and normal switch positions for proper voltage and frequency. Leave essential and secondary inverter switches on NORMAL. Flight instrument and autopilot inverter switches OFF. Give power clearance to radio operator or copilot (as applicable).

(5.) Interphone - Contact ground crewman (E, GC)

Have ground crewman insure and report lower forward entrance door is closed.

(6.) Engine Hydraulic Lock Check - Crank 8 blades (E, GC)

Have ground crewman insure and report all four props are clear prior to turning each prop. Upon completion of this check, turn the starter selector switch to the OFF position.

(7.) Main Tank Fuel Manifold - Pressurized (E, GC)

Turn one boost pump switch on EMERGENCY, and all others to NORMAL. Leave in this position for pilot's and boom operator's visual check of the fuel system. Notify the ground crewman to advise pilot when the fuel manifold is pressurized.

CAUTION

Carburetor will be subjected to one minute NORMAL boost pressure prior to EMERGENCY boost operation. Do not change fuel selector switches with boost pumps on EMERGENCY, except as outlined in Section III.

ENGINEER'S DAILY PREFLIGHT (Cont)

8. External Tank Lines - Pressurized G
9. All Switches - As required
10. Complete before starting engines checklist

DEFENSE CONDITION (DEFCON ONE)

Normally, DEFCON ONE posture will be assumed from one of the following airplane configurations: (Based upon the degree of progression into the launch procedure.)

- Alert configured and fully cocked.
- One or more engines started.
- All engines started.

If engines have not been started, start APU or external power and monitor UHF radio for further progression into the launch procedure. If launch progression occurs, crew initiates the STARTING ENGINES checklist and continues normal "Scramble" procedures.

If one or more engines have been started, accomplish the following checklist to assume DEFCON ONE posture:

COCKING (DEFCON ONE)

PILOTS	ENGINEER
(1.) Start APU or Connect External Power - As applicable (P, E, N, GC)	(1.) APU or External Power - Started and on line, voltage checked (E, P, N, or GC)
	2. Secondary, Autopilot and Flight Instrument Inverter Switches - OFF
	3. Boost Pump Switches - OFF
(2.) Shutdown Engine(s) - Shutdown all engines (P, E)	(4.) Engines - Shutdown (when directed) (E, P)
3. Monitor Radio - Monitored (P or CP)	Shutdown any operating engines by placing mixtures in FUEL CUTOFF.
	5. Starter Selector Switch - OFF
	6. Ignition Switches - OFF
	7. Essential Inverter Switch - OFF
	8. Throttles - Cracked
	Throttles cracked (approximately 1 inch for 1000 rpm)
(4.) Receive Crew Report - "Cocking checklist complete" (ALL)	(9.) Report to Pilot - "Cocking checklist complete" (E, P)
5. Install Applicable Heating Equipment and Covers - As required (P, GC)	

MINIMUM REACTION POSTURE

When it becomes necessary to shut down engines and maintain the airplane in Minimum Reaction Posture, the following checklists will be utilized. All checklists through the BEFORE TAKEOFF checklist must have been completed prior to starting the MINIMUM REACTION POSTURE checklist. Certain items accomplished through use of the normal checklists are not repeated in order to expedite an immediate takeoff.

Due to the variable conditions that may be encountered, particularly at extremely low temperatures, it may be advantageous to keep engines running, in which case the normal alert procedures checklists are adequate.

In the event engine shutdown is required in extreme cold temperature, it will be necessary to periodically restart the engines to maintain a restart capability without the aid of oil dilution or preheat. The engines will be restarted when the cylinder head temperature reaches 0°C. After normal operating temperatures are reached, the throttles will be slowly advanced to field barometric pressure for a minimum of one minute prior to engine shutdown.

WARNING

Low fuel reserve may preclude prolonged running of engines. Supervisory and crew member personnel must carefully monitor fuel reserves against known mission requirements. Additionally, the flight crew must rigidly adhere to spark plug antifouling and defouling procedures outlined in Section VII.

NOTE

APU must be fully operational if all engines are to be shutdown.

COCKING (MINIMUM REACTION POSTURE)

PILOTS

1. Center Nose Wheel - Centered (P)
2. Check Hydraulic Pressure - Checked normal (CP)
3. Set Parking Brakes - Set (P)
4. IFF Master Switch - STANDBY (if applicable) (CP)
5. ADI Switch OFF - OFF (CP)
6. Landing Lights OFF - OFF (if applicable) (CP)
7. Wing Flaps UP - UP (CP)
8. Anticollision Lights OFF - OFF (CP)
9. Pitot Heat OFF - OFF (P)
10. Lock Controls - Locked (CP)
11. Shutdown Engines - Shutdown (P, E)
12. Open Reverse Lock Plate - Opened (CP)

ENGINEER

1. Prop Deicing Switch - OFF
2. Window Heat Selector Switch - OFF
3. Alternator Switches - OFF

   Use following sequence:

   a. Alternator Bus Selector Switch - OFF

   b. Alternator Switches - OFF
4. Air Conditioning Master Switch - OFF
5. Boost Pump Switches - OFF
6. Analyzer Switches - OFF
7. Secondary, Autopilot and Flight Instrument Inverter Switches - OFF

8. Engines - Shutdown (when directed) (E, P)

   NOTE

   When shutdown is to be accomplished, slowly advance the throttles to field barometric pressure. Hold this power for one minute and until oil temperature is at least 60° C, but do not exceed maximum CHT for ground operation.
9. Ignition Switches - OFF
10. Cowl Flap Switches - Set (2 in.)

COCKING (MINIMUM REACTION POSTURE) (Cont)

PILOTS

(13) Receive Engineer's Report - "Cocking checklist complete" (P, E)

14. Lights as Required - As required (P, CP)

15. Set Radios - Set (P, CP)

a. VHF - ON (monitor as required)

b. UHF - ON (monitor as required)

c. VOR Receiver - ON (set on desired frequency)

d. Radio Compass - ON (set on desired frequency)

e. Liaison Radio (ARC-21) G less TCTO 1-1-666, ARC-65 G plus TCTO 1-1-666 - ON (set on desired frequency)

f. TACAN - Set (as required)

WARNING

If departure is to be made on VOR, then turn the TACAN off. This will prevent the automatic switchover to TACAN in event of VOR power failure. This switchover may occur without being noticed by the pilot since there will be no warning flag indicating the VOR failure. If departure is to be made using a VORTAC facility, TACAN may be left on.

16. Trim Control Wheels - Set for takeoff (P)

ENGINEER

(11) Report to Pilot - "Cocking checklist complete" (E, P)

SCRAMBLE (MINIMUM REACTION POSTURE)

PILOTS

(1) Start Engines - Direct engineer to start engines (P, CP, E)

Pilot and copilot will act as safety observers and count prop blades over interphone during engine start. Report if fuel starts to run out of blower drain. A fire truck or fire guard should be available in the immediate area.

ENGINEER

1. Boost Pump Switches (one per main tank) - NORMAL

2. Engine Starting Selector Switch - No. 3

(3) Start Engines - (E, P, CP)

When pilot directs that engines be started, the copilot will check No. 3 and 4 engines clear, and state over interphone, "No. 3 and 4 engines clear, start No. 3." Engineer states, "Turning No. 3," press starter switch after required blades, ignition switch BOTH, ignition boost and prime. The copilot will count blades on interphone and report if fuel starts to run out of the blower drain. Pilot will repeat the above procedures for No. 2 and No. 1 engines.

PILOTS

2. Check Hydraulic Pressures - Checked (P, CP)

   If copilot is required to count prop blades during engine start, pilot will check No. 3 hydraulic pump by observing rise in pressure. As soon as No. 4 engine is started, copilot will turn emergency brake charging valve to OPEN, check emergency pressure, then return to CLOSED and report to pilot - Hydraulic pressure normal. F 1243 ▶ 1374 ▶ If copilot is required to count prop blades during engine start, pilot will check No. 3 hydraulic pump by observing rise in pressure. As soon as No. 4 engine is started, copilot will turn the depressurization and emergency charging valve to EMERGENCY brake charging, check emergency pressure, return to NORMAL and report to pilot - Hydraulic pressure normal. F G 1375 ▶

3. Set and Uncage Instruments - Set and uncaged (P, CP)

   Check that pilot instrument and autopilot inverter warning lights are not illuminated. Pilot and copilot will reset and uncage all flight instruments, cross check B-16 compass reading with N-1 compass repeaters, cage and uncage J-8 attitude indicator.

WARNING

Under MINIMUM REACTION takeoff conditions, and particularly during extremely cold weather, attitude indications may be sluggish. If possible, check other flight instruments for normal operation during taxi. See COLD WEATHER PROCEDURES, Section IX.

4. ADI Switch Climatic - Climatic (CP)

5. Set Throttle Lock Lever - Set (P)

   Adjust throttle lock as desired for takeoff.

ENGINEER

4. Oil Pressure - Check

   Oil pressure indication immediately and at least 50 psi within 30 seconds or shutdown engine. On interphone state, "Oil pressure up on No. 3."

5. Mixture - AUTO RICH, release primer

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

6. Steps 2, 3, 4 and 5 - Repeat on Remaining Engines as Pilots Clear Each Engine in Turn (E, P, CP)

7. Starter Selector Switch - OFF

8. Boost Pump Switches (main tanks) - NORMAL

   Turn both boost pumps in each tank on NORMAL.

9. Generators - Checked

   Generators on the line and taking load.

10. Inverters - ON

    Place secondary, autopilot and pilot's instrument inverter switches on normal switch positions checking voltage and frequency of each, then report over interphone "Inverters on."

11. Alternator Control Switches - ON

    Allow exciter regulators to warm up. Alternator Bus Selector Switch ON if required.

12. Air Conditioning Master Switch - ON

SCRAMBLE (MINIMUM REACTION POSTURE) (Cont)

PILOTS

(6.) Set Wing Flaps - Set 33% (P, CP, BO)

In freezing weather, operate wing flaps through one complete cycle before setting flaps for takeoff. Wing flap switch DOWN until indicators read 33%. At this time, aft compartment crew member will report, "Both flaps ____%."

NOTE

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

(7.) Anti-Icing Equipment Climatic - Climatic (P, E)

Direct engineer to turn on anti-icing equipment as desired.

8. Unlock Flight Controls - Unlocked and checked (P, CP)

9. Set Direction Indicators - Set (P, CP)

Pilot and copilot set direction indicator cards with runway heading under index at top of the dial. Pilot sets direction indicator pointer to agree with copilot's N-1 compass repeater heading pointer.

(10.) Set 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 wing flaps. Severe buffeting will also occur.

ENGINEER

(13.) Prop Deicing Switch - As required (E, P)

Turn prop deicing switch ON at direction of the pilot whenever icing is anticipated.

(14.) Window Heat - As required (E, P)

No higher than necessary, normally LOW.

15. Engine Pressures and Temperatures - Checked

When oil temperature is above 40° C, slowly advance throttles to field barometric. Check within takeoff limits.

NOTE

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

(16.) Cowl Flap Switches - Set (when directed) (E, P)

Set position as required by OAT.

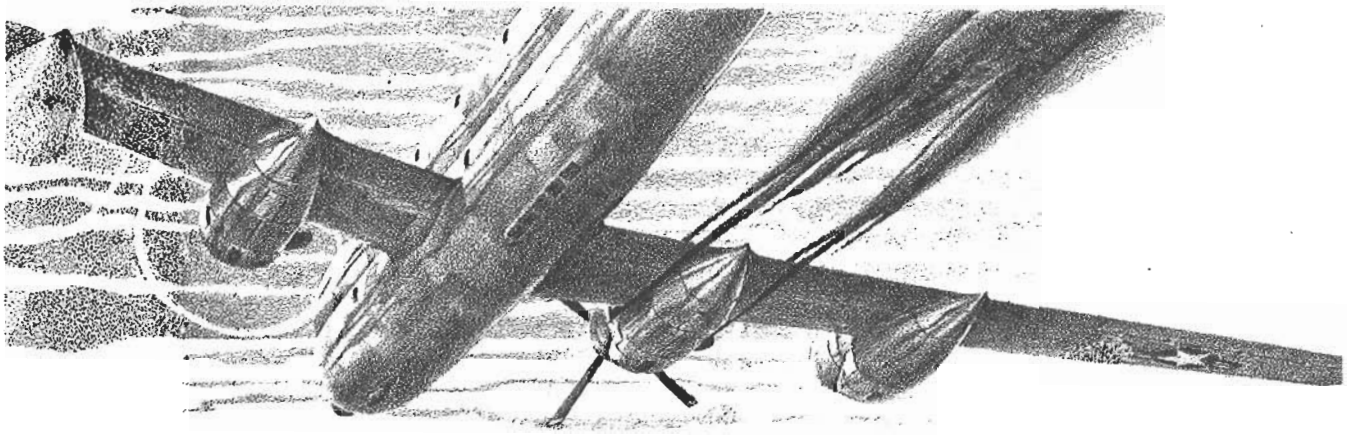
17. Mixtures - AUTO RICH (Locked)

PILOTS	ENGINEER
11. Windows Closed - Closed (P, CP)	
12. Pitot Heat Switches ON - ON (P)	
13. Anti-collision Lights ON - ON (CP)	
14. IFF Master Switch - NORM (mode switches set) (if applicable) (CP)	
15. Landing Lights ON - ON (if required) (CP)	
(16) Crew Takeoff Report - Received (ALL) Pilot will announce over interphone, "Takeoff report." Aft compartment crew member will report, "Cowl flaps set, ready for takeoff." Navigator and Engineer report, "Ready for takeoff."	(18) Report to Pilot "Ready for Takeoff" (E, P)

If takeoff is not accomplished, see TAXI BACK under ALERT PROCEDURES, this Section.

NOTE

The pilots' and flight engineer's alert procedures also appear in T.O. 1C-97(K)F-(CL)1-1 and T.O. 1C-97(K)F-(CL)1-3 respectively, which are condensed checklists. The condensed checklists have each numbered step (and some substeps) of the normal, air refueling, alert, and emergency procedures.



Section III Emergency Procedures

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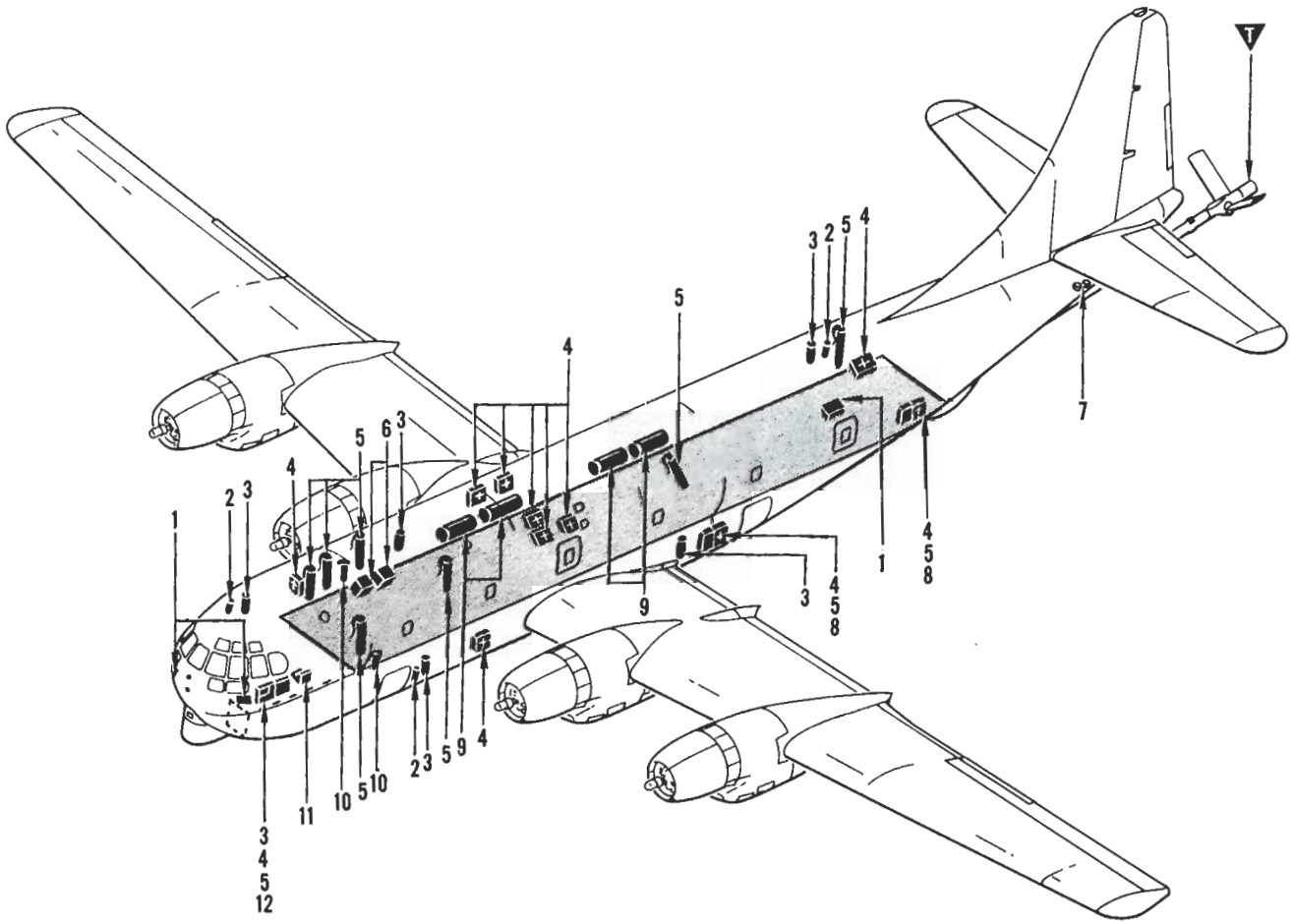
NOTE

This section contains text and amplified checklists to describe procedures to be followed in any emergency except those in connection with auxiliary equipment. 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 crew member to insure survival. These steps must be committed to memory. The boom operator and/or navigator will insure that passengers and extra crew members 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 crew member that will accomplish the actions.

CREW COORDINATION

An emergency requires the full, coordinated effort of each crew member. Emergency procedures should be practiced at every opportunity so the crew will become proficient in every procedure. 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 checklists.



1 ESCAPE ROPES (4 PLACES)
2 PORTABLE OXYGEN CYLINDER RECHARGER (5 PLACES)
3 PORTABLE OXYGEN CYLINDER (8 PLACES)
4 FIRST AID KIT (15 PLACES)
5 FIRE EXTINGUISHER (13 PLACES)
6 DINGHY RADIO (2 PLACES)
7 LANDING FLARE TUBES (2 PLACES)
8 EMERGENCY PANEL: (4 PLACES)
F G FIRE EXTINGUISHER AND FIRST AID KIT
G OXYGEN CYLINDER AND AXE
9 LIFE RAFTS (4 PLACES) F WITH TCTO K512
AND G 3214 WITH TCTO K539
10 FIRE FIGHTERS' OXYGEN SETS (4 PLACES) WITH TCTO 566
11 PYROTECHNIC PISTOL AND SIGNAL FLARE (2 PLACES)
12 PILOT'S AUXILIARY PANEL: (2 PLACES)
F G AXE, FIRST AID KIT, FIRE EXTINGUISHER AND PORTABLE OXYGEN CYLINDER
G PORTABLE OXYGEN CYLINDER RECHARGER

F AIRPLANES

EMERGENCY EQUIPMENT

Figure 3-1 (Sheet 1 of 2)

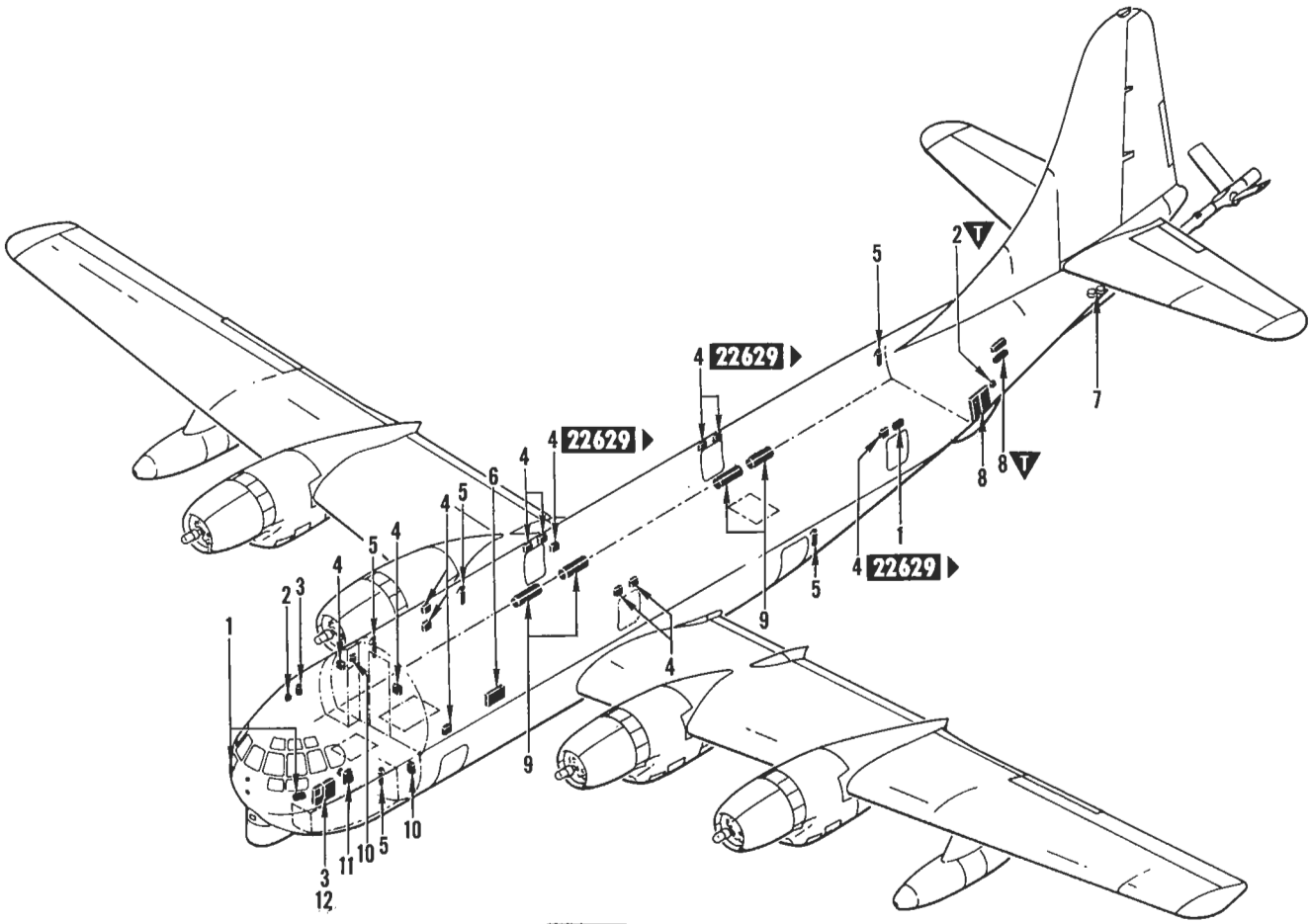


Figure 3-1 (Sheet 2 of 2)

EMERGENCY SIGNALS

If time and circumstances permit, the crew should be advised of the emergency, given instructions, and acknowledgment received, by interphone. (See also BREAKAWAY this Section.) The boom operator will insure that passengers and extra crew members are notified of the emergency.

On The Ground

1. Prepare to abandon airplane: Three short rings.
2. Abandon airplane: One long sustained ring.

In The Air

1. Prepare to bail out: Three short rings on the alarm bell.
2. Bail out: 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 interphone, "Bailout, Bailout, Bailout."
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.

Use of the following terms in the emergency check lists will be interpreted as follows:

1. Notify: Informing crew orally of an existing or impending emergency which does not require use of 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.

BREAKAWAY

When a crew member aboard either the tanker or receiver determines that an emergency exists, he will transmit on air refueling frequency, the other airplane's tactical call sign followed by "Breakaway, Breakaway, Breakaway." During mass refueling the cell position call sign will be used. This call is used to notify tanker and receiver that an emergency condition exists, such as, excessive rate-of closure, receiver under running, etc. The airplanes do not necessarily have to be in contact to call a "BREAKAWAY." Relative position of both airplanes must be monitored closely by tanker and receiver crew members during all phases of air refueling. If the tanker desires a breakaway while operating with loss of interplane communications, the crew member will state on interphone "BREAKAWAY" three times and the boom operator will turn the receiver director lights off and on rapidly. Should the receiver desire a breakaway during loss of interplane communications, the crew member will state on interphone "Breakaway" three times, and the pilot will institute breakaway procedure. The following action will be taken simultaneously by the indicated crew members:

1. Tanker Pilot.

   Increase power if available to obtain forward separation, and when clear of the receiver airplane, climb straight ahead with wings level.

2. Boom Operator.

   Actuate disconnect switch, move boom away from receiver, notify tanker pilot when clear to climb and stow boom if desired or deemed necessary.

3. Receiver Pilot.

   Immediately actuate the boom release, retard throttles to IDLE, and drop down and aft of tanker until entire tanker airplane is in sight. (Add drag if necessary to avoid collision.)

   NOTE

   The receiver pilot should use caution not to overrun the tanker. If overrunning does occur, under no conditions should a turn, either right or left, be made until breakaway has been completed.

4. Receiver Copilot.

   Actuate boom release, close slipway door(s), maintain visual contact with the tanker until clear, and standby for instructions from the pilot.

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 3-2) 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 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 feathered; however nose wheel steering should be used until positive rudder control is attained.

Symptoms Indicating Engine Failure

Symptoms indicating engine failure include low torque pressure, low fuel flow, decreasing cylinder head temperature, low oil pressure, dropping off of manifold pressure and rpm. Airplane yaw or loss of performance is the primary index of power loss however. See Appendix, T.O. 1C-97(K)F-1-1, for recommended cruise procedure for 2 and 3 engine operation.

Control of Yaw

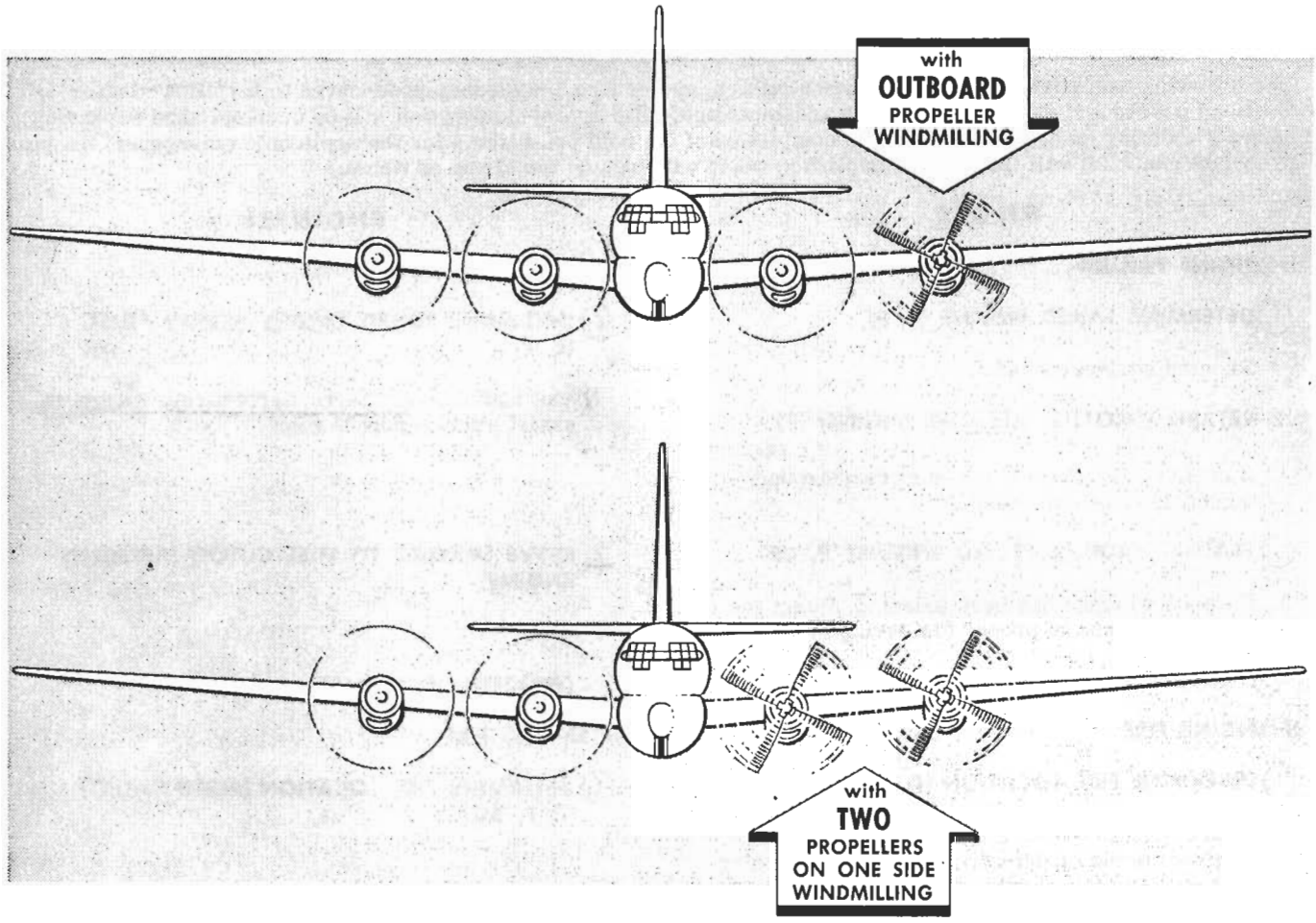
The most adverse conditions for maintaining constant headings occur at low airspeeds with unsymmetrical power. The speeds shown in figure 3-2 are for zero yaw and slight angle of bank required to hold a heading. Lower speeds may be maintained by holding a maximum bank angle of 5 degrees and full rudder 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 props on the inoperative engines. Flap position does not affect minimum control speeds. Feathering the inoperative props or decreasing power will reduce the minimum control speeds. The 5 degrees 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.

TO MAINTAIN DIRECTION

You Need These Speeds:

Rudder Boost ON—95 knots

Rudder Boost OFF—125 knots



Rudder Boost ON—120 knots

Rudder Boost OFF—165 knots

NOTE

See FLIGHT CHARACTERISTICS UNDER PARTIAL POWER CONDITIONS for detailed information

MINIMUM CONTROL SPEEDS

Figure 3-2

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 props 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.

ENGINE FAILURE/FIRE — TAKEOFF CONTINUED

The following checklist incorporates engine failure, engine fire and cleanup procedures to be followed after S_1 has been passed and safe stop cannot be accomplished. The appropriate action will be accomplished depending upon the existing emergency. After the completion of the bold print items for the applicable emergency, the appropriate checklist will then be accomplished which will include the clean-up items.

PILOTS	ENGINEER
IF ENGINE FAILURE	**IF ENGINE FAILURE**
(1.) **DETERMINE FAILED ENGINE (P, E)**	(1.) **DETERMINE FAILED ENGINE (NOTIFY PILOT) (E, P)**
Receive engineer's report	Use instruments, particularly torque meter, to assist pilot; report to pilot
2. **RETARD THROTTLE (AFFECTED ENGINE) (P)**	
If engine fails after S_1 speed is reached and takeoff is to be continued	
(3.) **FEATHER PROP (AFFECTED ENGINE) (P, CP)**	2. **MOVE MIXTURE TO FUEL CUTOFF (AFFECTED ENGINE)**
If correct engine has been selected, direct the copilot to push the proper feathering button	
(PROCEED TO STEP 4)	**(PROCEED TO STEP 3)**
IF ENGINE FIRE	**IF ENGINE FIRE**
(1.) **DETERMINE FIRE LOCATION (P, E, BO)**	(1.) **DETERMINE FIRE LOCATION (NOTIFY PILOT) (E, P, BO)**
To preclude premature action in the event of a malfunctioning or defective engine fire warning system, the pilot should, if circumstances permit, cross-check with the engineer for engine instrument indications and with aft compartment crew members for visual indications	
(2.) **GANG BAR AFFECTED ENGINE (P, E)**	(2.) Affected Engine - Gang bar (when directed) (E, P)
If fire exists direct engineer to gang bar affected engine	a. Mixture (affected engine) - FUEL CUTOFF
WARNING	
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, then feather prop.	

PILOTS	ENGINEER
(3.) **RELEASE CO_2 (P, E)**	(b.) CO_2 - Release (when directed) (E, P)
Direct engineer to discharge CO_2 as necessary. If fire still exists after all CO_2 has been expended, dependent upon conditions the pilot must decide whether to abandon the airplane, crash land or attempt to land on the airfield	

.....ENGINE FAILURE/FIRE — TAKEOFF CONTINUED.....

(4.) **GEAR UP (P, CP)**	
Direct copilot to retract gear when airplane is definitely airborne	
(5.) **DUMP FUEL (P, E)**	(3.) A/R Fuel - Dump (if directed) (E, P)
Direct engineer to dump fuel if performance is critical	

6. JETTISON TANKS (IF NECESSARY) (P OR CP) G

The pilot will accomplish or direct the jettisoning of the external tanks.

NOTE

If the external wing tanks are less than half full they may strike and cause some damage to the flaps, if extended.

.....CLEAN-UP.....

(7.) Wing Flaps UP - UP (P, CP)

Direct copilot to retract flaps when reaching minimum flap retraction speed. For flight path clearance, see Appendix, T.O. 1C-97(K)F-1-1.

NOTE

- In event unusual roll attitude of airplane is encountered during flap operation, immediately correct with aileron control and simultaneously return flaps to a symmetrical position.
- Check for synchronization of wing flap position pointers; if pointers get out of synchronization, immediately move wing flap switch to opposite position until the pointers are again synchronized, then move switch to OFF.

8. Maintain Best Three Engine Climb Speed - Maintained (P)

Maintain maximum power until best 3 engine climb speed is attained.

(9.) Power as Required - As required (P, E)	(4.) Power - Set (when directed) (E, P)

10. Notify Crew of Emergency - Notified (P)

ENGINE FAILURE/FIRE — TAKEOFF CONTINUED (Cont)

PILOTS	ENGINEER
(11.) Complete Engine Shut-Down Cleanup - "Complete engine shut-down cleanup" (P, E)	(5.) Engine Shut-Down Cleanup - Complete (when directed) (E, P) See ENGINE SHUT-DOWN CLEANUP this Section.
12. ADI OFF - OFF (CP)	
(13.) Engineer's Report - "Engine shut-down complete" (P, E)	

ENGINE FAILURE DURING FLIGHT

PILOTS	ENGINEER
(1.) **DETERMINE FAILED ENGINE (P, E)** Receive engineer's report and disengage autopilot clutch	(1.) **DETERMINE FAILED ENGINE (NOTIFY PILOT) (E, P)** Use instruments, particularly torque meter, to assist pilot; report to pilot
2. **RETARD THROTTLE (AFFECTED ENGINE) (P)**	
(3.) **FEATHER PROP (AFFECTED ENGINE) (P, CP)** If correct engine has been selected, direct the co-pilot to push the proper feathering button NOTE The prop can also be feathered by actuation of the fire gang switch; however, since this switch also actuates the oil shutoff valve, its general use is not recommended unless fire is present.	2. **MOVE MIXTURE TO FUEL CUTOFF (AFFECTED ENGINE)** 3. **MOVE MIXTURES TO AUTO RICH (ALL OTHER ENGINES)**
4. Rudder Boost ON - ON (P)	
(5.) Power as Required - As required (P, CP) Copilot will make power settings as required.	
6. Notify Crew - Notified (P)	
(7.) Jettison Cargo and Fuel - Jettisoned (P, E, BO) Have crew jettison cargo and engineer dump fuel if performance is critical	(4.) Fuel - Dump (when directed) (E, P) See FUEL DUMPING this Section
(8.) Complete Engine Shut-Down Cleanup - "Complete engine shut-down cleanup" (P, E)	(5.) Engine Shut-Down Cleanup - Complete (when directed) (E, P) See ENGINE SHUT-DOWN CLEANUP in this Section.
9. Autopilot as Required - As required (P)	
(10.) Power as Required - As required (P, E) Request engineer to adjust power on remaining engines as required	(6.) Power - Set (when directed) (E, P)
(11.) Engineer's Report - "Engine shut-down complete" (P, E)	

ENGINE SHUT-DOWN CLEANUP

ENGINEER (Only)

1. If Master Prop Feathered:

   Indicated by a slight rpm drop on remaining engines

   a. Auto Control Switch - Other Position

   b. Resynchronizer Switch - Actuate (momentarily)

2. Governor Selector Switch - DECREASE RPM (feathered Prop)

   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. When Engine has Cooled Sufficiently:

   a. Oil Cooler Flaps Switch - CLOSE then OFF

   b. Cowl Flaps Switch - SET (3/4 inches)

   c. Intercooler Flaps Switch - CLOSED

9. Ignition Switch - OFF

10. Throttle - OPEN (full forward)

11. Turbo Switch - MAN

12. Turbo Override Switch - OPEN (10 seconds then OFF)

13. Select Direction Valve Switch - NORMAL

14. Report to Pilot - "Engine shut-down complete" (E, P)

RESTARTING ENGINE DURING FLIGHT

CAUTION

Do not restart an engine unless it can be determined that it will be safe to do so. 3

PILOTS	ENGINEER
1. Restart Engine - "Restart number____" (P, E) Direct engineer	1. Restart Engine Procedure - Commence (when directed) (E, P)

PILOTS	ENGINEER
2. Reduce Airspeed - Reduced (160 knots IAS) (P) The airspeed should be reduced prior to unfeathering the prop to minimize the possibility of prop overspeeding	2. Gang Bar Switches - NORMAL
	(3.) Hydraulic Lock - Check (8 blades) (E, BO) Crank engine through continuously for a count of 8 blades to check for hydraulic lock
	4. Throttle (affected engine) - Close (to approximately 1/2 inch open) **CAUTION** Adjust throttle cautiously to avoid engine back-fire which can cause damage to the engine.
	5. Governor Selector Switch (feathered prop) - 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
(3.) Receive Engineer's Report - Received "Ready to unfeather" (P, E)	(13.) Report to Pilot - "Ready to unfeather" (E, P) **CAUTION** Watch for oil pressure rise and if no rise re-feather the prop.
4. Pull Out Feathering Button - Pulled out (CP) Pull out feathering button until rpm rise is observed	14. Mixture - AUTO RICH (at 800 rpm) NOTE Advance throttle enough to get a positive reading on the torque meter to insure the engine is running.

RESTARTING ENGINE DURING FLIGHT (Cont)

PILOTS	ENGINEER
	15. Warm up Engine - As required (at 1400 rpm with appropriate MP)
	16. Cowl Flaps - Set as required
	17. Intercooler Flaps - Set as required
	18. When Operating Oil Temperature is reached:
	a. Turbo Switch - AUTO
	b. Rpm and Throttle - Increase slowly to desired power
	c. Turbo Calibrating Knob - Turn clockwise to desired manifold pressure
	d. Prop Resynchronizer Switch - RESYNC (momentarily)
	19. Turbo Bleeder Switch - Check OPEN
	20. Generator Switch(es) - ON
	21. Alternator Switch (if applicable) - ON
(5.) Engineer's Report - "Restarting engine checklist complete" (P, E)	(22.) Report to Pilot - "Restarting engine checklist complete" (E, P)

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, set the select direction valve switch to FIRE. Shut-down immediately. Do not takeoff, investigate the cause and have it corrected.

NOTE

When hot fuel prime is used for starting, after the start the fuel pressure will drop approximately 20 psi and fuel flow will increase momentarily. This is normal and is due to refilling of the hot fuel prime tank.

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 No. 1 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.

1. 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 DURING FLIGHT checklist.
2. 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 if the engine is not absolutely essential to affect a safe, partial power, landing.

3. 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.

LANDING WITH ONE OR MORE ENGINES INOPERATIVE

One Engine Inoperative

If an inboard engine is inoperative, no rudder trim will be required. However, if an outboard prop is feathered some trim will be required. It is important to note that with an outboard engine windmilling, a minimum of 95 knots IAS with rudder boost on, or 125 knots IAS with rudder boost off, is required to maintain control.

Two Engines Inoperative

With two engines windmilling on one side the situation becomes much more critical: A minimum of 120 knots IAS is required with rudder boost on and 165 knots IAS with rudder boost off in order to maintain a heading. With symmetrical engines inoperative, control is not affected; however, when both inboard engines are inoperative, the engine driven hydraulic pumps will not be operating. In this connection, with the two inboard props feathered, several brake applications will be available from the service brake system after landing if the brake pedals, rudder boost and windshield wipers are not used after engine failure. On airplanes incorporating TCTO 541, only two full applications of the emergency brakes are available. On airplanes F 1243 ▶ 1374 the hand pump may be used to maintain pressure in the service brake system by placing the depressurization valve handle in the OFF, NORMAL POSITION. To pressurize the emergency brake system with the hand pump on airplanes F 1243 ▶ 1374 it is necessary to place the controllable hydraulic check valve handle in the GROUND TEST position and the EMERGENCY BRAKE CHARGING position. On airplanes F G 1375 ▶ it is only necessary to place the depressurization and emergency brake charging valve to the EMERGENCY BRAKE CHARGING position to charge both brake systems.

Approach

If one engine is inoperative make a normal approach at normal airspeeds. If two engines are inoperative make the approach slightly higher than normal, with airspeeds 10 knots higher than normal approach speeds. Use the normal DESCENT and BEFORE LANDING checklist keeping in mind that one or more engines are inoperative and that the landing gear will be lowered on final approach when certain the field can be reached.

Landing At A High Gross Weight

Every attempt consistent with safety, should be made to lighten the airplane when a landing is to be made at a high gross weight (see Section V.). Each crew member will be in his crash landing position. The rescue facilities will be alerted. Make the airplane touchdown as smooth and light as possible.

GO-AROUND WITH ONE OR MORE ENGINES INOPERATIVE

The procedure for GO-AROUND WITH ONE OR MORE ENGINES INOPERATIVE is the same as the GO-AROUND procedure for all engines operative given in Section II, except flaps may be retracted at minimum flap retraction speed. Directional control may be maintained by use of rudder trim at pilot's discretion.

CAUTION

Generally it is not considered feasible to attempt a two engine go-around when the flaps are full down and the weight is above 130,000 pounds gross. 500 feet of altitude can easily be lost during the period after the go-around decision has been made and the airplane is being changed from approach to climbout configuration and attitude. The decision to go-around should be made before descending to 500 feet if possible, as the altitude lost may cause the airplane to settle in. When weighing the possibilities for go-around in terms of altitude, airspeed, gross weight, airplane configuration, wind conditions, runway facilities and visibility, the pilot should always consider the advantages of a controlled crash landing as against an unsuccessful go-around, especially if airplane performance is critical or altitude is marginal (about 500 feet or less above the ground).

TAKEOFF WITH ONE ENGINE INOPERATIVE

This type takeoff is not recommended, but may be accomplished in extreme emergency. Refer to the appendix, T.O. 1C-97(K)F-1-1, for information on takeoff distance with one engine inoperative. To make the takeoff, hold the brakes and establish maximum power on symmetrical engines. Release the brakes and use

nose wheel steering for directional control. As the rudder begins to take effect begin to increase power on the other operating engine, up to maximum power as soon as the rudder can be used to offset the unsymmetrical thrust. Retract the gear when safely airborne and use rudder trim as required.

PRACTICE OF EMERGENCY PROCEDURES

Emergency flight procedures will be demonstrated or practiced only under the safest operating conditions and strictest control. No emergency procedures will be practiced during adverse weather, darkness, or when runway conditions are below maximum safety conditions. An adequate airspeed and altitude will be retained throughout the practice maneuver in case an actual emergency should develop. A simulated field elevation will be set up as a base point and traffic patterns flown at the normal altitude above the base point. 5000 feet above the terrain is 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. Descents below the published GCA minimum altitudes will not be made during LANDING AND 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 airplane commander will direct the copilot to alert all crew members prior to practice maneuvers to be especially watchful during the entire period.

Practice Maneuvers With One Or More Engines Inoperative

Retarding the desired throttle or throttles to 15 inches MP will simulate prop feathered condition. Retarding the desired throttle or throttles to idle will simulate a windmilling prop.

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 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 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 one inch Hg manifold pressure. For example, 23 in. 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 3 engine climb speed for 33-1/3 percent flap. 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 varying of airspeed will change the effect of the trim and make handling of the airplane during the turn more difficult.

EFFECT OF PROP PITCH ON TRIM. To determine the drag effect of an unfeathered prop, retard two throttles on one side to 25 inches MP and set the prop blades for those engines to a higher pitch position using manual decrease rpm. Trim the airplane for this condition. Now change the prop 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 prop 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 speed 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 MP. Trim the airplane for this condition. With feet off the rudder pedals, ease the control column back. As the speed 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 speed. 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.

PROPELLER FAILURE

The 34G60 solid Dural Prop 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. Over-speeds 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 prop overspeed must be used to bring the rpm back to a controllable range.

PROP 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 prop control loss, an abort is justified and a safe stop is preferred to continuing the takeoff. A prop 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 prop blade angle is limited by the pitch lock or low pitch stop so that some power may be obtained from the engine.

WARNING

When takeoff performance is critical, it is recommended that the prop be permitted to overspeed allowing pitchlock 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.

PROP RUNAWAY ON TAKEOFF

A flat pitch runaway prop has never been known to occur on this airplane and such an occurrence is considered extremely remote. However, if it does, the power off windmilling drag will make flight virtually impossible. The takeoff should be aborted if possible. If rpm is observed to be increasing rapidly above 3500 rpm, step 3 of the following procedure should be performed immediately. This step which combines feathering and engine freezing action will probably result in prop separation, will provide the only chance of regaining control of the airplane.

PROP OVERSPEED/RUNAWAY — TAKEOFF CONTINUED

The following procedure applies when overspeed occurs beyond the point of safe stoppage and the takeoff must be continued.

PILOTS

1. **RETARD THROTTLE (AFFECTED ENGINE) TO 2900 (P)**

(After pitch lock has engaged (3100 rpm) maintain 2900 rpm and land as soon as possible.)

(2.) **FEATHER PROP (AFFECTED ENGINE) (P, CP)**

If retarding throttle is ineffective and rpm is below 3500, rpm may be reduced by intermittent (one second) application of the feathering button until rpm is reduced to 2700

CAUTION

- Do not pull out feathering button beyond neutral position to unfeathering position.
- If rpm is above 3500 direct copilot to push the proper feathering button and hold it in.

(3.) **GANG BAR AFFECTED ENGINE (DIRECT ENGINEER IF RPM INCREASES RAPIDLY ABOVE 3500) (P, E)**

If prop control cannot be regained by use of throttle or intermittent feathering and if prop cannot be fully feathered, gang barring which includes engine freezing and probable prop separation will provide the only chance of reducing drag in time to avoid an uncontrolled crash

(4.) **GEAR UP (P, CP)**

Direct copilot to retract gear when the airplane is definitely airborne

ENGINEER

1. **SIMULTANEOUSLY:**

   a. **REPLENISH PROP OIL**

   b. **DECREASE RPM WITH GOVERNOR SELECTOR SWITCH (NOT BELOW 2700)**

   (c.) **NOTIFY PILOT (E, P)**

   Notify pilot if rpm can or cannot be decreased

(2.) Affected Engine - Gang bar (when directed) (E, P)

3. Mixture (affected engine) - FUEL CUTOFF (after prop is feathered)

PROP OVERSPEED/RUNAWAY — TAKEOFF CONTINUED (Cont)

PILOTS	ENGINEER
(5.) **DUMP FUEL (P, E)**	(4.) Fuel - Dump (when directed) (E, P)
Direct engineer to dump fuel if performance is critical	
6. **JETTISON TANKS (IF NECESSARY) (P or CP)** G	
The pilot will accomplish or direct the jettisoning of the external tanks.	
See EXTERNAL TANK JETTISONING this Section.	
NOTE	
If the external tanks are less than half full they may strike and cause some damage to the flaps, if extended.	
.....CLEAN-UP.....	
(7.) Wing Flaps Up - UP (P, CP)	
Direct copilot to retract flaps when reaching minimum flap retraction speed. For flight path clearance see Appendix, T.O. 1C-97(K)F-1-1.	
NOTE	
● In the event unusual roll attitude of airplane is encountered during flap operation, immediately correct with aileron control and simultaneously return the flaps to a symmetrical position.	
● Check for synchronization of wing flap position pointers; if pointers get out of synchronization, immediately move wing flap switch to opposite position until the pointers are again synchronized; then move switch to OFF.	
8. Maintain Best Three Engine Climb Speed - Maintained (P)	
Maintain maximum power until best three engine climb speed is attained	

9. Power as Required - As required (P, E)

10. Notify crew of Emergency - Notified (P)

11. Complete Engine Shut-Down Cleanup - "Complete engine shut-down cleanup" (if required) (P, E)

12. ADI Off - OFF (CP)

13. Engineer's Report - "Engine shut-down complete" (P, E)

5. Power - Set (when directed) (E, P)

CAUTION

Reduce rpm on the three engines not affected by overspeed, with prop governor selector switch. Reduce rpm on engine with malfunctioning prop with throttle, to not less than 1 inch manifold pressure per 100 rpm. Reducing rpm below 2550 on affected engine with either feathering button or manual decrease switch may unseat the flyweight valve and cause a secondary overspeed.

6. Engine Shut-Down Cleanup - Complete (when directed) (E, P)

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) prop. Unfortunately, the 34G60 Dural prop will generally separate from the airplane when rapid freezing is attempted at high rpm. As a result, a runaway prop has become a serious emergency. However, freezing with Dural props has been accomplished at low rpm. Some reasons for freezing might be:

1. Unbalance from cuff or tip damage.
2. High rate of oil loss.
3. 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 airplane Commander. 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 Dural Prop.

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 prop if prop separation is considered probable. Props separating from the aircraft have resulted in damage to the adjacent prop. Prop 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 one to three minutes after these indications. If the prop that has separated from the airplane should strike an adjacent prop or engine upon which power is applied, complete separation of the adjacent prop and or engine could result.

It is impossible to predict the direction in which the prop may travel as it leaves the airplane. Dependent upon the speed of prop rotation, airplane attitude, airspeed, or any combination thereof; the prop may go up, down, right or left. If the emergency involves an inboard prop 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 prop, a turn away from the wind-milling prop may be applicable. This may provide additional clearance between the airplane and a prop that has separated.

WARNING

The discharge of CO_2 has not been effective in emergencies involving engine nose section fires which have resulted from prop separation.

PROP OVERSPEED DURING FLIGHT

When flying at high altitude or airspeed, an overspeeding prop which does not exceed 3300 rpm indicates the pitch lock is effective and feathering should be possible. Maximum potential of the pitch lock is obtained by causing the prop to lock in as high a blade angle as possible. This is done by maintaining power until the pitch lock engages or 3300 rpm is reached. The pilot should be ready to immediately reduce power if the pitch lock is not effective. 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 prop while it is still in the controllable speed range.

PROP RUNAWAY DURING FLIGHT

In this case, 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 shut-down, airspeed and altitude reduction will materially aid in regaining prop control. Figure 1A8-2 indicates the effect on rpm. Minimum airspeeds and maximum rates of descent are obtained with extended wing flaps. The amount of 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 flaps up, which may make feathering possible.

PROP OVERSPEED/RUNAWAY DURING FLIGHT

PILOTS

1. **RETARD THROTTLES (P)**

NOTE

- At low altitude, retard the throttle for the affected prop only.
- During A/R, simultaneously execute the BREAKAWAY procedure and retard the throttle for the affected prop only. After attaining vertical separation, retard remaining throttles, if necessary.

2. **REDUCE AIRSPEED TO MINIMUM (P)**

Reduce to minimum consistent with safe flight, approximately 20 knots above stall speed. Flaps should be lowered to obtain minimum safe flight, (55%) if the IAS is below the placard flap extension speeds

(3.) **RECEIVE ENGINEER'S REPORT (P, E)**

If engineer has regained prop control, terminate the overspeed procedure and closely monitor affected prop. If pitch lock has engaged, refer to continuous operation in fixed pitch

ENGINEER

1. **SIMULTANEOUSLY:**

a. **REPLENISH PROP OIL**

b. **DECREASE RPM WITH GOVERNOR SELECTOR SWITCH (NOT BELOW 2700)**

(c.) **NOTIFY PILOT (E ,P)**

Notify pilot if rpm can or cannot be decreased

(PROCEED TO APPROPRIATE STEP (4)

4. **RPM ABOVE 3300 (RUNAWAY)**

(a.) **MIXTURE OFF (AFFECTED ENGINE) (P, E)**

Direct engineer

(b.) **FEATHER PROP (AFFECTED ENGINE) (P, CP)**

Direct copilot to depress the feathering button

c. Initiate Descent - Initiated (P)

If the prop cannot be feathered and descent is practical, descend to a lower altitude at minimum airspeed as a denser air will help reduce the windmilling rpm. Extension of the landing gear will permit a more rapid descent

(d.) Feather Prop (affected engine) - Feathered (hold in) (P, CP)

Direct copilot to depress feathering button and hold in

(2.) Mixture Lever (affected engine) - FUEL CUTOFF (when directed) (E, P)

3. Mixture Levers - AUTO RICH (all other engines)

4. Rpm Below 3300 (Overspeed)

(a.) Feather Prop - Feathered (P, CP)

Direct copilot to feather prop. If power must be maintained on the affected engine due to flight conditions and the engineer reports that he cannot reduce rpm with the prop governor selector switch, direct copilot to decrease rpm by intermittent (one second) applications of the feathering button until rpm is reduced to 2700. If pitch lock has engaged, refer to CONTINUOUS OPERATION IN FIXED PITCH, this Section.

CAUTION

If rpm cannot be maintained at 2700, fully depress the feathering button and feather the prop. Continuous intermittent feathering over a prolonged period of time may burn out the feathering motor with resultant loss of prop feathering action.

PROP OVERSPEED/RUNAWAY DURING FLIGHT (Cont)

PILOTS	ENGINEER
5. Notify Crew - Notified (P)	
6. Continuous Operation in Fixed Pitch:	
WARNING ● Operation in pitch lock is considered to be an emergency condition. Feather prop (if possible) and land at nearest suitable airfield.	
● If an overspeed occurs after an oil refill, and the oil refill light cannot be extinguished, continuous operation in pitch lock should only be attempted in extreme emergencies.	
a. Retard Throttle to 2550 - Retarded (2550) (P)	
b. Decrease Airspeed/Altitude - Decreased (P) Decrease airspeed and altitude as necessary to set up desired manifold pressure and rpm balance	
(7.) Complete Engine Shut-Down Cleanup - "Complete engine shut-down cleanup" (if required) (P, E)	(4.) Engine Shut-Down Cleanup - Complete (when directed) (E, P) See ENGINE SHUT-DOWN CLEANUP this Section.
(8.) Power As Required - As required (P, E)	(5.) Power - Set (when directed) (E, P)
(9.) Engineer's Report - "Engine shut-down complete" (if required) (P, E)	

PROP REVERSAL DURING FLIGHT

If a prop reverses in flight, the windmilling drag will be similar to a low pitch stop forward windmilling prop. 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 prop 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 one inch 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 (one second) applications of the feathering button.
3. Repeat Steps 1 and 2 above until a power setting of 50 inches of manifold pressure and 2700 rpm is obtained.
4. Retard throttle to desired rpm for cruise.

WARNING

Operation in pitch lock is considered to be an emergency condition. Feather engine (if possible) and land at the nearest suitable airfield.

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. Rpm - Reduce to 1500

      RPM may be reduced with throttle or governor selector switch

   b. Power - Return to METO
   c. Throttle - Retard 10 in. Hg

      If rpm does not follow, bleed valves have been reset

   d. If rpm does follow, refer to continuous operation in fixed pitch
2. Step 1 - Repeat on remaining affected engines

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 or engine with nacelle explosion or fire 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 SEPARATED ENGINE (NOTIFY PILOT) (E, P)
(1.) GANG BAR (AFFECTED ENGINE) (P, E)	(2.) Affected Engine - Gang bar (when directed) (E, P)
Direct engineer	For nacelle of missing engine

ENGINE SEPARATION DURING FLIGHT (Cont)

PILOTS	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.) **DIRECT ENGINEER TO SET RPM 2550 ON REMAINING ENGINES (P, E)**	(3.) Rpm (remaining engines) - Increase manually to 2550 (when directed) (E, P)
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 prop drag.	
(4.) **POWER AS REQUIRED (P, E)** Direct engineer to make necessary power changes. Use unsymmetrical power as required to aid directional control	(4.) Power - Set (when directed) (E, P) (Make rpm changes manually)
NOTE (Do not hesitate to exceed METO power as needed for either control or performance.)	
(5.) **OPEN COWL FLAPS (CLEAN SIDE) (P, E)** Direct engineer if additional drag on that side is required for directional control	(5.) Cowl Flaps (clean side) - OPEN (when directed) (E, P)
(6.) **SET WING FLAPS (P, CP)** Direct copilot to set flaps as required to reduce buffeting or to improve elevator control. Usually 10% to 20% is sufficient to eliminate all but extremely severe buffeting, but more may be required. See also BUFFETING in Section VI.	6. CO_2 Select Directional Valve - NORMAL (if fire is extinguished)
7. **AIRPLANE UNCONTROLLABLE:**	
a. **USE BAILOUT PROCEDURE**	

FIRE

ENGINE FIRE DURING ENGINE STARTING

PILOTS

1. **SIMULTANEOUSLY:**

   a. **CALL TOWER (CP)**

   Have tower dispatch fire trucks

   b. **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. **ABANDON AIRPLANE (ALL)**

   If fire is out of control notify personnel by means of the interphone on CALL position, to abandon airplane. Copilot will execute one long ring on the alarm bell

ENGINEER

1. **DETERMINE FIRE LOCATION (NOTIFY PILOT) (E, P)**
2. **STOP PRIMING**
3. **CONTINUE CRANKING**
4. **STOP CRANKING (IF FIRE CONTINUES)**
5. **MOVE ALL MIXTURES TO FUEL CUTOFF**
6. **GANG BAR AFFECTED ENGINE**
7. **RELEASE CO_2**

   Hold CO_2 release switch in FIRST FIRE position 5 seconds. After engine stops and fire is still not extinguished, move CO_2 release switch to SECOND FIRE position, hold 5 seconds

8. **REPORT FIRE STATUS (E, P)**

   Report to Pilot

9. Electrical Master and Ignition Switches - Off

ENGINE FIRE DURING FLIGHT

Any crew member seeing a fire will use the interphone CALL position to announce, "SMOKE and/or FLAME ON NO. _____ ENGINE." Engineer will advise the pilot of the engine on fire.

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 unavailable to discharge the CO_2.

PILOTS

1. **DETERMINE FIRE LOCATION (P, E)**

   If airplane drag is not critical and fire is on inboard engine extend the landing gear

ENGINEER

1. **REPORT OR ACKNOWLEDGE FIRE INDICATION (E, P, BO)**

   Report or acknowledge any indication of an engine fire, using CALL position on interphone, to pilot

ENGINE SMOKE AND FLAME IDENTIFICATION

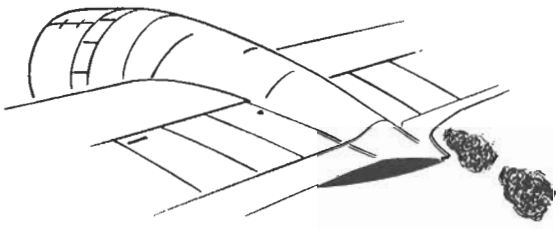
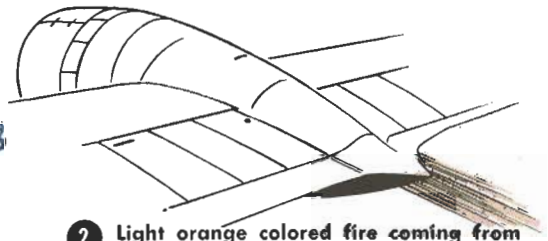
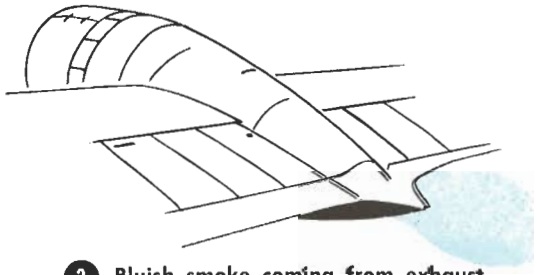
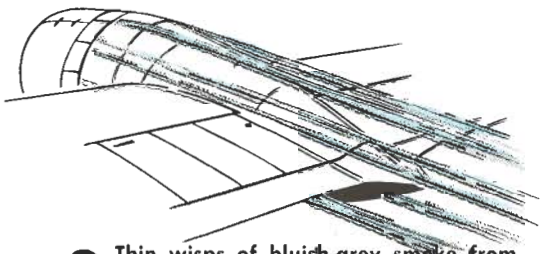
CAUSE	ACTION	
Detonation, afterfire and/or backfire. Also fouled plugs or failing valves. If fuel pump drive shaft is broken, engine gets insufficent fuel and mixture leans excessively. Indicated generally by high CHT high CAT fluctuating MP, fuel flow and in some cases fluctuating cabin airflow. Lean mixtures cause high CHT. High CAT produces detonation. Fluctuation in MP, fuel flow, cabin airflow will result from violent back-fire. If detonation continues, engine failure and fire is imminent.	Turn on fuel boost if fuel pressure 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 in-flight action 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, feather propeller, 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 fire procedure. Prepare to abandon airplane if fire does not go out.	5 Black smoke with orange-yellow flame coming from accessory section.

Figure 3-3 (Sheet 1 of 2)

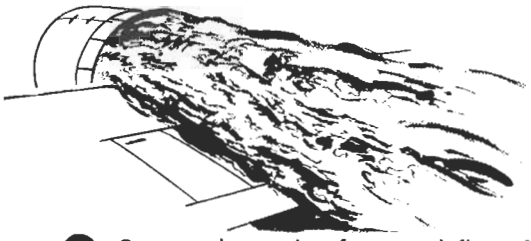
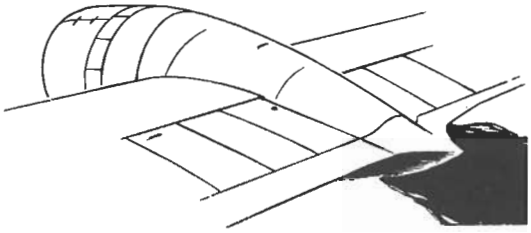
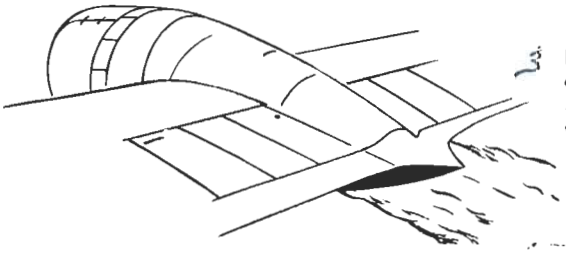
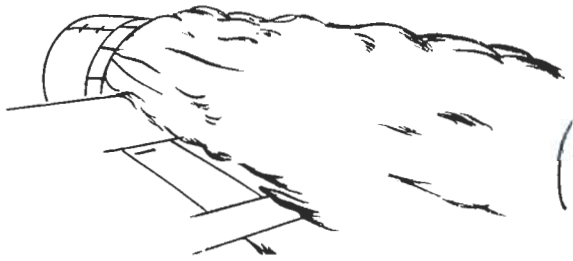
	CAUSE	ACTION
 6 Grey smoke coming from cowl flap of forward engine section.	Cylinder failure or exhaust stack failure. If condition results in blown cylinder head or open exhaust stack, fire and black smoke will appear in exhaust stream.	During takeoff or when more than 3-engine power is required for safety, reduce power slightly and let engine operate until safe altitude and airspeed is attained, then feather propeller.
 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 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 fire procedure. Alert crew for bailout. IF FIRE DOES NOT GO OUT WITHIN 30 SECONDS IT MAY BE BEST TO ORDER CREW TO BAILOUT AS FIRE WILL PROBABLY CAUSE EXPLOSION IN WING.
 9 Dense white smoke coming from cowl flap areas.	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. Prepaire 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 fire procedure.

Figure 3-3 (Sheet 2 of 2)

ENGINE FIRE DURING FLIGHT (Cont)

PILOTS	ENGINEER
(2.) **GANG BAR AFFECTED ENGINE (P, E)**	(2.) **GANG BAR AFFECTED ENGINE (WHEN DIRECTED) (E, P)**
If fire exists direct engineer to gang bar the affected engine.	3. **MOVE MIXTURE TO FUEL CUTOFF (AFFECTED ENGINE)**
(3.) **ALERT CREW (P, CP)**	4. **MOVE MIXTURES TO AUTO RICH (ALL OTHER ENGINES)**
Alert crew by means of interphone on CALL position. Copilot executes three short rings on the alarm bell	
(4.) **RELEASE CO_2 (P, E)**	(5.) CO_2 - Release (when directed) (E, P)
Direct engineer to discharge CO_2 as necessary	
5. **FIRE NOT EXTINGUISHED:**	
a. **USE BAILOUT PROCEDURE**	
6. Fire Extinguished:	6. Cowl Flaps Switch - Set (2 inches)
a. Rudder Boost ON - ON (P)	Open cowl flaps approximately 2 inches
(b.) Power as Required - As required (P, CP, E)	
(c.) Complete Engine Shut-Down Cleanup - "Complete engine shut-down cleanup" (P, E)	
(d.) Engineer's Report - "Engine shut-down complete" (P, E)	(7.) Engine Shut-Down Cleanup - Complete (when directed) (E, P)
e. Land as soon as possible (P)	See ENGINE SHUT-DOWN CLEANUP this Section.

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 is indicated. Utilize the ENGINE FIRE procedures as outlined above. Direct the engineer to conduct a line check if desired. See TO CHECK A SUSPECTED LEAK IN THE AIRPLANE FUEL SYSTEM, this Section.

FUSELAGE/ELECTRICAL FIRE DURING FLIGHT

PILOTS

The pilot will initiate the following procedures if a fuselage or electrical fire is observed or reported.

1. **NOTIFY CREW (P)**

   Notify crew of fire location and emergency by means of the interphone on CALL position

2. **OXYGEN MASKS ON (100%) (P, CP)**

   Set regulators to 100% oxygen

3. **DETERMINE FIRE CAUSE (ALL)**

   a. **SHUTOFF SYSTEM FEEDING FIRE (FUEL, OIL OR ELECTRICAL)**

4. **DEPRESSURIZE THE AIRPLANE (AS REQUIRED) (P, E)**

WARNING

The cabin pressure release handle should not be utilized during fuselage/electrical fires except as a last resort to effect depressurization to permit opening of the bailout escape hatches. Use of the cabin pressure release handle may aggravate the situation, result in an uncontrollable fire which may prevent crew members from gaining access to the escape hatches. If the severity of the fire MAY require abandonment of the airplane, direct the engineer to depressurize the airplane. Resetting of the cabin selector above airplane altitude and the rate of change to MAX will draw smoke and fumes from the control cabin which will be eliminated through the cabin pressurization regulator ports.

5. **FIRE REPORTED NOT EXTINGUISHED:**

   a. **USE BAILOUT PROCEDURE**

ENGINEER

1. **REPORT OR ACKNOWLEDGE FIRE INDICATION (E, P)**

   Report or acknowledge to pilot, using the CALL position on interphone, any indication of a fuselage or electrical fire. If body heater fire exists as indicated by fire warning light, gang bar heaters and advise pilot. If APU fire exists as indicated by fire warning light, turn off APU, activate CO_2 switch and advise pilot.

2. **DON OXYGEN MASK (REGULATOR 100%)**

3. **DETERMINE AND REPORT CAUSE OF FIRE (E, P)**

   When cause of fire is determined, report source to pilot. If fire is determined to be of electrical origin, applicable equipment will be turned OFF or circuit breakers and fuses pulled. If source of fire is reported as a result of fuel system failure shut off applicable system feeding the fire

4. Depressurize Airplane: (when directed) (E, P)

   a. Cabin Altitude Selector - Reset above airplane altitude

   b. Cabin Pressure Rate-of-Change Selector - MAX

WARNING

Prolonged exposure (5 minutes or more) to high concentrations (pronounced irritation of eye and nose) of Bromochloromethane (CB) or its decomposition products should be avoided. CB is an anesthetic agent of moderate intensity. It is safer to use than previous fire extinguishing agents (carbon tetrachloride methylbromide). However, especially in confined spaces, adequate respiratory and eye protection from excessive exposure, including the use of oxygen when available, should be sought as soon as the primary fire emergency will permit.

FUSELAGE/ELECTRICAL FIRE DURING FLIGHT (Cont)

PILOTS	ENGINEER
6. Electrical Fire: (Source Not Found)	5. Electrical Fire : (Source Not Found)
a. Instrument Emergency Power Switch to Battery - BATTERY (P)	a. Mixtures - AUTO RICH
(b.) Set rpm 2350 - Set 2350 (P, CP) Direct copilot to set rpm 2350.	b. Cowl Flap Switches - Set (2 inches)
c. Rudder Boost ON - ON (P)	
(d.) Electrical Master Switch OFF- OFF (P, E) Direct Engineer	(c.) Electrical Master Switch - OFF (when directed) (E, P)
NOTE When all electrical power is turned off, the propellers will be in constant rpm, the turbo wastegates and fuel valves will remain positioned as they were prior to power off. If pitot heat is required, emergency bus power must be utilized.	
(e.) Turn off all Electrical Equipment - Switches, circuit breakers turned Off (except emergency bus) (ALL) Direct crew to turn off all switches and pull all circuit breakers except those on the emergency bus	(d.) All Electrical Equipment - Turn OFF Switches, Pull Circuit Breakers (except those on emergency bus when directed) (ALL)
	e. Turbo Switches - MAN
	f. Turbo Override Switches - OFF
(f.) Electrical Master Switch ON - ON (P, E)	(g.) Electrical Master Switch - ON (when directed) (E, P)
	h. Generator Switches - ON (one at a time)
	i. Essential and Pilot's Instrument Inverter Switches - ON
(g.) Essential and Other Equipment On - On (P,E) If fire is extinguished have engineer turn master switch on and resume normal instrument power operation, after pilots instrument inverter is turned on. Turn on essential equipment and other equipment as needed, carefully observing equipment, instruments or wiring. As soon as fault is detected, isolate this circuit or equipment by disconnecting or leaving inoperative	(j.) Switches and Circuit Breakers - On (One at a time) (for essential equipment) (ALL) Carefully observe equipment and instruments. As soon as fault is detected, isolate this circuit or equipment by disconnecting or leaving inoperative
7. Eliminate Smoke and Fumes - Eliminated (P) Use SMOKE OR FUMES ELIMINATION procedure in this Section to clear the airplane	

WING AND EMPENNAGE FIRE DURING FLIGHT

PILOTS

(1.) **ALERT CREW (P, CP)**

Alert crew by means of interphone on CALL position. Copilot executes three short rings on alarm bell

(2.) **RELEASE CO_2 (P, E)**

Direct engineer to discharge second CO_2 charge if necessary

3. **FIRE NOT EXTINGUISHED:**

a. **USE BAILOUT PROCEDURES**

4. Fire Extinguished:

a. Land as Soon as Possible (P)

WARNING

To prevent a recurrence of the fire do not restart affected heaters.

ENGINEER

(1.) **REPORT OR ACKNOWLEDGE FIRE INDICATION (E, P)**

Report or acknowledge any indication of a wing or empennage fire, using the CALL position on interphone to pilot

2. **GANG BAR AFFECTED HEATERS**

3. **RELEASE CO_2 FIRST FIRE**

Report fire status to pilot

(4.) CO_2 - Release SECOND FIRE (when directed) (E, P)

5. Fire Extinguished:

a. CO_2 Directional Valve Switch - NORMAL

WHEEL WELL FIRE DURING FLIGHT

If a wheel well overheat warning light illuminates, fire or explosion occurs, the pilot will initiate the following procedure:

PILOTS (Only)

(1.) **ALERT CREW (P, CP)**

Alert crew by means of interphone on CALL position. Copilot executes three short rings on alarm bell.

(2.) **GEAR DOWN (P, CP, E)**

If performance is critical, consideration should be given to extend only the affected gear.

(3.) **GANG BAR AFFECTED ENGINE (P, E)**

Direct engineer to gang bar affected inboard engine if fire exists.

4. Land Airplane - Land at nearest airfield (P)

The pilot should anticipate failure of both tires on landing and utilize as much of the runway as possible. See BOTH TIRES ON ONE MAIN GEAR FLAT, this Section.

ELECTRICAL FIRE

In the event of a short circuit that may be detected by fire, smoke, excessive amperage load or overheating of any electrical wiring or equipment, causing an electrical fire use procedures outlined in FUSELAGE/ELECTRICAL FIRE.

SMOKE OR FUME ELIMINATION

PRESSURIZED OR UNPRESSURIZED

PILOTS

If smoke or fumes, other than fuel fumes are observed or reported, the pilot will initiate the following procedures:

(1.) Oxygen Masks On - On if required (100%) (P, CP, E)

Direct copilot and engineer to don oxygen masks and set regulators to 100% oxygen, if oxygen is required.

2. Pull Cabin Pressure Release - Pulled (P)

(3.) Open Main Compartment Hatches - Opened (P, N, RO, BO)

Open per EMERGENCY EXITS, Figure 3-6. Direct crew to open left aft and either the right or left overwing 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.

ENGINEER

(1.) Smoke or Fumes Indication - Report or acknowledge (E, P)

Report or acknowledge to pilot any indication of smoke or fumes, using the CALL position on interphone.

(2.) Oxygen Mask - On, if required (regulator 100%) (E, P)

3. Turbo Bleeder Switch - CLOSE (if engine fire)

4. Air Conditioning Master Switch - ON

5. Cabin Air Selector Switches - ALTERNATE

PILOTS

ENGINEER

④ Open Floor Hatches - Opened (P, N, RO, BO)

Direct crew to open if fumes are discovered in the lower compartments.

5. Increase Airspeed - Increased (as desired) (P)

To assist ventilation

⑥ Determine if Smoke and Fumes Eliminated - Determined (ALL)

FUEL FUMES

PILOTS

ENGINEER

If fuel fumes are observed or reported, the pilot will initiate the following procedures:

1. **INSTRUMENT EMERGENCY POWER SWITCH TO BATTERY (P)**

① **REPORT OR ACKNOWLEDGE FUEL FUMES INDICATION (E, P)**

Report or acknowledge to pilot any indications of fuel fumes, using the CALL position on interphone.

② **SET RPM (AS REQUIRED) (P, CP)**

Direct copilot to set rpm as required

② **SET MIXTURES AND COWL FLAPS (AS REQUIRED) (P, E)**

Set mixtures and cowl flaps as required for any power change that may be accomplished.

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.

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.

3. **RUDDER BOOST ON (P)**

3. **MOVE FUEL VALVES AND SWITCHES (AS REQUIRED)**

Move A/R transfer and line valve switches to CLOSE. Move fuel valve selector switches to TE, if fuel loading permits.

FUEL FUMES (Cont)

PILOTS

④ **TURBO WASTE GATES — OPEN (AS REQ'D.) (P, E)**

ENGINEER

④ **TURBO WASTE GATES — OPEN (AS REQUIRED) (E, P)**

Turbo switches manual, 10 seconds, guards up

NOTE

Turbo waste gates 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 4 of the Engineer's Checklist.

CAUTION

With turbo waste gates 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.

⑤ **ELECTRICAL MASTER SWITCH — OFF (P, E)**

⑤ Electrical Master Switch - OFF (when directed) (E, P)

⑥ Oxygen Masks On - On, if required (100%) (P, CP, E)

Direct copilot and engineer to don oxygen masks and set regulators to 100% oxygen, if oxygen is required.

⑥ Oxygen Mask - On, if required (regulator 100%) (E, P)

7. Pull Cabin Pressure Release - Pulled (P)

7. All Electrical Switches - Turn OFF

⑧ Open Main Compartment Hatches - Opened (P, N, RO, BO)

Open per EMERGENCY EXITS, figure 3-6. Direct crew to open hatches.

8. Turbo Controls - Off and Manual

a. TBS Lever - ZERO

b. Turbo Switches - Manual

c. Turbo Manual Override Switch - OFF (Guards up)

NOTE

To reduce fume accumulation in the control cabin due to airflow effects, close the cabin pressure emergency release valve after the overwing hatches have been opened.

⑨ Open Floor Hatches - Opened (P, N, RO, BO)

10. Increase Airspeed - Increased (as desired) (P)

Increase to assist ventilation.

11. Pitot Heat on Emergency - Climatic (P)

FUEL FUMES (Cont)

PILOTS

(12) Fuel Fumes Cleared, Electrical Master Switch ON - ON (P, E, N)

When crew reports airplane and lower nose compartment is free of fumes, have engineer turn the electrical master switch ON and restore normal power to flight instruments

ENGINEER

9. Fuel Fumes Cleared:

(a.) Electrical Master Switch - ON (when directed) (E, P)

b. Generator Switches - ON (one at a time)

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
- A/R system
- Autopilot
- Cabin heaters
- Control cabin cooling fan
- Glide slope receiver
- HF/MF Equipment
- IFF radio
- Interaircraft signal lamp
- Localizer and VOR receiver
- Loran radio
- Pull marker beacon circuit breaker
- Radio Altimeter
- Radio compass
- Rendezvous Equipment
- Search radar
- Tacan

RAPID DECOMPRESSION

When a rapid decompression occurs, the cabin pressure is reduced to the outside pressure in less than one second. Any rapid decompression affects all crew members and can be extremely dangerous if occurring at high altitudes. Following are some of the effects accompanying rapid decompression:

1. Rush of air from lungs.
2. A momentary dazed sensation that passes immediately.
3. Possible gas pains.
4. Anoxia if oxygen equipment is not immediately available.

Following are precautions to observe in pressurized compartments:

1. Maintain a safe pressure differential.
2. Have oxygen equipment immediately available.
3. Have heavy flight clothing available.

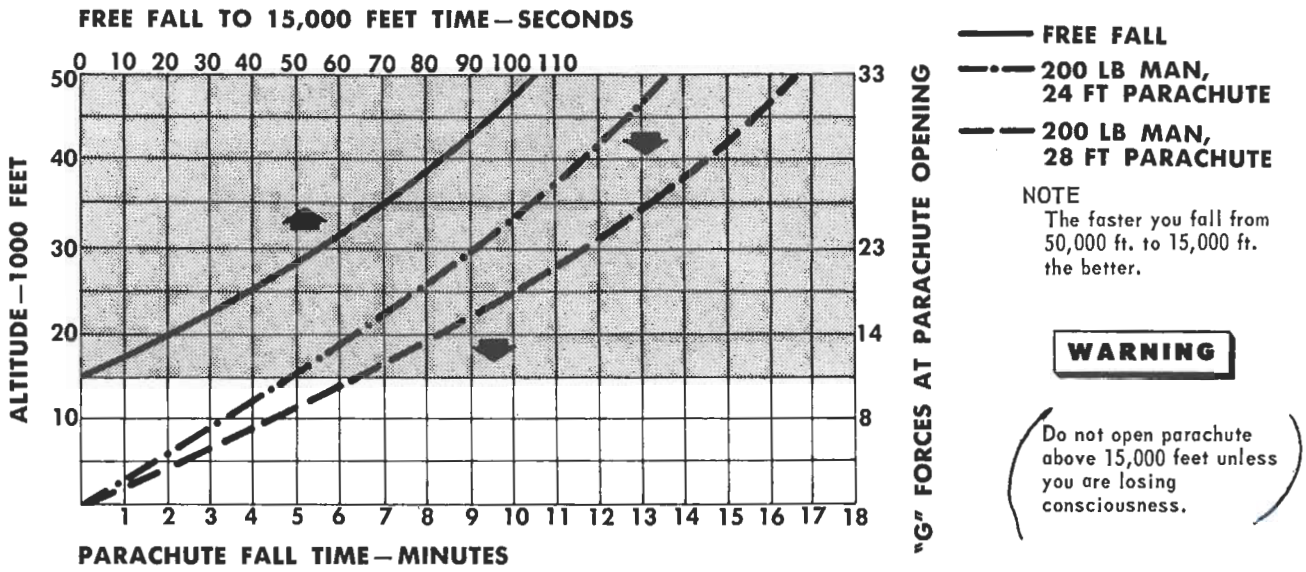
If a rapid decompression occurs the pilot should try to ascertain the cause of the trouble and if it cannot be fixed in flight, he should decide whether to continue on his mission or to descend to a safe altitude immediately.

BAILOUT

NOTE

Prior to each mission the pilot will assure that the boom operator has briefed extra crewmembers and passengers on primary and secondary exits for bailout, method of removing hatches and other pertinent instructions commensurate with the experience of the applicable personnel.

When bailout is required or decided upon, try to plan bailout before the last minute. Over water 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 exposure suit will increase this time but still cannot compare with the time of survival possible in a life raft. Exposure suits available in the airplane should be put on if time permits; it takes about a minute to put on a suit. Exposure suits should be worn over flying clothing, then put on Mae Wests and parachute harness; mittens will be found in the leg pockets. When the bailout order is given, if time permits, crew members 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 freefall descent from any altitude to 15,000 feet and expected "G" forces at parachute opening.



TIME OF DESCENT FROM 50,000 FT

Figure 3-4

BAIL-OUT

PILOTS

(1.) ALERT CREW (P, CP)

Alert crew by means of interphone on CALL position. Copilot executes three short rings on the alarm bell.

NOTE

- If time permits have personnel don exposure suits and life vests if applicable.
- If IFF control panel is at copilot's position, turn IFF on EMERGENCY if time permits.

2. AUTOPILOT SWITCH ON (P)

3. PULL CABIN PRESSURE RELEASE (P)

4. REDUCE AIRSPEED (P)

(5.) OPEN HATCHES (P, BO)

Direct aft crew members to open bailout hatch(es).

(6.) WARN CREW (P, CP)

Give bailout order on interphone on CALL position. Copilot executes one long ring on the alarm bell.

7. ENGAGE AUTOPILOT (P)

After jumpmaster reports that all personnel have bailed out, engage autopilot just before leaving. Don chest pack and adjust parachute harness. Attach survival kit if time permits.

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 bailout 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)** } POWER SETTING 3
2. **SET RPM 2000 (P, CP)** }

Direct copilot to set rpm 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.

4. ***WING FLAPS 55% (P, CP)***

Direct copilot to extend flaps to 55%.

NOTE

Landing gear and wing flaps can be started down immediately after closing throttles from normal cruising speed; speed will be down to wing flap extension speed by the time flaps are 55% extended.

5. Maintain Airspeed - Maintained (190 knots)

6. Oxygen Mask On - On (if required) (ALL)

Direct crew.

ENGINEER

1. **MOVE MIXTURES TO AUTO RICH**
2. **SET COWL FLAPS (3 INCHES)**
3. Oxygen Mask - On (if required) (E, P)

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.

TAKEOFF AND LANDING EMERGENCIES (EXCEPT DITCHING)

ABORT

If an emergency occurs prior to S_1 (for S_1 see Appendix, T.O. 1C-97(K)F-1-1)

PILOTS (ONLY)

1. **CLOSE THROTTLES (P)**
2. **REVERSE PROPS (SYMMETRICAL ENGINES) (P)**
3. **APPLY BRAKES (P)**

(See STOPPING DISTANCE Chart in Part 3 of the Appendix, T.O. 1C-97(K)F-1-1)

In extreme cases retract the landing gear using normal and emergency switches.

NOTE

A physical inspection of the brakes will be made after an aborted takeoff or at any time after any excessive braking has been used. See BRAKE LIMITATIONS, Section V and USE OF LANDING WHEEL BRAKES, Section VII.

CRASH LANDING AFTER TAKEOFF

PILOTS	ENGINEER
(1.) **GEAR UP (P, CP)**	
Direct copilot to raise gear	
2. **LOCK SHOULDER HARNESS (P, CP)**	1. **LOCK SHOULDER HARNESS**
Pilot and copilot manually lock inertia reel.	
(3.) **WING FLAPS FULL DOWN (P, CP)**	
Signal copilot to lower flaps full down. Land as slow as possible.	
(4.) **WARN CREW (P, CP)**	
Notify personnel by interphone on CALL position for crash landing: copilot executes one long sustained ring on alarm bell.	
(5.) **SIMULTANEOUSLY:**	(2.) **SIMULTANEOUSY:**
a. **CLOSE THROTTLES (P, E)**	a. **MOVE MIXTURES AND IGNITION SWITCHES TO FUEL CUTOFF AND OFF (E, P)**
	Move mixture levers to FUEL CUTOFF, turn ignition switches OFF, when pilot closes throttles.
b. **ELECTRICAL MASTER SWITCH OFF (P, E)**	b. **MOVE ELECTRICAL MASTER SWITCH TO OFF (WHEN DIRECTED) (E, P)**
Direct engineer to turn electrical master switch OFF just as ground contact is made.	

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 crew member will notify other personnel and will assist in positioning and securing the passengers. All personnel not located in the main compartment should proceed thereto 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 3-5. On G airplanes 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 3-5, 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 3-5 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.

CRASH LANDING (Cont)

- 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 - Alerted (P, CP)

Alert personnel by means of interphone on CALL position. Copilot executes six short rings on the alarm bell.

(2.) Reduce Gross Weight - Reduced (P, E, BO)

a. Dump A/R Fuel - Dumped (if aboard)

b. Dump Airplane Fuel - Dumped (if required)

c. Jettison Cargo - Jettisoned (if aboard)

Direct engineer to dump A/R fuel if aboard. Have engineer transfer airplane fuel for dumping if required. Direct aft compartment crew members to jettison cargo if aboard. See CARGO JETTISONING, this Section.

Reduce gross weight as much as possible, at pilot's discretion, give all non-essential personnel permission to bail out.

NOTE

Before jettisoning reduce speed below 131 knots IAS, lower wing flaps to 55% to attain a tail high attitude. Have cargo jettisoned through the rear escape hatches to avoid danger of damaging the horizontal stabilizer

WARNING

When utilizing the rear hatch(es) for jettisoning, do not open either of the overwing hatches as the increased volume and velocity of air entering these hatch(es) will render its use extremely hazardous.

ENGINEER

(1.) Fuel - Dump (when directed) (E, P, BO)

Begin dumping A/R fuel if on board. (See FUEL DUMPING in this section.) Transfer airplane fuel for dumping if directed by pilot.

2. APU - Turn OFF

PILOTS

3. Jettison Tanks - Jettisoned (as applicable) (P) G

If landing is to be accomplished on any surface not prepared with foam, jettison external fuel tanks in accordance with procedures in EMERGENCY JETTISONING this Section.

NOTE

Do not jettison external wing tanks if they are empty and landing is to be made on a runway that has been prepared with foam.

4. IFF - EMERGENCY (CP or N)

5. Open Windows, Door, Exits - Opened (P, CP, BO)

Open, remove, and secure pilot's and copilot's windows; have crew open and release emergency exits (figure 3-6); unlock front and aft entrance door safety pins and have floor hatch open or removed. If time permits pull single point refueling circuit breaker, flare release circuit breaker, fuel dump circuit breaker, and close air refueling vent valve (if applicable).

6. Order Personnel to Crash Landing Positions - Ordered (P, BO)

Order personnel by interphone on CALL position to take crash landing positions, and brace themselves. Check that all personnel in lower compartments have been moved to main compartment and braced for crash landing. See figure 3-5 for crash landing positions.

7. Fasten and Lock Safety Belt and Shoulder Harness - Fastened and locked (P, CP, E)

Remove parachute harness prior to fastening safety belt and shoulder harness.

ENGINEER

3. Body and Surface Anti-icing Heater Switches - OFF

4. Safety Belt and Shoulder Harness - Fasten and lock (E, P)

3 Remove parachute harness prior to fastening safety belt and shoulder harness.

CAUTION

The crew member 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 before moving the handle.

8. Autopilot OFF - OFF (P)

9. Rudder Boost ON - ON (P)

CRASH LANDING (Cont)

PILOTS

(10) Mixtures RICH - 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."

(11) Rpm - 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) Gear DOWN - DOWN (P, CP)

Direct copilot to place gear switch down and obtain visual check of gear that will extend.

a. 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. One Main Gear Retracted - Make contact on nose gear and extended main gear

With one main gear retracted, make contact on the nose gear and extended main gear simultaneously; 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 only over extended gear with caution.

c. 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.

d. 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.

ENGINEER

(5) Mixtures - AUTO RICH and LOCKED (when directed) (E, P)

Report to pilot

(6) Rpm - Set 2350 or as directed (E, P)

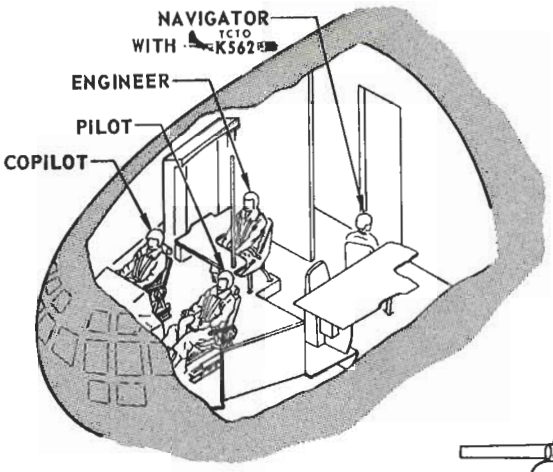
Report to pilot

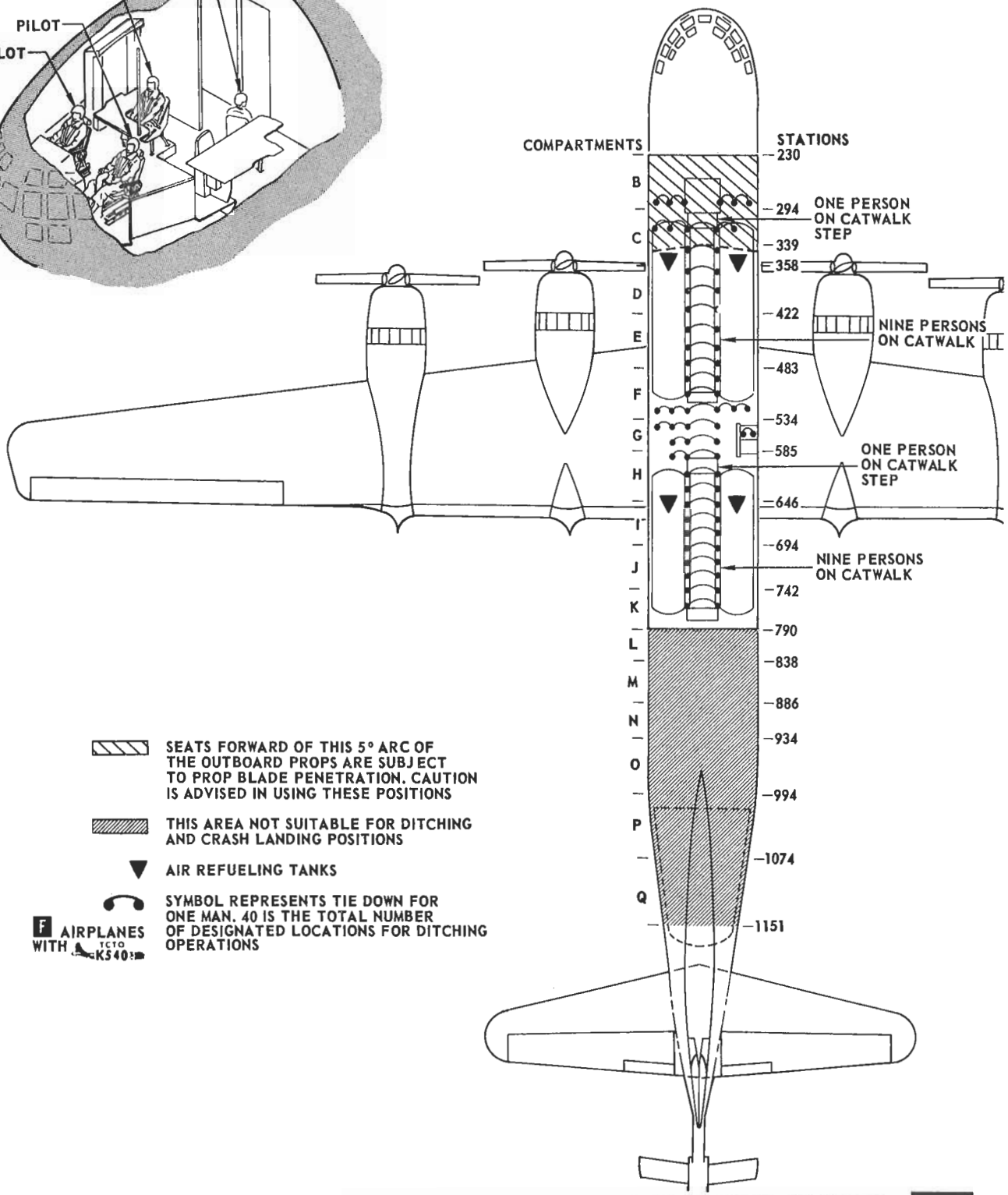
7. Cowl Flap Switches - OPEN (2 inches)

PILOTS	ENGINEER
(13.) Set Wing Flaps - Set (55%) (P, CP) Direct copilot to extend wing flaps to 55%	
14. ADI ON - ON (CP)	
(15.) Wing Flaps Full DOWN - Full DOWN on final approach (P, CP) Direct copilot to extend flaps full down.	8. Boost Pump Switches - OFF
(16.) Landing Lights ON - ON (if required) (P, CP)	
(17.) Warn Personnel - Warned (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.	
18. Land as Slow as Possible: (P)	9. Simultaneously:
(a.) Close Throttles - Closed (P, E)	(a.) Mixtures and Ignition Switches - FUEL CUT-OFF and OFF (E, P) Move mixture levers to FUEL CUTOFF, turn ignition switches OFF when pilot closes throttles.
(b.) Electrical Master Switch OFF - OFF (at ground contact) (P, E) Direct engineer to turn electrical master switch OFF just as ground contact is made.	(b.) Electrical Master Switch - OFF (when directed) (E, P)

LANDING WITH LESS THAN 55% OF WING FLAPS

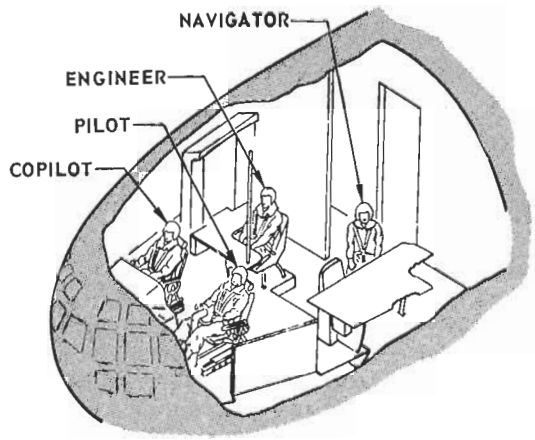
When a landing is made with less than 55 percent flap, approach speed should be maintained at least 35 knots above the flaps up power-off stalling speed. The airplane should be flown so that the flare-out is made close to the ground. The amount of flare-out required will be less than that needed for 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 flare-out 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. Caution must be observed if this type of landing is practiced for pilot check-out and also during conditions of high gross weights, unsymmetrical power, high altitude fields, etc.

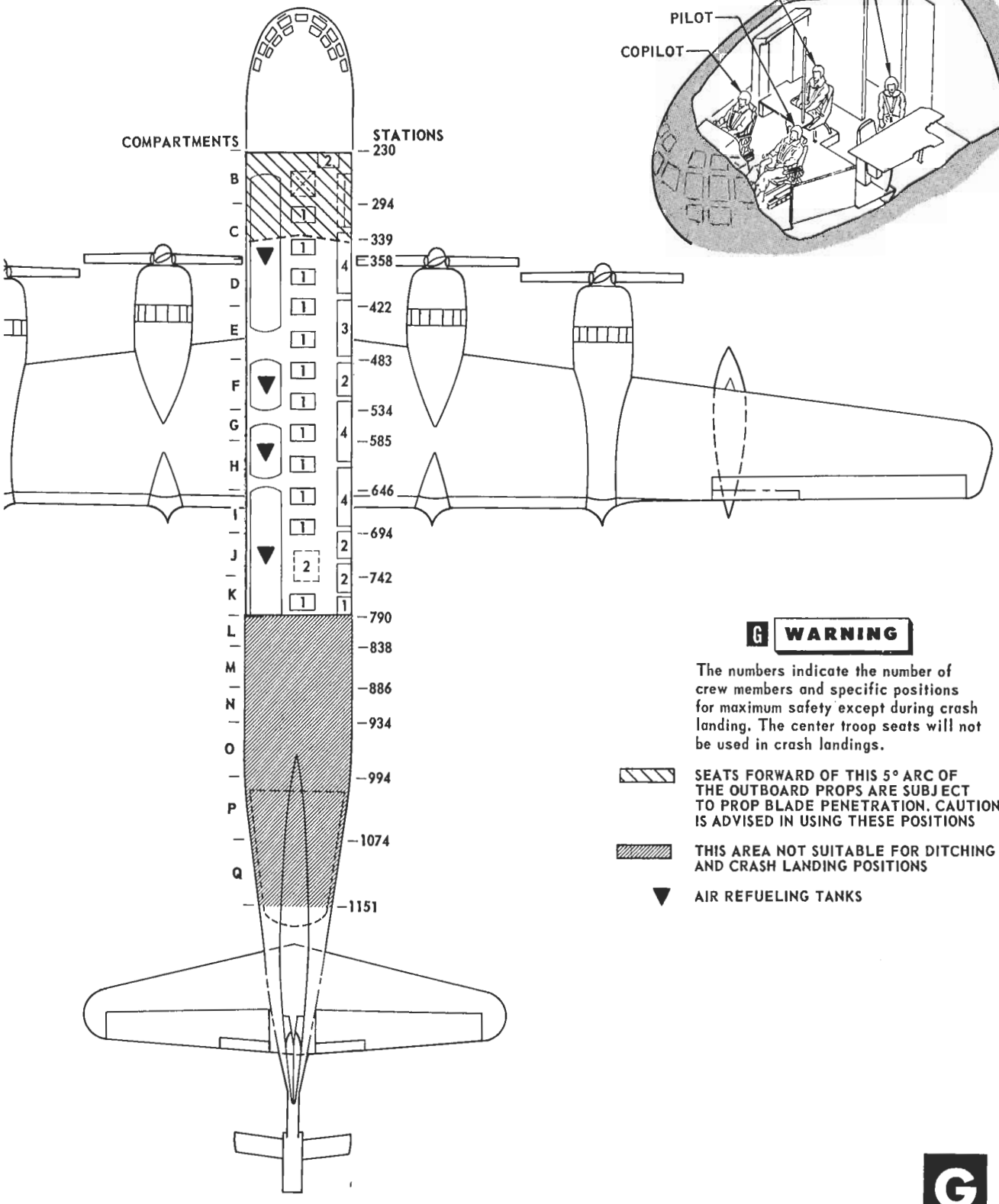




DITCHING AND CRASH LANDING POSITIONS F

Figure 3-5 (Sheet 1 of 2)





G WARNING

The numbers indicate the number of crew members and specific positions for maximum safety except during crash landing. The center troop seats will not be used in crash landings.

SEATS FORWARD OF THIS 5° ARC OF THE OUTBOARD PROPS ARE SUBJECT TO PROP BLADE PENETRATION. CAUTION IS ADVISED IN USING THESE POSITIONS

THIS AREA NOT SUITABLE FOR DITCHING AND CRASH LANDING POSITIONS

▼ AIR REFUELING TANKS

G

Figure 3-5 (Sheet 2 of 2)

LANDING WITHOUT BRAKES

Prior to landing, the pilot will direct an aft compartment crew member to open or remove the floor hatches and unlock the aft entrance door safety pin. Land with wing flaps full down and make contact with the main gear first. Ease the nosewheel onto the runway as rapidly as possible. After nosewheel makes contact, move symetrical throttles to REVERSE. The amount of reverse thrust required will depend on runway available. For stopping distances utilizing reverse thrust, see figures 1A7-1 through 1A7-3. 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 nosewheel steering is completely inoperative, directional control must be maintained by use of differential throttling, particularly at speeds below 50 knots.

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. For COLD WEATHER PROCEDURES, see Section IX.

When time permits, careful consideration should be given to runway length, width, slope, climatic conditions and available towing facilities.

CAUTION

After airplane is stopped, cut engines and utilize towing facilities. If towing facilities are not available and taxiing is absolutely necessary, follow EMERGENCY TAXIING INSTRUCTIONS, this Section.

LANDING WITH FLAT TIRE

Nose Gear Tire Flat

With one or both wheel tires flat, relocate movable equipment and cargo to move the cg to the aft limit. Crew assume crash landing stations. Make a normal approach and landing. After touchdown hold the nose wheel off 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 tire 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 throttles, brakes on the good tire side and nose wheel steering to maintain a straight landing roll. Do not attempt to taxi.

EMERGENCY TAXIING INSTRUCTIONS

If, while taxiing, the hydraulic system and emergency brakes fail, the hydraulic pressure cannot be raised with the hand pump and towing facilities are not available, use prop 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 on airplanes G 2843 ▶ plus those incorporating TCTO 224 ◀, 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. To provide governed forward speed of the airplane, increase the speed of the outboard engines to overcome the action of the reverse thrust 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 prop to normal pitch.

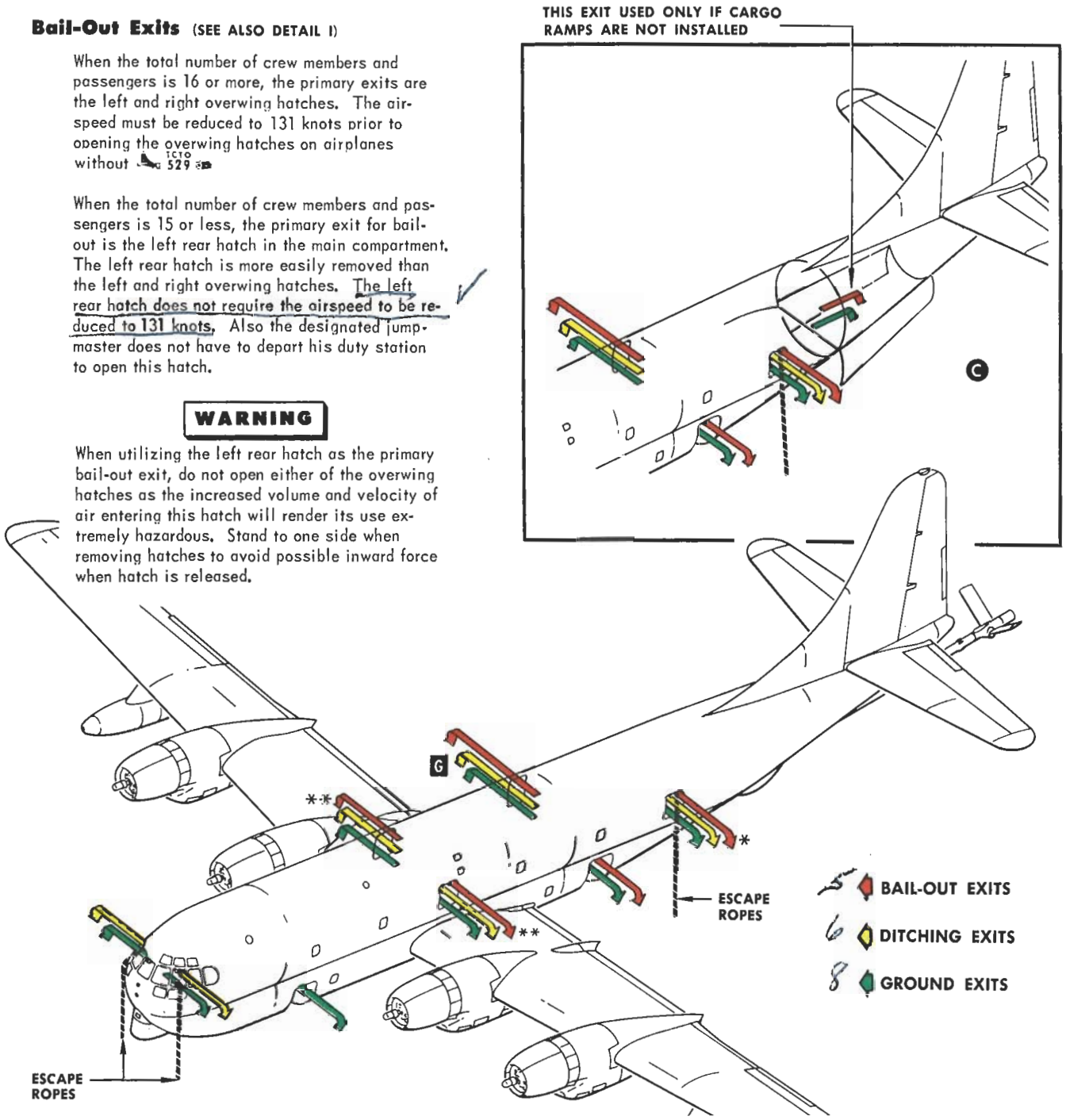
Bail-Out Exits (SEE ALSO DETAIL I)

When the total number of crew members and passengers is 16 or more, the primary exits are the left and right overwing hatches. The airspeed must be reduced to 131 knots prior to opening the overwing hatches on airplanes without T.O. 1C-97-529.

When the total number of crew members and passengers is 15 or less, the primary exit for bail-out is the left rear hatch in the main compartment. The left rear hatch is more easily removed than the left and right overwing hatches. The left rear hatch does not require the airspeed to be reduced to 131 knots. Also the designated jumpmaster does not have to depart his duty station to open this hatch.

WARNING

When utilizing the left rear hatch as the primary bail-out 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.



WARNING

Stow boom before leaving the airplane in flight so that personnel will be less likely to hit it during bail-out.

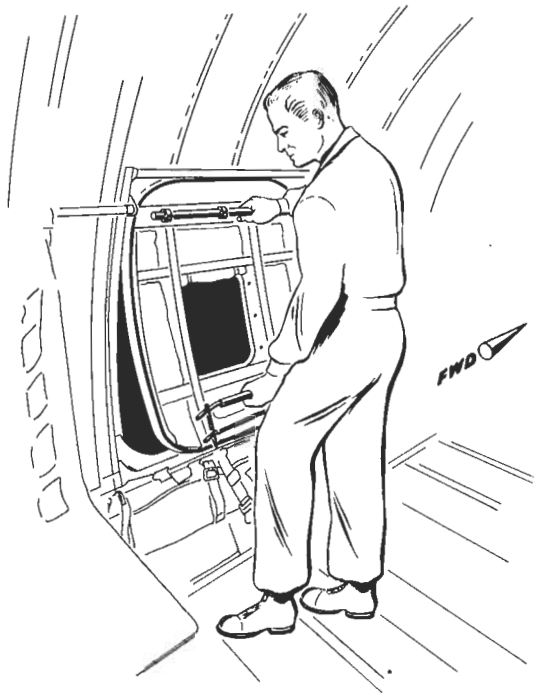
3 (* The bail-out sequence is: All passengers, navigator, radio operator, engineer, copilot, boom operator and pilot

** One half of all passengers, engineer and copilot use right hatch. Remainder of passengers and flight crew use left hatch.)

EMERGENCY EXITS

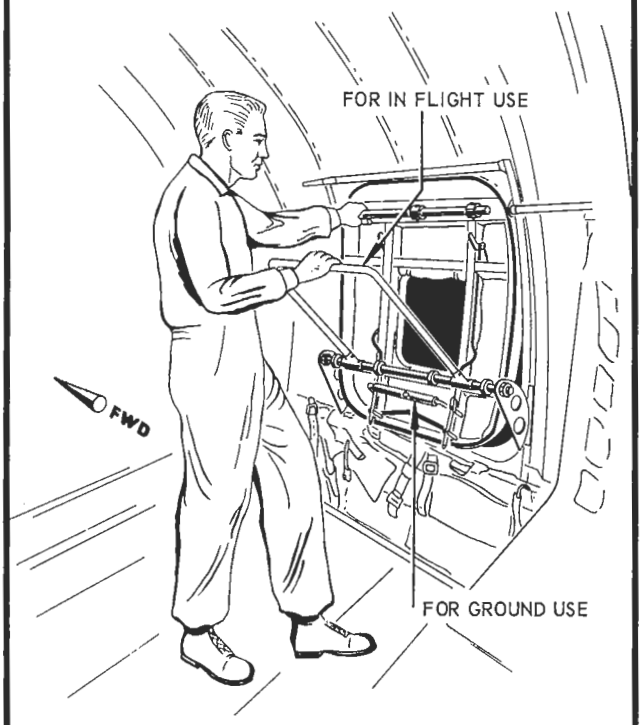
Figure 3-6 (Sheet 1 of 3)

LEFT OVERWING EMERGENCY EXIT HATCH

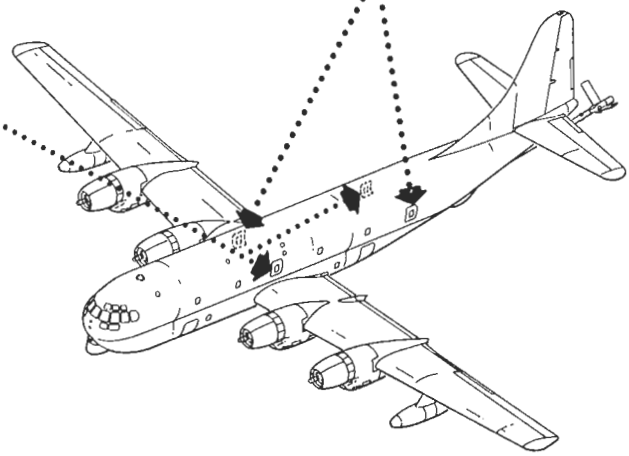


HATCHES NOT INCORPORATING TCTO 529 ON AIRPLANES
F G 1243 ▶ 3195

RIGHT OVERWING EMERGENCY EXIT HATCH



HATCHES INCORPORATING TCTO 529 ON AIRPLANES
F G 1243 ▶ 3195



TO OPEN LEFT OVERWING HATCH INFLIGHT OR ON THE GROUND (FOR HATCHES NOT INCORPORATING TCTO 529)

1. Stand at forward edge of hatch, facing the hatch
2. Grip upper bar 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 aft hatch, reverse hand holds

WARNING

Be prepared for inward force when hatch is released.

NOTE

On airplanes F, G 1243 ▶ 3195 that have both modified and unmodified hatches, always install the hatches incorporating TCTO 529 in the right overwing emergency exit and the left aft emergency exit.

DETAIL I

Figure 3-6 (Sheet 2 of 3)

TO OPEN RIGHT OVERWING OR LEFT AFT HATCH (FOR HATCHES INCORPORATING ICTO 529)

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 break safety wire and release pins. Continue a steady pull inboard and with a downward movement of release bar until pressure is releaved 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

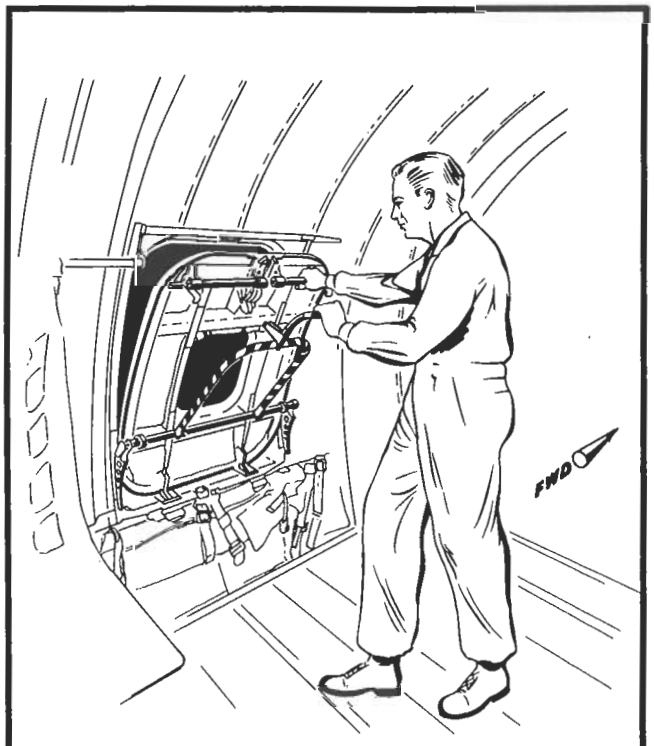
1. Use lower release bar attached to release pins by pulling up on release bar and pulling escape hatch away from frame.

WARNING

- Depressurize cabin before attempting to open emergency exits. If the airplane is not depressurized, the emergency exits can not be opened because the available leverage will not overcome cabin pressure.
- 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.

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.



EMERGENCY EXIT HATCHES INSTALLED AT ALL EMERGENCY EXITS ON AIRPLANES G 3196 ▶

TO OPEN ALL HATCHES INFLIGHT OR ON THE GROUND (ON AIRPLANES G 3196 ▶)

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 releaved from handle.
4. Step back pulling release bar completely down and remove hatch from opening.

DETAIL I (Cont)

Figure 3-6 (Sheet 3 of 3)

EMERGENCY ENTRANCE

See figure 3-7.

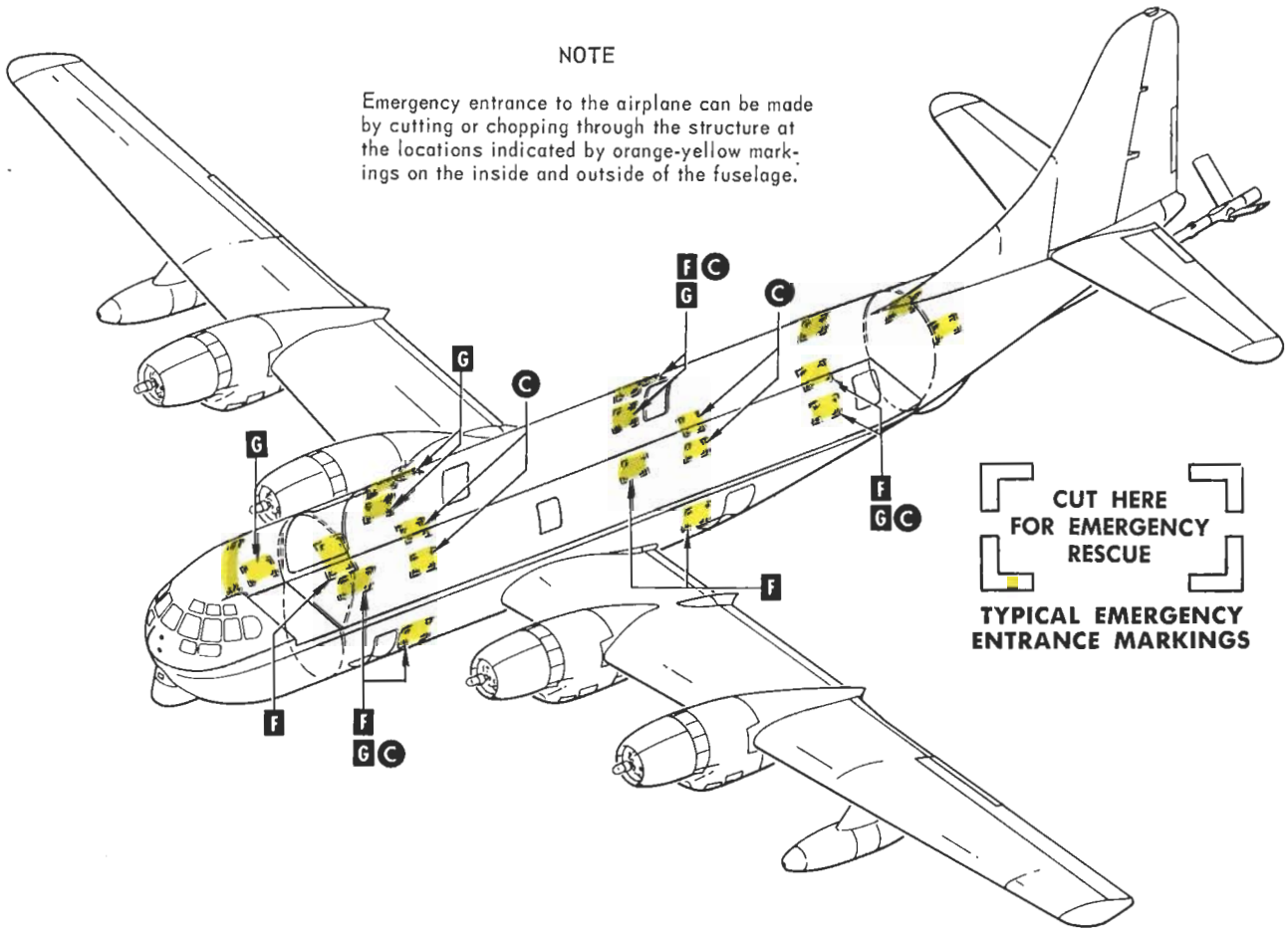
DITCHING

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 over water flight that the necessary equipment is on board and stowed in the proper places. The following list will be used as a guide:

1. Life Rafts - The number and type of rafts on board will be governed by the number of persons on board the airplane. On F airplanes incorporating ICTO K512, and G airplanes incorporating ICTO K239, there are four 20 man rafts stowed above the Air Refueling tanks in the main cabin. (See figure 3-1.)
2. Life Vests - At least one life vest will be available for each person on board. Crew members and passengers will wear life vests during all overwater takeoffs and landings and at any time the pilot deems it necessary.
3. Crash Axes
4. Dinghy Transmitters
5. Exposure Suits
6. First Aid Kits
7. Flashlights
8. Survival Kits
9. URC-4 Radios



EMERGENCY ENTRANCES

Figure 3-7

DITCHING PREPARATION

When it becomes apparent that ditching is necessary, the pilot gives alert signal on alarm bell (6 short rings) and orders the crew to prepare for ditching. A crew member notifies other personnel to prepare for ditching and assists in positioning and securing the personnel, as shown in figure 3-5. Personnel not located in the main compartment should proceed thereto immediately, and all personnel should don exposure suits if time permits. No personnel should be allowed aft of station 790. The lower compartment doors should not be opened. Open the hatches in the main compartment and stow them securely inside the airplane. Jettison all loose, unnecessary equipment and cargo. Place emergency equipment and any extra life rafts near the emergency exits that open over the wing and secure them in position. Leave the primary 20 man life raft in the stowing bracket 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 3-5, 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 insure the greatest safety during the ditching operation: Experience has shown that the best results are obtained in the ditching operation 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 is ditched along the top of a swell, parallel to the swells unless the wind is high. If the wind is high, ditch into the wind to take advantage of the lowered forward speed. Use a flap setting of 55% to give the lowest rate of descent (one hundred 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 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 props should be considered. Feathering the inboard props may lessen the possibility of prop or engine separation, upon impact, with possible resultant fuselage fracture and personnel injury. The decision to feather or not to feather the inboard props 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 power as required to give the flattest approach and the lowest possible forward speed.

b. If No. 2 and No. 4 or No. 1 and No. 3 engines are operative, considerable power may be used for control.

c. With only two engines operative on the same side of the airplane, use power on the inboard engine only.

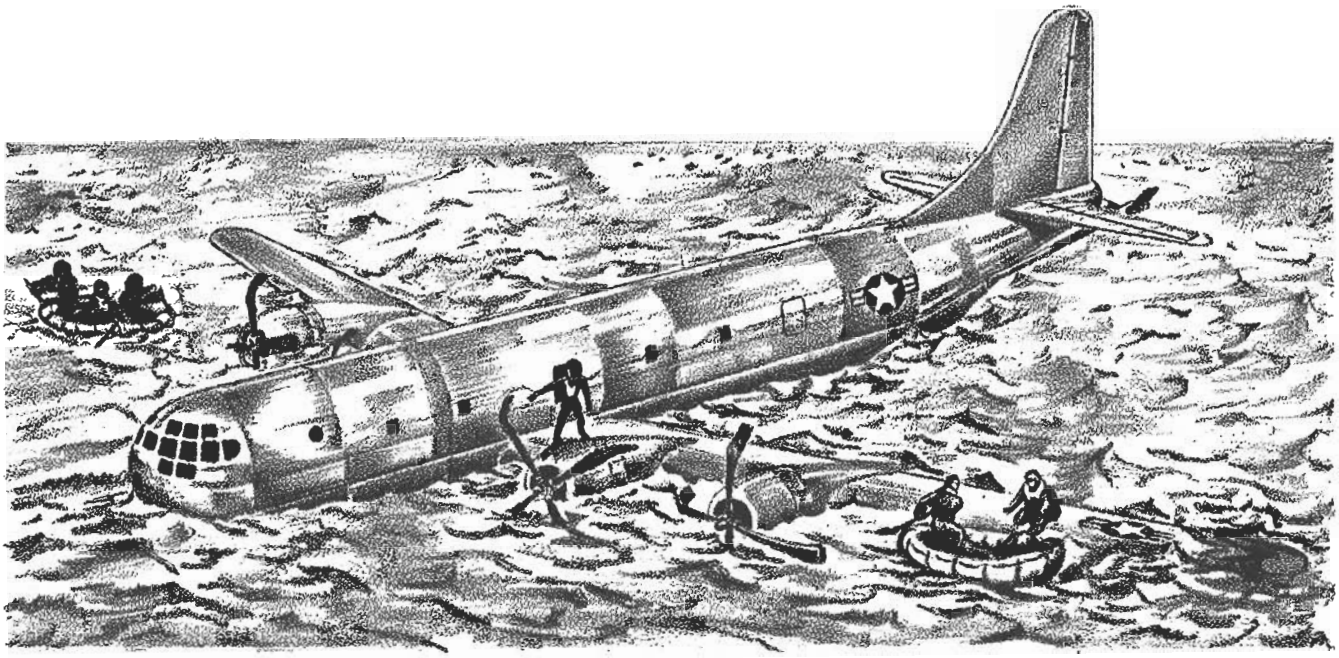
d. On let-down with power off or any engine inoperative, it is advisable to hold the speed 25 knots above stalling speed until flare-out, at which time the speed shall be reduced to just above the stalling speed as the level to 5 degrees nose high landing attitude is assumed.

Crosswind Ditching

Crab the airplane with the rudder to kill the drift. Hold the wings level. Use 55% 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 let-down, holding the airspeed to 25 knots above stalling speed. Use 55% 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% 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.



Crew Member	Duty	Provide	Position	Exit
PILOT	Alert crew to prepare for ditching, giving approximate time left. Check and don life vest, fasten shoulder harness and safety belt. Check control cabin windows closed.	Parachute, flashlight, first aid kit and URC-4 radio	Pilot's seat.	Overwing hatch Take command of No. 1 raft.
COPILOT	Jettison external fuel tanks on G airplanes, ring alarm bell, maintain contact with crew, check and don life vest, safety belt and shoulder harness. At night turn "on" all emergency lights. On G 2901 ▶ 3339 IFF to emergency.	Parachute, flashlight, first aid kit, and URC-4 radio, and dinghy radio if radio operator is not aboard	Copilot's seat.	Overwing hatch. Take command of No. 2 (if applicable).
ENGINEER	Dump fuel. Check emergency cabin pressure release valves to make certain they are closed and locked. Secure all equipment in control cabin.	Parachute, flashlight, first aid kit, water.	Engineer's seat.	Overwing hatch.

DITCHING CHART

Figure 3-8 (Sheet 1 of 2)

Crew Member	Duty	Provide	Position	Exit
NAVIGATOR	On airplanes F and G 17260 ▶ 2900, 3340 ▶ IFF to EMERGENCY. Prepare emergency position report. If radio operator not aboard, transmit report, and obtain D/F service if time permits.	Navigation kit, flashlight, flares and pyrotechnic pistol.	Navigator's seat. (If shoulder harness not installed, ditch in main compartment with boom operator). On F airplanes with TCTO K562 ▶, it is permissible to rotate seat facing aft and use for ditching.	Overwing hatch
BOOM OPERATOR T **LEFT SCANNER** C	Stow and latch boom, turn off all air refueling equipment, take charge of main compartment, close floor hatches, remove and secure emergency exit hatches, supervise and instruct passengers in ditching procedures. Jettison cargo.	Life raft, flashlight, first aid kit, dinghy radio, water.		Overwing hatch
RADIO OPERATOR F, G 17260 ▶ 2900, 3340 ▶	IFF to EMERGENCY (if applicable). Obtain emergency report from navigator and transmit. Obtain D/F service if time permits.	Parachute, flashlight, first aid kit and dinghy radio.	All crew members and passengers not assigned specific locations should take up positions in the main compartment as shown in figure 3-5.	Overwing hatch.
PASSENGERS OR ADDITIONAL CREW MEMBERS	As briefed.	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 rafts to prevent damage of the rafts by ragged edges of flaps or leading edge of wings.

NOTE

- If time permits exposure suits will be donned in accordance with the procedure outlined in Section III, Overwater Bail Out.
- With a normal crew exit the (left F ; right G) overwing hatch. Launch No. 1 raft from downwind side of wing. Secure raft lanyard prior to passing raft through escape hatch. CO_2 activation and raft inflation will occur after the first ten feet of lanyard pull, then the raft will float or extend a distance of approximately 25 feet from the point where the lanyard is secured. This will prevent raft from being blown away. 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 copilot use the right overwing hatch. Remainder of passengers and flight crew use left overwing hatch. A minimum of one crew member 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, it is recommended that ditching be made into the wind. 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

(1.) Alert Crew - Alerted (P, CP)

Alert crew by means of the interphone on CALL position. Copilot executes six short rings on the alarm bell. Advise approximate time remaining.

2. Have IFF Turned to EMERGENCY - IFF EMERGENCY (CP or N)

(3.) Position Passengers - Positioned (P, BO)

Have crew members check that all personnel in lower compartments have been moved to the main compartment and are seated with safety belts fastened.

(4.) Hatches - Check (P, RO, BO)

a. Floor Hatches - Closed

b. Overwing Emergency Exit Hatch - Open (right overwing G; left overwing F)

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 3-6.)

(5.) Jettison Tanks - Jettisoned (P or CP) G

Jettison external fuel tanks in accordance with instructions given under EXTERNAL FUEL TANK JETTISONING in this Section.

ENGINEER

PILOTS	ENGINEER
(6.) Jettison Cargo and Dump Fuel - Jettisoned and dumped (if necessary) (P, E, BO) See CARGO JETTISONING this Section.	(1.) Fuel - Dump (when directed) (E, P)
(7.) Don Exposure Suits - Donned (if time permits) (ALL) Have crew and passengers remove parachute harness and don exposure suits.	2. Cabin Pressure Relief and Release Valves - CLOSE and LOCK
	3. Control Cabin - Secure (all loose equipment)
	4. APU - OFF and ports CLOSED
	5. Body and Surface Anti-Icing Heaters - OFF
(8.) Don Life Vests - Donned (ALL) Have crew and passengers don life vests.	6. Cabin Air Selector Switches - NORMAL
(9.) Turn on Exterior Lights - On (P, CP) Turn on all exterior lights to assist in rescue.	
(10.) Set Altimeters - Set (P, CP, N) Obtain absolute altitude from navigator.	
(11.) Fasten and Lock Safety Belts and Shoulder Harness - Fastened and locked (P, CP, E) Pilot and copilot fasten safety belts and shoulder harness and lock inertia reel.	(7.) Safety Belt and Shoulder Harness - Fasten and lock (E, P) (Insure parachute harness is removed prior to fastening safety belt and shoulder harness.)
12. Order Personnel to Ditching Positions - Ordered (P) Order crew to ditching positions by means of interphone on CALL position. Crew members will fasten safety belts, shoulder harnesses, and lock inertia reel (if applicable).	
(13.) Set Wing Flaps - Set (P, CP) Direct copilot to extend flaps as desired. 55% 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.	
14. Maintain Lowest Rate of Descent - Maintained (P) 100 feet per minute is recommended.	
15. Maintain Speed Above Stall - Maintained (25 knots above stall) (P) Maintain 25 knots above stall until flare-out.	

DITCHING PROCEDURE (Cont)

PILOTS	ENGINEER
(16) Landing Lights Extended and On - Extended and ON (if required) (P, CP)	
(17) Warn Personnel - Warned (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.	
18. Flare-Out Just Above Water - Flare-out (P) 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.	
19. Hold Wings Level - Level (P) Hold the wings level to avoid digging a wing into the sea and cart-wheeling the airplane.	
20. After Impact - Proceed to emergency exit (P, CP) Provide required equipment. After airplane comes to a stop, open as many emergency exit hatches as necessary to evacuate the airplane.	8. 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.

EMERGENCY JETTISONING

EXTERNAL FUEL TANK JETTISONING G

Move the external fuel tanks release switch to the EXTERNAL TANK RELEASE position.

NOTE

- The emergency bus does not supply power to the external fuel tanks release switch.

WARNING

- The external fuel tanks are unstable when less than half full and may strike the wing surfaces, especially if the wing flaps are extended.
- The external tanks can be jettisoned only with normal electrical power.

In the event that the external fuel tanks must be jettisoned when less than half full, and time permits, check the wing flaps fully retracted and stabilize the airspeed within the ranges quoted before jettisoning tanks.

WEIGHT	AIRSPEED (IAS)
120,000 lb	185-200 knots
140,000 lb	195-215 knots
160,000 lb	215-230 knots

FUEL DUMPING

Fuel dumping may be accomplished by pressure and on G airplanes 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 G 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 hand pump 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 G 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. Fuel Dumping Complete:
   a. Isodraulic Handle - Retard (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 (ZERO)**
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 pm may be expected. With one outboard engine inoperative, 60 percent of the above figure should be realized. OR 3600 PPM

Gravity Fuel Dumping G

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

When cargo jettisoning becomes necessary, consideration should be given to all the factors involved so as not to compound the emergency. The cabin should be depressurized before any of the hatches are opened, using the emergency cabin pressure release handle located on the engine control stand. Oxygen masks should be worn at all times if at an altitude requiring the use of oxygen equipment. The boom operator should check the boom stowed and latched to prevent possible damage by jettisoned cargo. The external fuel tanks should be jettisoned, but only after checking the wing flaps fully retracted. If possible, the airspeed should be reduced to 131 knots IAS and the wing flaps lowered to 55 percent to attain a tail high attitude, in order to prevent possible damage to the horizontal stabilizer by jettisoned cargo.

NOTE

The cargo hoist may be used if necessary to move cargo, but only if there are no fuel fumes present.

On the tanker configuration the rear cabin escape hatches are generally considered the best jettisoning exits.

WARNING

- When using the rear cabin escape hatches, the overwing hatches should not be opened as the volume and velocity of air entering these hatches will make their use hazardous. If for any reason the overwing hatches on airplanes not incorporating TCTO 529 are used, the airspeed should be reduced to 131 knots IAS prior to opening.
- On cargo configuration, with or without the aerial delivery installation, the rear cargo door should be considered the primary jettisoning exit. Only in extreme emergencies should the forward cargo doors be used. In jettisoning cargo, care should be taken that it is jettisoned in such an order that the c.g. limits are not exceeded.

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. On airplanes G 3196, plus F, G incorporating TCTO 338, an overboost may be indicated by an increase of several inches 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. **IMMEDIATELY AND SIMULTANEOUSLY:**

   a. **RETARD THROTTLE (AFFECTED ENGINE)**

   NOTE

   A sudden closing of the throttles when above 2300 bhp may cause backfire which may damage the induction system.

   b. **MOVE TURBO OVERRIDE SWITCH TO OPEN, GUARD DOWN (AFFECTED TURBO)**

   NOTE

   In order that this procedure be effective, the manual override switches should have been positioned to OPEN (guards down) when the turbo switches were positioned to AUTO and remain OPEN (guards down).

   c. **MOVE TURBO SWITCH TO MAN (AFFECTED TURBO)**

   NOTE

   - This action will transfer control of the wastegate to the manual override switch and cause the wastegate to be driven to the full open position.
   - Do not disturb the TBS lever setting.

2. Turbo Amplifier Fuse - Have checked

   a. If Blown - Replace

   b. Amplifier (If Fuse Not Blown) - Replace

3. Amplifier - Warm up

   Warm for at least one minute

4. Turbo to Automatic Control - Return

Return to automatic per the procedure MANUAL TO AUTOMATIC CONTROL, ONE OR MORE TURBOS in Section VII.

5. Malfunction still indicated:

   a. Perform Step 1 again

6. Manual Control - Use (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 see 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 in Section VII. If the automatic control system still does not operate properly, control all the turbosuperchargers per procedure AUTOMATIC TO MANUAL CONTROL in 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 in Section VII. If the automatic control system still does not operate properly, control all the turbos per procedure AUTOMATIC TO MANUAL CONTROL in 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 - Turbo oil leakage
2. At the Pilot's Discretion Either (For The Affected Engine):
   a. Wastegate - Open
   b. Prop - Feather

Turbine Wheel Bearing Failure

The most probable cause of turbine wheel bearing failure is faulty lubrication. The most positive indication of bearing failure and pending turbo failure is a drop in manifold pressure. 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 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 Override Switches - OPEN (guard down)
4. At Pilot's Discretion - Shut down engine

   Engine shutdown is recommended if power requirement is not critical.

OIL SYSTEM

See figure 3-9.

CAUTION

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.

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. CWT Secondary Valve - OPEN (manually) F G 1255 ▶

   If fuel is to be transferred into this tank.
5. Fuel Quantity Gages - Monitor
6. Leaking Tank Nearly Empty: F G 1255 ▶

   a. CWT Secondary Valve - CLOSE
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 would damage pumps.

8. Fuel Management - As required

Fuel Line Failure, Airplane Main Fuel Manifold

ENGINEER (Only)

1. **MOVE ALL FUEL SELECTOR SWITCHES TO TE**
2. **MOVE MAIN WING TANK FUEL BOOST PUMP SWITCHES TO NORMAL (ONE EACH TANK)**

(3.) Line Check - Conduct (if required) (E, P)

Coordinate with pilot if a fuel manifold line check is desired.

To Check A Suspected Leak In The Airplane Fuel System

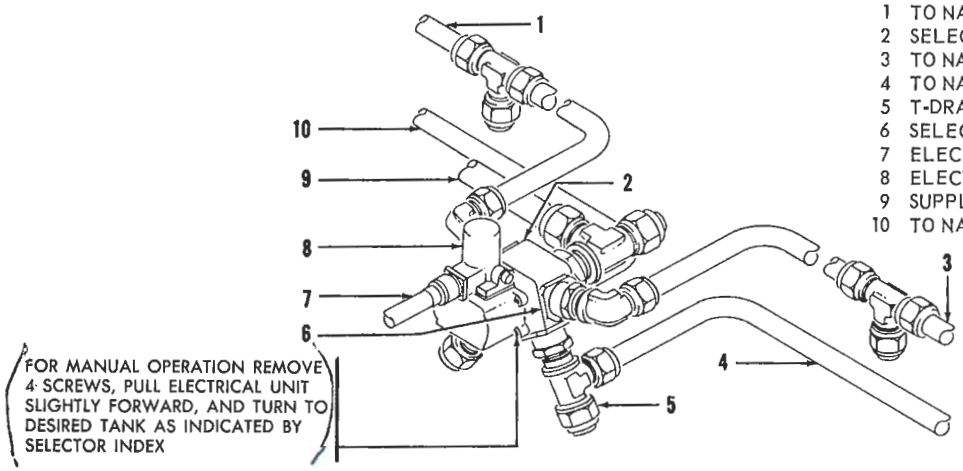
The following are inflight procedures to check for a possible leak in the engine fuel system. Check all applicable lines, valves, switches, circuit breakers, and nacelles visually if possible.

Between The Fuel Selector Valve And The Engine

1. Shut-down affected engine per procedure ENGINE FIRE DURING FLIGHT in this Section.
2. Turn fuel tank selector switch to TE.
3. Turn boost pump switch to NORMAL.
4. When fuel pressure stabilizes turn boost pump switch to EMERGENCY.
5. When fuel pressure stabilizes again turn fuel selector switch to OFF.
6. Turn boost pump switch to OFF.

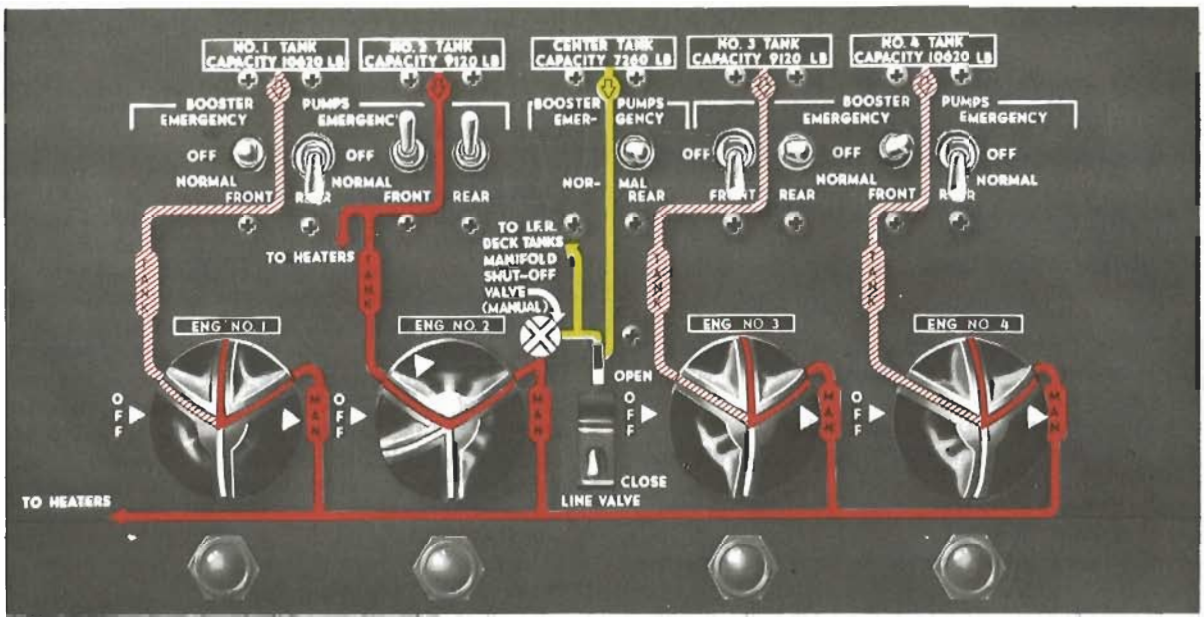
If pressure due to trapped fuel remains constant or drops slowly, no fuel leaks are indicated and the engine can be restarted by the procedure for RESTARTING ENGINE IN FLIGHT in this Section. Monitor the engine for erratic operation. Reduce power if necessary, or turn fuel boost pump on EMERGENCY. If there is an indication of a fuel leak: (noted by a rapid or immediate drop in fuel pressure)

1. Move fire gang bar switches to FIRE.
2. Maintain a watch for fire, fuel fumes or visual indication of fuel leakage, if possible.



MANUAL OPERATION OF THE CENTRAL OIL SYSTEM SELECTOR VALVE

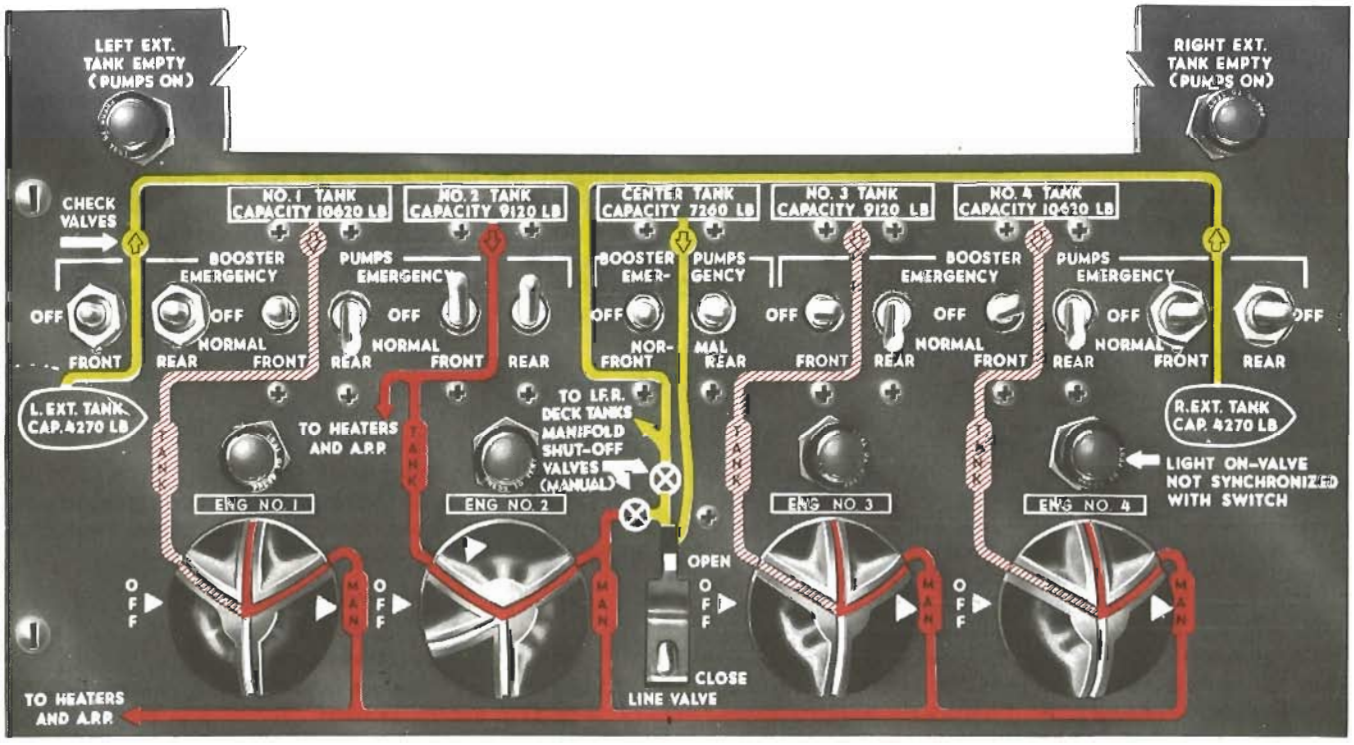
Figure 3-9



F AIRPLANES

EMERGENCY EMPTYING OF NO. 2 TANK WITH NO. 2 ENGINE SHUT DOWN

PRIMARY FLOW SECONDARY FLOW NO FLOW



G AIRPLANES

EMERGENCY EMPTYING OF NO. 2 TANK WITH NO. 2 ENGINE SHUT-DOWN

FUEL SYSTEM EMERGENCY OPERATION

Figure 3-10

In The Fuel Manifold

To check a suspected leak in the fuel manifold:
1. Turn all engine fuel selector switches to TE.
2. Stop one engine with mixture lever and feather prop.
3. Turn boost pump switches for that engine to NORMAL.
4. When pressure stabilizes turn these boost pump switches to EMERGENCY.
5. When pressure stabilizes again turn fuel selector switch OFF.
6. Turn these boost pump switches OFF.
7. Observe the fuel pressure for about 10 seconds. If the fuel pressure remains constant or drops slowly continue this procedure.
8. Turn the fuel selector switch to TME.
9. Again turn boost pump switches for the stopped engine to NORMAL.
10. When pressure stabilizes turn these boost pump switches to EMERGENCY.
11. When pressure stabilizes again, turn fuel selector switch to ME.
12. Turn these boost pump switches to OFF.
13. Observe fuel pressure indicator (should the pressure drop slowly, although somewhat faster than in Step 7, no leaks are indicated).
14. Restore engine to operation per the procedure RESTARTING ENGINE IN FLIGHT in this Section.

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 hand pump to maintain service brake pressure. If necessary, on airplanes F 1243 ▶ 1374, the emergency brake system may be recharged by the hydraulic hand pump by placing the controllable hydraulic check valve handle on the copilot's auxiliary panel in the GROUND TEST POSITION. On airplanes F 1375 ▶, the emergency brake system may be recharged from main system pressure by moving the depressurization and emergency charging valve handle to the EMERGENCY BRAKE CHARGING position. On G airplanes the emergency brake system may be recharged from main system or service brake system pressure, whichever is higher.

Line Rupture

On F 1243 ▶ 1374, in the event of main system line rupture with the system pressurized, move the depressurization handle to the DEPRESSURIZED POSITION. On airplanes F, G 1375 ▶, move the depressurization and emergency charging handle to the DEPRESSURIZED POSITION. On all airplanes, 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 hand pump.

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 botton 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 three full applications of the emergency brakes are available, on airplanes incorporating TCTO 571 ▶, 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 the emergency wing flap switch on the overhead panel to raise or lower the flaps to the desired position as indicated on wing flap position indicator.

CAUTION

Limit switches are not actuated when emergency wing flap switch is used. 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. Milk the flaps the last 10 percent (coordinate with assigned scanner), and return switch to OFF position after the stops are contacted.

ALTERNATING CURRENT FAILURES

Essential inverter power failure will affect the following:

1. A/R Fuel Pressure Gages
2. APN-69 plus TCTO K211 (Emergency)
3. Autopilot Repeater Indicator
4. Cabin Air Flow Indicator
5. Combustion Heater Ignition
6. Cowl Flap Position Indicators
7. Driftmeter F G 17260 ▶ 22628 less TCTO K235
8. Fuel Flowmeters
9. Fuel Pressure Gages
10. Fuel Quantity Gages
11. Glide slope indicator
12. High Range Radio Altimeter
13. Hydraulic Pressure Gages G 2894 ▶
14. Instrument Transformer
15. Intercooler Flap Position Indicators
16. Loran Receiver
17. Nesa Window Heat Control G 2826 ▶
18. Oil Pressure Gages
19. Radio Magnetic Indicator (RMI)
20. Torquemeters
21. Turbosupercharger Control

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 G 17260 ▶ 3267
4. Anti-Collision Lights Rotation Motors plus TCTO 591
5. IFF Transmitter
6. Ignition Analyzer
7. Radar Equipment
   a. APN-12
   b. APN-76 less TCTO K572
   c. APS-42

Inverter failure indications and emergency action. . . . . . If the essential inverter fails, an automatic change-over 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, an automatic change-over 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 change-over relay fails, place the corresponding inverter switch in the SPARE INV position. Wait three seconds at OFF before switching to SPARE INV. If two main inverters fail, at least one bus is de-energized. The corresponding power failure red warning light remains illuminated.

Alternator failure will affect the following:

1. APN-69 plus TCTO K211
2. Nesa Glass

Emergency action. . . . . If an alternator fails, the amber 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

NOTE

An alternator failure may be due to a faulty exciter regulator circuit. If an alternator fails, the exciter regulator should be disconnected by removing the "A" lead from the terminal strip on the exciter regulator.

WHEN APN-69 EMERG. IS USED, LORAN – RADIO ALT. & 115 V. TEST OUTLET INOP.

ELECTRICAL SYSTEM EMERGENCY OPERATION

Figure 3-11 (Sheet 1 of 4)

ALTERNATING CURRENT FAILURES (CONT)

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

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.

Flight instrument inverter power failure will affect the following:

1. Pilot's Attitude Indicator
2. Pilot's Directional Indicator

Failure indications and emergency action. . . . . . If the normal flight instrument inverter fails, the instrument inverter red light will flash on; an automatic change-over relay starts the spare instrument inverter. The instrument inverter amber warning light goes on as the red light goes out. If the instrument inverter change-over relay fails, place the flight instrument inverter switch in the SPARE INV position. If both instrument inverters fail the pilot's directional 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 d-c 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 G 22629 ▶ and F G with TCTO K235
6. Master Direction Indicator
7. N-1 Compass

DC ELECTRICAL 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

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 G 2930 ▶ and F G with TCTO 239
6. Flight Instrument Spare Inverter
7. Generator Field Reset G 2930 ▶ and F G with TCTO 239
8. IFF Radio Destructors
9. Landing Flare Release
10. Pilot's Turn and Slip Indicator
11. Single Point Ground Refueling F, G 1255 ▶
12. Pilot's Pitot Heat Emergency Power G 3142 ▶ plus TCTO 292

ELECTRICAL SYSTEM EMERGENCY OPERATION (CONT)

Figure 3-11 (Sheet 2 of 4)

DC ELECTRICAL SYSTEM EMERGENCY OPERATION (Cont)

Generator Failure

❶ 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 two to three 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.

❷ 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. Trouble shoot system as required.

Three generator Operation. . . . . Three generators will supply enough power to operate all the d-c equipment including inverters under normal conditions. See DC ELECTRICAL LOADS chart in Section VII. As a precautionary measure the loadmeters should be checked frequently, especially when propeller deicers are operating.

Two generator Operation. . . . Operation with two generators will require more care, but under most conditions sufficient d-c power is available. With propeller deicers operating, the auxiliary power plant must be started; all non essential d-c equipment and the secondary inverter should be turned off. During landing, prior to extending the wing flaps or landing gear, the propeller deicers should be turned off. Do not extend or retract gear and wing flaps at the same time. Complete the operation of one system prior to operating the next system. Monitor d-c loadmeters continually. 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 d-c system fault or short circuit causing progressive overloading. In event of this, proceed as follows:

❶ Turn electrical master switch OFF. Turn off all inverters and all d-c equipment. Do not move engine controls except throttles and mixture controls. Mixtures should be set to AUTO RICH.

❷ 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.

❸ Place pilot's instrument inverter emergency power switch to BATTERY to operate spare instrument inverter, pilot's turn and slip indicator and on airplanes G 2930 ▶ plus F and G airplanes incorporating TCTO 239, the emergency lights.

❹ In the lower forward compartment manually reset generator field control relays that are easily accessible by means of the push button on each relay box. The remaining relays can then be reset electrically. On code G 2930 ▶ airplanes all relays can be reset electrically. Do not move generator switches to ON. Check all generator voltages with voltmeter.

❺ Turn electrical master switch ON. 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 d-c bus system. Be alert for sudden changes in engine operation as the control circuits are re-energized.

❻ 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 deicers on landing. 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. . . . ❶ One operative generator per engine or not less than five operative engine-driven generators total. (Any one generator on any one engine may be padded.)

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	OFF	ZERO	ABOVE NORMAL	ZERO	NORMAL	Internal generator failure	Move generator switch to OFF, no other action posible 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 removing the voltage regulator), 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 remove the voltage regulator. Leave generator switch OFF until the cause of the failure has been determined and corrected.
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 d-c 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.

ELECTRICAL SYSTEM EMERGENCY OPERATION (CONT)

Figure 3-11 (Sheet 4 of 4)

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.

Main Landing Gear Operation With Aux Flap Motor

NOTE

Aircrew member in lower aft compartment 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 the emergency wing flap control circuit breaker.

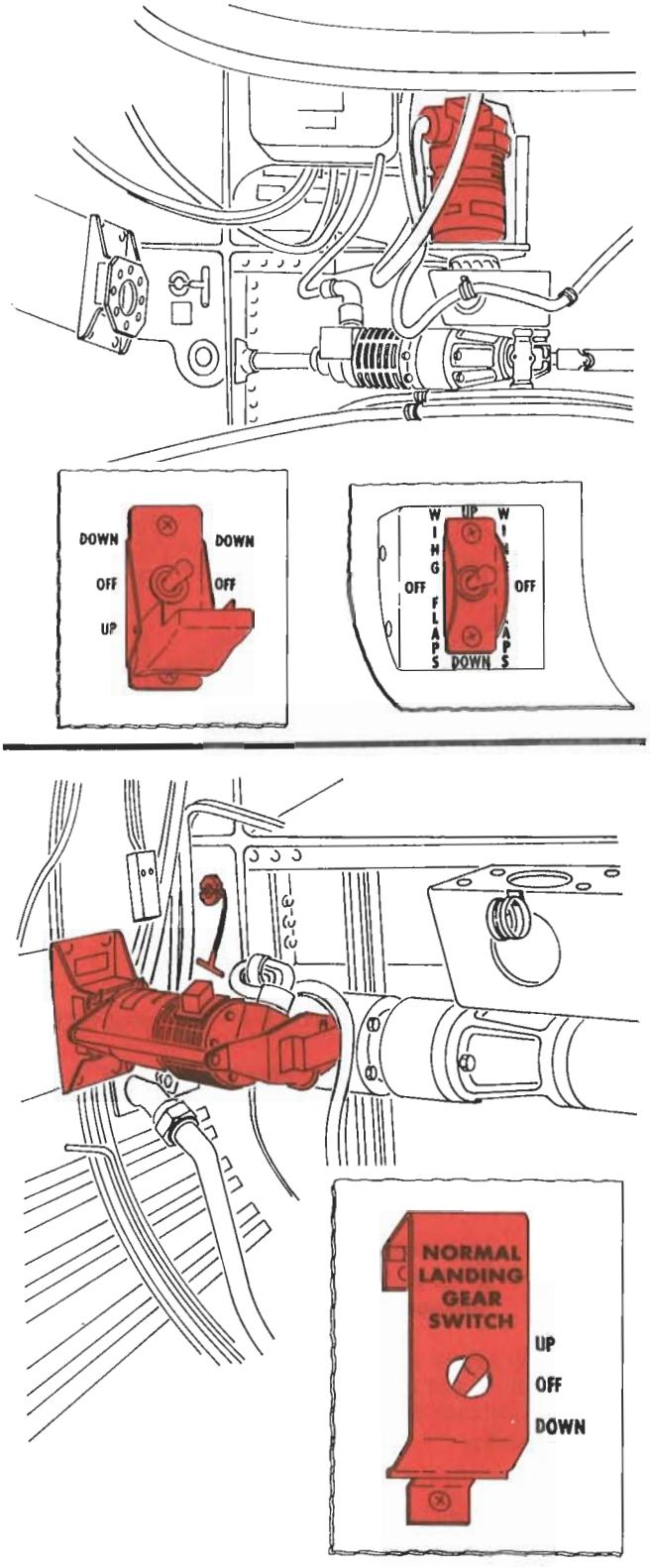
WARNING

The control circuit breaker for the portable auxiliary flap motor, located on the main dc circuit breaker panel, must be pulled whenever 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 the red handle, near each emergency landing gear hand crank receptacle out 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 the switch on the motor in the direction indicated on the switch cover.
5. Run the motor until the landing gear stops are hit and the motor clutch starts slipping (approximately 60 seconds required).
6. Always release the clutch handle immediately after emergency operation is complete; return portable auxiliary flap motor to normal stowed position for emergency wing flap operation.

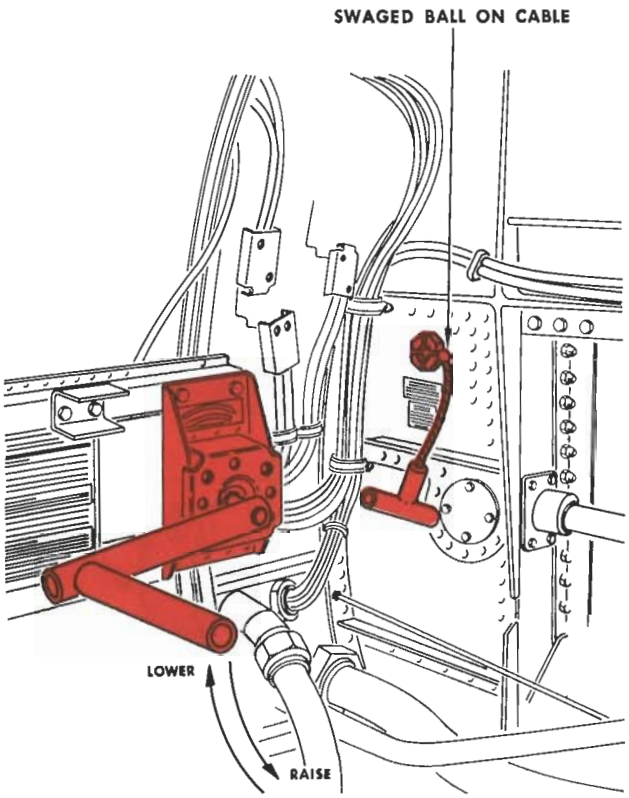
Manual Gear Lowering—Main Gear (All Crew Members)

1. Establish Interphone Contact - Established



USING THE AUXILIARY FLAP MOTOR

Figure 3-12



MANUAL OPERATION OF THE MAIN LANDING GEAR

Figure 3-13

2. Check Landing Gear Switch OFF - Checked OFF

   Have copilot check landing gear switch OFF

3. Pull Control Circuit Breaker - Pulled

   Have engineer pull applicable control circuit breaker.

CAUTION

When presence of ice is suspected, turn emergency hand crank 3 turns in both extend and retract directions prior to pulling red T-handle.

4. Pull Red T-Handle Out and Seat Swaged Ball - Pulled and seated

   Seat swaged ball in slot to disengage motor clutch and to engage manual clutch

5. Insert Emergency Hand Crank - Inserted

6. Rotate Ten Turns in Down Direction - Rotated

7. Snap Red T-Handle Forward - Snapped forward

8. Oscillate Emergency Hand Crank Rapidly - Oscillated

   a. Allow Free Fall (5 seconds)

   Rapidly oscillate emergency hand crank to free manual clutch; gear will lower by gravity after clutch is disengaged

CAUTION

After manual clutch is released do not attempt to re-engage manual clutch or operate gear for five 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.

9. Pull Red T-Handle Out and Seat Swaged Ball - Pulled and seated

   This will re-engage the manual clutch

10. Rotate Emergency Hand Crank in Down Direction - Rotated

    Rotate until stops are hit and the lock is engaged

11. Check for Safe Indication - Checked

    Check with pilot for safe indication.

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 hand crank may be lashed down with the A-1 web tie-down strap to minimize gear collapse during landing roll. This may be accomplished as follows:

  (a) Leave red "T" handle pulled and the swaged ball seated in the slot.

  (b) Anchor the A-1 tie-down strap to the airframe and the emergency hand crank so that tension will be applied in the gear lowered direction. Do not anchor to fluid lines.

  (c) Leave the hand crank anchored and the swaged ball seated in the slot until after landing and until the ground locks are installed or jacks placed under the wing.

  (d) After gear has been locked down, the hand crank torque tubes to the landing gear actuator should be inspected for twists or buckles.

12. Reset Red T-Handle and Oscillate Emergency Hand Crank - Reset and oscillated

    Always reset the red handle and oscillate emergency hand crank after emergency operation is completed to allow electrical operation of the landing gear

13. Stow Emergency Hand Crank - Stowed

14. Reset Control Circuit Breaker - Reset

15. Gear Switch DOWN - DOWN

    Cover in place

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 the red handle to engage the manual clutch.

3. Insert the emergency hand crank and rotate it in the direction indicated until the stops are contacted and the lock is engaged (490 turns are required).

CAUTION

- Always reset the red handle and oscillate emergency hand crank after emergency operation is completed to allow electrical operation of the landing gear.
- When presence of ice is suspected, turn emergency hand crank 3 turns in both extend and retract directions prior to pulling red T-handle.

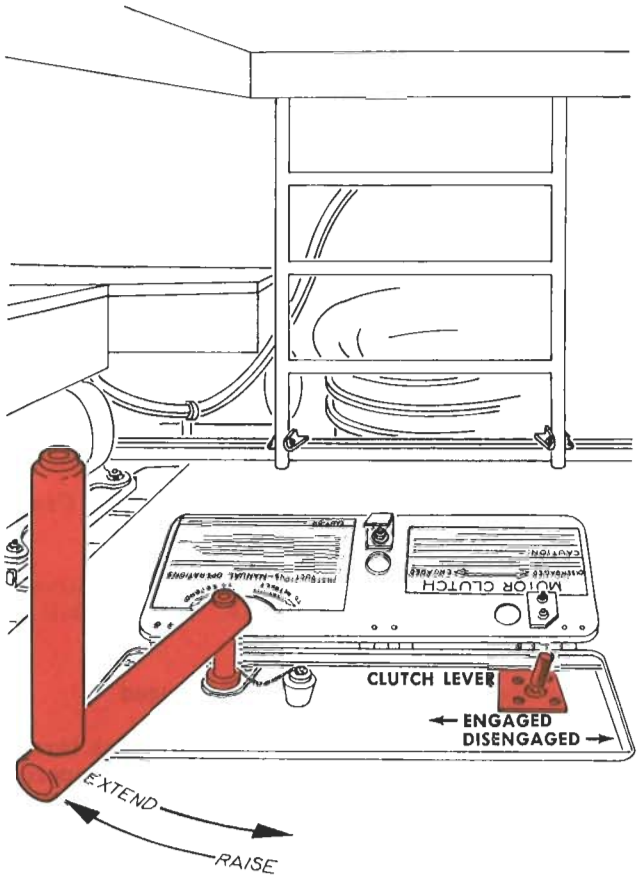
NOTE

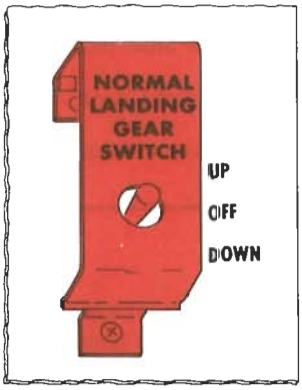
Aircrew member in lower aft compartment will establish interphone contact with the pilot before initiating manual gear operation.

Manual Gear Lowering—Nose Gear (All Crew Members)

1. Check Landing Gear Switch Off - Checked OFF

   Have copilot check landing gear switch OFF





LANDING GEAR SWITCH OFF DURING MANUAL OPERATION

MANUAL OPERATION OF THE NOSE GEAR

Figure 3-14

2. Pull Control Circuit Breaker - Pulled

   Have engineer pull the nose gear control circuit breaker.

3. Disengage Motor Clutch - Disengaged

4. Remove Rubber Plug - Removed

5. Engage Emergency Hand Crank - Engaged

   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 - Rotated

7. Remove Emergency Hand Crank - Removed

   a. Allow Free Fall (5 Seconds)

8. Re-engage and Rotate Emergency Hand Crank - Re-engaged and rotated

   Re-engage the crank and rotate in down direction until the gear hits the stops. The lock will then set with a perceptible snap.

9. Re-engage Motor Clutch - Re-engaged

   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 for Safe Indication - Checked

    Check with pilot for safe indication

11. Stow Emergency Hand Crank - Stowed

12. Replace Rubber Plug - Replaced

13. Reset Control Circuit Breaker - Reset

    Have engineer reset nose gear control circuit breaker

14. Gear Switch DOWN - DOWN

    Cover in place

Manual Raising of Nose Gear

CAUTION

If normal gear retraction system fails, the gear will not be manually retracted unless a gear down condition is unsafe.

1. Landing gear switch OFF.

2. Pull the nose gear control circuit breaker.

3. Disengage the motor clutch.

4. Remove the rubber plug from the socket and engage the emergency hand crank through the two keyed sections by pressing down on the crank hub for the first full turn.

5. Crank the gear up; approximately 220 turns of the emergency hand crank are required to return nose gear fully retracted.

6. Return motor clutch to the 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 the emergency hand crank and replace the rubber plug.

8. Reset nose gear circuit breaker.

NOTE

- The pilots' emergency procedures also appear in T.O. 1C-97(K)F-(CL)1-1, which is a condensed checklist. The condensed checklist has each numbered step (and some sub-steps) of the normal, air refueling, alert, and emergency procedures.

- The flight engineer's emergency procedures also appear in T.O. 1C-97(K)F-(CL)1-3, which is a condensed checklist. The condensed checklist has each numbered step (and some sub-steps) of the normal, air refueling, alert, and emergency procedures.

NAVIGATOR'S EMERGENCY PROCEDURES

FUSELAGE/ELECTRICAL FIRE

(1.) Fire Indication - Report or acknowledge (N, P)

Crew member discovering any indication of a fuselage or electrical fire will use the interphone CALL function to notify other crew members.

2. Oxygen - Mask on and regulator 100%

Use walk-around bottle if necessary

(3.) Cause of Fire - Determine and report (N, P, RO, BO)

When cause of fire is determined, notify pilot. If fire is determined to be of electrical origin, applicable equipment will be turned off and/or circuit breakers and fuses pulled. If source of fire is result of fuel system failure, coordinate with engineer on positioning applicable fuel valves.

4. Runner - Navigator (loss of interphone communication)

If fire is of undetermined electrical origin, it will be necessary to turn the master switch OFF. At this time, the navigator assumes duty of relaying pilot's instructions to other crew members.

5. Electrical Equipment - Turn off, pull circuit breakers

6. If Fire Accessible - Fight with hand fire extinguisher

WARNING

Prolonged exposure (5 minutes or more) to high concentrations (pronounced irritation of eye and nose) of Bromochloromethane (CB) or its decomposition products should be avoided. CB is an anesthetic agent of moderate intensity. It is safer to use than previous fire extinguishing agents (carbontetrachloride methylbromide). However, especially in confined spaces, adequate respiratory and eye protection from excessive exposure, including the use of oxygen when available, should be sought as soon as the primary fire emergency will permit.

(7.) Fire Status - Report to pilot (N, P, BO, RO)

One crew member will notify the pilot when fire has been extinguished and if any smoke or fumes are present. Should fire become uncontrollable, immediately notify pilot so bail-out procedures may be initiated.

8. Switches and Circuit Breakers (for essential equipment) - On (one at a time) (ALL)

If fire was from an undetermined electrical 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.) Smoke or Fumes Indication - Report or acknowledge (N, P)

Crew member discovering any indication of smoke or fumes will use the interphone CALL function to notify the other crew members.

2. Oxygen - Mask on and regulator 100%

3. Runner - Navigator (only when fuel fumes reported)

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 crew members.

(4.) Hatches - Open as directed by pilot (N, P, BO, RO)

If smoke or fumes are present in lower compartment, open floor hatches to assist in ventilation after opening the emergency exit hatches as directed by pilot.

(5.) Status of Smoke or Fumes - Report to pilot (N, P, BO, RO)

One crew member will notify pilot when smoke or fumes no longer exist or that ventilation has not been successful.

(6.) Electrical Equipment - All switches off (N, RO, E)

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.

(7.) Switches and Circuit Breakers (for essential equipment) - On (one at a time) (ALL)

If smoke or fumes resulted from an electrical fire of 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.

BAILOUT

(1.) Alert Signal - Acknowledge (N, CP)

If time permits, the alert signal of three short rings on the alarm bell will be acknowledged on interphone

2. IFF - EMERGENCY F G 1243 ▶ 2900, 3340 ▶

3. SIF - Set Emergency Codes

4. Anti-Exposure Suit, Life Vest, Parachute Harness - Don and check

Don anti-exposure suit and life vest as applicable prior to adjusting parachute and harness.

5. Trailing Wire - Fully retracted (if installed)

6. Position Report - Prepare

a. Position and Time - Determine and record

(b.) Pilot's Intentions - Determine and record (N, P)

c. Course and Ground Speed - Determine and record

d. Number of Personnel on Board - Determine and record

e. Nature of Emergency - Determine and record

(f.) Assistance Desired - Determine and record (N, P)

g. Type Airplane - Record

h. Altitude - Record

(7.) Set Radio Channelization - Set (N, CP)

Coordinate with copilot to ascertain that proper channel is set on the radio to be used for distress message.

8. Distress Message - Transmit

Navigator will establish contact with last ground 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.

9. Individual Survival Kits or One-Man Life Raft and Parachute Pack - Attach

Recheck equipment for proper fit.

(10.) Survival Equipment - Release on command (one long ring) (N, P)

Release survival kits, emergency radios, and multiple place life rafts as applicable between personnel as they leave the airplane.

11. Bail Out in Sequence - On command (one long ring)

DITCHING/CRASH LANDING

(1.) Alert Signal - Acknowledge (N, CP)

If time permits, the alert signal of six short rings on the alarm bell will be acknowledged on interphone.

2. IFF - EMERGENCY F G 1243 ▶ 2900, 3340 ▶

3. SIF - Set Emergency Codes

4. Position Report - Prepare

a. Position and Time - Determine and record

(b.) Pilot's Intentions - Determine and record (N, P)

c. Course and Ground Speed - Determine and record

d. Number of Personnel on Board - Determine and record

e. Nature of Emergency - Determine and record

(f.) Assistance Desired - Determine and record (N, P)

g. Type Airplane - Record

h. Altitude - Record

(5.) Set Radio Channelization - Set (N, CP)

Coordinate with copilot to ascertain that proper channel is set on the radio to be used for distress message.

6. Distress Message - Transmit

Navigator will establish contact with last ground facility utilized. If contact cannot be made, navigator will establish contact on an emergency freqency. Transmit "Mayday" three times, identification three times, and emergency position report. Request fix or bearing service if desired.

(7.) Absolute Altitude - Give to pilot (ditching only) (N, P)

Navigator will obtain accurate absolute altitude and give to pilot. Pilot will set absolute altitude on his pressure altimeter.

8. Pyrotechnic Pistol - Insert in mount

9. Parachute Harness - Remove

10. Ditching/Crash Landing Preparation - Complete

Assemble navigation kit and flashlight. Assist other crew members in securing emergency equipment near emergency exits and jettisoning unnecessary equipment and cargo.

11. Anti-Exposure Suit and Life Vest - Don (ditching only)

12. Assume Ditching/Crash Landing Position - Safety belt fastened

13. After Impact - Proceed to emergency exit

After airplane has come to a complete stop, open additional emergency exit hatches if necessary and abandon airplane by appropriate exit. Assist other crew members in removing emergency equipment and launching life rafts (if applicable).

Manual Gear Lowering—Main Gear

(1.) Establish Interphone Contact - Established (N, CP, E)

(2.) Check Landing Gear Switch OFF - Checked OFF (N, CP)

Have copilot check landing gear switch OFF.

(3.) Pull Control Circuit Breaker - Pulled (N, E)

Have engineer pull applicable control circuit breaker.

4. Pull Red T-Handle Out and Seat Swaged Ball - Pulled and seated

Seat swaged ball in slot to disengage motor clutch and to engage manual clutch.

5. Insert Emergency Hand Crank - Inserted

6. Rotate Ten Turns in Down Direction - Rotated

7. Snap Red T-Handle Forward - Snapped forward

8. Oscillate Emergency Hand Crank Rapidly - Oscillated

a. Allow Free Fall (5 seconds)

Rapidly oscillate emergency hand crank to free manual clutch; gear will lower by gravity after clutch is disengaged.

CAUTION

After manual clutch is released do not attempt to re-engage manual clutch or operate gear for five 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.

9. Pull Red T-Handle Out and Seat Swaged Ball - Pulled and seated

This will re-engage the manual clutch.

10. Rotate Emergency Hand Crank in Down Direction - Rotated

Rotate until stops are hit and the lock is engaged.

(11.) Check for Safe Indication - Checked (N, CP)

Check with copilot for safe indication.

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 hand crank may be lashed down with the A-1 web tie-down strap to

minimize gear collapse during landing roll. This may be accomplished as follows:

(a) Leave red "T" handle pulled and the swaged ball seated in the slot.

(b) Anchor the A-1 tie-down strap to the airframe and the emergency hand crank so that tension will be applied in the gear lowered direction. Do not anchor to fluid lines.

(c) Leave the hand crank anchored and the swaged ball seated in the slot until after landing and until the ground locks are installed or jacks placed under the wing.

(d) After gear has been locked down, the hand crank torque tubes to the landing gear actuator should be inspected for twists or buckles.

12. Reset Red T-Handle and Oscillate Emergency Hand Crank - Reset and oscillated

Always reset the red handle and oscillate emergency hand crank after emergency operation is completed to allow electrical operation of the landing gear.

13. Stow Emergency Hand Crank - Stowed

(14) Reset Control Circuit Breaker - Reset (N, E)

Have engineer reset applicable control circuit breaker.

(15) Gear Switch DOWN - DOWN (N, CP)

Cover in place.

Manual Gear Lowering—Nose Gear

(1) Check Landing Gear Switch OFF - Checked OFF (N, CP)

Have copilot check landing gear switch OFF.

(2) Pull Control Circuit Breaker - Pulled (N, E)

Have engineer pull the nose gear control circuit breaker.

3. Disengage Motor Clutch - Disengaged

4. Remove Rubber Plug - Removed

5. Engage Emergency Hand Crank - Engaged

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 - Rotated

7. Remove Emergency Hand Crank - Removed

a. Allow Free Fall (5 seconds)

8. Re-engage and Rotate Emergency Hand Crank - Re-engaged and rotated

Re-engage the crank and rotate in down direction until the gear hits the stops. The lock will then set with a perceptible snap.

9. Re-engage Motor Clutch - Re-engaged

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 for Safe Indication - Checked (N, CP)

Check with copilot for safe indication.

11. Stow Emergency Hand Crank - Stowed

12. Replace Rubber Plug - Replaced

(13) Reset Control Circuit Breaker - Reset (N, E)

Have engineer reset nose gear control circuit breaker.

(14) Gear Switch DOWN - DOWN (N, CP)

Cover in place.

NOTE

The navigator's emergency procedures also appear in T.O. 1C-97(K)F-(CL)1-2, which is a condensed checklist. The condensed checklist has each numbered step (and some sub-steps) of the normal, air refueling, alert, and emergency procedures.

BOOM OPERATOR'S EMERGENCY PROCEDURES

FUSELAGE/ELECTRICAL FIRE

(1.) Fire Indication - Report to crew or acknowledge (ALL)

Crew member discovering any indication of a fuselage or electrical fire will use the CALL position of the interphone to notify the other crew members.

2. Oxygen - Mask on and regulator 100%

Use walk-around bottle if necessary.

(3.) Cause of Fire - Determine and report (BO, P)

When cause of fire is determined, report source to pilot. If fire is determined to be of electrical origin, applicable equipment will be turned off and/or circuit breakers and fuses pulled. If source of fire is result of fuel system failure, coordinate with engineer on positioning applicable fuel valves.

4. If Fire Accessible - Fight with hand fire extinguishers

WARNING

Prolonged exposure (5 minutes or more) to high concentrations (pronounced irritation of eye and nose) of Bromochloromethane (CB) or its decomposition products should be avoided. CB is an anesthetic agent of moderate intensity. It is safer to use than previous fire extinguishing agents (carbontetrachloride methylbromide). However, especially in confined spaces, adequate respiratory and eye protection from excessive exposure, including the use of oxygen when available, should be sought as soon as the primary fire emergency will permit.

(5.) Fire Status - Report to pilot (BO, P, RO, N)

One crew member will inform the pilot when fire has been extinguished and if there is any smoke or fumes remaining. Should fire become uncontrollable, immediately notify pilot so bail-out procedures may be initiated.

SMOKE, OR FUME ELIMINATION

(1.) Smoke or Fumes Indication - Report to crew or acknowledge (ALL)

Crew member discovering any indication of smoke or fumes will use the CALL position of the interphone to notify the other crew members.

2. Oxygen - Mask on and regulator 100%

Use walk-around bottle if necessary.

(3.) Hatches - Open as directed by pilot (BO, P, RO, 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.) Status of Smoke or Fumes - Report to pilot (BO, (P, N, RO)

One crew member will report to pilot when smoke and/or fumes no longer exist or that ventilation has not been successful.

5. Fuel Valves - CLOSE

On F airplanes visually check the line valve, transfer valves and manual fuel-shutoff valve for CLOSED position.

On airplanes G 17260 ▶ 22664, visually check that the following valves are CLOSED: line valve, No. 1 and No. 2 manual fuel-shutoff valves, and transfer valves. On airplanes 22665 ▶, visually check that the following valves are CLOSED: line valve, No. 1 and No. 2 manual fuel-shutoff valves, external tank manifold shutoff valve, and secondary valve.

(6.) Electrical Equipment - All switches off (BO, RO, N, E)

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.

(7.) Switches and Circuit Breakers (for essential equipment) - On (one at time) (ALL)

If smoke or fumes resulted from an electrical fire of 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.

BAILOUT

(1.) Alert Signal - Acknowledge (BO, CP)

If time permits, the alert signal of three short rings on the alarm bell will be acknowledged on interphone

2. Boom - Stow and latch

3. Passengers Survival Equipment - Check

Check passengers for required equipment and proper fit. Have passengers don exposure suits if time permits.

4. Anti-Exposure Suit, Life Vest and Parachute Harness - Don and check

Don anti-exposure suit and life vest as applicable prior to adjusting parachute harness

(5.) Emergency Exit Hatches - Open (BO, P)

Open emergency exit hatches when directed by pilot.

(6.) Survival Equipment - Release on command (one long ring (BO, P)

Release survival kits, emergency radios and multiple place life rafts as applicable between personnel as they leave the airplane

7. Individual Survival Kit or One Man Life Raft and Parachute Pack - Attach

Recheck for proper fit

(8.) Inform Pilot - "All personnel have bailed out" (BO, P)

9. Jumpmaster - Bailout

CRASH LANDING

(1.) Alert Signal - Acknowledge (BO, CP)

If time permits, the alert signal of six short rings on the alarm bell will be acknowledged on interphone

2. Boom - Stow and latch

(3.) Emergency Exit Hatches - Remove and stow (BO, P)

Open emergency exit hatches when directed by pilot

(4.) Loose Equipment and Cargo - Jettison (BO, P)

Jettison loose equipment and cargo when directed by pilot

(5.) Boom Hydraulic System - Depressurize (BO, E)

Depressurize boom hydraulic system after fuel dump is complete

(6.) Entrance Doors Safety Pins, Front and Aft - Unlock (BO, P)

7. Floor Hatches - Remove and stow

8. Circuit Breakers - Pull (if time permits)

Pull flare release, fuel dump circuit breakers, and single point refueling circuit breakers.

9. Parachute Harness - Remove

10. Crash Landing Positions - Check

Check that all personnel in lower compartments have been moved to main compartment and braced for crash landing. Assume crash landing position.

11. After Impact - Proceed to emergency exit

After airplane comes to complete stop, abandon airplane by any available exit. Assist other personnel to abandon the airplane

DITCHING

(1.) Alert Signal - Acknowledge (BO, CP)

If time permits, the alert signal of six short rings on the alarm bell will be acknowledged on interphone

2. Boom - Stow and latch

3. All A/R Light Switches - ON

4. APU Exhaust Door - Closed

5. Floor Hatches - Closed

(6.) Emergency Exit Hatches - Remove and stow (BO, P)

Open emergency exit hatches when directed by pilot.

(7.) Loose Equipment and Cargo - Jettison (BO, P)

Jettison loose equipment and cargo when directed by pilot

8. Survival Equipment - Secure near overwing emergency exit hatches

9. Parachute Harness - Remove

10. Ditching Positions - Check

Check that all personnel in lower compartments have been moved to main compartment and braced for ditching. Boom operator will then don anti-

exposure suit and life vest and assume ditching position.

11. After Impact - Proceed to emergency exit

After airplane has come to a complete stop, open additional emergency exit hatches if necessary and abandon airplane by appropriate exit. Assist other crew members in removing emergency equipment and launching life rafts (if applicable).

Manual Gear Lowering—Main Gear

(1) Establish Interphone Contact - Established (BO, CP, E)

(2) Check Landing Gear Switch OFF - Checked OFF (BO, CP)

Have copilot check landing gear switch OFF.

(3) Pull Control Circuit Breaker - Pulled (BO, E)

Have engineer pull applicable control circuit breaker.

4. Pull Red T-Handle Out and Seat Swaged Ball - Pulled and seated

Seat swaged ball in slot to disengage motor clutch and to engage manual clutch.

5. Insert Emergency Hand Crank - Inserted

6. Rotate Ten Turns in Down Direction - Rotated

7. Snap Red T-Handle Forward - Snapped forward

8. Oscillate Emergency Hand Crank Rapidly - Oscillated

a. Allow Free Fall (5 seconds)

Rapidly oscillate emergency hand crank to free manual clutch; gear will lower by gravity after clutch is disengaged.

CAUTION

After manual clutch is released do not attempt to re-engage manual clutch or operate gear for five 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.

9. Pull Red T-Handle Out and Seat Swaged Ball - Pulled and seated

This will re-engage the manual clutch.

10. Rotate Emergency Hand Crank in Down Direction - Rotated

Rotate until stops are hit and the lock is engaged.

(11) Check for Safe Indication - Checked (BO, CP)

Check with copilot for safe indication.

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 hand crank may be lashed down with the A-1 web tie-down strap to minimize gear collapse during landing roll. This may be accomplished as follows:
  - (a) Leave red "T" handle pulled and the swaged ball seated in the slot.
  - (b) Anchor the A-1 tie-down strap to the airframe and the emergency hand crank so that tension will be applied in the gear lowered direction. Do not anchor to fluid lines.
  - (c) Leave the hand crank anchored and the swaged ball seated in the slot until after landing and until the ground locks are installed or jacks placed under the wing.
  - (d) After gear has been locked down, the hand crank torque tubes to the landing gear actuator should be inspected for twists or buckles.

12. Reset Red T-Handle and Oscillate Emergency Hand Crank - Reset and oscillated

Always reset the red handle and oscillate emergency hand crank after emergency operation is completed to allow electrical operation of the landing gear.

13. Stow Emergency Hand Crank - Stowed

(14) Reset Control Circuit Breaker - Reset (BO, E)

Have engineer reset applicable control circuit breaker.

(15) Gear Switch DOWN - DOWN (BO, CP)

Cover in place.

Manual Gear Lowering—Nose Gear

(1) Check Landing Gear Switch OFF - Checked OFF (BO, CP)

Have copilot check landing gear switch OFF.

(2) Pull Control Circuit Breaker - Pulled (BO, E)

Have engineer pull the nose gear control circuit breaker.

3. Disengage Motor Clutch - Disengaged

4. Remove Rubber Plug - Removed

5. Engage Emergency Hand Crank - Engaged

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 - Rotated

7. Remove Emergency Hand Crank - Removed

a. Allow Free Fall (5 seconds)

8. Re-engage and Rotate Emergency Hand Crank - Re-engaged and rotated

Re-engage the crank and rotate in down direction until the gear hits the stops. The lock will then set with a perceptible snap.

9. Re-engage Motor Clutch - Re-engaged

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 for Safe Indication - Checked (BO, CP)

Check with copilot for safe indication.

11. Stow Emergency Hand Crank - Stowed

12. Replace Rubber Plug - Replaced

(13) Reset Control Circuit Breaker - Reset (BO, E)

Have engineer reset nose gear control circuit breaker

(14) Gear Switch DOWN - DOWN (BO, CP)

Cover in place.

NOTE

The boom operator's emergency procedures also appear in T.O. 1C-97(K)F-(CL)1-4, which is a condensed checklist. The condensed checklist has each numbered step (and some sub-steps) of the normal, air refueling, alert, and emergency procedures.

RADIO OPERATOR'S EMERGENCY PROCEDURES

FUSELAGE/ELECTRICAL FIRE

(1) Fire Indication - Report or acknowledge (RO, P)

Crew member discovering any indication of a fuselage or electrical fire will use the CALL position of the interphone to notify the other crew members.

2. Oxygen - Mask on and regulator 100%

Use walk-around bottle if necessary.

(3) Cause of Fire - Determine and report (RO, P)

When cause of fire is determined, report to pilot. If fire is determined to be of electrical origin, applicable equipment will be turned OFF and/or circuit breakers and fuses pulled. If source of fire is result of fuel system failure, coordinate with engineer on positioning applicable fuel valves.

4. If Fire Accessible - Fight with hand fire extinguishers

WARNING

Prolonged exposure (5 minutes or more) to high concentrations (pronounced irritation of eye and nose) of Bromochloromethane (CB) or its decomposition products should be avoided. CB is an anesthetic agent of moderate intensity. It is safer to use than previous fire extinguishing agents (carbontetrachloride methylbromide). However, especially in confined spaces, adequate respiratory and eye protection from excessive exposure, including the use of oxygen when available, should be sought as soon as the primary fire emergency will permit.

(5.) Fire Status - Report to pilot (RO, P, N, BO)

One crew member will relay information to pilot when fire has been extinguished and if there is any presence of smoke or fumes remaining. Should fire become uncontrollable, immediately notify pilot so bail-out procedures may be initiated.

SMOKE OR FUME ELIMINATION

(1.) Smoke or Fumes Indication - Report or acknowledge (RO, P)

Crew member discovering any indication of smoke or fumes will use the CALL position of the interphone to notify the other crew members.

2. Oxygen - Mask on regulator 100%

Use walk-around bottle if necessary.

(3.) Hatches - Open as directed by pilot (RO, P, N, BO)

If smoke or fumes are present in lower compartments, open floor hatches to assist in ventilation, after opening the main compartment emergency exits as directed by the pilot.

(4.) Status of Smoke or Fumes - Report to pilot (RO, P, N, BO)

One crew member will report to pilot when smoke and/or fumes no longer exist or that ventilation has not been successful.

5. Electrical Equipment - All switches Off (RO, N, E)

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.

(6.) Switches and Circuit Breakers (for essential equipment) - On (one at a time) (ALL)

If smoke or fumes resulted from an electrical fire of 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.

BAIL-OUT

(1.) Alert Signal - Acknowledge (RO, P)

If time permits, the alert signal of three short rings on the alarm bell will be acknowledged on interphone

2. IFF - EMERGENCY (if applicable)

Turn IFF to EMERGENCY if the control is installed at the radio position and the navigator is not aboard.

3. Anti-Exposure Suit, Life Vest and Parachute Harness - Don and check

Don anti-exposure suit and life vest as applicable before adjusting harness and parachute.

4. Distress Message - Transmit (time permits)

Obtain position report from navigator and transmit distress message on last frequency worked or on emergency frequency.

(5.) Emergency Exit Hatches - Open (RO, BO, P)

Assist boom operator in opening the emergency exit hatches.

6. Individual Survival Kit or One Man Raft and Parachute Pack - Attach

Recheck equipment for proper fit

(7.) Survival Equipment - Release on command (one long ring) (RO, P)

Release survival kits, emergency radios, multiple place life rafts as applicable between personnel as they leave the airplane

8. Bail Out in Sequence - On command (one long ring)

CRASH LANDING

(1.) Alert Signal - Acknowledge (RO, P)

If time permits, the alert signal of six short rings on the alarm bell will be acknowledged on interphone.

2. IFF - EMERGENCY (if applicable)

   Turn IFF to EMERGENCY if the control is installed at the radio position and the navigator is not aboard.

3. Distress Message - Transmit (time permits)

   Obtain position report from navigator and transmit distress message on last frequency worked or on emergency frequency.

(4.) Emergency Exit Hatches - Remove and secure (RO, BO, P)

   Open hatches when directed by pilot

(5.) Cargo and Loose Equipment - Jettison (rear emergency exits) (RO, BO, P)

   Jettison equipment when directed by pilot

(6.) Entrance Door Safety Pins - Unlock (forward and aft doors) (RO, BO, P)

7. Parachute Harness - Remove

8. Assume Crash Landing Position - Safety belt fastened

9. After Impact - Proceed to emergency exit

   After airplane comes to complete stop, abandon airplane by any available exit. Assist other personnel to abandon the airplane.

DITCHING

(1.) Alert Signal - Acknowledge (RO, P)

   If time permits, the alert signal of six short rings on the alarm bell will be acknowledged on interphone.

2. IFF - EMERGENCY (if applicable)

   Turn IFF to EMERGENCY if the control is installed at the radio position and the navigator is not aboard

3. Distress Message - Transmit (time permits)

   Obtain position report from navigator and transmit distress message on last frequency worked or on emergency frequency

4. Floor Hatches - Closed

(5.) Emergency Exit Hatches - Remove and secure (RO, BO, P)

   Open exit hatches when directed by pilot

(6.) Cargo and Loose Equipment - Jettison (rear emergency exits) (RO, BO, P)

   Jettison equipment when directed by pilot

7. Emergency Equipment - Secure near overwing emergency exits

8. Parachute Harness - Remove

9. Anti-Exposure Suit and Life Vest - Don

10. Assume Ditching Position - Safety belt fastened

11. After Impact - Proceed to emergency exit

    After airplane has come to a complete stop, open additional emergency exit hatches if necessary and abandon airplane by appropriate exit. Assist other crew members in removing emergency equipment and launching life rafts

Manual Gear Lowering — Main Gear

(1.) Establish Interphone Contact - Established (RO, CP, E)

2. Check Landing Gear Switch OFF - Checked OFF (RO, CP)

   Have copilot check landing gear switch OFF.

(3.) Pull Control Circuit Breaker - Pulled (RO, E)

   Have engineer pull applicable control circuit breaker.

4. Pull Red T-Handle Out and Seat Swaged Ball - Pulled and seated

   Seat swaged ball in slot to disengage motor clutch and to engage manual clutch.

5. Insert Emergency Hand Crank - Inserted

6. Rotate Ten Turns in Down Direction - Rotated

7. Snap Red T-Handle Forward - Snapped forward

8. Oscillate Emergency Hand Crank Rapidly - Oscillated

   a. Allow Free Fall (5 seconds)

   Rapidly oscillate emergency hand crank to free manual clutch; gear will lower by gravity after clutch is disengaged.

CAUTION

After manual clutch is released do not attempt to re-engage manual clutch or operate gear for five 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.

9. Pull Red T-Handle Out and Seat Swaged Ball - Pulled and seated

   This will re-engage the manual clutch.

10. Rotate Emergency Hand Crank in Down Direction - Rotated

    Rotate until stops are hit and the lock is engaged.

(11) Check for Safe Indication - Checked (RO, CP)

Check with copilot for safe indication.

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 hand crank may be lashed down with the A-1 web tie-down strap to minimize gear collapse during landing roll. This may be accomplished as follows:

  (a) Leave red "T" handle pulled and the swaged ball seated in the slot.

  (b) Anchor the A-1 tie-down strap to the airframe and the emergency hand crank so that tension will be applied in the gear lowered direction. Do not anchor to fluid lines.

  (c) Leave the hand crank anchored and the swaged ball seated in the slot until after landing and until the ground locks are installed or jacks placed under the wing.

  (d) After gear has been locked down, the hand crank torque tubes to the landing gear actuator should be inspected for twists or buckles.

12. Reset Red T-Handle and Oscillate Emergency Hand Crank - Reset and oscillated

    Always reset the red handle and oscillate emergency hand crank after emergency operation is completed to allow electrical operation of the landing gear.

13. Stow Emergency Hand Crank - Stowed

(14) Reset Control Circuit Breaker - Reset (RO, E)

Have engineer reset applicable control circuit breaker.

(15) Gear Switch DOWN - DOWN (RO, CP)

Cover in place.

Manual Gear Lowering—Nose Gear

(1) Check Landing Gear Switch OFF - Checked OFF (RO, CP)

Have copilot check landing gear switch OFF.

(2) Pull Control Circuit Breaker - Pulled (RO, E)

Have engineer pull the nose gear control circuit breaker.

3. Disengage Motor Clutch - Disengaged

4. Remove Rubber Plug - Removed

5. Engage Emergency Hand Crank - Engaged

   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 - Rotated

7. Remove Emergency Hand Crank - Removed

   a. Allow Free Fall (5 seconds)

8. Re-engage and Rotate Emergency Hand Crank - Re-engaged and rotated

   Re-engage the crank and rotate in down direction until the gear hits the stops. The lock will then set with a perceptible snap.

9. Re-engage Motor Clutch - Re-engaged

   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 for Safe Indication - Checked (RO, CP)

   Check with copilot for safe indication.

11. Stow Emergency Hand Crank - Stowed

12. Replace Rubber Plug - Replaced

(13) Reset Control Circuit Breaker - Reset (RO, E)

   Have engineer reset nose gear control circuit breaker.

(14) Gear Switch DOWN - DOWN (RO, CP)

   Cover in place.

NOTE

The radio operator's emergency procedures also appear in T.O. 1C-97(K)F-(CL)1-5, which is a condensed checklist. The condensed checklist has each numbered step (and some sub-steps) of the normal, air refueling, alert, and emergency procedures.

Section IV Auxiliary Equipment

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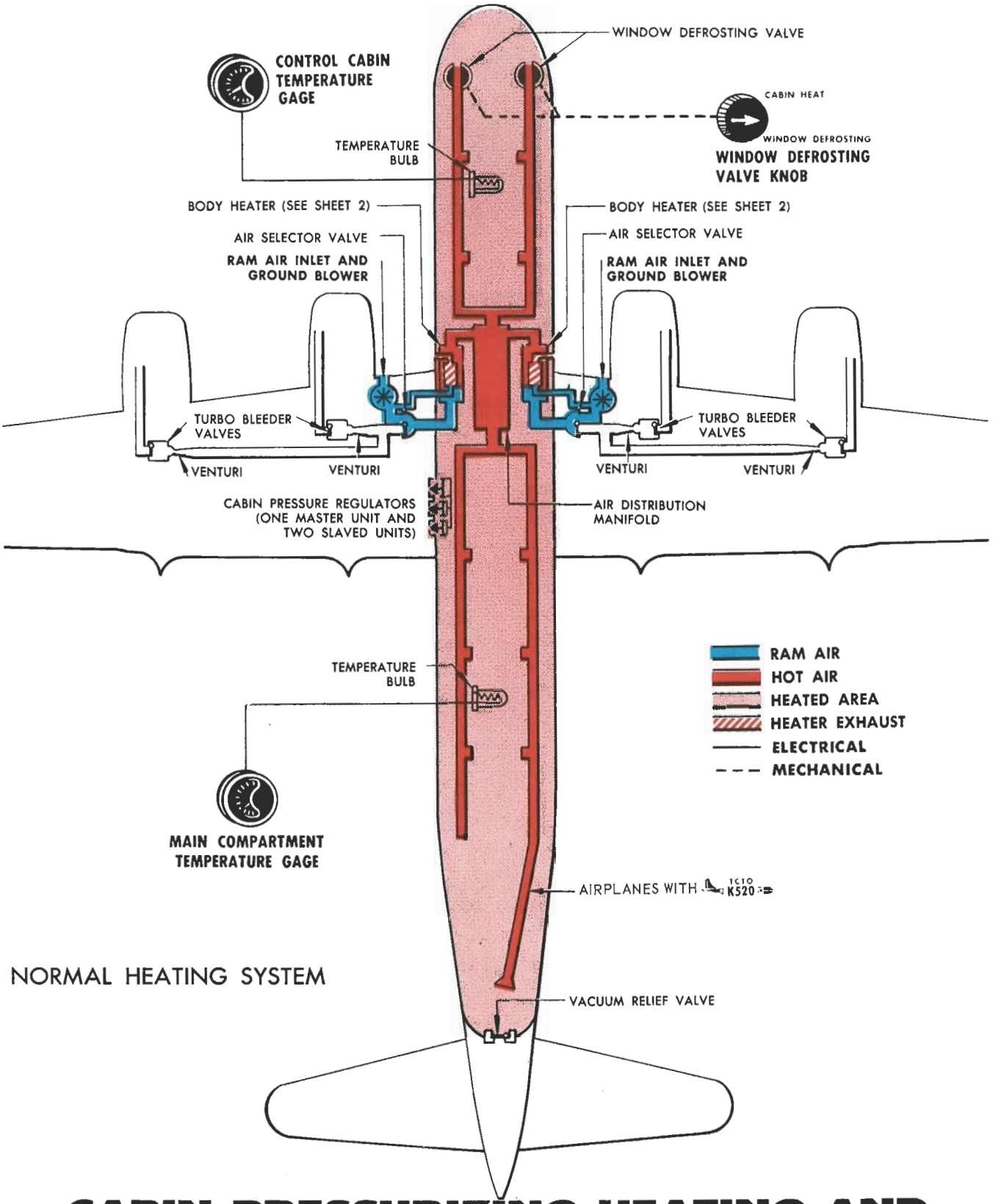
CABIN PRESSURIZING, HEATING AND VENTILATING SYSTEM

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 prevents 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

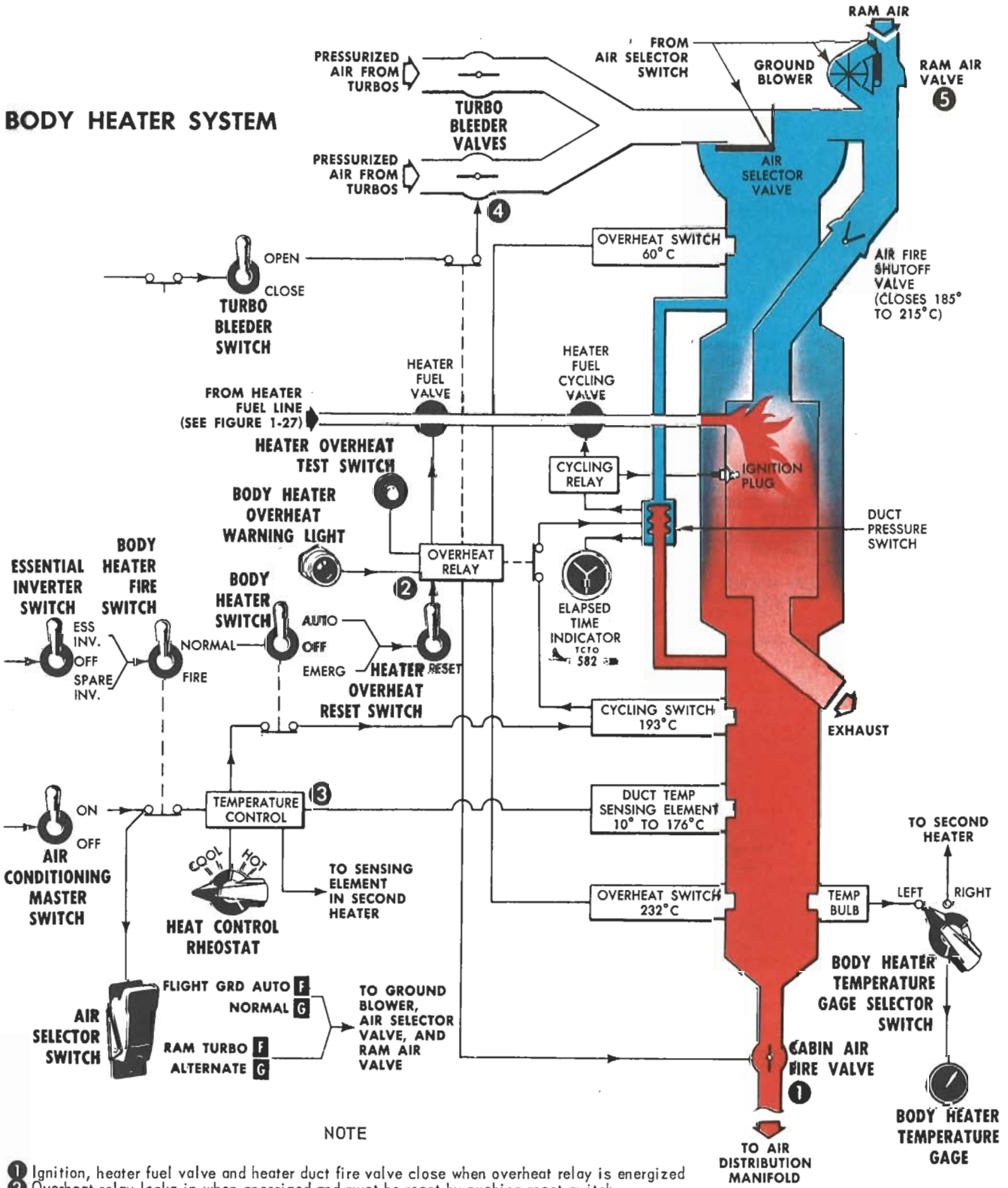
Three methods of preventing structural damage as a result of excessive positive or negative pressure are incorporated into the system. The cabin pressure regulators automatically limit the differential pressure between cabin and atmosphere to 13.4 inches Hg (approximately 15,000 feet altitude differential) 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 whenever a cabin pressure regulator malfunction increases the differential pressure above 14 inches Hg. This valve can be adjusted 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

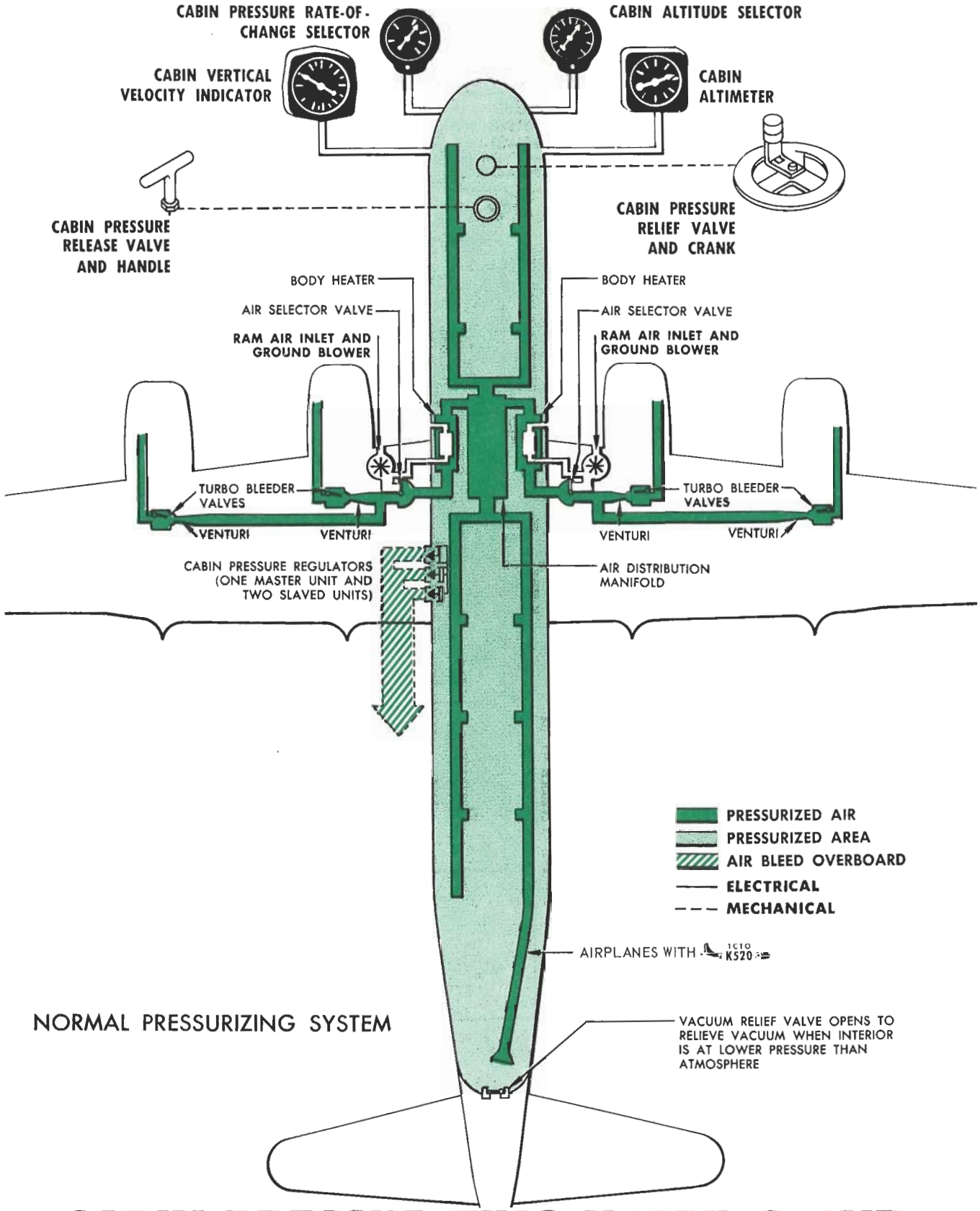
Figure 4-1 (Sheet 1 of 4)



NOTE

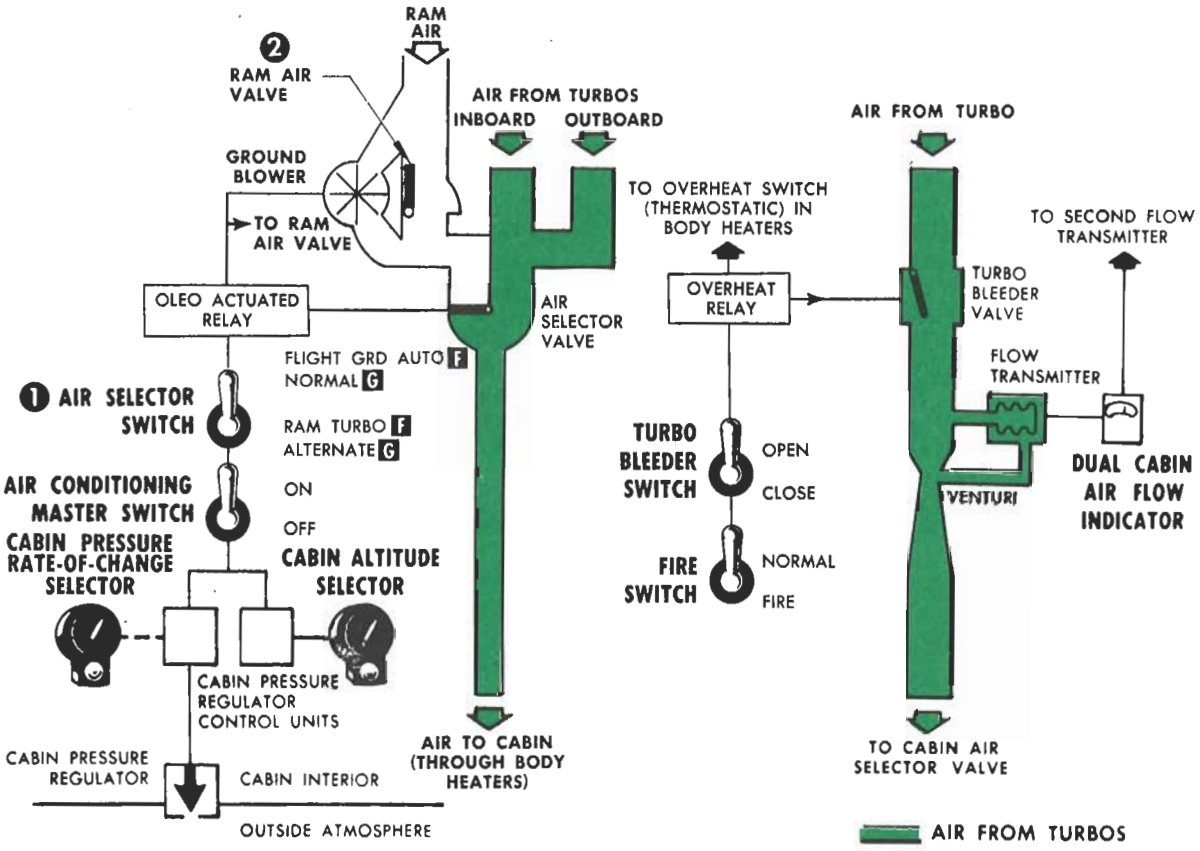
1. Ignition, heater fuel valve and heater duct fire valve close when overheat relay is energized
2. Overheat relay locks in when energized and must be reset by pushing reset switch
3. Temperature control circuit cycles heater on and off as required to maintain selected temperature
4. Turbo bleeder valves 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)



CABIN PRESSURIZING, HEATING AND VENTILATION (CONT)

Figure 4-1 (Sheet 3 of 4)



CONTROL OF AIR SELECTOR VALVES (TYPICAL)

CONTROL OF TURBO BLEEDER VALVES (TYPICAL)

1 AIR SELECTOR SWITCH POSITION

F	G	DURING FLIGHT	ON THE GROUND
FLIGHT GRD AUTO	NORMAL	Turbo air directed to cabin	Ground blower air directed to cabin
RAM TURBO	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 (figure 4-3, sheet 2), 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 is from the No. 2 tank or the 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 RAM TURBO position on F airplanes or the ALTERNATE position on G airplanes. 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 control cabin fans (1, figure 4-15), 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. See CONTROL CABIN FAN SWITCHES in this Section.

Air Fire Shutoff Valve

An air fire shutoff valve is 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.

System Power Requirements

All electrical controls in the cabin pressurizing, heating, and ventilating system 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 CONTROLS

Air Conditioning Master Switch

The air conditioning master switch (15,figure 4-3), marked ON--OFF, is 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 switch is in the OFF position, these circuits are de-energized. The master switch receives power through circuit breakers on the forward power panel.

Fire Switches

See FIRE EXTINGUISHER SYSTEM in Section I for descriptions of these switches.

Cabin Altitude Selector

A cabin altitude selector (12, figure 4-3) is 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 (figure 1-35, sheet 4).

Cabin Pressure Rate-of-Change Selector

A cabin pressure rate-of-change selector (13, figure 4-3) is 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 (figure 1-35, sheet 4).

Turbo Bleeder Switches

Four turbo bleeder switches (16,figure 4-3), one for each turbo bleeder valve, are on the engineer's instrument panel. The switches have two positions: OPEN and 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 (figure 1-35, sheet 1) and an oil, fuel, hydraulic oil, and cabin air bleeder fire-gang switch (19, figure 1-12) on the overhead panel.

Cabin Air Selector Switches

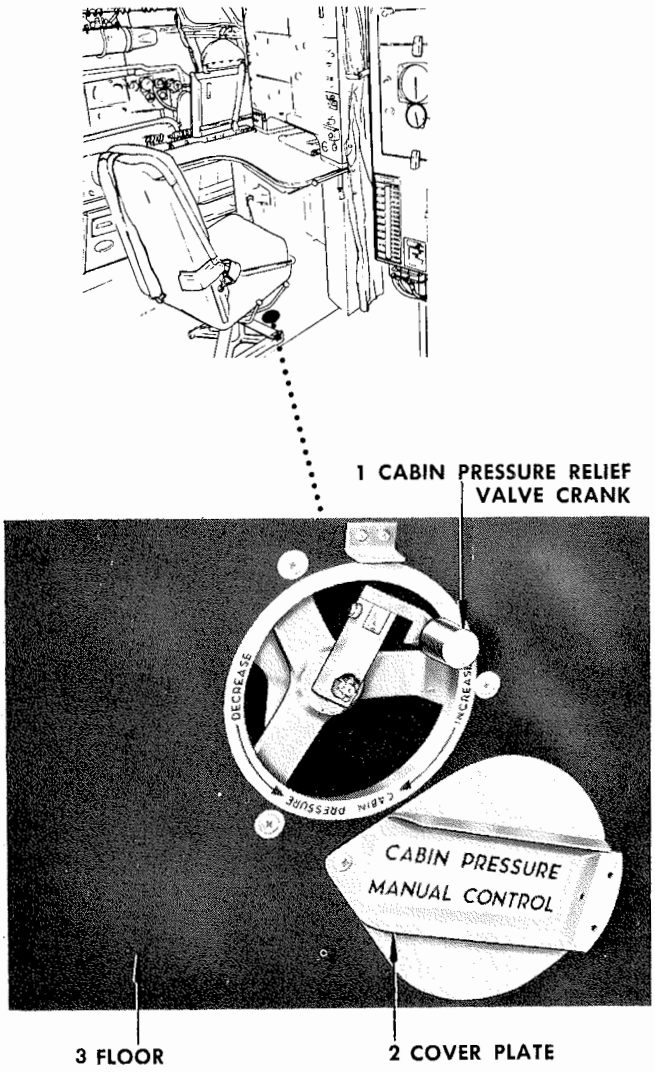
Airplanes F G 1243 ▶ 22806 have two guarded cabin air selector switches (18, figure 4-3 or 31, figure 1-22) on the engineer's instrument panel. On airplanes G 3106 ▶, these two switches (12, figure 1-21) are on the engineer's auxiliary overhead panel. The switches have two positions: FLIGHT GROUND AUTO--RAM TURBO on F airplanes and NORMAL--ALTERNATE on G airplanes. Although the switches have different markings, the function of each switch position is the same. The switches control the left and right cabin air selector valves and the ground blowers. When the switches are in the FLIGHT GROUND AUTO (or NORMAL) position and the airplane is on the ground, cabin air is supplied by the ground blowers. During flight, with the switches on FLIGHT GROUND AUTO (or NORMAL), the cabin air is supplied by the turbosuperchargers. When the switches are in the RAM TURBO (or 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 RAM TURBO (or ALTERNATE), cabin air is supplied by the turbosuperchargers. The air conditioning master switch (15, 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 (figure 1-35, sheet 5).

Body Heater Switches

Two body heater switches (20, figure 4-3), marked AUTO--OFF--EMERG, are 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: (1) the body heater fire switch, (2) the air conditioning master switch, and (3) 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 350°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 (380°F). When using the EMERG position, the cabin temperature can be controlled by periodically switching from EMERG to OFF. The body heater switches receive power through circuit breakers on the forward power panel. The ignition for the body heaters receives power through fuses on the A-C power panel.

Heat Control Rheostat

A heat control rheostat (1, figure 4-3 or 3, figure 1-21), marked with COOL and HEAT ranges, is 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



CABIN PRESSURE RELIEF VALVE CRANK

Figure 4-2

conditioning master switch, body heater fire switch, and a circuit breaker on the forward power panel (figure 1-35). The heat control rheostat is inoperative when the body heater switches are on EMERG. See BODY HEATER SWITCHES in 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 cabin air fire valves downstream of the heaters, close the heater fuel valve, de-energize the ignition, and will illuminate the heater overheat warning lights. The relays lock out the heaters until the overhead condition is eliminated and a reset switch is actuated.

Heater Overheat Test Switch

This switch (23,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 will then turn on all overheat warning lights, turn off the ignition for each heater, and close all fuel and air 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. See HEATER OVERHEAT RESET SWITCH in 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 bleed 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 shutoff. Momentarily placing the heater overheat reset switch (26, figure 4-3) to the RESET position restores heater operation - providing the overheat condition no longer exists. This switch is operative when the essential inverter switch and the body heater switches are ON. Circuit protection is through circuit breakers on the forward power panel.

Heater Fuel Supply Switch

This switch (19, 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 1-27.) 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 (2, figure 1-22) 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 (figure 1-35, sheet 1).

Cabin Pressure Relief Valve Crank

A 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 if manual control is rotated clockwise and decreased if 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 handle (21, figure 1-16) 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 with a selector valve lever (32, figure 4-3) and a distribution valve lever (33, figure 4-3) is 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 airflow to the control cabin is increased in relation to the airflow 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 bleeds on the side of the airplane of the inoperative heater.

Control Cabin Fan Switches

On F airplanes, there are two switches (14, figure 4-3) on the engineer's instrument panel for the fans in the control cabin. On G airplanes, these two switches (13, figure 1-21) are on the engineer's auxiliary overhead panel. There is a ceiling fan and a bulkhead fan (1, figure 4-15) 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 (figure 1-35, sheet 1).

Cabin Air Pressure Indicator (Cabin Altimeter)

A cabin altimeter (11, 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 (17, 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 (31, figure 4-3 and 59, figure 1-22) are on the engineer's instrument panel. These gages 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.

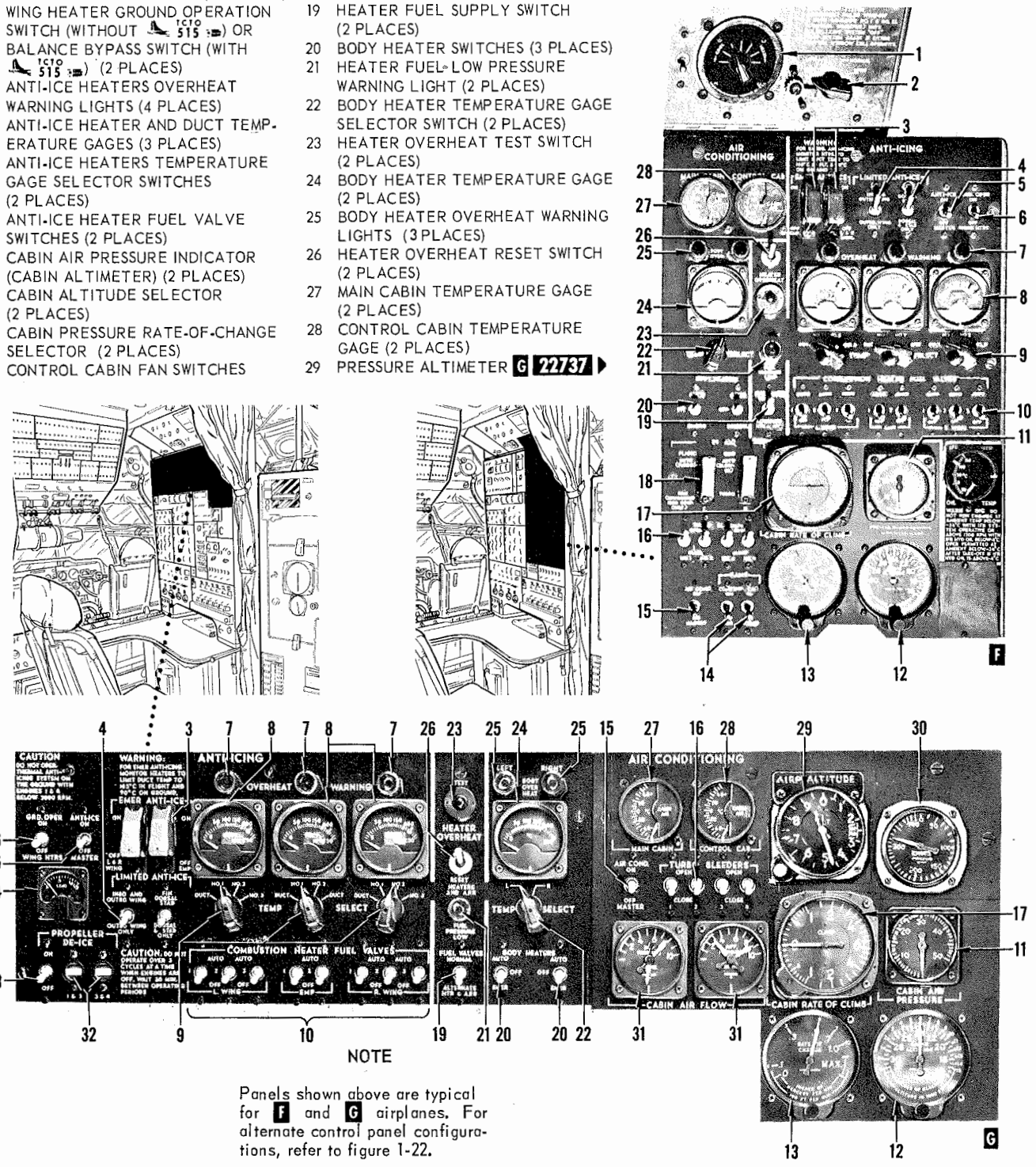
Cabin Temperature Gages

The control cabin and main compartment temperatures are indicated in degrees Centigrade by cabin temperature gages (27 and 28, figure 4-3) on the engineer's instrument panel. The indicating circuits are protected by a circuit breaker on the overhead circuit breaker panel (figure 1-35, sheet 1).

Body Heater Elapsed Time Indicators TCTO 582

Airplanes incorporating TCTO 582 have 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.

1 HEAT CONTROL RHEOSTAT
2 WINDOW HEAT SELECTOR SWITCH
3 EMERGENCY ANTI-ICE SWITCHES (2 PLACES)
4 LIMITED ANTI-ICE SWITCHES (2 PLACES)
5 ANTI-ICE MASTER SWITCH (2 PLACES)
6 WING HEATER GROUND OPERATION SWITCH (WITHOUT TCTO 515) OR BALANCE BYPASS SWITCH (WITH TCTO 515) (2 PLACES)
7 ANTI-ICE HEATERS OVERHEAT WARNING LIGHTS (4 PLACES)
8 ANTI-ICE HEATER AND DUCT TEMPERATURE GAGES (3 PLACES)
9 ANTI-ICE HEATERS TEMPERATURE GAGE SELECTOR SWITCHES (2 PLACES)
10 ANTI-ICE HEATER FUEL VALVE SWITCHES (2 PLACES)
11 CABIN AIR PRESSURE INDICATOR (CABIN ALTIMETER) (2 PLACES)
12 CABIN ALTITUDE SELECTOR (2 PLACES)
13 CABIN PRESSURE RATE-OF-CHANGE SELECTOR (2 PLACES)
14 CONTROL CABIN FAN SWITCHES
15 AIR CONDITIONING MASTER SWITCH (2 PLACES)
16 TURBO BLEEDER SWITCHES (2 PLACES)
17 CABIN VERTICAL VELOCITY INDICATOR (2 PLACES)
18 CABIN AIR SELECTOR SWITCHES
19 HEATER FUEL SUPPLY SWITCH (2 PLACES)
20 BODY HEATER SWITCHES (3 PLACES)
21 HEATER FUEL LOW PRESSURE WARNING LIGHT (2 PLACES)
22 BODY HEATER TEMPERATURE GAGE SELECTOR SWITCH (2 PLACES)
23 HEATER OVERHEAT TEST SWITCH (2 PLACES)
24 BODY HEATER TEMPERATURE GAGE (2 PLACES)
25 BODY HEATER OVERHEAT WARNING LIGHTS (3 PLACES)
26 HEATER OVERHEAT RESET SWITCH (2 PLACES)
27 MAIN CABIN TEMPERATURE GAGE (2 PLACES)
28 CONTROL CABIN TEMPERATURE GAGE (2 PLACES)
29 PRESSURE ALTIMETER G 22737 ▶
30 AIRSPEED INDICATOR G 3106 ▶
31 CABIN AIR FLOW INDICATOR (2 PLACES)
32 PROP DEICING INDICATORS
33 PROP DEICING SWITCH
34 PROP DEICING SYSTEM LOADMETER
35 MANIFOLD SELECTOR VALVE LEVER
36 MANIFOLD DISTRIBUTION VALVE LEVER

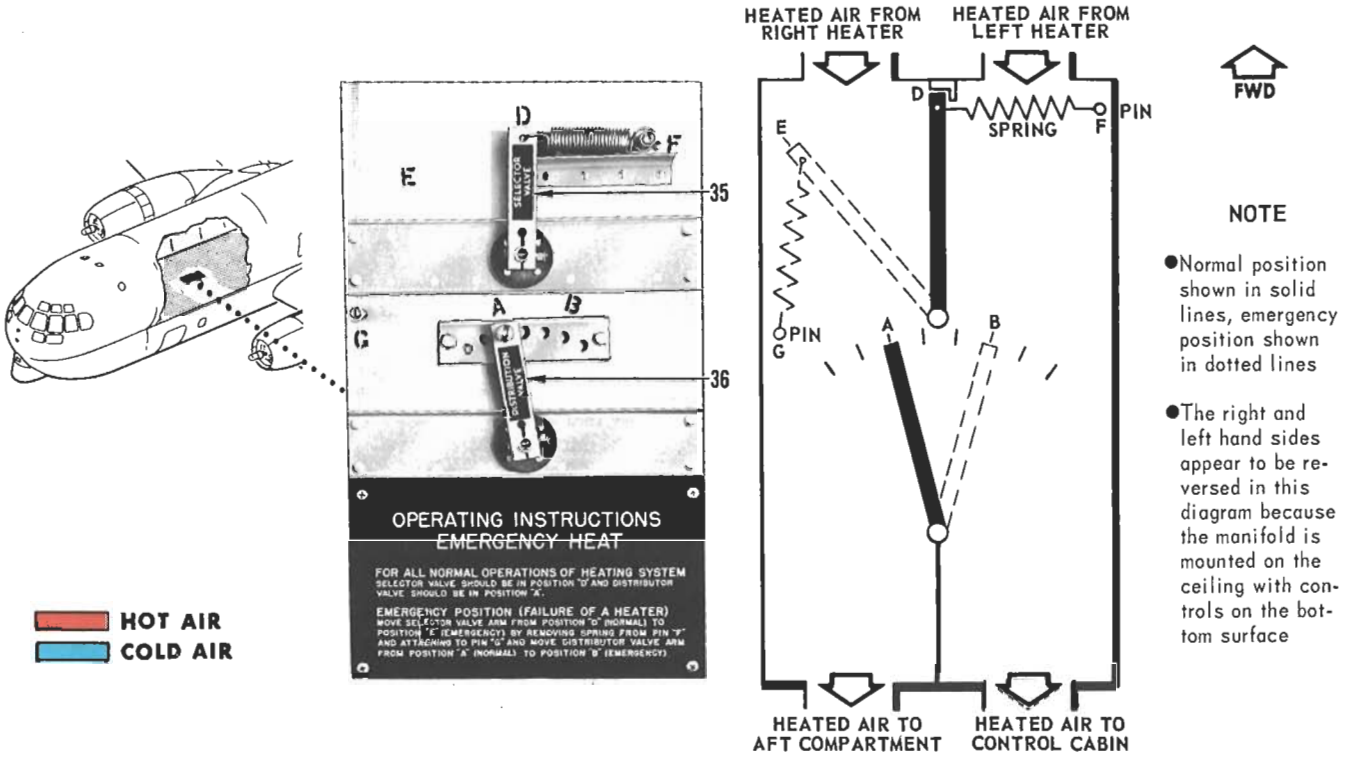


NOTE

Panels shown above are typical for F and G airplanes. For alternate control panel configurations, refer to figure 1-22.

AIR CONDITIONING AND ANTI-ICING CONTROLS

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

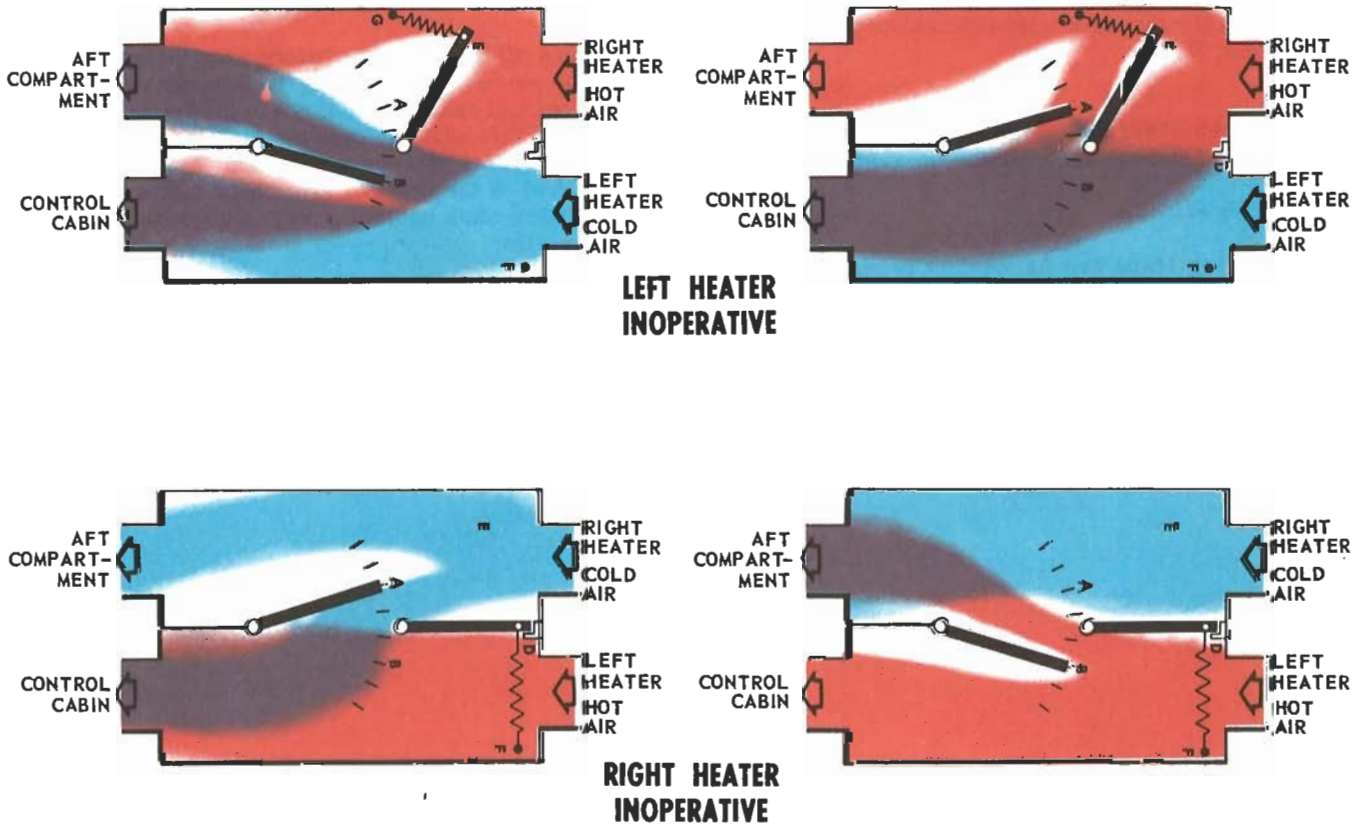


Figure 4-3 (Sheet 2 of 2)

Body Heaters Temperature Gage and Selector Switch

The outlet duct temperature of each of the body heaters is indicated in degrees Centigrade by a gage (24, figure 4-3) on the engineer's instrument panel. A L--R selector switch (22, 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 (figure 1-35, sheet 1).

Body Heater Overheat Warning Lights

Two red press-to-test lights (25, 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.

Heater Fuel Low Pressure Warning Light

An amber warning light (21, figure 4-3) on the engineer's instrument panel will illuminate 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 (figure 1-35, sheet 1).

CABIN PRESSURIZING, HEATING, AND VENTILATING SYSTEMS NORMAL OPERATION

Ground Operation

The following steps are necessary to obtain ground ventilation:

1. Check cabin air distribution manifold valve levers in their normal positions
2. Have external power connected to airplane, the APU operating, or the engines running
3. Electrical master switch ON
4. Air conditioning master switch ON
5. Cabin air selector switches FLIGHT GROUND AUTO F, or cabin air selector switches NORMAL G
6. Control cabin fan switches ON, if desired

With ground ventilation obtained, the following steps are necessary to obtain heating:

1. 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.

2. Have fuel pressure from No. 2 tank or manifold available
3. Move heat control rheostat into the HEAT range
4. Check that the body heater overheat warning lights are not illuminated
5. Check the heater fuel supply switch NORMAL
6. 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
7. Monitor the body heater temperature gage; the heaters should cycle at approximately 175°C
8. 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.

CAUTION

- 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 over rich mixture may not burn. Accumulation of 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 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 are the same as those used during ground operation. To set up pressurizing during flight, or on the ground before the start of a flight, the following steps should be used:

1. If possible, determine the cruise altitude and destination altitude before flight; decide on a cabin altitude for the flight
2. Check that all cabin openings are closed including the cabin pressure relief valve, cabin pressure release valve, and the cabin pressure check points (figure 4-4)

NOTE

Some cabin pressure check points can only be checked on the ground.

3. Check that the shutoff cocks on the cabin pressure regulators are open
4. 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.

5. Check that the heater overheat warning lights are not illuminated
6. During warmup set the cabin rate-of-change selector to the MAX position for at least 3 minutes, then return it to O; this will allow time for the cabin pressure regulators to adjust themselves to the cabin altitude selection
7. Turbo bleeder switches OPEN; check that cabin air flow comes within the green range
8. During flight, monitor the cabin altimeter, cabin vertical velocity indicator, and cabin air flow indicators; when changing the cabin altitude selector, first return the cabin rate-of-change selector to O, reset the cabin altitude selector, then reset the cabin rate-of-change selector
9. During let-down, select a cabin altitude slightly above destination station elevation so that the cabin will be unpressurized during landing

Shutdown

Shut down body heaters by positioning the body heater switches to OFF.

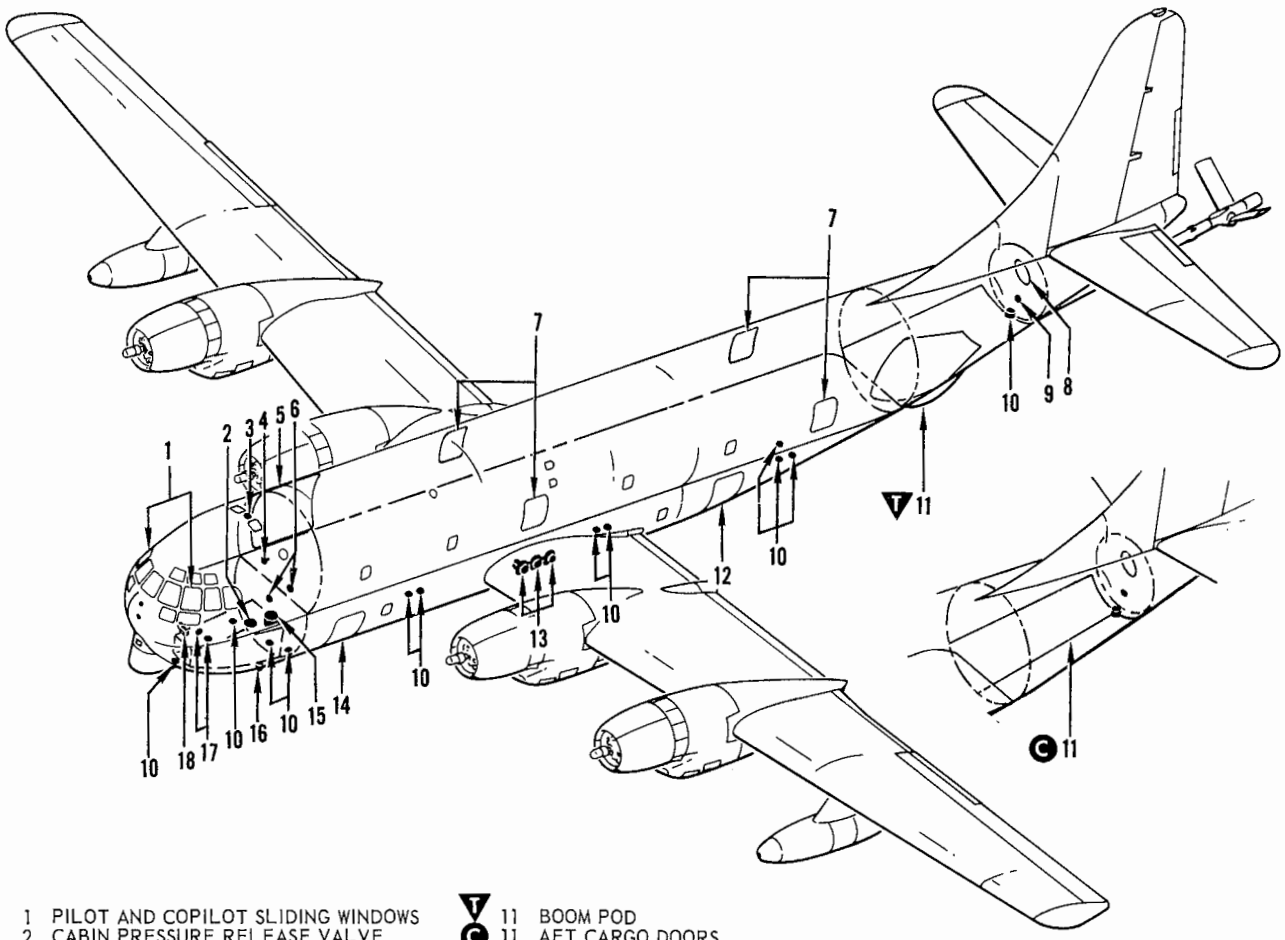
CAUTION

Heaters must be purged with air after being shutdown. 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 three 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 the 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.



1 PILOT AND COPILOT 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)
T 11 BOOM POD
C 11 AFT CARGO DOORS
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

Insufficient Pressure

In the event that cabin pressure falls below 19 inches Hg (12,000 feet indicated on the cabin altimeter), the following steps should be taken:

1. All crew members must use oxygen
2. Check air conditioning circuit breakers set on overhead circuit breaker panel and forward power panel
3. Check cabin openings for closure as shown in figure 4-4
4. Check that heater overheat warning lights are not illuminated
5. Check that the cabin air flow is within the green range; if flow is low, readjust power settings (if possible) to bring it into the green range
6. 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 pressure warning light illuminates, proceed as follows:
1. Check circuit breakers set
2. Position heater fuel supply switch to ALTERNATE
3. If fuel pressure is still low, check for fuel leaks in heater area
4. 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.

5. If the heater fuel low pressure warning light remains illuminated with boost pump in EMERGENCY, turn heater switches OFF and return boost pump switch to original position.

If a heater temperature is too low, proceed as follows:
1. Move the heat control rheostat to the maximum HEAT position
2. Check circuit breakers set
3. Actuate heater overheat reset switch to RESET
4. If heater does not come up to temperature, position the body heater switch for the 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:
1. If in pressurized flight, check cabin air flow
2. If in unpressurized flight, position the cabin air selector switches to RAM TURBO F or ALTERNATE G

If either body heater overheat warning light illuminates, proceed as follows:
1. Position the respective body heater switch OFF; this will prevent damage which could result if the heater lock-out circuit failed
2. Allow heater to cool
3. Check circuit breakers set
4. Reposition body heater switch to AUTO; actuate heater overheat reset switch to RESET
5. If heater still overheats, repeat procedure but reposition the body heater switch to EMERG after the cooling period
6. If heater still overheats, reposition body heater switch to OFF

If one of the body heaters cannot be retained in operation, proceed as follows for best equal heat distribution:
1. Move the distribution manifold selector valve lever from position D to position E by moving the spring from pin F to pin G
2. Move the distribution valve lever from position A to position B. See figure 4-3 for other combinations of heat distribution
3. Close turbo bleeds on inoperative heaters

Minor Smoke or Fume Elimination

The pilot will initiate the following procedures:
1. Set the cabin altitude selector to an altitude above the airplane altitude
2. Set cabin pressure rate-of-change selector on MAX
3. 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. See CABIN HEATING AND VENTILATING in 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 combustion. In addition to heating air for surface anti-icing, the wing heaters are also used for preheating the engines. See COLD WEATHER PROCEDURES in 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. See ENGINE PREHEAT SWITCH in this Section.

Anti-Ice Master Switch

This switch (5, 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 (figure 1-35, sheet 1).

Heater Fuel Valve Switches

These eight switches (10, 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 (figure 1-35). 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 see CABIN HEATING AND VENTILATING in this Section.

Limited Anti-Ice Switches

These two switches (4, 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 (figure 1-35, sheet 1).

Heater Overheat Test Switch

See CABIN HEATING AND VENTILATING in this Section for a description of this switch.

Heater Overheat Reset Switch

See CABIN HEATING AND VENTILATING in this Section for a description of this switch.

Wing Heater Ground Operation Switch or Balance Bypass Switch

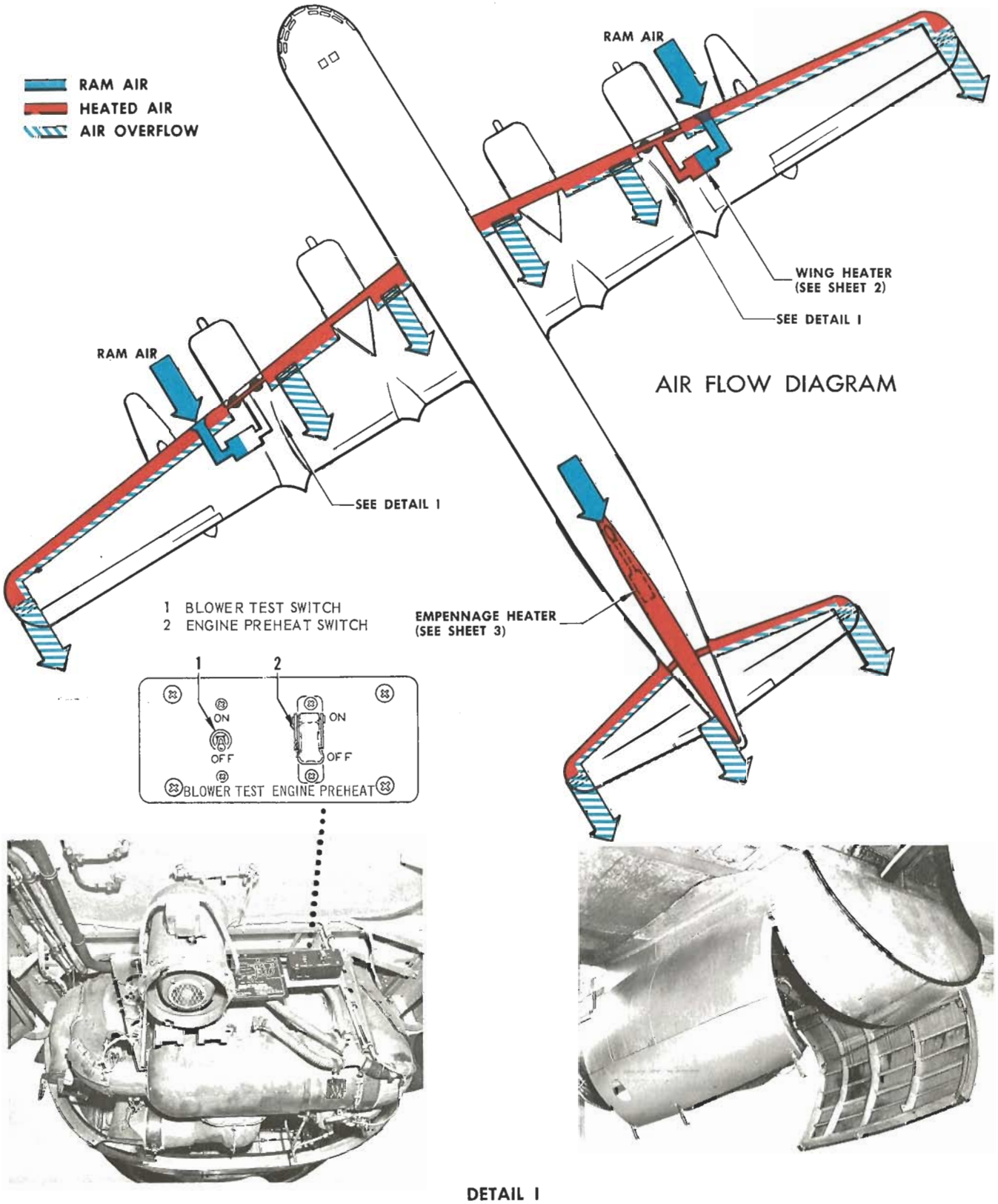
F and G 1243 ▶ 3195 less TCTO 515

G 3196 ▶ plus TCTO 515

The wing heater ground operation switch (6, figure 4-3), on the engineer's instrument panel, is spring-loaded to the OFF position. When the switch is held in the ON position, the differential pressure switches in the wing heater control circuits are bypassed. Holding the switch to ON allows the heaters to operate on a lower than normal air flow at a maximum duct temperature of 90°C. On airplanes G 3196 ▶ plus those incorporating TCTO 515, the ground operation switch is replaced by the balance bypass switch which 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 (figure 1-35, sheet 1).

Emergency Anti-Ice Switches

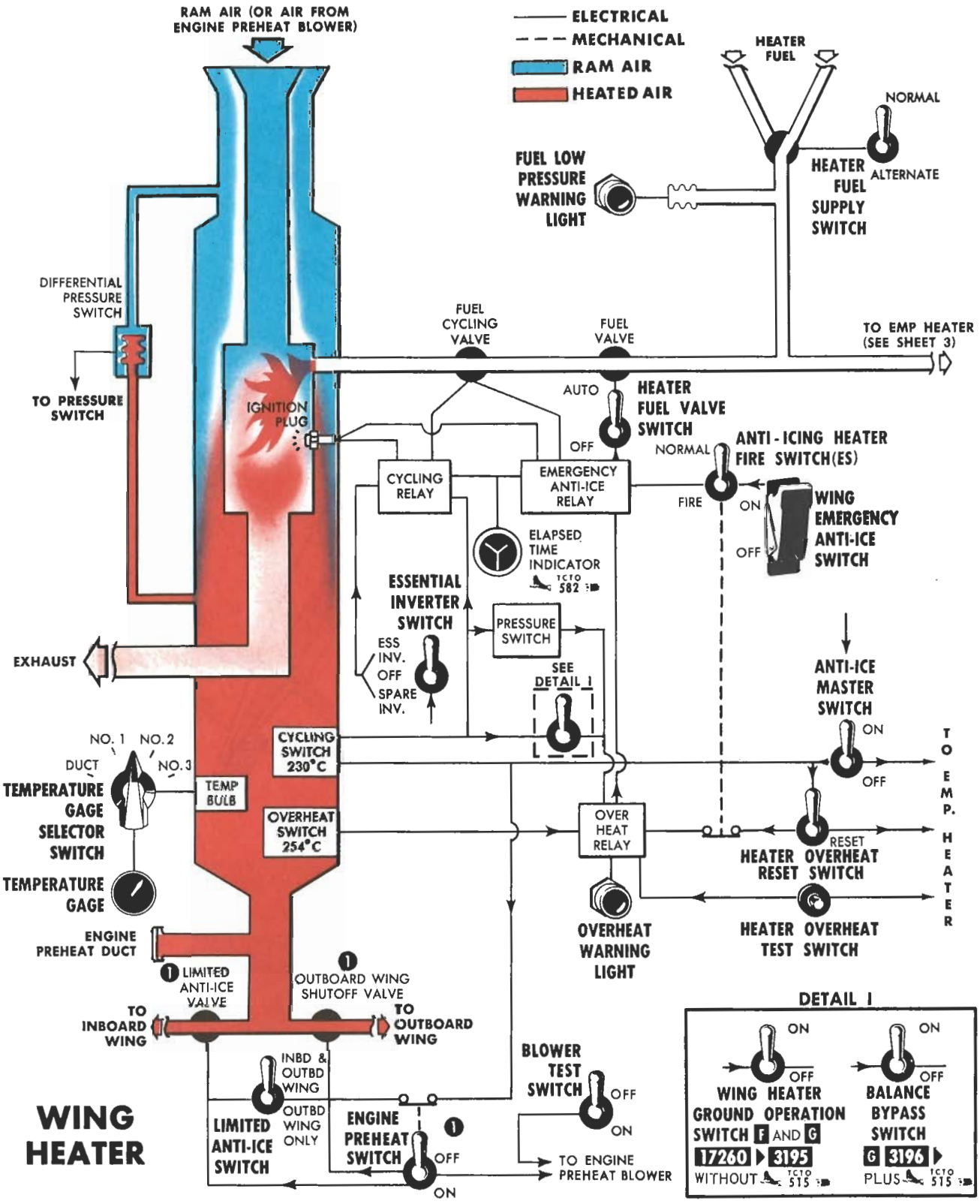
These two switches (3, figure 4-3) on the engineer's instrument panel, control emergency operation of the anti-icing system and are guarded to the OFF position. In the ON position, these switches directly operate the anti-icing systems for the wings and empennage by bypassing the lockout controls of 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 (figure 1-35, sheet 4).



DETAIL 1

WING AND EMPENNAGE ANTI-ICING DISTRIBUTION

Figure 4-5 (Sheet 1 of 3)



1 Limited anti-ice valve and outboard wing shutoff valve are closed when engine preheat switch is in ON position

WING AND EMPENNAGE ANTI-ICING DISTRIBUTION (CONT)

Figure 4-5 (Sheet 2 of 3)

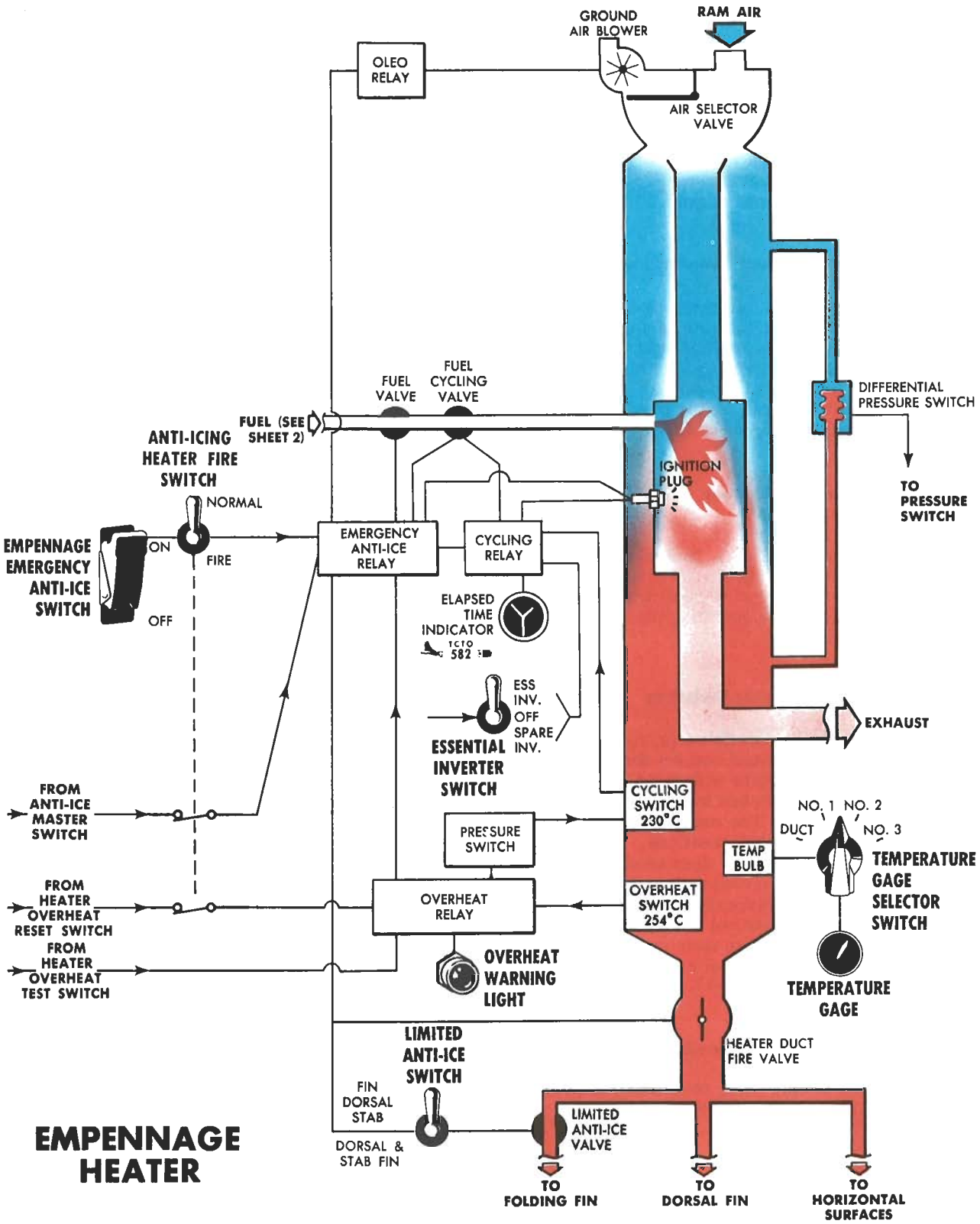


Figure 4-5 (Sheet 3 of 3)

Anti-Ice Heaters Overheat Warning Lights

Three red press-to-test lights (7, 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 test switch is depressed. The lights remain illuminated, even when the overheat condition has been eliminated, until the heater overheat reset switch is actuated. The warning lights are protected by circuit breakers on the overhead circuit breaker panel (figure 1-35, sheet 1).

Anti-Icing Heater and Duct Temperature Gages

Three temperature gages (8, 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 (figure 1-35, sheet 1).

Wing and Empennage Heaters Elapsed Time Indicators

Airplanes incorporating TCTO 582 have 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 selector switches (9, figure 4-3) on the engineer's instrument panel connect duct and heater temperature sensing circuits with their temperature indicators. 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 indicator is on the overhead circuit breaker panel (figure 1-35, sheet 1).

Heater Fuel Low Pressure Warning Light

For a description of this light see CABIN HEATING AND VENTILATING in this Section.

Engine Preheat Switch

These switches (2, figure 4-5), one in each outboard nacelle, have two positions: ON and OFF. Placing the switch ON, turns on the engine preheat blower and closes the wing anti-icing valves. The blower supplies the high volume of air required by the wing heater for combustion; and, the wing anti-icing valves 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 de-energizes the blower and opens the wing anti-ice valves. Each switch receives power through a circuit breaker on the respective nacelle solenoid panel.

Blower Test Switch

The engine preheat blowers in the outboard nacelles can be tested with the blower test switches (1, figure 4-5). The switch is spring-loaded to OFF. Holding the switch in the ON position energizes the blower. The test 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.

- 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.

1. Position heater fuel supply switch to NORMAL
2. Position all heater fuel switches to AUTO
3. Position wing limited anti-ice switch to INBD & OUTBD WING, and empennage limited anti-ice switch to FIN DORSAL STAB
4. Position anti-ice master switch to ON

NOTE

Check each heater and duct temperature frequently during operation. Turn OFF the heater fuel switch for any heater that approaches the maximum temperature limit, or any heater indicating an unusually low temperature.

5. If a heater overheat warning light illuminates during operation, check all heater temperatures, and turn OFF the fuel switch for any heater near the maximum temperature limit. Use the overheat reset switch to start the remaining heaters of that system
6. If the heater fuel low pressure warning light illuminates, position the heater fuel supply switch to ALTERNATE
7. If the light remains illuminated, turn a No. 2 boost pump switch, or a boost pump switch for any other tank set to MANIFOLD to EMERGENCY

CAUTION

Operation of boost pumps in EMERGENCY should be limited to prevent extreme shortening of boost pump life.

8. If the heater fuel low pressure warning light remains illuminated, turn all heater fuel valve switches 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:
1. Operate the outboard engines at 2000 rpm or above
2. Hold the wing heater ground operation switch ON while operating the heaters F G without TCTO 515, or hold the balance bypass switch ON while operating the heaters G 3196 ▶ and F G with TCTO 515
3. Operate the heaters as in flight operation

To operate the wing heaters for preheating the engines refer to COLD WEATHER PROCEDURES in Section IX.

CAUTION

When operating heaters on the ground, be sure that heaters are purged after heater shutdown by maintaining 2000 rpm for two 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 wing heater ground operation switch on airplanes F G without TCTO 515, or balance bypass switch on airplanes G 3196 ▶ and F G with TCTO 515.

SURFACE ANTI-ICING SYSTEM EMERGENCY OPERATION

Flight Operation

1. Place emergency anti-ice switches to ON
2. Turn all heater fuel valve switches to AUTO
3. Check heater temperatures frequently, since there are no overheat lockout controls in the emergency circuits
4. Manually cycle any heater approaching the maximum temperature limit

If the heater fuel low pressure warning light illuminates, proceed as follows:
1. Check circuit breakers set
2. Position heater fuel supply switch to ALTERNATE
3. If operation of the anti-icing systems is necessary, turn a No. 2 fuel tank boost pump switch, 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.

4. 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 airplane outboard engines, use external auxiliary 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 prop blade heating elements using d-c 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

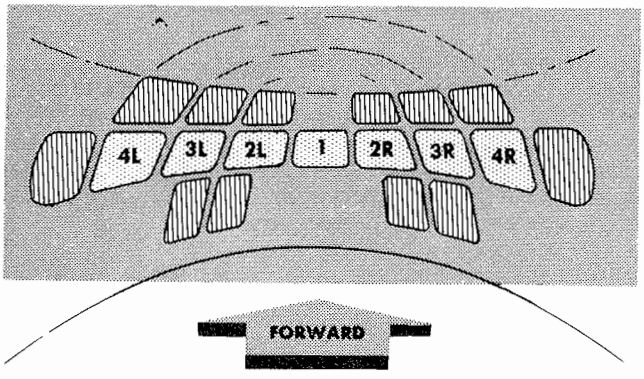
This switch (7, figure 1-12), on the overhead panel on F airplanes or on the engineer's instrument panel on G airplanes, operates the propeller deicing system. In the ON position, current from the timer energizes relays which furnish power from the nacelle solenoid panels to the blade heating elements. In the OFF position, the propeller deicing system is inoperative. The circuit breaker is on the overhead circuit breaker panel (figure 1-35, sheet 1).

Propeller Deicing Indicators

Two indicators (65, figure 1-22) 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
F G 1243 ▶ 22628 with TCTO 534
Propeller Deicing Loadmeter
G 22629 ▶

A meter for the propeller deicing system (66, figure 1-22), on the engineer's instrument panel, indicates the amount of current going through the circuit. On airplanes F G 1243 ▶ 22628 the instrument is graduated in amperes and on airplanes G 22629 ▶ the instrument 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 (figure 1-35, sheet 5).



HEATED WINDOWS (CONTROL CABIN)

Figure 4-6

PROPELLER DEICING SYSTEM OPERATION

Flight Operation

Place the propeller deicing switch in the ON position and check propeller deicing indicators occasionally for proper cycling. (The normal cycle is two minutes long, each propeller being heated for thirty seconds.) On airplanes having either an ammeter or loadmeter, 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

On airplanes having either propeller deicing ammeter or loadmeters, pull the appropriate propeller deicing circuit breaker if any one propeller deicing meter reading deviates from the average by more than 20 amperes. 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

When the airplane engines are not running, do not operate the propeller deicing system as serious damage to the propeller blades may result.

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 this 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. See WINDOW DEFROSTING CONTROL KNOB in this Section.

Window Heat Selector Switch

This switch (2, figure 1-21) 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 (figure 1-35) 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. On ▼ airplanes, 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. The IFR (Air Refueling) EMER position should not be used on ● airplanes. 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 knob (9, figure 1-11), 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 ▼

This switch (14, figure 4-72), 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 switch 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 windows 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 are 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 v dc heating elements in each of the two pitot heads.

Pitot Heat Switches

Airplanes F G 1243 ▶ 3141 less those incorporating ICIO 292 have two ON--OFF switches (36, figure 1-12) on the overhead panel to operate the pitot heaters. The left switch controls the pitot heater in the pilot's airspeed indicating system, and the right switch controls the pitot heater in the copilot's airspeed indicating system. Power is supplied from the 28 volt DC bus and circuit protection is through the switches, which are circuit breaker type. On airplanes G 3142 ▶ plus those incorporating ICIO 292, the pilot's pitot heater switch has EMER--OFF--NORM positions. When in the EMER position, power is supplied from the battery bus. Circuit protection is provided for this switch by circuit breakers on the forward power panel (figure 1-35, sheet 4).

PITOT HEAD ANTI-ICING SYSTEM OPERATION

In flight, turn the pitot heaters on by turning pitot heat switches to ON (or NORM, as applicable). To prevent burning out the heater element, ground operation of the pitot heaters should be limited to brief maintenance checks and extreme cold weather ground operation.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

WARNING

- Due to high voltages within electronic equipment, do not attempt inflight maintenance of electronic equipment beyond checking circuit breakers and fuses. Locations of all electronic equipment circuit breakers can be determined from figure 1-35 and figure 4-40.

▽● Do not operate unnecessary electrical or electronic equipment during air refueling.

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 crew member's interphone control panel. A master d-c radio and radar power circuit breaker is on the forward power panel (figure 1-35, sheet 4). Circuit protection for radio a-c circuits is on the a-c power panel (figure 1-35, sheet 3).

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.

INTERPHONE (AN/AIC-8) (AN/AIC-10)

F 1243 ▶ 1371
F G 1372 ▶

Airplanes F 1243 ▶ 1371 have AN/AIC-8 interphone equipment and airplanes F G 1372 ▶ have AN/AIC-10 interphone equipment. The AIC-8 and AIC-10 have different control panels and related equipment; however, the function of the controls and the operating procedures for each interphone is the same. 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 crew members, transmission and reception on the liaison, MF command, 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 crew members. The auxiliary interphone panels are located in the nose wheel well, at the rear wing spar, APU, overwing emergency exit hatches, left scanner's station, boom

operator's compartment (or aft cargo door C), the A/R hydraulic panel on airplanes G 22665 ▶, and the right scanner's station on airplanes G 17260 ▶ 22664. Control power is 28 volt DC with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

Interphone Controls

F 1243 ▶ 1371

NORMAL--SINGLE REC SWITCH. This switch (12, figure 4-8), on the AN/AIC-8 interphone control panel, allows only one receiving channel to be heard when in the SINGLE REC position. When more than one interphone mixer switch is in the ON position, the signals take priority in the following order: VHF COMM, LIAISON, HF COMM, INTER, UHF, ADF 1, ADF 2, MARKER and VHF NAV. The switch should normally be in the NORMAL position.

F G 1372 ▶

NORMAL--AUXILIARY LISTEN SWITCH. Each AN/AIC-10 interphone control panel has a NORMAL--AUX 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 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.

F 1243 ▶ 1371

INTERPHONE SELECTOR SWITCH. A rotary selector switch (7, figure 4-8) on the AN/AIC-8 interphone control panel is for the selection of one facility for talking and listening. Switch markings are CALL--INTER--HF COMM--LIAISON--VHF COMM. On airplanes incorporating TCTO K527, the HF COMM position is marked UHF COMM. Rotating the selector 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 must be held in the CALL position to talk and released to INTER to listen. INTER position allows communication between all crew stations. The HF COMM position is for receiving on the BC-454 receiver and transmitting either voice or code on the MF command radio on airplanes less TCTO K572. On airplanes incorporating TCTO K527, the UHF COMM position is used to transmit and receive on the UHF radio. The LIAISON position selects reception of the BC-348 receiver and permits transmission on liaison radio. The VHF COMM position allows the operator to receive on the VHF radio and transmit when his respective mike switch is depressed.

F G 1372 ▶

INTERPHONE SELECTOR SWITCH. A rotary 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--LIA--COMM VHF--COMM MF. Rotating the selector 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 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 crew members 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. COMM MF allows voice transmission or code transmission and reception on the MF command radio on airplanes less TCTO K572. The copilot and navigator are provided with a key for code transmission.

F 1243 ▶ 1371

INTERPHONE MIXER SWITCHES. These switches (1, 2, 3, 4, 5, 9, 10, 11 and 13, figure 4-8) are all on the AN/AIC-8 interphone control panel. The switches are marked ADF 1--ADF 2--HF COMM--MARKER--VHF NAV--UHF--INTER--LIAISON--VHF COMM. When the NORMAL--SINGLE REC switch (12, figure 4-8) is on NORMAL, the ON position of any of the above mentioned mixer switch mixes the audio signal

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
INTERPHONE (AN/AIC-8) F 1243 ▶ 1371 (AN/AIC-10) F G 1372 ▶	Intercrew Communication and use with other radio equipment	All crew members	Intraplane only except when used in conjunction with other equipment	All crew stations. Call boxes located at various positions in airplane	
VHF RADIO (AN/ARC-3)	Short range, two-way voice and code communication	Pilot	Up to 135 NAM at 10,000 feet, characterized by line-of-sight conditions	Control stand	Remote tuning on 8 channels
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. On airplanes F G 1243 ▶ 3177 less TCTO 600, master control at navigator's station Airplanes G 3178 ▶ less TCTO 600 have master control on radio rack	1750 frequencies can be selected manually
UHF DIRECTION FINDER (AN/ARA-25) G 3178 ▶ PLUS TCTO 321	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
LIAISON RADIO (AN/ARC-8) F [TRANSMITTER (T-47/ART-13) RECEIVER (BC-348)]	Long range, two-way voice and code communications	Radio Operator	Range depends upon transmitting frequency and conditions. Up to several thousand miles	Radio Operator's Station	
LIAISON RADIO (AN/ARC-21) G AIRPLANES WITHOUT TCTO 1-1-666	Long range, two-way voice and code communications	Copilot	Range depends upon transmitting frequency and conditions. Up to several thousand miles	Control stand	20 preset channels. CW & MCW keying provided for copilot. Key on copilot's auxiliary panel.
LIAISON RADIO (AN/ARC-65) G AIRPLANES WITH TCTO 1-1-666	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	20 preset channels. CW & MCW keying provided for copilot, Key on copilot's auxiliary panel. Either amplitude modulation (AM) or single sideband (SSB) operation
MF COMMAND RADIO F LESS TCTO K572 **[TRANSMITTER (T-47/ART-13) RECEIVER (BC-454)]**	Long range two-way voice and code transmission	Pilot	Range depends upon transmitting frequency and conditions. Up to several thousand miles	Control stand	

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

Figure 4-7 (Sheet 1 of 3)

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
MF COMMAND RADIO (AUX LIAISON) TRANSMITTER (AN/ART-13) G LESS TCTO K572	Long range voice and code communication	Navigator	Range depends upon transmitting frequency and conditions. Up to several thousand miles	Navigator's station	Used as an auxiliary liaison and special transmitter for rendezvous
LIAISON RECEIVER (BC-348) G LESS TCTO K572 OR LIAISON RECEIVER (AN/ARR-36) G LESS TCTO K572		Navigator (BC-348) Pilot (ARR-36)	Reception depends upon power of transmitting station and conditions	Main radio rack (BC-348) overhead panel (ARR-36)	For additional monitoring requirements
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
UHF NAVIGATION RADIO (TACAN) (AN/ARN-21) TCTO 572	Provides continuous bearing and distance data to ground beacon	Pilot	195 NAM 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 pilot's instrument panel. Requires N-1 compass data.
DINGHY TRANSMITTERS (AN/CRT-3A)	Emergency transmitter to send signals when forced down	Any crew member	Range depends upon transmitting frequency, location, etc. Up to several thousand miles maximum under ideal conditions at 8364KC. 200-300 miles optimum on 500 KC	Stowed forward of life raft supports in main compartment	
RADIO ALTIMETER (SCR-718C)	Indicates distance from airplane to surface	Navigator	0-40,000 feet	Navigator's Station	
LORAN (AN/APN-9) F	Indicates mapping fixes	Navigator	Up to 1400 NAM depending upon conditions and time of day	Navigator's Station	
LORAN (AN/APN-70) G	Provide accurate fixes for navigation	Navigator	Up to 1400 NAM depending upon conditions and time of day	Navigator's station	

Figure 4-7 (Sheet 2 of 3)

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
IFF (AN/APX-6) WITHOUT TCTO 590 **(AN/APX-25)** WITH TCTO 590	Airplane Recognition (Identification Friend or Foe)	Radio Operator F Navigator G 17260 ▶ 2900 G 3340 ▶ Pilot G 2901 ▶ 3339	Line-of-sight	Navigator's Station F Navigator's station G 17260 ▶ 2900 G 3340 ▶ pilot's station G 2901 ▶ 3339	
SEARCH RADAR (AN/APS-42)	Search and navigation radar	Navigator	205 NAM maximum	Navigator's Station	For obstacle detection and navigation
T **RADAR BEACON (AN/APN-69)**	Sends signals to other airplane for rendezvous	Navigator	Up to 205 NAM (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
T **RENDEZVOUS RADAR (AN/APN-12)**	Rendezvous radar transmitter-receiver	Navigator	Up to 350 NAM	Navigator's Station	Sends signals to and receives signals from AN/APN-76 transponder in other airplane or ground station
T **RENDEZVOUS RADAR (AN/APN-76)** LESS TCTO K572	Rendezvous radar transponder	Navigator	Up to 350 NAM	Navigator's Station	Sends signals to approaching airplane when triggered by signals from AN/APN-12 radar in 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 rudder-vators and boom nozzle hood	

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT (CONT)

Figure 4-7 (Sheet 3 of 3)

from the respective receiver separately or simultaneously with the output from the interphone selector switch. This allows the crew member to monitor incoming signals from the various equipment without changing the interphone selector switch position. The MARKER mixer switch on the navigator's panel is also used to monitor the APN-69 radar beacon tone. On airplanes incorporating TCTO 572, the VHF NAV mixer switch (11, figure 4-8) has been changed to VHF TACAN NAV (13, figure 4-8) to permit reception of the identity code transmitted by the selected TACAN station. However, the reception of VOR (Omni) or TACAN signals is also dependent upon the position of the instrument select switch (18, figure 4-23). When the NORMAL--SINGLE REC switch is on SINGLE REC and more than one mixer switch is ON, the mixer switch with the highest priority will pass a signal. For mixer switch priority, see NORMAL--SINGLE REC SWITCH this Section.

F G 1372 ▶

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 crew member 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 the VHF COMM mixer switch allows audio signals from the VHF radio receiver 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--AUX REC--MARKER--APN-76 MONITOR--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 pilot's stations and only on airplanes incorporating TCTO 572. The APN-76 MONITOR mixer switch on airplanes G 3142 is only on the navigator's panel.

F 1243 ▶ 1371

INTERPHONE VOLUME KNOB. This knob (8, figure 4-8) on the AN/AIC-8 interphone control panel controls the volume of all signals heard in the headset except for transmission on CALL.

F G 1372 ▶

INTERPHONE VOLUME KNOB. A volume knob (8, figure 4-8) on the AN/AIC-10 interphone control panel and 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 except on the auxiliary interphone control panel which normally should be set to maximum clockwise position. The volume levels of the various equipment connected to the interphone should then be set for comfortable listening using the individual equipment volume controls.

F G 1372 ▶

LOUDSPEAKER SWITCH. Loudspeakers at each of the major crew stations are turned on and off by an ON--OFF switch (17, 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 regardless of the airplane altitude. With the switch OFF, no sound will be heard through the loudspeakers, unless a signal is originated using the CALL function.

F 1243 ▶ 1371

INTERPHONE AND MICROPHONE JACKS. These jacks (15 and 16, figure 4-8) are on the AN/AIC-8 interphone call boxes. They connect headsets and microphones to the interphone.

AUXILIARY INTERPHONE CALL BUTTON. The function of the CALL button (14, figure 4-8) on the auxiliary interphone 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 crew member 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 press-to-talk switch.

CONTROL WHEEL MIKE SWITCH. This switch (20, figure 4-8) is on the pilots' control wheels. When the switch is depressed, the respective crew member's mike is connected to the facility selected by the interphone selector switch. The switch allows the crew member to listen and talk over the interphone or the selected radio without removing his hands from the control wheel to operate switches on the control panel.

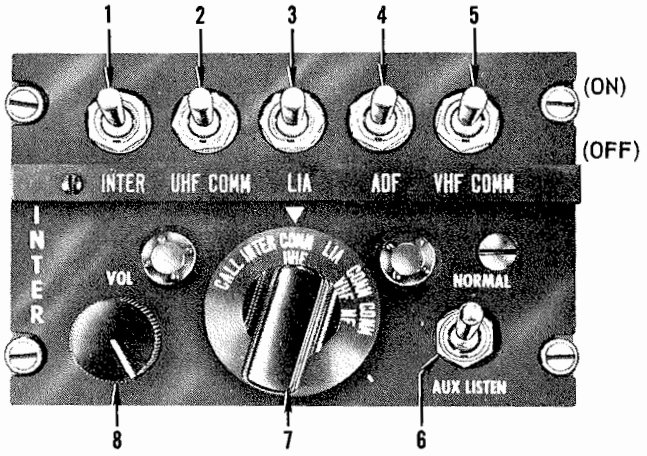
FOOT MIKE SWITCHES. On airplanes F G 1243 ▶ 3177 there are three foot-operated mike switches (7, figure 4-9) on the floor at the navigator's, engineer's, and radio operator's stations for their use. On airplanes G 3178 ▶, there are two foot mike switches at the navigator's station. When the foot switch 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. This five-position rotary filter switch (21, 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.

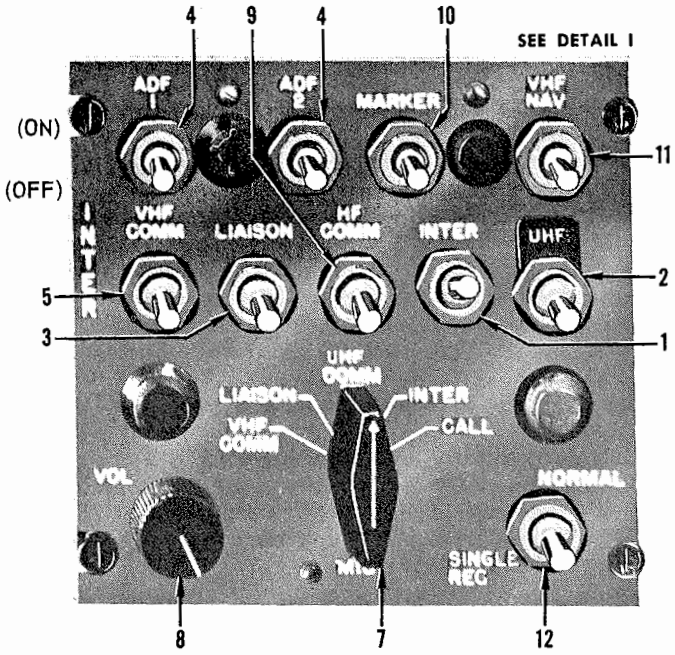
Normal Operation of the Interphone

INTERCOMMUNICATIONS. Communication between crew members may be accomplished as follows:

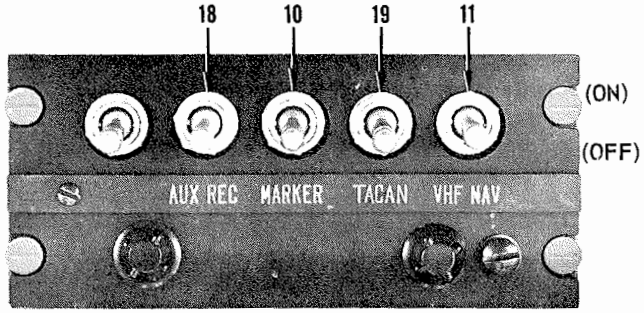
1. Place the NORMAL--SINGLE REC switch (or NORMAL--AUX LISTEN switch, if applicable) on the in-



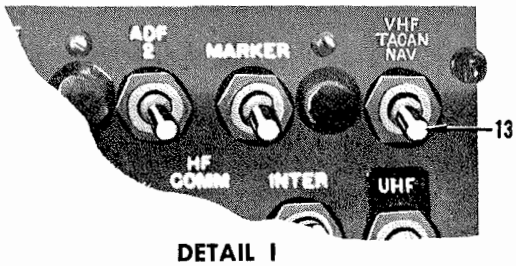
AN/AIC-10 INTERPHONE CONTROL PANEL F G 1372 ▶



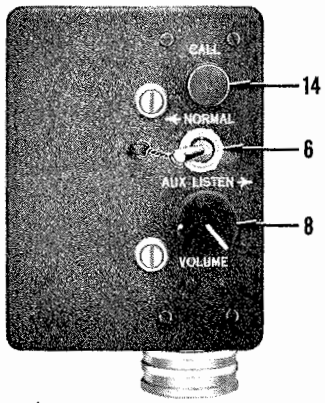
AN/AIC-8 INTERPHONE CONTROL PANEL
F 1243 ▶ 1371



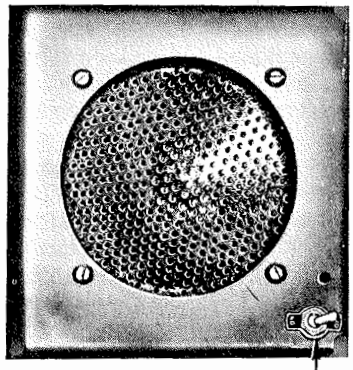
AN/AIC-10 INTERPHONE MIXER SWITCH PANEL (TYPICAL) F G 1372 ▶



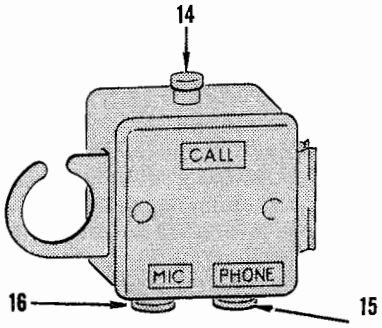
DETAIL I



AN/AIC-10 AUXILIARY INTERPHONE CONTROL PANEL
F G 1372 ▶



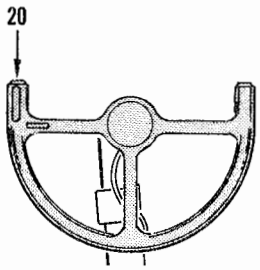
LOUDSPEAKER
F G 1372 ▶



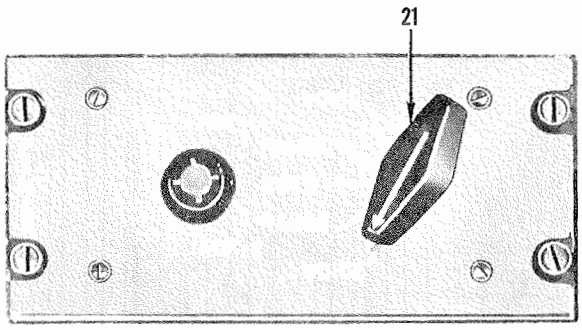
AN/AIC-8 INTERPHONE CALL BOX
F 1243 ▶ 1371

INTERPHONE CONTROL PANELS

Figure 4-8 (Sheet 1 of 2)



CONTROL WHEEL (PILOT'S SHOWN)



RADIO RANGE FILTER CONTROL PANEL

1 INTERPHONE MIXER SWITCH (2 PLACES)
2 UHF RADIO MIXER SWITCH (2 PLACES)
3 LIAISON RADIO MIXER SWITCH (2 PLACES)
4 RADIO COMPASS (ADF) MIXER SWITCH (3 PLACES)
5 VHF RADIO MIXER SWITCH (2 PLACES)
6 NORMAL--AUXILIARY LISTEN SWITCH (2 PLACES)
7 INTERPHONE SELECTOR SWITCH (2 PLACES)
8 INTERPHONE VOLUME KNOB (3 PLACES)
9 MF COMMAND (HF COMMAND) RADIO MIXER SWITCH
(1) 10 MARKER BEACON MIXER SWITCH (2 PLACES)
11 VHF NAVIGATION RADIO (VOR) MIXER SWITCH (2 PLACES) AIRPLANES WITHOUT TCTO 572
12 NORMAL--SINGLE REC SWITCH
13 VHF NAVIGATION RADIO (VOR) /UHF NAVIGATION RADIO (TACAN) MIXER SWITCH AIRPLANES WITH TCTO 572
14 AUXILIARY INTERPHONE CALL BUTTON (2 PLACES)
15 INTERPHONE HEADSET JACK
16 MICROPHONE JACK
17 LOUDSPEAKER SWITCH
18 "AUXILIARY" LIAISON RADIO RECEIVER MIXER SWITCH
19 UHF NAVIGATION RADIO (TACAN) MIXER SWITCH AIRPLANES WITH TCTO 572
20 CONTROL WHEEL MIKE SWITCH
21 RADIO RANGE FILTER SWITCH

NOTE

(1) The MARKER BEACON mixer switch on navigator's AN/AIC-8 interphone control panel is also the APN-69 MONITOR mixer switch.

Figure 4-8 (Sheet 2 of 2)

terphone 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 crew members

2. The pilot or copilot may communicate with other stations by depressing his control wheel mike switch. The navigator and flight engineer may use the foot switch to permit use of their mike. Volume of signals received may be regulated by the volume knob

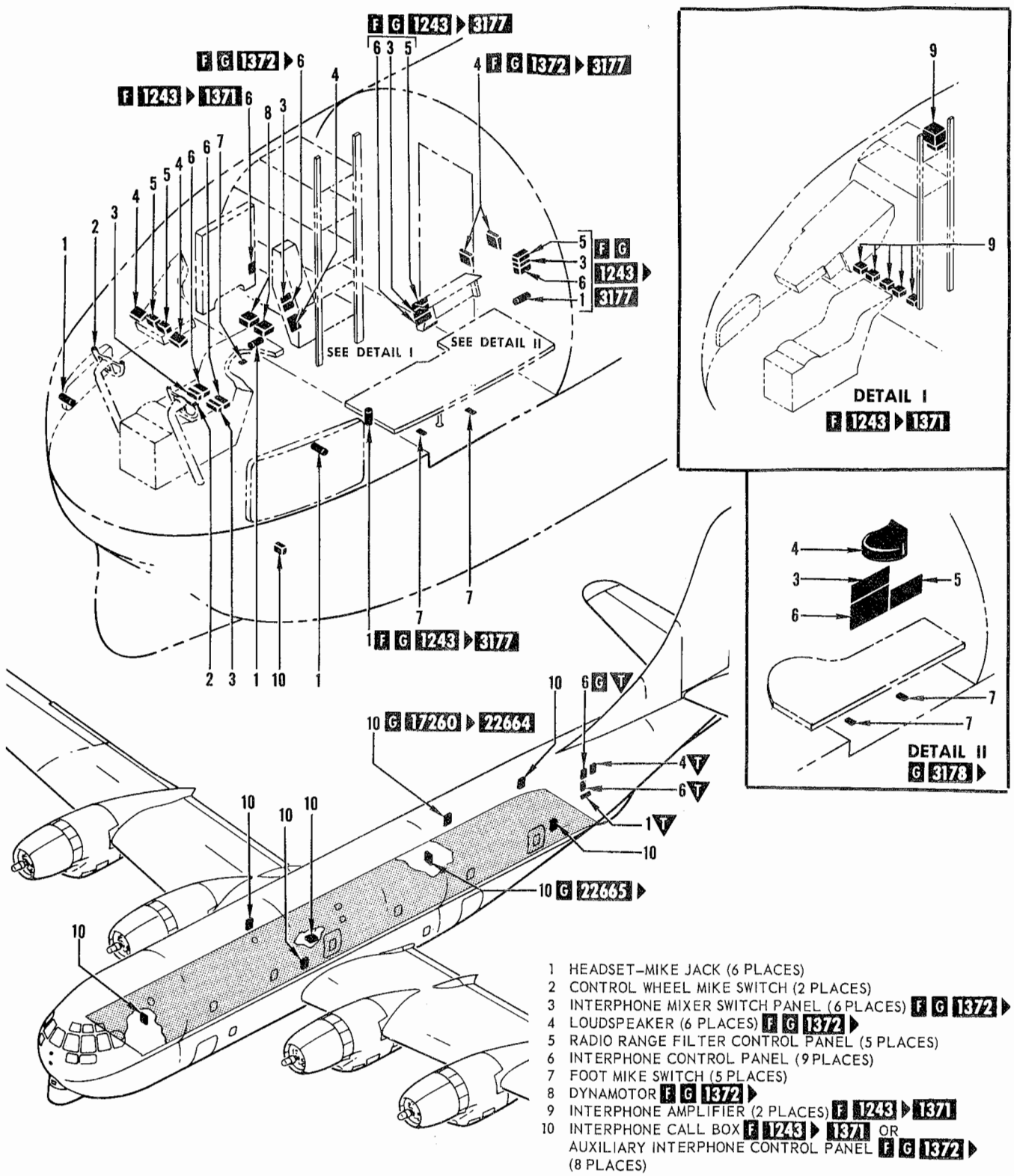
3. Call all crew members from the pilot's or copilot's station by depressing the control wheel mike switch on the pilots' control wheel or by placing the pilots' interphone selector switch to CALL. Call by other crew members may be made by positioning their interphone selector switch to CALL. Call from 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:

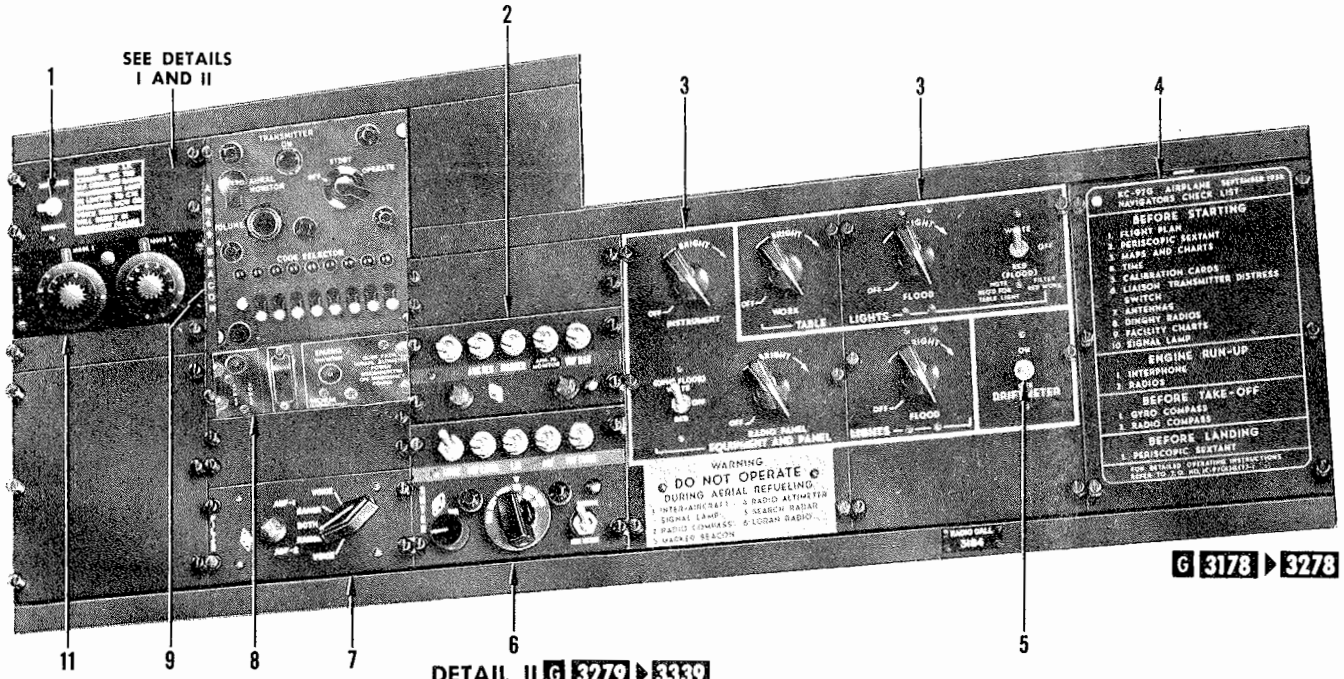
1. The command radios as well as intercommunication between crew members may be heard by placing the proper mixer switch marked UHF COMM or VHF COMM to ON. The pilot and copilot may transmit over a command radio by positioning the interphone selector switch to the desired command radio and using their mike switch on the control wheel. When transmitting, the crew member 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



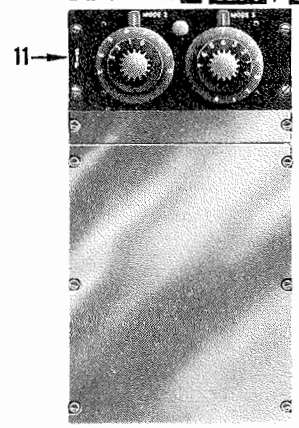
1 HEADSET–MIKE JACK (6 PLACES)
2 CONTROL WHEEL MIKE SWITCH (2 PLACES)
3 INTERPHONE MIXER SWITCH PANEL (6 PLACES) F G 1372 ▶
4 LOUDSPEAKER (6 PLACES) F G 1372 ▶
5 RADIO RANGE FILTER CONTROL PANEL (5 PLACES)
6 INTERPHONE CONTROL PANEL (9 PLACES)
7 FOOT MIKE SWITCH (5 PLACES)
8 DYNAMOTOR F G 1372 ▶
9 INTERPHONE AMPLIFIER (2 PLACES) F 1243 ▶ 1371
10 INTERPHONE CALL BOX F 1243 ▶ 1371 OR AUXILIARY INTERPHONE CONTROL PANEL F G 1372 ▶ (8 PLACES)

INTERPHONE EQUIPMENT LOCATIONS

Figure 4-9



DETAIL II G 3279 ▶ 3339



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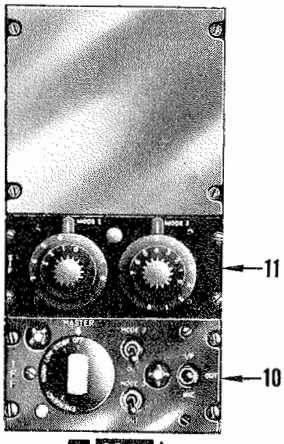
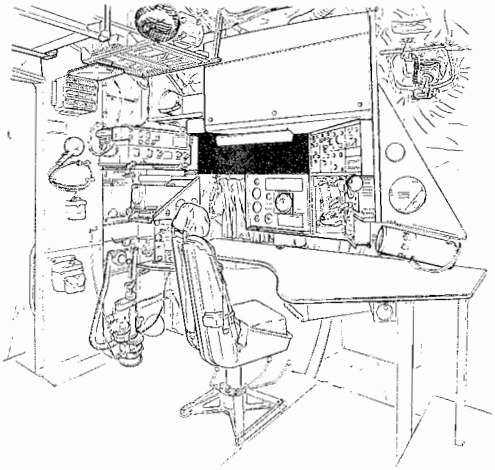


G 3340 ▶



1 AUXILIARY LIAISON NORMAL/MONITOR SWITCH G 3178 ▶ 3278
2 INTERPHONE MIXER SWITCH PANEL (SEE FIGURE 4-8)
3 LIGHT SWITCHES (2 PLACES)
4 NAVIGATOR'S CHECKLIST
5 DRIFTMETER SWITCH
6 INTERPHONE CONTROL PANEL (SEE FIGURE 4-8)
7 RADIO RANGE FILTER CONTROL PANEL (SEE FIGURE 4-8)
8 RADAR BEACON POWER CONTROL PANEL AN/APN-69 (SEE FIGURE 4-34)
9 RADAR BEACON CONTROL PANEL AN/APN-69 (SEE FIGURE 4-34)
10 IFF CONTROL PANEL (SEE FIGURE 4-30) G 3340 ▶
11 SIF CODER CONTROL PANEL (3 PLACES) (SEE FIGURE 4-32) TCTO 590

NAVIGATOR'S INTERPHONE AND LIGHT PANELS

G 3178 ▶

Figure 4-10

crew member may receive command conversation by placing his interphone selector switch to the desired command position. The crew members may also listen to other facilities while receiving command radio (selected by the interphone selector in the desired command position) by positioning the desired mixer switch in the ON position

2. 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 crew member 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

3. Liaison radio reception may be heard separately by positioning the interphone selector switch to LIA. All crew members may transmit over a liaison radio by placing their respective interphone selector switches to LIA and using their mike switch. On airplanes incorporating TCTO K527, the command mike switch must be positioned to LIAISON also.

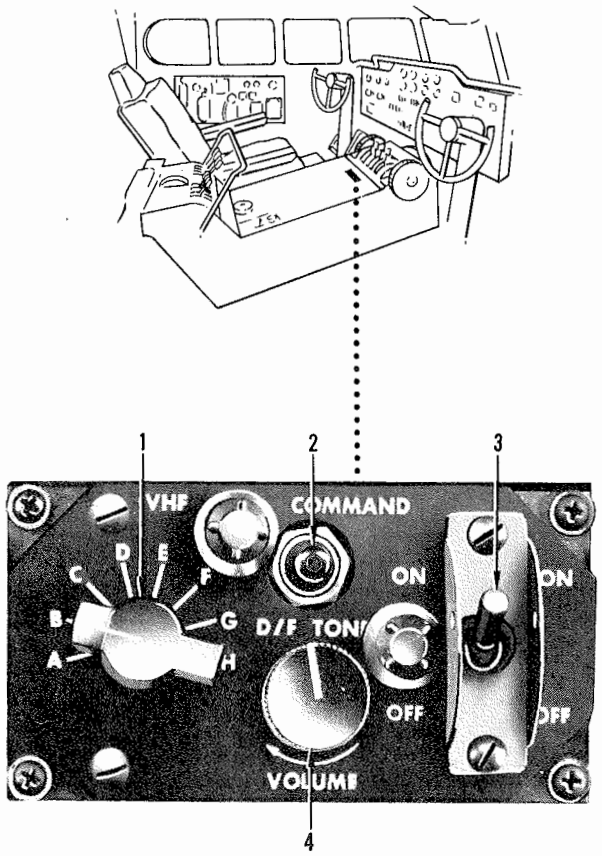
Emergency Operation of the Interphone

To contact all stations in an emergency:

1. The pilot or copilot will position his interphone selector switch to CALL
2. Other crew members place their interphone selector switch to CALL
3. A crew member 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. Place NORMAL--SINGLE REC switch in SINGLE REC position (or the NORMAL--AUXILIARY LISTEN switch in AUX LISTEN, if applicable)
2. Place all mixer switches in OFF position and turn interphone selector switch to the desired listening facility
3. 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--SINGLE REC SWITCH (or NORMAL--AUXILIARY LISTEN SWITCH) in this Section for priority of switches



VHF RADIO CONTROL PANEL

NOTE

The command mike switch (14, figure 4-12) also controls the VHF radio on airplanes without TCTO K527.

1 CHANNEL SELECTOR SWITCH
2 D/F TONE BUTTON
3 VHF POWER SWITCH
4 VHF VOLUME KNOB

VHF RADIO CONTROLS

Figure 4-11

VHF RADIO (AN/ARC-3)

The VHF radio is for air to air or air to ground voice or modulated code communications. Range of the equipment is characterized by line-of-sight and by atmospheric conditions. The set operates in a frequency range of 100 to 156 megacycles. Eight crystal controlled channels are provided and may be selected at a control panel (figure 4-11) on the control stand. Channelization crystal changes are possible and only limited to the availability of crystals in the sets frequency range. The radio is turned on and off with the power switch on the control panel. Since the radio is connected to the interphone, the interphone selector switch and mixer switch must be in the appropriate COMM VHF position to transmit or receive. Control power is 28 volt dc with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2). Additional circuit protection for the set is provided by fuses on the VHF power junction box (J-68/ARC-3) on top of the main radio rack.

VHF Radio Controls

VHF POWER SWITCH. The VHF radio is turned on and off by positioning the power switch (3, figure 4-11) on the VHF radio control panel, to the desired position.

CHANNEL SELECTOR SWITCH. A channel selector switch (1, figure 4-11) on the VHF radio control panel is for selection of one of the eight lettered channels available. The switch has positions marked A through H.

D/F TONE BUTTON. In addition to supplying a tone for direction-finding purposes, this button (2, figure 4-11) on the VHF radio control panel may be used as a key when MCW operation is desired. Maximum keying speed is limited to approximately 15 words per minute.

VHF VOLUME KNOB. A volume knob (4, figure 4-11) on the VHF radio control panel is to adjust the sound level through the interphone.

Normal Operation of the VHF Radio

The VHF radio can be operated from any crew station that has an interphone control panel; however, the channelization and power are controlled at the pilots' station only. Operation of the set is as follows:

1. Place the power switch ON
2. Ascertain that selector switch on interphone control panel is on COMM VHF
3. Allow 30 to 45 seconds for set to reach normal operating temperature
4. Test set for sidetone by pressing the microphone switch
5. Release microphone switch. Place channel selector switch on any desired channel. The receiver will continuously monitor selected channel
6. Adjust sound level with the VHF volume knob. Clockwise rotation increases volume. Counterclockwise rotation decreases volume
7. To turn the set off, position the power switch to OFF

NOTE

To select proper VHF crystals when crystal charts are not available, the following procedure will be used:

1. Transmitter - To find the proper transmitter crystal for a particular channel, divide the desired operating frequency by 18.
2. Receiver - The proper receiver crystal for a particular channel will be determined in the following manner:

$$FC = \frac{FO - 12}{H}$$

FC = Crystal Frequency
FO = Operating Frequency Desired
H = Harmonic

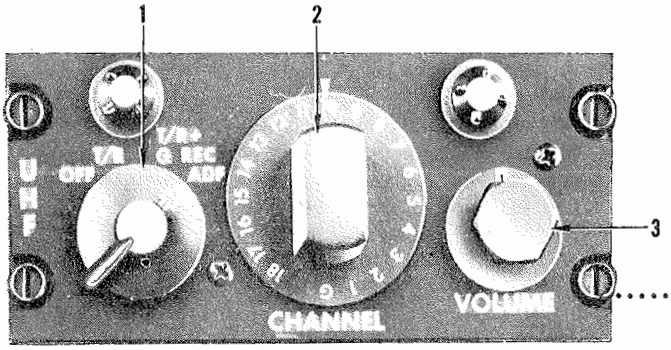
The correct value of (H) is given in the following table:

Operating Frequency (MCS)	Receiver Harmonic (H)
100 - 108	11
108 - 116	12
116 - 124	13
124 - 132	14
132 - 140	15
140 - 148	16
148 - 156	17
156 -	18

The receiver thumb wheel setting for each channel must be set on the desired operating frequency.

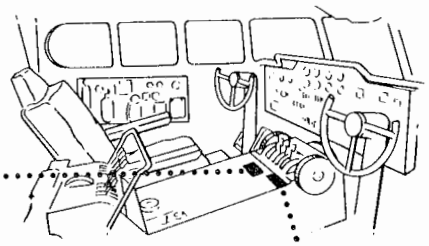
Emergency Operation of the VHF Radio

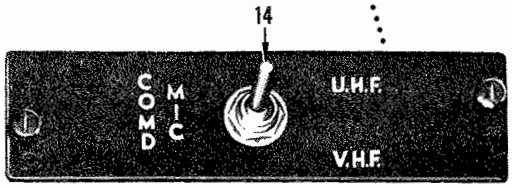
If an obstruction has caused the defective operation of a desired channel, place the channel selector switch to a different frequency and return immediately to the desired channel. This will often correct the difficulty. A crystal failure on one frequency will not affect all frequencies.



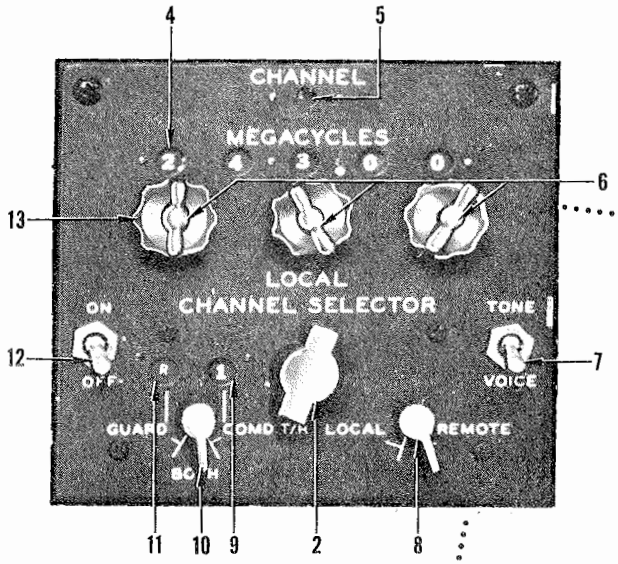
UHF RADIO (REMOTE) CONTROL PANEL

AIRPLANES WITHOUT TCTO 600



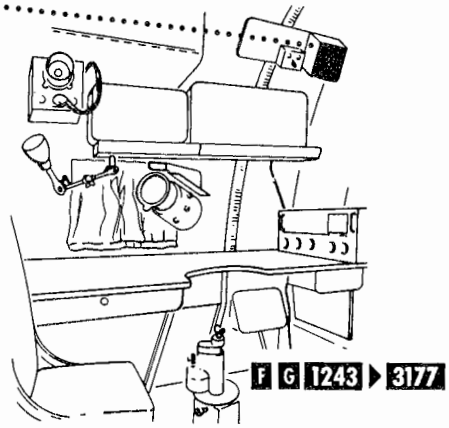


F 1243 ▶ 1371 WITHOUT TCTO K527

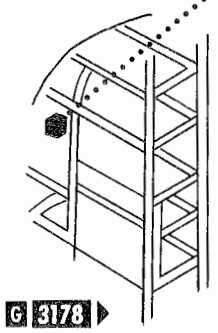


UHF RADIO MASTER CONTROL PANEL

AIRPLANES WITHOUT TCTO 600



F G 1243 ▶ 3177



G 3178 ▶

1 PILOTS' UHF OPERATION SWITCH (2 PLACES)
2 CHANNEL SELECTOR SWITCH (3 PLACES)
3 VOLUME KNOB (2 PLACES)
4 FREQUENCY WINDOW (2 PLACES)
5 CHANNEL WINDOW
6 FREQUENCY SELECTOR KNOBS (2 PLACES)
7 TONE--VOICE SWITCH
8 CONTROL TRANSFER SWITCH
9 CHANNEL SELECTOR WINDOW
10 MASTER UHF OPERATION SWITCH
11 GUARD RECEIVER MODE WINDOW
12 UHF POWER SWITCH
13 FREQUENCY SELECTOR KNOB LOCK SCREW
14 COMMAND MIKE SWITCH LESS TCTO K527

UHF RADIO CONTROLS

Figure 4-12 (Sheet 1 of 2)

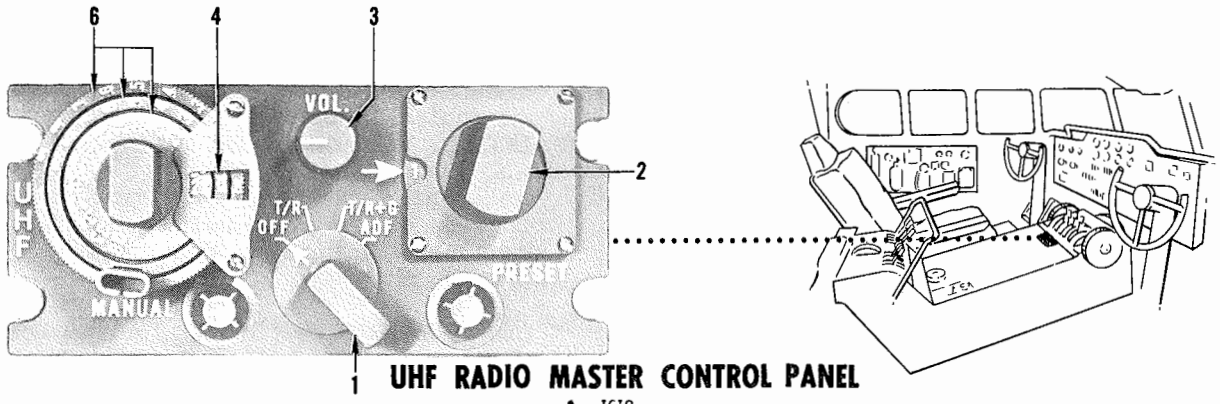


Figure 4-12 (Sheet 2 of 2)

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-slight distances. There are three types of panels to control operation of the radio. Airplanes without TCTO 600 have two separate panels, a remote control panel for the pilots and a master control panel at the navigator's station (airplanes F G 1243 ▶ 1371) or on the main radio rack (airplanes G 3178 ▶). (See figure 4-12, sheet 1.) The radio can be operated from either one of the two panels but not from both panels simultaneously. The position of the control transfer switch on the master control panel determines which panel has control. Airplanes incorporating TCTO 600 have one master control panel on the control stand at the pilots' station. (See figure 4-12, sheet 2.) The master control panel (all airplanes) 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 18 preset channels (20 channels on airplanes with TCTO 600) can have any frequency within the operating capability of the set. Refer to CHANGING PRESET FREQUENCIES in this Section. The master control panel on airplanes without TCTO 600 has a provision for transmitting a continuous tone for direction finding by other stations. On airplanes F G 1372 ▶ plus those incorporating TCTO 527 , 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). To connect the radio to the interphone on airplanes F 1243 ▶ 1371 less those incorporating TCTO 527 , the interphone selector switch is positioned to VHF COMM and the command mike switch (14, figure 4-12) placed on UHF. Reception of the UHF receiver is also heard when the UHF radio mixer switch (2, figure 4-8) is ON (up). On airplanes G 3178 ▶ plus those incorporating TCTO 321 , the UHF radio is a component of the direction finder (UHF/DF) AN/ARA-25. Refer to DIRECTION FINDER in this Section. Control power for the radio is 28 volt DC with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

UHF Radio Controls

UHF OPERATION SWITCH. Each UHF radio control panel has a UHF operation selector switch (1 and 10, figure 4-12) for selecting different transmitting and receiving operations. The switch on the control panel at the pilots' station has four positions and, on airplanes without TCTO 600 , the switch on the master control panel has three positions. See figure 4-13 for an explanation of the switch positions.

FREQUENCY SELECTOR KNOBS. The UHF radio master control panel has three knobs (6, figure 4-12) for manually selecting one of the 1750 different operating frequencies. The knobs are effective when the channel selector switch (2, figure 4-12) on the master control panel is on "M." The knobs are positioned so that the numbers of the desired frequency appear in the frequency window (4, figure 4-12). On airplanes without TCTO 600 , the frequency selector knobs are also used to change the preset frequencies. Refer to CHANGING PRESET FREQUENCIES in this Section.

CHANNEL SELECTOR SWITCH. The channel selector switch (2, figure 4-12) on each type of UHF radio control panel is different. On airplanes without TCTO 600 , the switch has channel positions numbered from 1 to 18 for selection of one of the preset frequencies. The switch on the remote control panel (pilots' station) has a "G" position to select the guard frequency for both transmission and reception. The selector switch on the master control panel has an "M" position to permit manual selection of a frequency (without affecting a preset frequency) with the frequency selector knobs (6, figure 4-12). The position of the control transfer switch (8, figure 4-12) determines which of the two channel selector switches is operative. Refer to CONTROL TRANSFER SWITCH in this Section. The channel selector switch on airplanes incorporating TCTO 600 has numbered positions from 1 to 20 for 20 preset channels plus the "G" and "M" positions described above.

OPERATOR	OPERATION SWITCH POSITION	EQUIPMENT OPERATION
PILOT	OFF	Primary power off (on airplanes without TCTO 600, power is off if control transfer switch is in REMOTE)
	T/R	Transmitter on standby, main receiver on. ADF on standby
	T/R + G REC	Transmitter on standby, main receiver on, guard receiver on. ADF on standby
	On airplanes G 3178 plus TCTO 321 ADF	ADF (AN/ARA-25) antenna connected, ADF operation ready

On airplanes without TCTO 600

NAVIGATOR	GUARD	Transmitter on guard channel in standby. Main receiver on guard channel. Guard receiver off
	COMD T/R	Transmitter on standby. Main receiver on. Guard receiver in standby
	BOTH	Transmitter on standby. Main receiver on, guard receiver on

OPERATION SWITCH POSITIONS

Figure 4-13

UHF VOLUME KNOB. A volume knob (3, figure 4-12) on the control panel at the pilots' station adjusts the audio signal level from the receiver to the interphone.

Airplanes without TCTO 600

UHF POWER SWITCH. The power switch (12, figure 4-12) on the UHF radio master control panel has two positions: ON and OFF. Placing the switch ON supplies power to operate the radio from the master control panel. Turning the switch OFF de-energizes the radio if the control transfer switch (8, figure 4-12) is on LOCAL. With the control transfer switch on REMOTE, placing the power switch OFF de-energizes some controls at the master control panel. Refer to CONTROL TRANSFER SWITCH in this Section.

Airplanes without TCTO 600

TONE--VOICE SWITCH. There is a two-position TONE--VOICE switch (7, figure 4-12) on the UHF radio master control panel. The switch is operative when the control transfer switch (8, figure 4-12) is on LOCAL. The switch must be on VOICE to transmit voice communications. With the switch on TONE, the transmitter sends a continuous tone so that other stations can determine the bearing of the airplane with their direction finding equipment.

Airplanes without TCTO 600

CONTROL TRANSFER SWITCH. A two-position switch (8, figure 4-12), marked LOCAL--REMOTE, on the UHF master control panel is for transfer of control of the radio. When the switch is on LOCAL, all of the switches on the master control panel are operative and all of the switches on the pilots' panel are inoperative. Placing the switch on REMOTE transfers control of the radio by making the pilots' panel operative and some of the controls on the master control panel inoperative. Regardless of which panel has control, any crew member can transmit and receive on the selected frequency when his interphone selector switch (7, figure 4-8) is on COMM UHF.

COMMAND MIKE SWITCH. On airplanes not incorporating TCTO K527, the command mike switch (13, figure 4-11) on the control stand has two positions: UHF and VHF. The switch is used to connect either the UHF radio or the VHF radio to the interphone. Transmission and reception on the selected radio is then controlled by using the VHF COMM position of the interphone selector switch. The selected radio is also heard when the VHF COMM interphone mixer switch is ON. On airplanes with TCTO K527, the switch is marked LIAISON--HF COMM. For these airplanes, the switch connects either the liaison radio (ART-13 & BC-348 at the radio operator's station) or the MF command radio (ART-13 & BC-454 on the radio rack) to the interphone. Operation on either the liaison or MF command radio is made with the interphone selector switch on LIAISON.

UHF Radio Indicators

Airplanes without TCTO 600

FREQUENCY WINDOWS. There are five frequency windows (4, figure 4-12) on the UHF radio master control panel. The numbers in the windows indicate the selected frequency of the transmitter and main receiver.

Airplanes without TCTO 600

CHANNEL WINDOW. A window (5, figure 4-12) on the UHF master control panel indicates the channel to which the transmitter and receiver are tuned. The number appearing in the window is the number of the preset channel selected on the panel which has control.

Airplanes without TCTO 600

GUARD RECEIVER MODE WINDOW. A window (11, figure 4-12) on the UHF radio master control panel indicates the operation of the guard receiver. When the navigator's UHF operation switch is placed in the GUARD position, the symbol T/R will appear in the window. This indicates that both the transmitter and main receiver will transmit and receive only on the frequency of the guard channel. When the switch is placed in the BOTH position, the letter R appears in the window. This indicates that the guard receiver is on and will receive signals transmitted on the guard frequency while the main receiver-transmitter is operating on any other frequency. When the switch is placed in the COMD T/R position, the word OFF appears in the window. This indicates that the guard receiver is off but the main transmitter and receiver are on and will operate on the frequency selected by the channel selector switch.

Airplanes without TCTO 600

CHANNEL SELECTOR WINDOW. A window (9, figure 4-12) on the UHF radio master control panel indicates the channel selection of the channel selector switch. Also when the navigator's UHF operation switch is in the GUARD position, the word OFF appears in the window indicating that the main transmitter and receiver will not be operating on a channel selected by the channel selector switch on the master control panel.

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 only at either the pilots' or navigator's position, depending upon the position of the control transfer switch and the type of control panel installed.

Airplanes without TCTO 600

Operation of the radio from the master control panel (transfer switch in the LOCAL position) is as follows:

1. Place the UHF power switch (12, figure 4-12) to the ON position

CAUTION

Allow at least one minute for the set to warm-up before operating to preclude damage to the equipment. Warmup time should be extended when voltage input is below normal.

2. Place the interphone controls to the desired position for UHF radio operation
3. Select mode of operation with the master UHF operation switch. See figure 4-13 for possible modes
4. Select desired channel with channel selector switch on master control panel. Preset frequency will appear in frequency windows (4, figure 4-12). Channel number selected will also appear in window next to channel selector and at the top center of the panel
5. If some frequency other than those preset is desired, select M with channel selector switch. Turn frequency selector knobs until desired frequency appears in the frequency windows
6. In normal operation, the tone--voice switch is in VOICE. In TONE position, the radio set transmits a continuous tone

Pilot operation of the UHF radio is as follows:

1. On airplanes without TCTO 600, place control transfer switch on REMOTE
2. Select mode of operation desired with pilots' UHF operation switch (1, figure 4-12)
3. Select preset channel with the channel selector switch on the UHF control panel at the pilots' station. This switch has a "G" position which sets transmitter and main receiver to guard frequency. On airplanes with TCTO 600, the channel selector switch has an "M" position to make the frequency selector knobs operative.
4. Adjust volume to desired level

NOTE

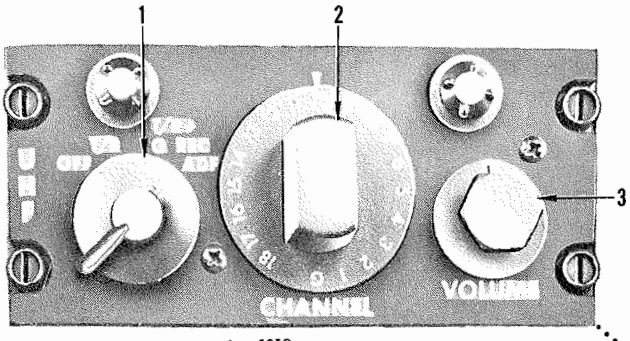
Tone modulation is not available from UHF control panel on the control stand or on airplanes with TCTO 600.

5. If the radio is to be turned off, turn pilots' UHF operation switch to OFF. On airplanes without TCTO 600, it is necessary to turn UHF power switch to OFF if the control transfer switch is in the LOCAL position.

CHANGING PRESET FREQUENCIES. On airplanes incorporating TCTO 600, the frequency of a preset channel can only be changed by removing the control panel at the pilots' station. 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 (6, figure 4-12). On airplanes without TCTO 600, the frequency of a preset channel can be changed at the master control panel. To change a frequency: (1) Set the channel selector switch (2, figure 4-12), on the panel that has control, to the number of the channel being changed; (2) Loosen the frequency selector knob lock screws (13, figure 4-12); (3) Rotate the frequency selector knobs (6, figure 4-12) until the numbers of the desired frequency appear in the frequency windows (4, figure 4-12); (4) Tighten the frequency selector knob lock screws; and (5) Enter the frequency on the frequency chart.

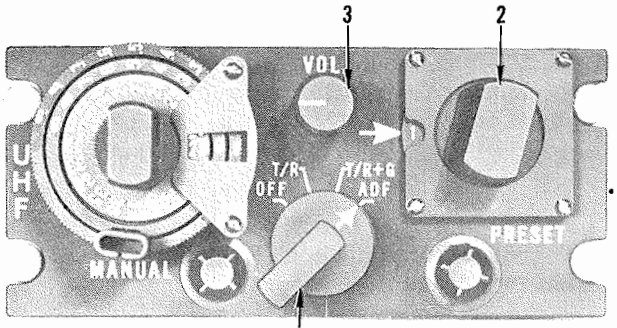
Emergency Operation of the UHF Radio

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 on the master control panel to "M" and adjust the knobs to the desired frequency.

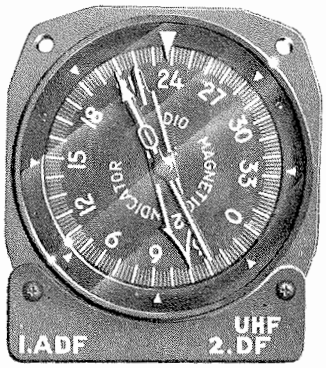


AIRPLANES WITHOUT TCTO 600

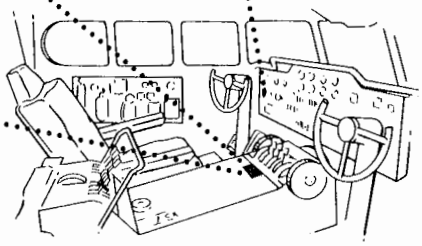
UHF RADIO CONTROL PANEL



AIRPLANES WITH TCTO 600



RADIO MAGNETIC INDICATOR (RMI) (TYPICAL)



* 1 PILOTS' UHF OPERATION SWITCH (2 PLACES)
2 CHANNEL SELECTOR SWITCH (2 PLACES)
3 VOLUME KNOB (2 PLACES)

* THIS SWITCH MUST BE IN ADF POSITION IN ORDER TO ALLOW DIRECTION FINDER TO FUNCTION

UHF DIRECTION FINDER CONTROLS

G 3178 ▶ PLUS TCTO 321

Figure 4-14

DIRECTION FINDER (AN/ARA-25)

G 3178 ▶ plus TCTO 321

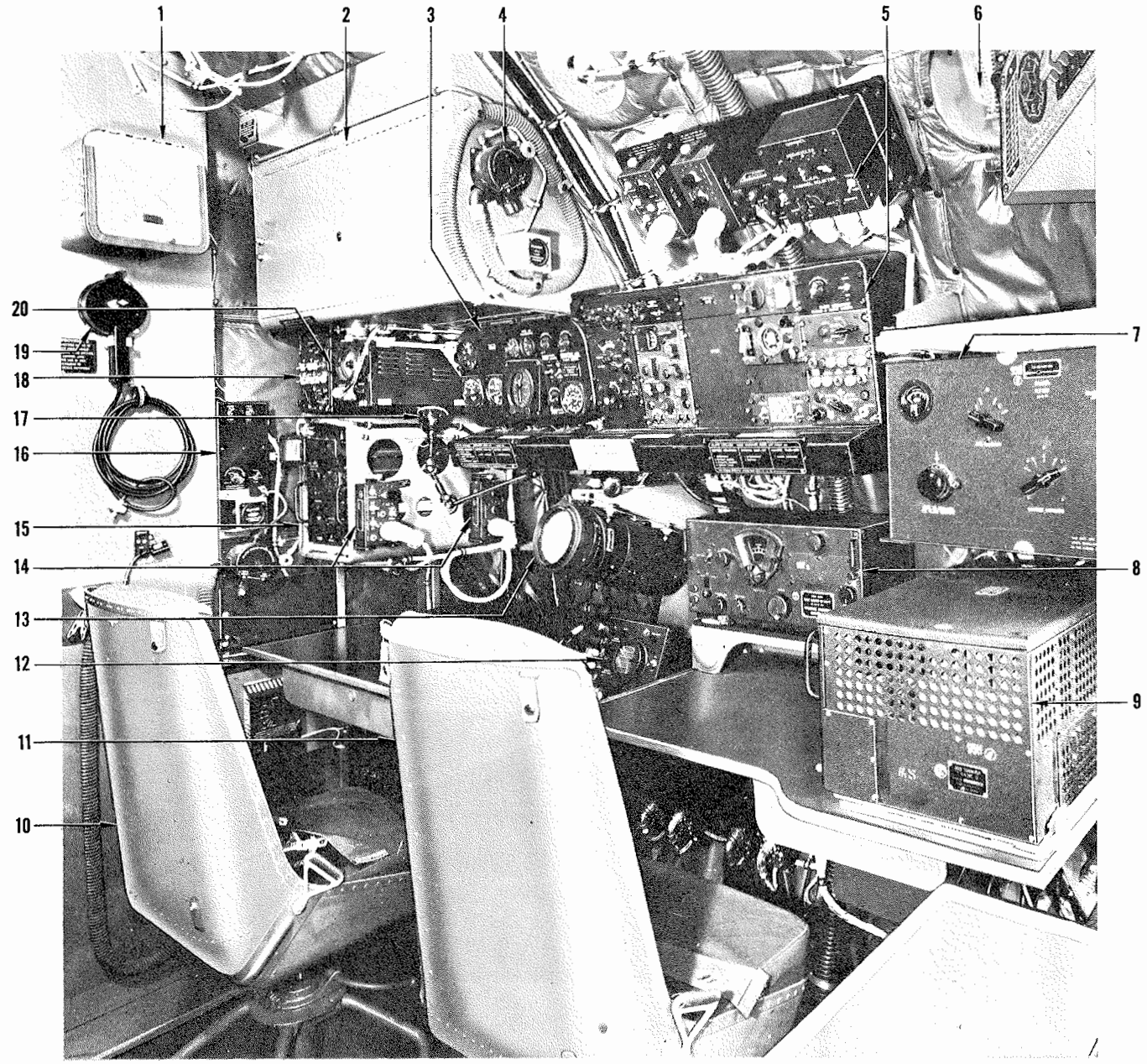
The direction finder indicates the relative bearing of radio signals in the frequency range of 225 to 400 megacycles. The signals are received by the UHF command radio set (AN/ARC-27), using the direction finder antenna. The direction finder is controlled from the UHF radio control panel when the pilot's UHF operation switch (1, figure 4-14) is positioned to ADF. Bearing of the received signal is indicated by the No. 1 bearing indicator of the pilots' UHF D/F radio magnetic indicator (RMI) (15, figure 1-9) on airplanes not incorporating TCTO 572. On airplanes with TCTO 572 the bearing indication is displayed on the No. 2 bearing indicator of RMI's marked 1. ADF--2. UHF DF. Control power is 28 volt DC with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

Normal Operation of the Direction Finder

G 3178 ▶ plus TCTO 321

The direction finder (AN/ARA-25) is made operative by the following procedure:

1. Rotate pilots' UHF operation switch to ADF as shown in figure 4-14. (On airplanes without TCTO 600, the control transfer switch on the UHF radio master control panel must be in REMOTE)
2. Select the desired frequency with the channel selector switch
3. Allow 3 minutes warmup period if the pilots' UHF operation switch was in OFF
4. If the direction finder is being used for homing, fly the airplane to keep the UHF D/F bearing indicator of the radio magnetic indicator under the reference index at the top of the instrument.
5. 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 D/F bearing indicator of the radio magnetic indicator.
6. 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 REC

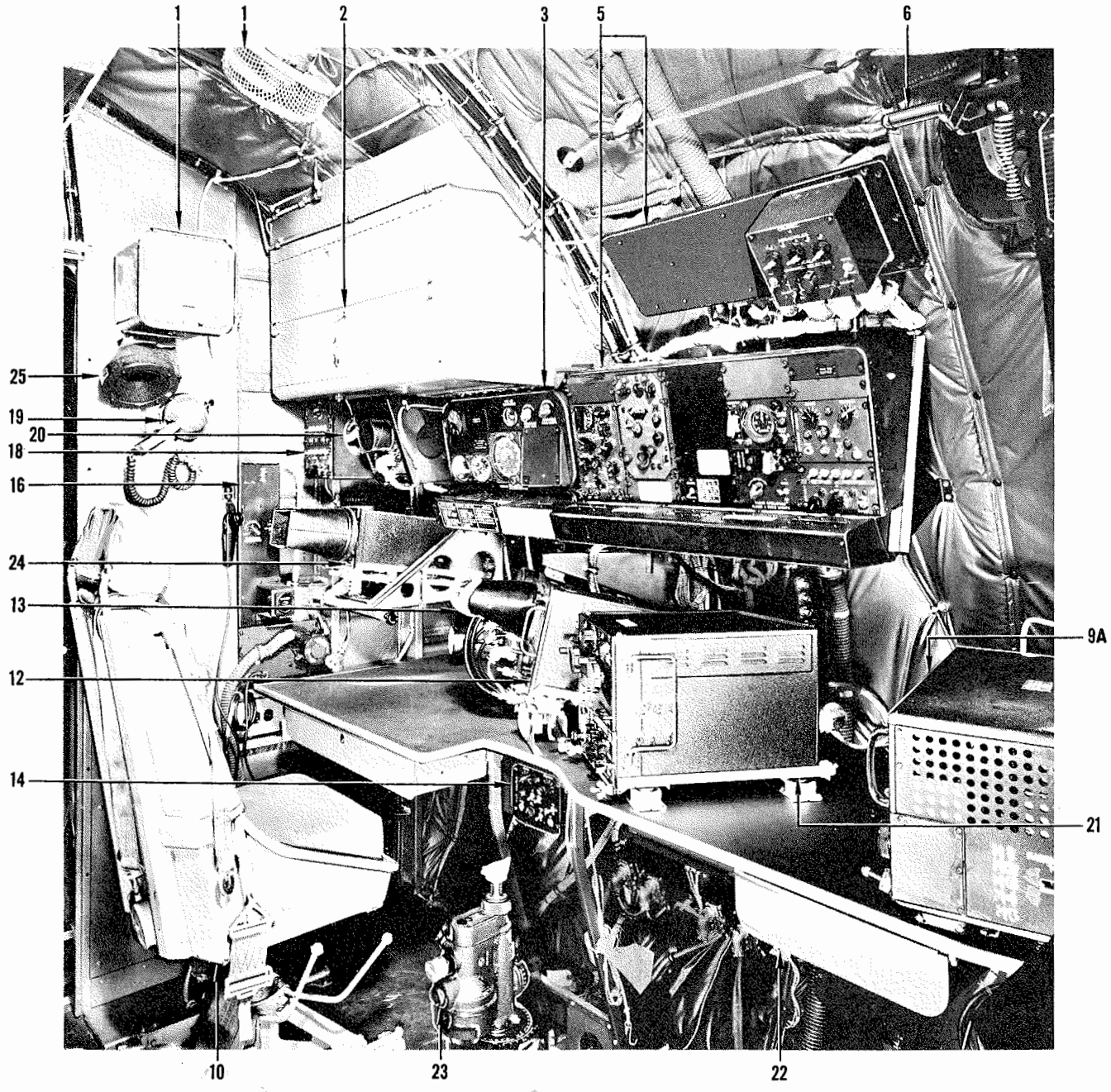


1 VENTILATING FAN (3 PLACES)
2 NAVIGATOR'S STOWAGE CABINET (2 PLACES)
3 NAVIGATOR'S INSTRUMENT PANEL (FIGURE 4-50) (2 PLACES)
4 RADIO OPERATOR'S OXYGEN REGULATOR
5 RADIO AND RADAR CONTROL PANELS (FIGURE 4-17) (2 PLACES)
6 PYROTECHNIC PISTOL MOUNT (2 PLACES)
7 LIAISON RADIO ANTENNA LOADING UNIT (FIGURE 4-18)
8 BC-348 LIAISON RECEIVER (FIGURE 4-18)

NAVIGATOR'S AND RADIO OPERATOR'S STATION

F

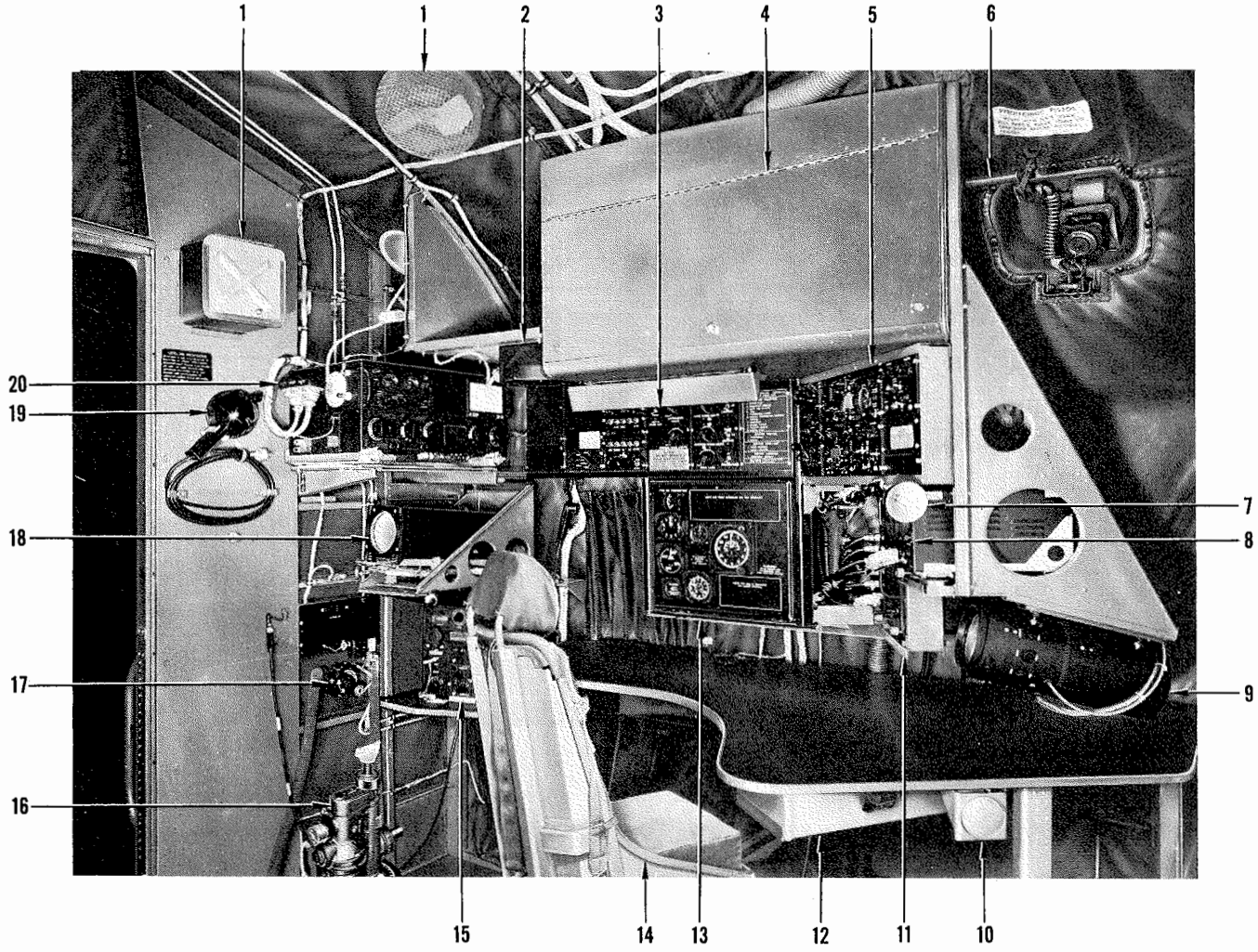
Figure 4-15 (Sheet 1 of 2)



9 LIAISON TRANSMITTER (AN/ART-13) (FIGURE 4-18)
9A AUXILIARY LIASON TRANSMITTER (AN/ARC-13) LESS 1CTO K572
10 NAVIGATOR'S SEAT (2 PLACES)
11 RADIO OPERATOR'S SEAT
T 12 APN-12 RENDEZVOUS RADAR INDICATOR (FIGURE 4-35) (2 PLACES)
13 SEARCH RADAR INDICATOR (FIGURE 4-33) (2 PLACES)
T 14 APN-12 RENDEZVOUS RADAR CONTROL PANEL(S) (FIGURE 4-35) (2 PLACES)
15 LORAN RECEIVER AND INDICATOR (FIGURE 4-28)
16 NAVIGATOR'S AUXILIARY PANEL (2 PLACES)
17 TABLE LIGHT
18 NAVIGATOR'S INTERPHONE PANEL (FIGURE 4-8) (2 PLACES)
19 SIGNAL LAMP (2 PLACES)
20 RADIO ALTIMETER (FIGURE 4-26) (2 PLACES)
21 LORAN CONTROL UNIT (FIGURE 4-27)
22 NAVIGATOR'S TABLE DRAWER
23 DRIFTMETER (FIGURE 4-53 OR 4-55)
24 LORAN INDICATOR (FIGURE 4-29)
25 LOUDSPEAKER F G 1372 ▶

G 17260 ▶ 3177

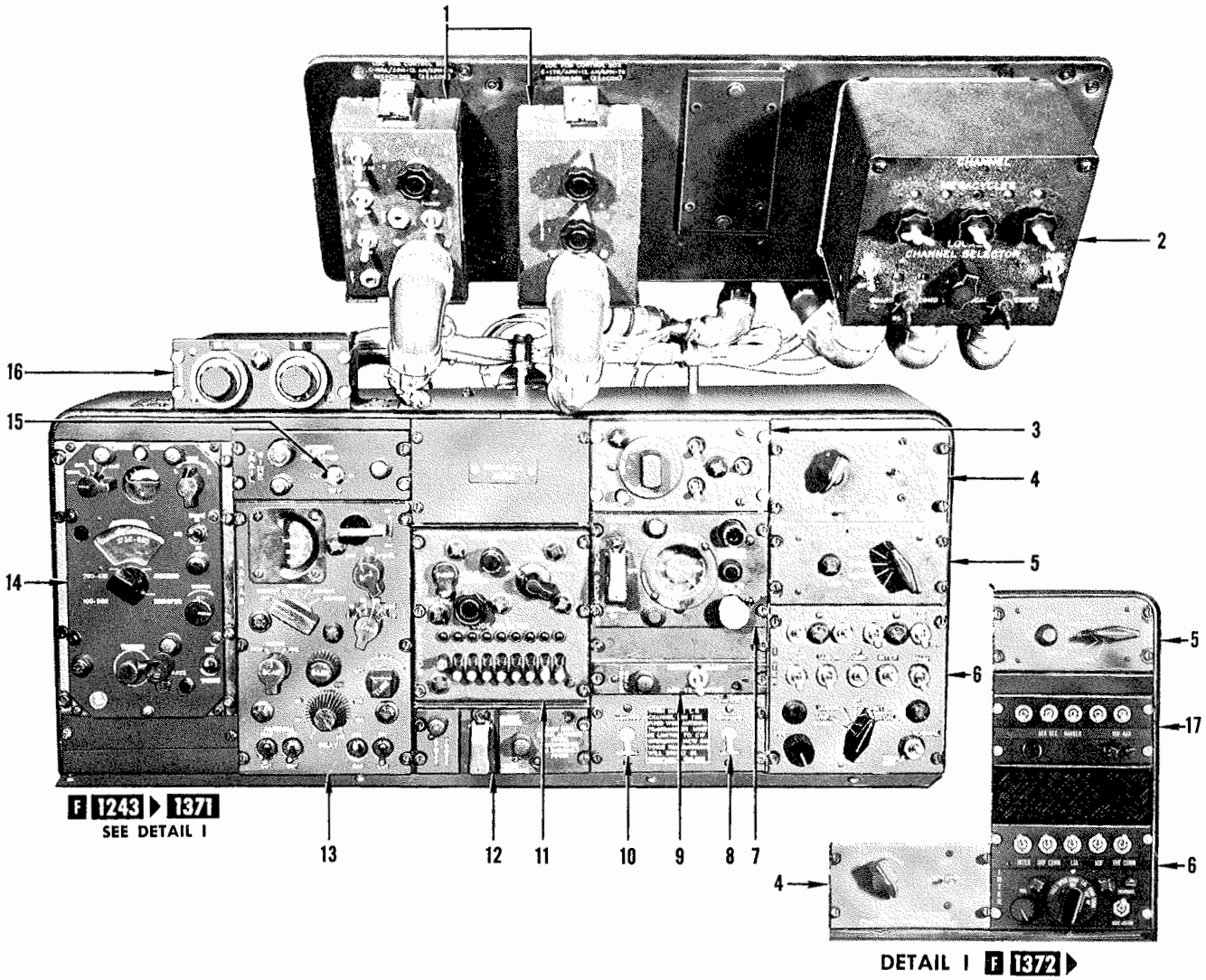
Figure 4-15 (Sheet 2 of 2)

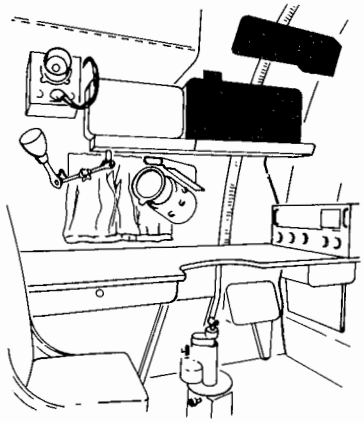


1 VENTILATING FAN (2 PLACES)
2 LOUDSPEAKER
3 NAVIGATOR'S INTERPHONE AND LIGHT PANEL (FIGURE 4-10)
4 NAVIGATOR'S STOWAGE CABINET
5 RADIO AND RADAR PANELS (FIGURE 4-17)
6 PYROTECHNIC PISTOL DOOR HANDLE
7 NAVIGATOR'S TABLE LAMP
8 RADIO ALTIMETER (FIGURE 4-26)
9 SEARCH RADAR INDICATOR (FIGURE 4-33)
10 ASH TRAY
▼T 11 RENDEZVOUS RADAR INDICATOR (FIGURE 4-35)
12 NAVIGATOR'S TABLE DRAWER
13 NAVIGATOR'S INSTRUMENT PANEL (FIGURE 4-50)
14 NAVIGATOR'S SEAT
15 LORAN CONTROL UNIT (FIGURE 4-29)
16 DRIFTMETER (FIGURE 4-55)
17 OXYGEN REGULATOR
18 LORAN INDICATOR (FIGURE 4-29)
19 SIGNAL LAMP
20 MF COMMAND TRANSMITTER (FIGURE 4-20) LESS 1CTO K572

NAVIGATOR'S STATION G 3178

Figure 4-16





1 APN-76 RENDEZVOUS RADAR CONTROL PANELS (4 PLACES) (SEE FIGURE 4-37) LESS TCTO K572
2 UHF RADIO MASTER CONTROL PANEL (2 PLACES) (SEE FIGURE 4-12) WITHOUT TCTO 600
3 IFF CONTROL PANEL (2 PLACES) (SEE FIGURE 4-32) F G 1243 ▶ 2900, G 3340 ▶
4 RADIO OPERATOR'S FLOOD AND TABLE LIGHTS CONTROL PANEL (3 PLACES) F G 1243 ▶ 3177
5 RADIO RANGE FILTER CONTROL PANEL (2 PLACES) (SEE FIGURE 4-8) F
6 RADIO OPERATOR'S INTERPHONE PANEL (3 PLACES) (SEE FIGURE 4-8) F G 1243 ▶ 3177
7 RADAR PRESSURIZING CONTROL PANEL (3 PLACES) (SEE FIGURE 4-38)
8 KEY TRANSFER SWITCH F
9 MARKER BEACON--APN-69 MONITOR INTERPHONE SWITCH (SEE FIGURE 4-34) F 1243 ▶ 1371
10 LIAISON NORMAL/MONITOR SWITCH (2 PLACES) F G 1243 ▶ 3278
11 RADAR BEACON CONTROL PANEL (2 PLACES) (SEE FIGURE 4-34)
12 RADAR BEACON POWER CONTROL PANEL (2 PLACES) (SEE FIGURE 4-34)
13 SEARCH RADAR CONTROL PANEL (3 PLACES) (SEE FIGURE 4-33)
14 RADIO COMPASS CONTROL PANEL (3 PLACES) (SEE FIGURE 4-22)
15 LORAN TRAILING WIRE ANTENNA CONTROL SWITCH F
16 SIF CODER CONTROL PANEL (2 PLACES) (SEE FIGURE 4-32) TCTO 590
17 INTERPHONE MIXER SWITCH PANEL (SEE FIGURE 4-8)
18 APN-12 RENDEZVOUS RADAR CONTROL PANEL (SEE FIGURE 4-35)

RADIO AND RADAR CONTROL PANELS

Figure 4-17 (Sheet 1 of 2)

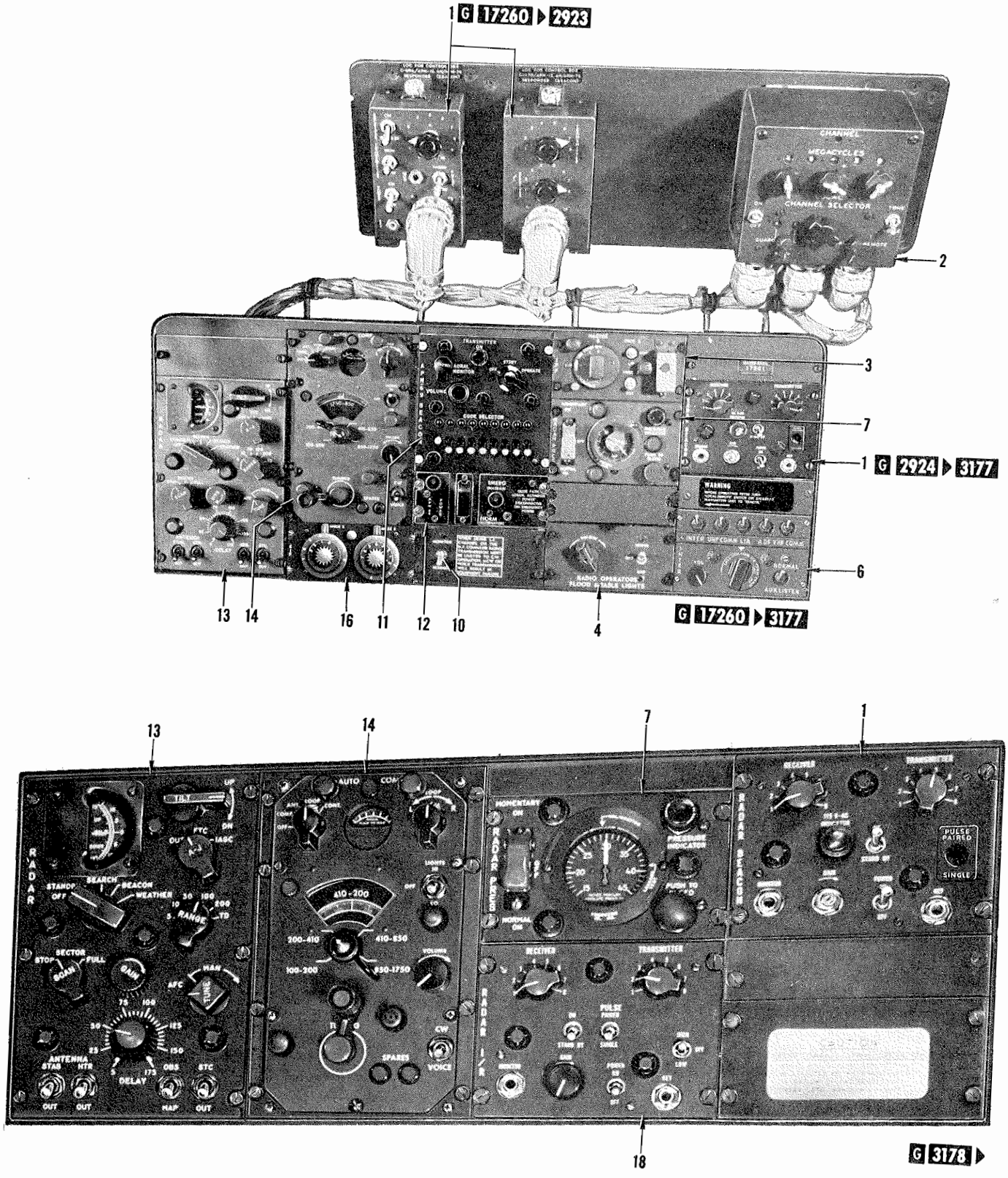


Figure 4-17 (Sheet 2 of 2)

LIAISON RADIO (AN/ARC-8) F

The liaison radio consists of an AN/ART-13 transmitter and a BC-348 receiver. (See figure 4-18.) These units, on the table at the radio operator's station, are described separately under MF TRANSMITTER (AN/ART-13) and LIAISON RECEIVER (BC-348) in this Section. Code transmissions on the liaison radio are possible when the key transfer switch is positioned to LIAISON. Operation of the liaison radio is also controlled by the command mike switch on airplanes F 1243 ▶ 1371 incorporating TCTO K527 .

MF (HF) TRANSMITTER (AN/ART-13)

Two liaison transmitters on airplanes less TCTO K572 can be used for transmitting voice, modulated continuous wave telegraphy (MCW), or continuous wave telegraphy (CW). Transmitting frequencies are in the range of 2000 to 18,000 kilocycles and either 200 to 1500 kc or 300 to 500 kc depending upon the type of oscillator installed. If a crystal control unit (CDA-T) is installed, the low frequency range is 300 to 500 kc and the selection of frequencies in this range is limited to those frequencies for which crystals are provided. When using a variable frequency oscillator (VFO), the low frequency range is 200 to 1500 kc and transmission is possible on frequencies other than crystal frequencies. (With a VFO, the frequency is derived with respect to a crystal check frequency and the master oscillator is not crystal stabilized.) The transmitter may operate either with crystal frequency control or VFO frequency control. For VFO operation, ten frequencies in the high frequency range can be preset to correspond with the ten numbered positions of the channel selector switch. During crystal operation, on transmitters having a CDA-T unit installed, there are provisions for presetting 24 frequencies. The 24 available frequencies consist of 10 frequencies in the high frequency range for each position of the A--B switch and 4 frequencies in the low frequency range (using the low frequency channel selector). A channel selector switch is used to select one of the preset frequencies or one channel that permits manual selection of any desired frequency. The transmitter automatically tunes (auto-tune) to a selected preset channel, but a manually selected frequency must be manually tuned. Dials A and B are used to select the frequency for each preset channel or to obtain a frequency manually. Dial A is the coarse frequency control and dial B is the fine frequency control. Dial B has a movable vernier, which is set to zero for the crystal check point and the operating frequency is obtained by moving the dial with respect to the vernier. While obtaining a crystal check point during crystal operation in the high frequency range, dials A and B must be tuned to the crystal frequency. The lowest crystal frequency given on the calibration chart on the transmitter determines the settings of the dials for this tuning. When transmitting on frequencies between 200 to 600 kilocycles (liaison radio only), the antenna tuning and loading circuits in the transmitter are not used and the antenna loading unit is automatically connected to the transmitter. On F airplanes less TCTO K572 the transmitter on the main radio rack is remotely controlled with the control panel (33, figure 1-16) on the control stand. Any crew member can make a voice transmission by pressing a microphone switch when the transmitter is selected with the interphone selector switch (or by plugging a mike into the microphone jack). On airplanes F 1243 ▶ 1371 plus those incorporating TCTO K527 , the interphone selector must be placed on LIAISON and the command mike switch correctly positioned to make a transmission. Code transmissions are made by using the key at the copilot's station, or, on F airplanes, at the radio operator's station or by connecting a key to the key jack on the transmitter. See KEY TRANSFER SWITCH in this Section. Control power is 28 volt DC with circuit protection located on the dynamotor unit (DY-17/ART-13) and on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

MF Transmitter Controls

EMISSION SWITCH. The emission switch (7, figure 4-18) is used to turn the equipment on and off and to select the desired mode of transmission. The switch positions are: OFF--VOICE--CW--MCW. The position of the local--remote switch determines which switch is operative. Refer to LOCAL--REMOTE SWITCH in this Section.

CHANNEL SELECTOR SWITCH. The channel selector switch (26, figure 4-18) permits selection of any one of ten preset, high frequency channels and one low frequency channel. If a CDA-T unit is installed, selection of the preset channel for the low frequency range is also controlled by the low frequency channel selector (11, figure 4-18). In addition, a position marked MANUAL is provided where the frequency control knobs can be rotated freely without disturbing the preset positions. The switch sets the auto-tune system into operation when a preset channel is selected so that the channel automatically tunes. The selector switch that is effective depends on the position of the local--remote switch. Refer to LOCAL--REMOTE SWITCH in this Section.

LOCAL--REMOTE SWITCH. This switch (27, figure 4-18) is used to transfer operation of the channel selector switch and the emission switch to a remote station. The red pilot light (6, figure 4-18) indicates the position of the local--remote switch. When the set is energized and the switch is on LOCAL, the light on the transmitter is lit at all times except when the auto-tune is cycling. The light on the transmitter goes out

when the switch is placed to REMOTE and on F airplanes the light on the panel at the pilot's station will go on.

CTO SWITCH. This switch (5, figure 4-18) has three positions: CALIBRATE, TUNE, and OPERATE. When on CALIBRATE, the variable frequency oscillator is turned on to permit calibration. (In this position, the power amplifier is not energized so that set does not transmit during tuning.) In the TUNE position, the equipment is operated at reduced power to prevent damage to the P.A. tube during preliminary tuning and loading of the antenna circuits. The switch is placed on OPERATE after final tuning has been completed and the equipment operates at full power. The switch should be left in OPERATE except during tuning.

LOW FREQUENCY EXTENDED RANGE SWITCH. This two position switch (18, figure 4-18) permits the transmitter to operate in lower than normal frequencies. In the NORMAL position, the equipment operates at the usual frequencies. In the EXTENDED position, the transmitter is capable of operating in the frequency range of 1670 to 2000 kilocycles.

BATTERY--P.A.GRID--P.A.PLATE SWITCH. This switch (3, figure 4-18) serves to switch the tuning meter (4, figure 4-18) to the desired circuit. For tuning and normal operation, the switch should be left on the P.A. (power amplifier) PLATE position. Refer also to TEST SWITCH in this Section.

FREQUENCY CONTROL AND ANTENNA LOADING DIALS. The dials (13, 16, 19, 21, and 23, figure 4-18), labelled A, B, C, D, and E, are used to manually select a frequency and to change the preset frequencies. On F airplanes, dials P, Q, and R (32, 30, and 34, figure 4-18) are used to tune and load the antenna for the liaison radio transmitter in the range of 200 to 600 kilocycles. High frequency tuning dials A and B, the corrector knob, vernier scale, and revolution counter provide a means of calibrating and tuning the variable frequency oscillator to the desired operating frequency. Dials C and D are the coarse and fine antenna tuning controls respectively. Dials C and D, are used in conjunction with dial E to properly tune the antenna. The antenna is loaded after calibration and initial tuning have been completed. The dials turn freely when the channel selector switch (26, figure 4-18) is set on MANUAL. When the channel selector is on any other position, the dials are positioned by loosening the locking bar (28, figure 4-18) in the center of each knob and then rotating them to the settings obtained from the calibration tables. After the dials are adjusted, the locking bars are tightened. To lock the dials, first note the exact dial reading obtained in the tuning procedure. Then rotate the dial one quarter turn counterclockwise and return to (but not past) the exact desired setting. Hold the dial on the setting and tighten the locking bar.

CORRECTOR KNOB. The corrector knob (14, figure 4-18) provides an accurate zero line on the vernier scale which serves as an index or indicator mark for the fine tuning of the B dial. The corrector knob moves the vernier scale clockwise or counterclockwise as required to establish the correct setting as noted in the calibration tables for each frequency to be tuned.

T.S. (THROTTLE SWITCH) JACK. This jack (25, figure 4-18) is a provision for a microphone switch - used with "hot" mike installations. (The T.S., throttle switch, terminology is a carry-over from other types of airplanes having microphone switches on the throttle.)

TEST SWITCH. The antenna current meter (2, figure 4-18) and the tuning meter (4, figure 4-18) are operative when the test switch (1, figure 4-18) is held to the TEST position. The switch is spring-loaded to an unmarked OFF position.

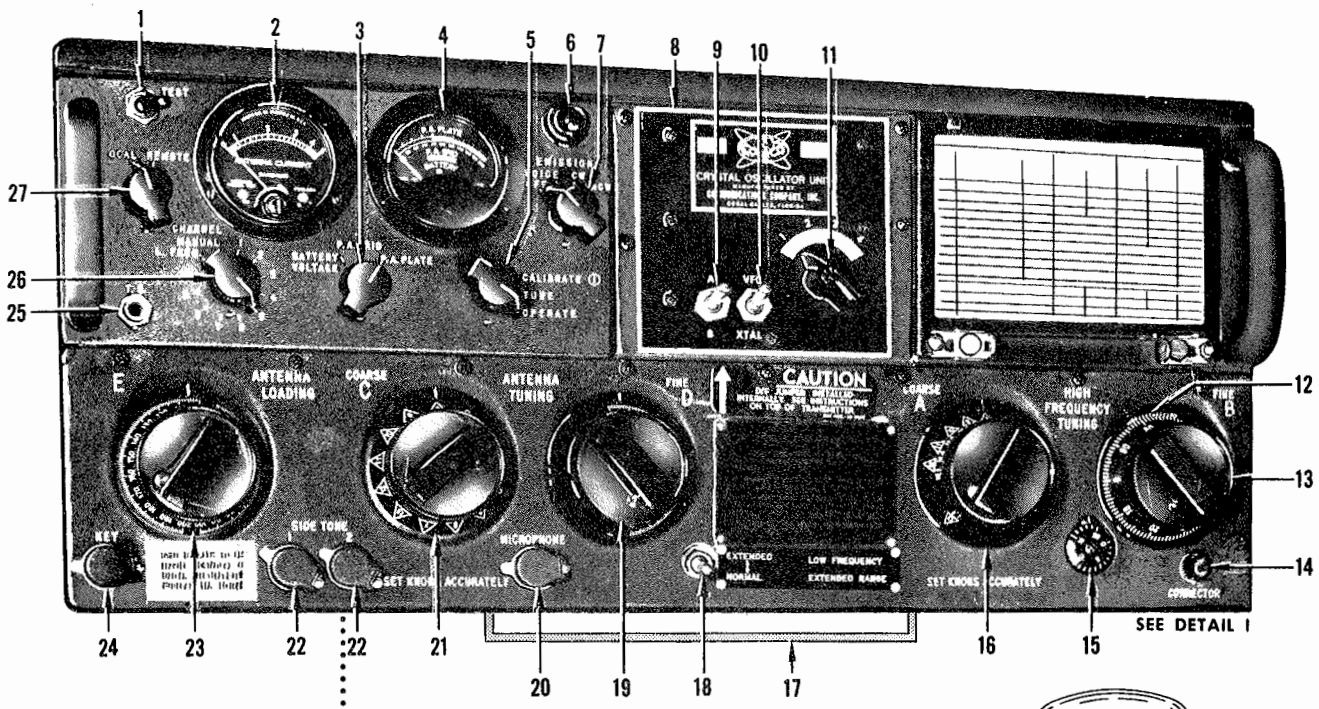
LOW FREQUENCY CHANNEL SELECTOR. The rotary selector switch (11, figure 4-18) is used to select one of four available crystal controlled frequencies in the low frequency range. The selector is operative when the VFO--XTAL switch (10, figure 4-18) is on XTAL, and the channel selector switch (26, figure 4-18) is on L. FREQ. When using the low frequency channel selector, dial A must be set on position 13, and dial C on position 8. (Dial B has no function when using any of the low frequency units.) Calibration charts are not required when using the CDA-T unit, as its output is directly coupled to the power amplifier. Meter readings for low frequency crystal operation, as with high frequency crystal operation, will be lower than VFO operation.

A--B SWITCH. To obtain 2 frequencies for each of the 10 channels, place the A--B switch (9, figure 4-18) to each of its positions. The switch is operative when the VFO--XTAL switch (10, figure 4-18) is on XTAL.

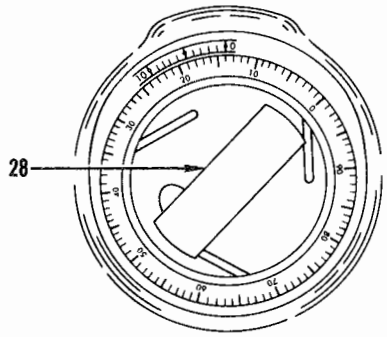
Tuning Procedures for MF Transmitter (AN/ART-13)

For VFO operation:

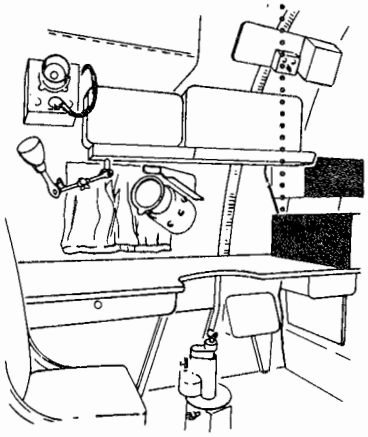
1. Check all dials locked. Place LOCAL--REMOTE switch to LOCAL. Place emission switch to VOICE. VFO--XTAL switch to VFO. Low frequency extended range switch to NORMAL
2. Select desired channel; wait for complete cycling of auto-tune system before using set. (Red pilot light will illuminate indicating cycle is complete)
3. Unlock all dials
4. Set dial C on 1
5. Find the desired frequency in the calibration tables, set dials A and B to the settings of the nearest crystal check point marked in heavy black type

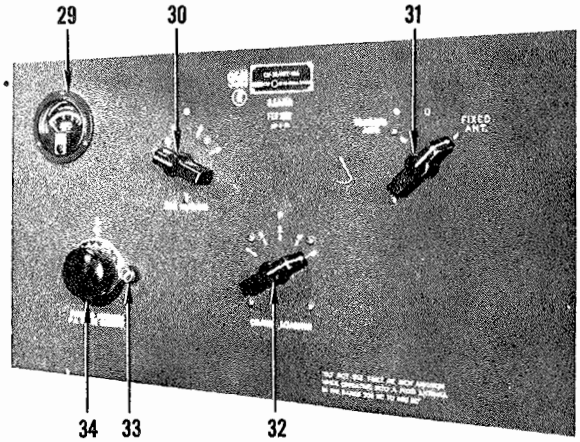


AN/ART-13 MF TRANSMITTER



DETAIL I





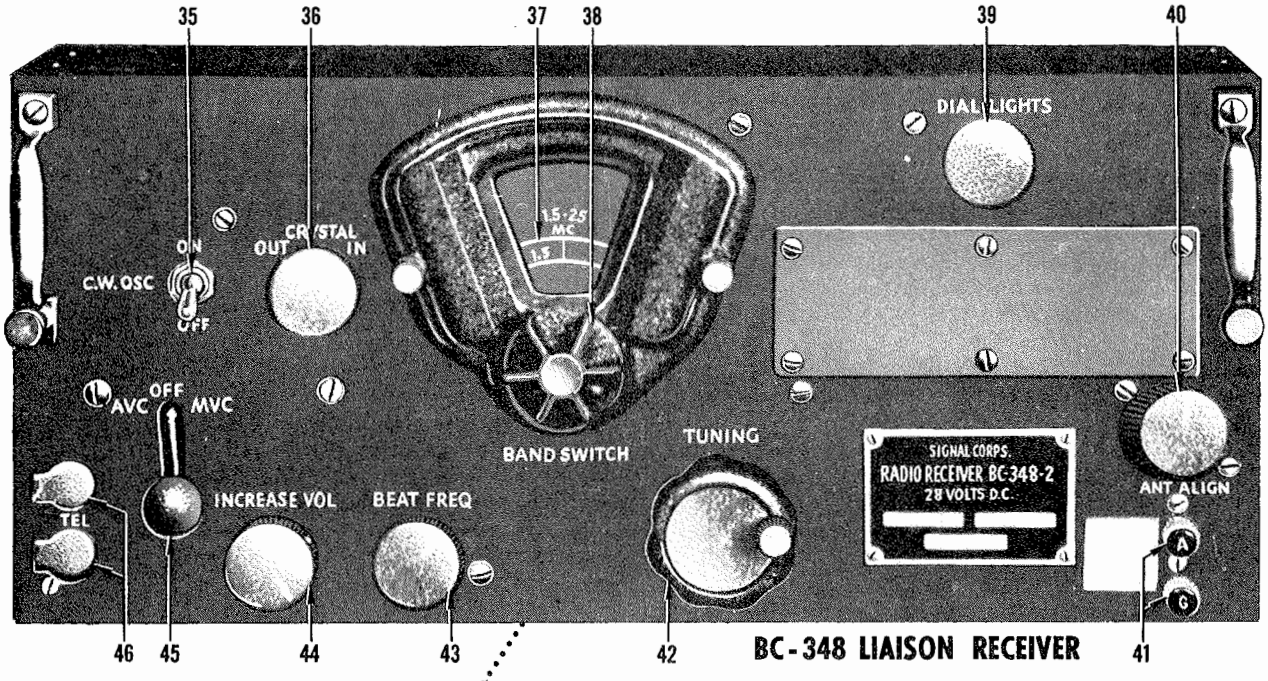
NOTE

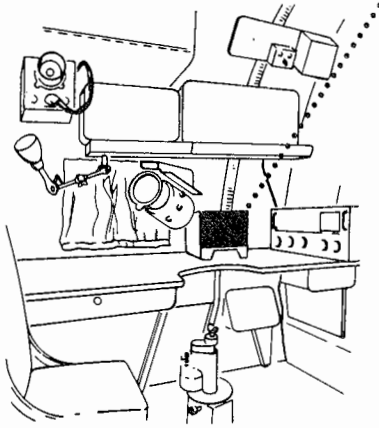
Antenna loading unit is used for transmissions on frequencies between 200 and 600 kilocycles.

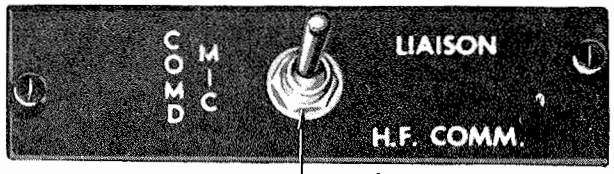
ANTENNA LOADING UNIT

LIAISON RADIO (AN/ARC-8) CONTROLS F

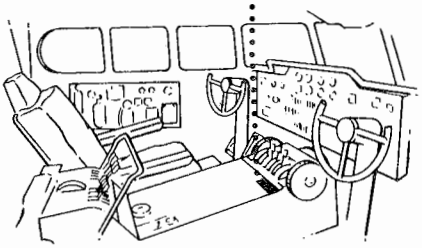
Figure 4-18 (Sheet 1 of 2)







F 1243 ▶ 1371
WITH TCTO K527
47



1 TEST SWITCH
2 ANTENNA CURRENT METER
3 BATTERY--P.A.GRID--P.A. PLATE SWITCH
4 TUNING METER
5 CTO (CALIBRATE-TUNE-OPERATE) SWITCH
6 PILOT LIGHT
7 EMISSION SWITCH
8 CDA-T OSCILLATOR
9 A-B SWITCH
10 VFO--XTAL (VARIABLE FREQUENCY OSCILLATOR-CRYSTAL) SWITCH
11 LOW FREQUENCY CHANNEL SELECTOR
12 DIAL B VERNIER
13 DIAL B (HIGH FREQUENCY FINE TUNING)
14 CORRECTOR KNOB
15 DIAL B REVOLUTION COUNTER
16 DIAL A (HIGH FREQUENCY COARSE TUNING)
17 CALIBRATION TABLES STOWAGE
18 LOW FREQUENCY EXTENDED RANGE SWITCH
19 DIAL D (ANTENNA TUNING FINE ADJUSTMENT)
20 MICROPHONE JACK
21 DIAL C (ANTENNA TUNING COARSE ADJUSTMENT)
22 SIDETONE JACK (2 PLACES)
23 DIAL E (ANTENNA LOADING ADJUSTMENT)
24 KEY JACK
25 T.S. (THROTTLE SWITCH) JACK
26 CHANNEL SELECTOR SWITCH
27 LOCAL--REMOTE SWITCH
28 LOCKING BAR
29 RF (RADIO FREQUENCY) AMMETER
30 DIAL Q (ANTENNA LOADING FINE ADJUSTMENT)
31 ANTENNA SELECTOR SWITCH
32 DIAL P (ANTENNA LOADING COARSE ADJUSTMENT)
33 DIAL R LOCK
34 DIAL R (ANTENNA TUNING ADJUSTMENT)
35 C.W. OSC SWITCH
36 CRYSTAL FILTER SWITCH
37 TUNING DIAL
38 BAND SWITCH
39 DIAL LIGHT RHEOSTAT
40 ANTENNA ALIGNMENT KNOB
41 ANTENNA AND GROUND BINDING POSTS
42 TUNING CRANK
43 BEAT FREQUENCY KNOB
44 VOLUME KNOB
45 POWER SWITCH
46 TEL. JACKS
47 COMMAND MIKE SWITCH

Figure 4-18 (Sheet 2 of 2)

6. Check the liaison normal/monitor switch on the navigator's radio and radar panel in the NORMAL position
7. Place CTO switch to CALIBRATE. Rotate dial B back and forth until zero beat (aural-null signal) is obtained
8. Place CTO switch to TUNE
9. Turn corrector knob to position vernier scale index to the crystal check point setting for dial B
10. Set dial B to the reading obtained for the desired operating frequency in the calibration tables, utilizing the vernier scale index as zero reference. Recheck dial A for proper operating frequency setting. Lock dials A and B
11. Place emission switch to CW
12. Place battery--P.A. grid--P.A. plate switch to P.A. PLATE
13. Set dials C, D and E to the values obtained from the 60 foot antenna calibration tables
14. If dial C is on position 7 or below:
    a. Hold test switch closed and rotate dial E for minimum dip on P.A. Plate meter
    b. Place CTO switch to OPERATE
    c. If the plate current meter reading is above the area marked CW, move dial D a few divisions lower and re-adjust dial E for minimum plate current. If the plate current meter reading is below the area marked CW, move dial D a few divisions higher and re-adjust dial E for minimum plate current
15. If dial C is on position 8 or above:
    a. Hold test switch closed and rotate dial D for minimum dip on P.A. Plate meter
    b. Place CTO switch to OPERATE
    c. If the plate current meter reading is above the area marked CW, move dial E a few divisions lower and re-adjust dial D for minimum plate current. If the plate current meter reading is below the area marked CW, move dial E a few divisions higher and re-adjust dial D for minimum plate current

NOTE

If a minimum dip is not obtained on P.A. Plate meter by rotating the specified dial, set control C to the next higher position and rotate dial D or E as required.

16. Lock dials C, D and E
17. Place emission switch to VOICE. The equipment is now ready for operation

For crystal operation, the tuning procedure for crystal operation is essentially the same as for VFO OPERATION outlined above. Meter readings will be lower.

Liaison Normal/Monitor Switch

On airplanes F G 1243 ▶ 3177, the liaison normal/monitor switch (10, figure 4-17) is on the navigator's radio and radar control console. On airplanes G 3178 ▶ 3278, the switch (1, figure 4-10) is on the navigator's interphone and light panel. The switch is used with the MF command (auxiliary liaison) transmitter and the BC-348 liaison receiver on airplanes less TCTO K572. The switch must be in the NORMAL position to calibrate the transmitter. While the switch is on NORMAL, the sidetone can be heard, when the transmitter is operated. Positioning the switch on MONITOR cuts out the sidetone and the signals from the transmitter are heard through the receiver. Using the MONITOR position enables the operator to tune and zero beat the BC-348 receiver to the exact frequency of the transmitter, or to tune and zero beat the transmitter to an exact preselected and preset frequency on the receiver.

LIAISON RECEIVER (BC-348)

F and G 17260 ▶ 3278 less TCTO KG206 TCTO K572

The BC-348 receiver operates over a frequency range from 200 to 500 KC and 1.5 to 18.0 megacycles. All controls are on the front panel of the receiver, where they may be easily operated by airplane personnel. (See figures 4-18 and 4-21.) Antenna, ground, and headphone connections are made through a connector plug on the back of the receiver. The receiver is capable of voice, tone and CW reception. Manual or automatic volume control may be selected by a switch on the front panel of the receiver. The receiver is not intended for remote control and no provision has been made for this operation. The receiver is on the radio operator's table on F airplanes and on the main radio rack on G airplanes. Control power is 28 volt DC with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

BC-348 Liaison Receiver Controls

F and G 17260 ▶ 3278 less TCTO KG206 TCTO K572

POWER SWITCH. A power switch (45, figure 4-18) with AVC--OFF--MVC positions is on the BC-348 liaison receiver control panel. Placing the switch to AVC (automatic volume control) or MVC (manual volume control) selects a method of regulating the volume and turns on the power to energize the equipment. With the switch in the OFF position, no power is supplied to the receiver.

BAND SWITCH. A band switch (38, figure 4-18) on the BC-348 control panel allows the operator to change the frequency band.

TUNING CRANK. Reception is accomplished by tuning the receiver to the desired signal by use of the tuning crank (42, figure 4-18) on the BC-348 control panel. The frequency to which the receiver is tuned is indicated at all times on the dial scale.

VOLUME KNOB. The volume level of the audio signal is controlled by the volume knob (44, figure 4-18). When the receiver is operated with manual volume control, the sensitivity of the receiver is controlled. When automatic volume control is desired, the level of the audio signal fed into the output tube is controlled.

C.W. OSC SWITCH. This switch (35, figure 4-18) on the BC-348 liaison receiver control panel has ON--OFF positions. The CW oscillator is turned ON for CW, or OFF for voice reception.

DIAL LIGHT RHEOSTAT. This knob (39, figure 4-18) on the BC-348 liaison receiver control panel adjusts the brilliancy of dial illumination. The dial lamps may be adjusted for any desired degree of illumination or turned off completely.

BEAT FREQUENCY KNOB. This knob (43, figure 4-18) adjusts the frequency of the CW oscillator and allows the operator to adjust the tone of the received signal to the pitch he considers the most suitable.

CRYSTAL FILTER SWITCH. This control (36, figure 4-18) on the BC-348 liaison receiver control panel, inserts a crystal filter into the circuit when turned to the IN position. This filter increases the selectivity of the receiver, enabling reception through heavy interference.

TEL. JACKS. Dual output is provided through two open circuit phone jacks (46, figure 4-18). These jacks are connected to the output circuit of the receiver and permit headphone reception by the operator.

ANTENNA AND GROUND BINDING POSTS. The antenna is connected to the binding post marked A, while the ground lead is connected to the binding post marked G, (41, figure 4-18) on the BC-348 liaison receiver control panel.

ANTENNA ALIGNMENT KNOB. This knob (40, figure 4-18) on the BC-348 liaison receiver control panel is provided to allow the operator to align the antenna for best signal reception.

BC-348 Liaison Receiver Indicators

F and G 17260 ▶ 3278 less TCTO KG206 TCTO K572

TUNING DIAL. This dial (37, figure 4-18) on the BC-348 liaison receiver control panel is adjusted by the band switch and tuning knob. The frequency set in with these knobs appears in the dial window.

Normal Operation of the BC-348 Liaison Receiver F and G 17260 ▶ 3278 less TCTO KG206 TCTO K572

The BC-348 liaison receiver is put into operation as follows:

1. Place LIAISON interphone mixer switch F 1243 ▶ 1371 or AUX REC interphone mixer switch F G 1372 ▶ to ON (up)
2. Set power switch (45, figure 4-18) to MVC. Allow set approximately 30 seconds to warmup.
3. Adjust volume knob (44, figure 4-18) until a slight background noise is heard
4. Set band switch (38, figure 4-18) to the frequency band in which signals can be heard
5. Rotate the tuning crank (42, figure 4-18) with reference to the tuning dial (37, figure 4-18), tune in the desired signal

NOTE

All tuning should be done with the power switch set on MVC and with the volume knob advanced only enough to give the desired signal strength. In the absence of a signal, the setting of the volume can be judged by the loudness of the background noise. On MVC with the volume set at maximum, very strong carrier waves will block the receiver and intelligible signals cannot be received.

6. Set power switch to AVC. The desired signal should still be heard
7. With the beat frequency knob (43, figure 4-18) at zero position (arrow on knob pointing up), place the C.W. OSC switch ON position. An audible beat note should be heard which should vary in pitch when the beat frequency adjustment is changed
8. With the C.W. OSC switch in the ON position, place the crystal filter switch (36, figure 4-18) to IN. Noise should be greatly reduced and the signal can be tuned out by a much smaller movement of the tuning crank than when the crystal filter switch is in the OUT position
9. Turn the dial light rheostat (39, figure 4-18) and observe if control of illumination is secured with both dial lights functioning
10. When the receiver is not being used, turn the power switch to OFF

Modulated Signal Reception of the BC-348 Liaison Receiver F and G 17260 ▶ 3278 less TCTO KG206 TCTO K572

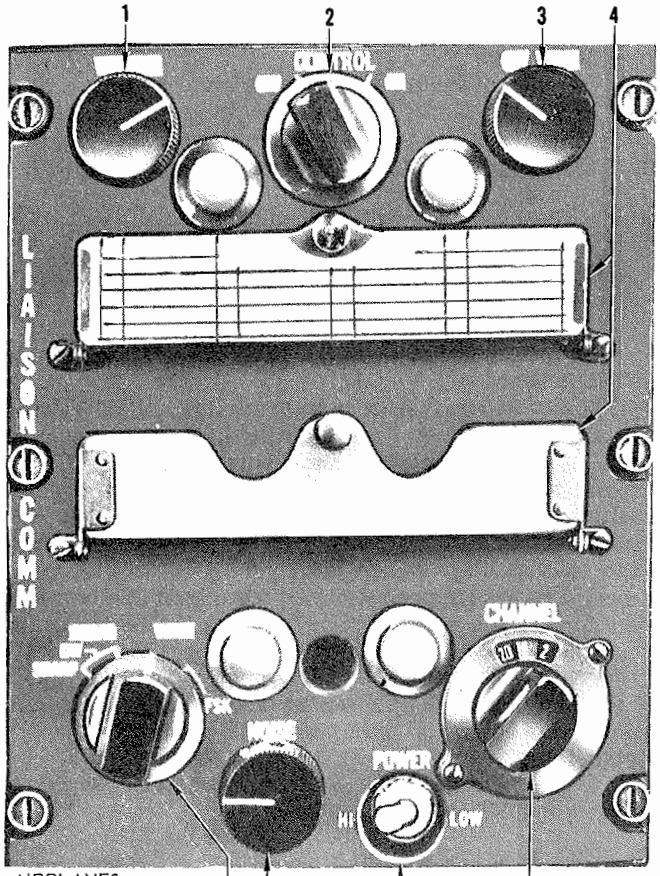
For the reception of modulated signals in the frequency bands covered by this receiver, proceed as follows:

1. Turn the power switch to MVC
2. Place the C.W. OSC switch to the OFF position
3. Position the crystal filter switch to OUT

NOTE

Tuning should be done with the power switch in the MVC position and with the volume knob advanced only as far as required for a comfortable output level.

4. Allow set to warmup (approximately 30 seconds) before adjusting volume knob until the background noise can be heard
5. Turn tuning crank until frequency of the desired signal is reached and signal is heard in the headphones. Turn tuning crank slowly back and forth until the position at which the signal is received is the strongest found
6. If automatic volume control is desired, position power switch to AVC and readjust volume knob for the desired output
7. In the event interference is encountered, position crystal filter switch to IN

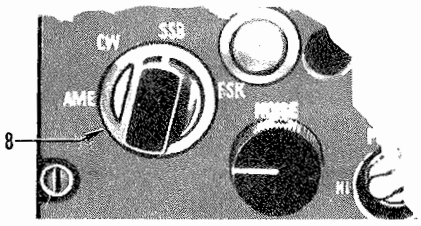


AIRPLANES WITHOUT TCTO 1-1-666

SEE DETAIL I

AN/ARC-21

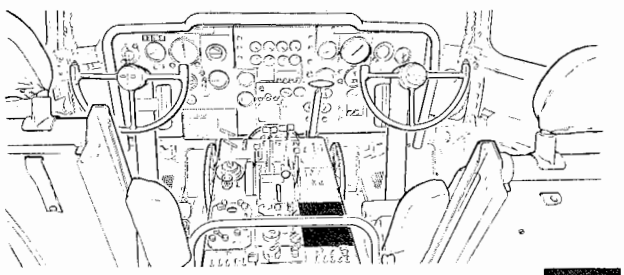
1 VOLUME KNOB
2 CONTROL SWITCH
3 CW TUNING KNOB
4 PRESETTING DRUM COVERS
5 CHANNEL SELECTOR SWITCH
6 HI-LOW POWER SWITCH
7 NOISE CONTROL KNOB
8 OPERATION SELECTOR SWITCH (2 PLACES)



DETAIL I

AIRPLANES WITH TCTO 1-1-666

AN/ARC-65



LIAISON RADIO CONTROLS

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Figure 4-19

CW Reception of the BC-348 Liaison Receiver F and G 17260 ▶ 3278 less TCTO KG206 TCTO K572

For reception of the CW signals, proceed as follows:

1. Turn power switch to MVC
2. Place C.W. OSC switch to the ON position
3. Position beat frequency knob to the zero beat position (arrow on knob pointing up)
4. Proceed as instructed for the reception of modulated signals and when the signal is tuned in, adjust beat frequency knob to the position producing the most satisfactory tone
5. Automatic volume control may be used by switching the power switch to AVC

LIAISON RADIO

(AN/ARC-21 on airplanes without TCTO 1-1-666)
(AN/ARC-65 on airplanes with TCTO 1-1-666)

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 (shown in figure 4-19) is on the control stand. The set permits long range two-way voice and code communication from airplane to airplane or from airplane to ground. The radio is turned on and off by a control switch on the liaison radio control panel. Twenty channels may be preset on the control panel and individually selected with the channel selector switch. 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 crew member 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 telegraphy (CW). 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 (figure 1-35, sheet 2).

On airplanes incorporating TCTO 1-1-666, the AN/ARC-21 is replaced by an AN/ARC-65 liaison radio which has the additional capability of single sideband (SSB) transmission and reception. Both sets use the same control panels and all but one of the controls (the operation selector switch) have the same function.

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" (AME).

Liaison Radio Controls

CONTROL SWITCH (LIAISON RADIO). A two-position ON--OFF rotary switch (2, figure 4-19) 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 4-19) 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.

CHANNEL SELECTOR SWITCH. A channel selector switch (5, figure 4-19) on the liaison radio control panel has channel positions numbered from 1 to 20 providing selection of any of the preset frequencies.

HI--LOW POWER SWITCH. A two-position switch (6, figure 4-19), marked POWER, is on the liaison radio control panel. The switch has HI--LOW positions and provides a means of selecting the power output in a 10 to 1 proportion. The HI position will normally be used when maximum range transmissions are desired. The LOW position is used when shorter range transmissions are desired.

NOISE CONTROL KNOB. A knob (7, figure 4-19), marked NOISE, 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 covers (4, figure 4-19). 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 4-19) 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 selector switch (8, figure 4-19) on the liaison radio control panel has CW SHARP--CW BROAD--VOICE--FSK positions and is used to select the type of liaison radio operation desired. CW SHARP position provides CW operation with a narrow band width to increase intelligibility of signals. CW BROAD provides CW operation with 7-kilocycle band width for general operation. VOICE position allows voice transmission and reception of the liaison radio. FSK position is provided for teletypewriter operation, although this equipment is not provided. On airplanes incorporating TCTO 1-1-666, the switch has AME--CW--SSB--FSK positions for use in single sideband operation. 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. 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:

1. Loosen two screws holding drum covers in position and open covers
2. Remove presetting tool from clip inside top drum cover
3. Place channel selector 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

4. 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
5. Move the top drum left button to coincide with the figure representing thousands of kilocycles
6. Move the top drum right button to coincide with the figure representing hundreds of kilocycles
7. Move the bottom drum left button to coincide with the figure representing tens of kilocycles
8. Move the bottom drum right button to coincide with the figure representing units and halves of kilocycles
9. Record the frequency (just set) adjacent to the applicable channel number on the card mounted on the top drum cover
10. Turn the channel selector switch to the next channel number to be preset and repeat Steps 4 through 9. Preset remaining channels in the same manner
11. 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.

G

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:
1. Place interphone selector switch in LIA to receive and transmit liaison radio signals
2. 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 allow for tube warmup and the remaining 10 seconds allow 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 warmup for 15 minutes. During the warmup period, do not change channel or transmit. After the warmup, proceed with normal operation.

- The AN/ARC-65 liaison radio requires a warmup time of approximately 10 to 15 minutes to give optimum performance.

3. 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
4. Rotate the operation selector switch to VOICE, SSB, or AME (as applicable)
5. Place power switch in HI or LOW depending on desired range of transmissions

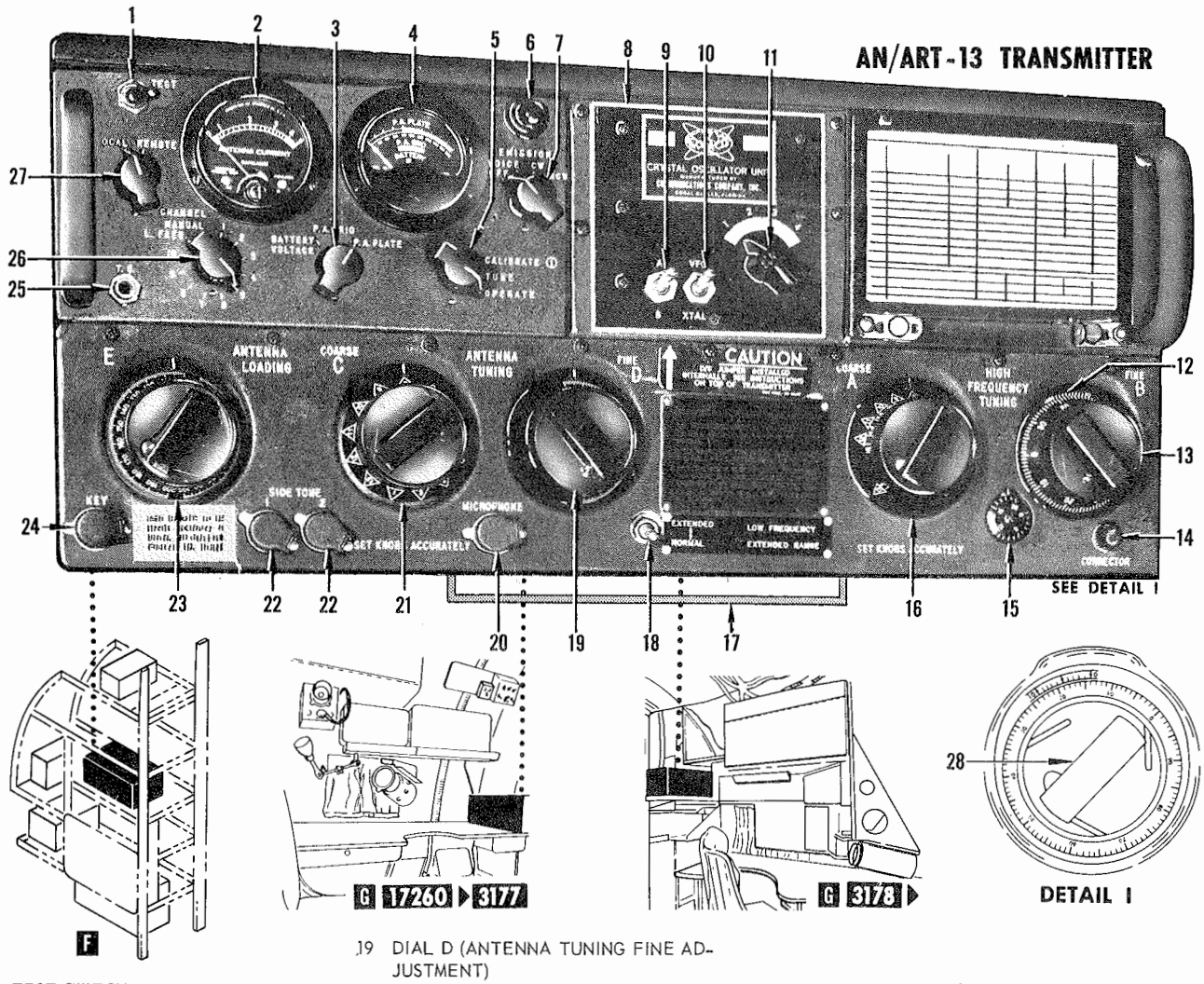
NOTE

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.

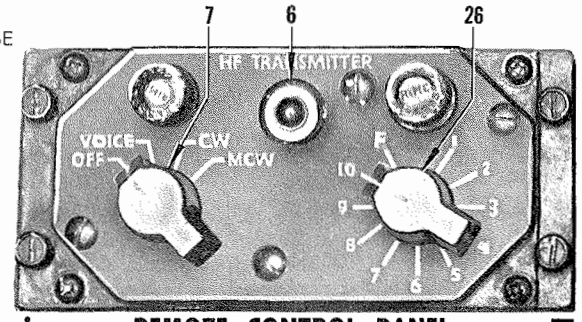
6. Depress the microphone switch until the side-tone signal is heard in the headphones, then release the microphone switch. The presence of the side-tone signals, while talking, will indicate the transmitter tune-up is completed and signals are being transmitted. This step will not have to be repeated 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 side-tone will be heard in the headset when talking if the transmitter is on the air
7. Turn the equipment off by rotating the liaison radio control switch on the panel to OFF

Emergency Operation of the Liaison Radio G

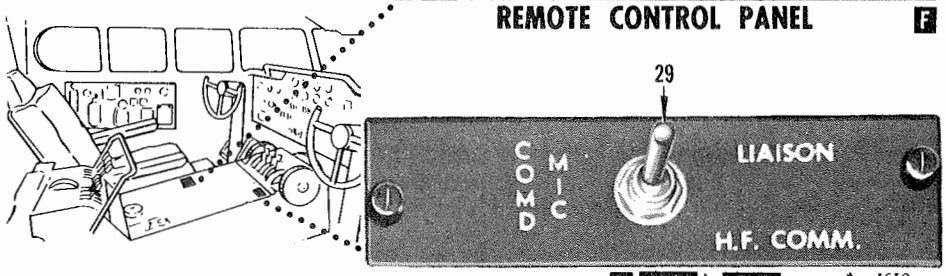
When a frequency selection cycle is not completed in the normal time interval, causing the liaison radio control knob to return to OFF position, a second try preferably on another channel is recommended. If tuning is normal, return to the initially selected channel. Malfunction within the equipment is indicated by the liaison radio control knob 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 on the air.



1 TEST SWITCH
2 ANTENNA CURRENT METER
3 BATTERY–P.A. GRID–P.A. PLATE SWITCH
4 TUNING METER
5 CTO (CALIBRATE–TUNE–OPERATE) SWITCH
6 PILOT LIGHT
7 EMISSION SWITCH
8 CDA–T OSCILLATOR
9 A–B SWITCH
10 VFO-XTAL (VARIABLE FREQUENCY OSCILLATOR–CRYSTAL) SWITCH
11 LOW FREQUENCY CHANNEL SELECTOR
12 DIAL B VERNIER
13 DIAL B (HIGH FREQUENCY FINE TUNING)
14 CORRECTOR KNOB
15 DIAL B REVOLUTION COUNTER
16 DIAL A (HIGH FREQUENCY COARSE TUNING)
17 CALIBRATION TABLES STOWAGE
18 LOW FREQUENCY EXTENDED RANGE SWITCH
19 DIAL D (ANTENNA TUNING FINE ADJUSTMENT)
20 MICROPHONE JACK
21 DIAL C (ANTENNA TUNING COARSE ADJUSTMENT)
22 SIDETONE JACK (2 PLACES)
23 DIAL E (ANTENNA LOADING ADJUSTMENT)
24 KEY JACK
25 T.S. (THROTTLE SWITCH) JACK
26 CHANNEL SELECTOR SWITCH
27 LOCAL–REMOTE SWITCH
28 LOCKING BAR
29 COMMAND MIKE SWITCH



REMOTE CONTROL PANEL F



F 1243 ▶ 1371 with TCTO K527

MF (HF) COMMAND TRANSMITTER CONTROLS LESS TCTO K572

Figure 4-20

MF COMMAND (HF COMMAND) RADIO

F less TCTO K572

On F airplanes the MF command radio consists of the AN/ART-13 transmitter on the radio rack and a BC-454 receiver. Each of these units are controlled from panels on the control stand. For a description of each component, refer to MF TRANSMITTER (AN/ART-13) and LIAISON RECEIVER (BC-454) in this Section. Code transmissions are possible on the MF command radio when the key transfer switch is positioned to COMMAND. Operation of the MF command radio is also controlled by the command mike switch on airplanes incorporating TCTO K527. On G airplanes, the MF command radio consists of the AN/ART-13 transmitter (figure 4-20) on the radio operator's table (airplanes G 17260 ▶ 3177) or at the navigator's station (airplanes G 3178 ▶); and, a liaison receiver. The liaison receiver is the BC-348 receiver on the main radio rack on airplanes G 17260 ▶ 3278 less those incorporating TCTO KG206 or the ARR-36 receiver on the overhead panel on airplanes G 3279 ▶ plus those incorporating TCTO KG206 . (See figure 4-21.) For a description of each component refer to MF TRANSMITTER (AN/ART-13), LIAISON RECEIVER (BC-348), and LIAISON RECEIVER (AN/ARR-36) in this Section.

LIAISON RECEIVER (BC-454)

F less TCTO K572

The MF command radio has a BC-454 receiver. This receiver operates over a frequency range from 3.0 to 6.0 megacycles (3000 to 6000 kilocycles). The controls for the receiver, on the control stand, are used to turn on the set, select the frequency, and select the type of signal to be received (CW or MCW). The reception of the receiver is heard on the interphone when the HF COMM interphone mixer switch is ON. The set uses 28 volt d-c power and has circuit protection on radio junction box circuit breaker panel (figure 1-35, sheet 2).

Liaison Receiver (BC-454) Controls

F less TCTO K572

POWER SWITCH. This switch (11, figure 4-21) on the BC-454 control panel has CW--OFF--MCW positions. Moving the switch out of the OFF position to either CW or MCW turns on the receiver. When CW is selected, the reception will be code signals which are being transmitted by interrupting an unmodulated continuous wave (CW). To receive voice transmissions as well as modulated continuous wave code signals, the switch is placed on MCW.

F less TCTO K572

TUNING CRANK. The frequency of the receiver is selected by positioning the tuning dial (3 , figure 4-21) with the tuning crank (8 , figure 4-21).

F less TCTO K572

VOLUME KNOB. The volume level of the sound from the BC-454 receiver into the interphone is adjusted with the volume knob (10, figure 4-21).

Liaison Receiver (BC-454) Normal Operation

F less TCTO K572

For reception on the liaison radio (BC-454) receiver:

1. Place the power switch to either CW or MCW
2. Turn tuning crank to the desired frequency

CAUTION

Do not attempt to rotate the dial beyond the boundary calibration marks.

3. Place the HF COMM interphone mixer switch ON
4. Adjust volume

Liaison Receiver (BC-454) Emergency Operation

F less TCTO K572

If the liaison radio (BC-454) receiver becomes inoperative, it may be necessary to replace a fuse in the receiver on the main radio rack to restore operation.

WARNING

Place the BC-454 receiver power switch OFF before attempting to change a fuse. The dynamotor on the receiver generates a high voltage.

LIAISON RECEIVER (AN/ARR-36)

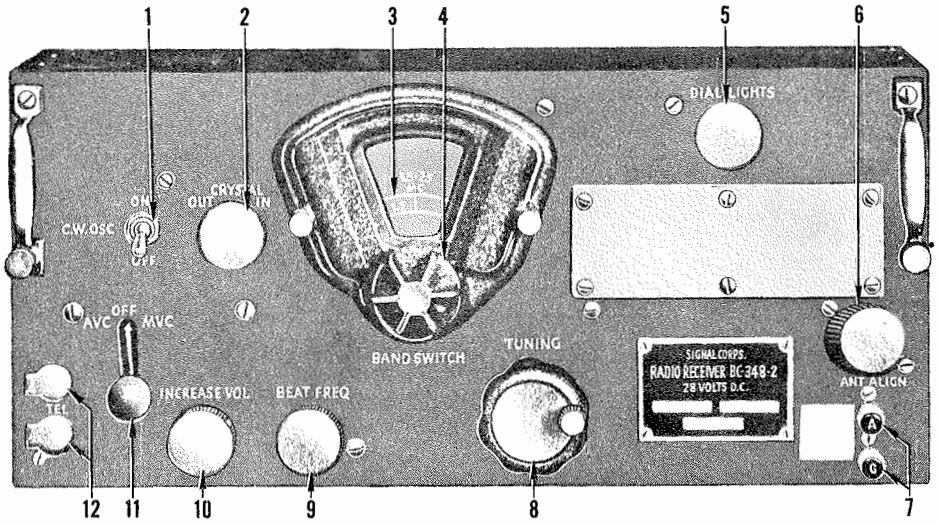
G 3279 ▶ plus TCTO KG206
less TCTO K572

The AN/ARR-36 is a radio receiver that provides CW, voice, and frequency shift reception in the frequency range from 2 to 23.9 megacycles in 500-cycle steps giving a total of 44,000 usable frequencies. Any 20 of the 44,000 possible frequencies can be set up, in any order, for selection by the operator through the use of a channel selector switch on the control panel. The ARR-36 liaison receiver control panel (45, figure 1-12) is on the overhead panel. Control power is 28 volt DC with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

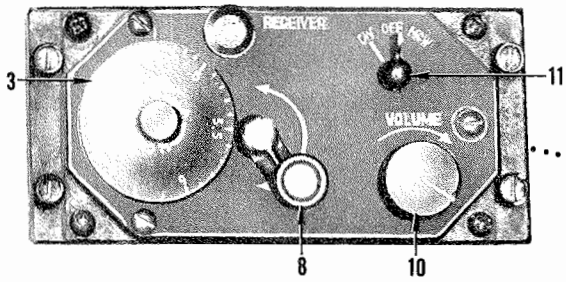
AN/ARR-36 Liaison Receiver Controls

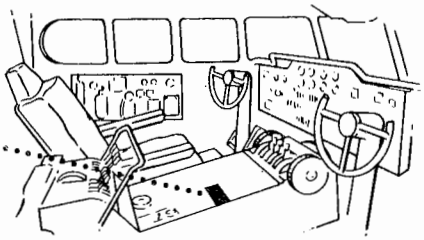
G 3279 ▶ plus TCTO KG206
less TCTO K572

OPERATION SELECTOR SWITCH. A rotary-type selector switch (18, figure 4-21) on the ARR-36 liaison receiver control panel has CW SHARP--CW BROAD--VOICE--FSK positions. This switch is used to select a type of reception on the ARR-36 liaison receiver. The CW SHARP position provides CW reception on a narrow band width to increase intelligibility of signals. CW BROAD has a 7-kilocycle band for general CW reception. VOICE is for voice reception. The FSK position is a provision for a teletypewriter and is not used.

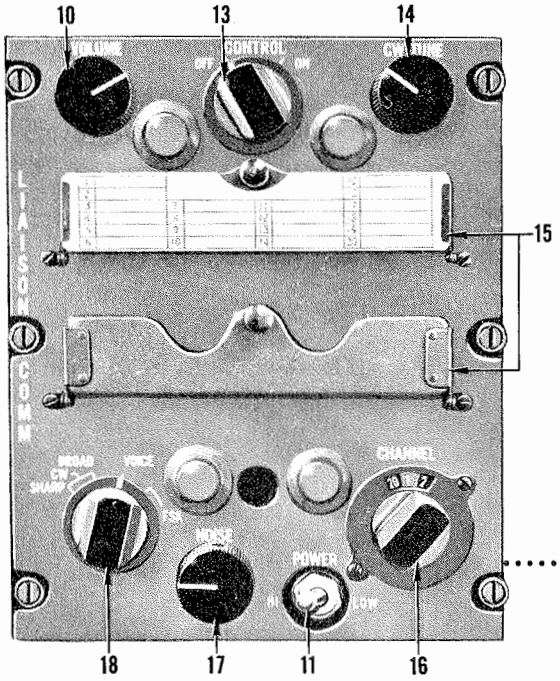


BC-348 LIAISON RECEIVER CONTROL PANEL G 17260 ▶ 3278 LESS TCTO KG206

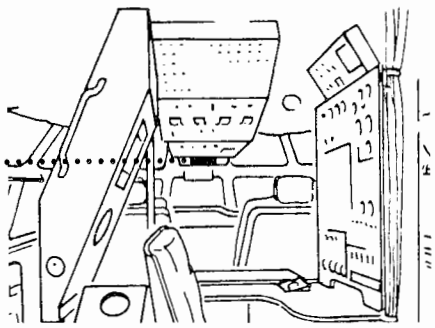




BC-454 LIAISON RECEIVER CONTROL PANEL F



1 C.W. OSC SWITCH
2 CRYSTAL FILTER SWITCH
3 TUNING DIAL
4 BAND SWITCH
5 DIAL LIGHT RHEOSTAT
6 ANTENNA ALIGNMENT KNOB
7 ANTENNA AND GROUND BINDING POSTS
8 TUNING CRANK (2 PLACES)
9 BEAT FREQUENCY KNOB
10 VOLUME KNOB (3 PLACES)
11 POWER SWITCH (3 PLACES)
12 TEL. JACKS
13 CONTROL SWITCH
14 CW TUNING KNOB
15 PRESETTING DRUM COVERS
16 CHANNEL SELECTOR SWITCH
17 NOISE CONTROL KNOB
18 OPERATION SELECTOR SWITCH



ARR-36 LIAISON RECEIVER CONTROL PANEL
G 3279 ▶ PLUS TCTO KG206

AUXILIARY LIAISON RECEIVER CONTROLS

LESS TCTO K572

Figure 4-21

G 3279 ▶ plus TCTO KG206 less TCTO K572 ◀
CONTROL SWITCH. This switch (13, figure 4-21) with OFF--ON positions serve to turn the receiver on or off. The control switch is also a protective device that returns the switch to OFF when there are faults in the equipment.

G 3279 ▶ plus TCTO KG206 less TCTO K572 ◀
VOLUME KNOB. This knob (10, figure 4-21) on the ARR-36 liaison receiver control panel, controls the loudness of received signals to the interphone.

G 3279 ▶ plus TCTO KG206 less TCTO K572 ◀
CW TUNING KNOB. The CW tuning knob (14, figure 4-21) on the ARR-36 liaison receiver control panel is used to adjust the tuning when receiving CW signals.

G 3279 ▶ plus TCTO KG206 less TCTO K572 ◀
CHANNEL SELECTOR SWITCH. This switch (16, figure 4-21) on the ARR-36 liaison receiver control panel is used for selecting any one of the 20 preset frequencies.

G 3279 ▶ plus TCTO KG206 less TCTO K572 ◀
PRESETTING DRUM COVERS. These covers (15, figure 4-21) are on the ARR-36 liaison receiver control panel. The covers are held closed by thumb screws, which enclose the drums on which the desired frequencies are preset. A matte-surfaced plastic sheet for recording the preset channel is mounted on the top cover.

G 3279 ▶ plus TCTO KG206 less TCTO K572 ◀
POWER SWITCH. This switch (11, figure 4-21) on the ARR-36 liaison receiver control panel is not operative.

G 3279 ▶ plus TCTO KG206 less TCTO K572 ◀
NOISE CONTROL KNOB. This knob (17, figure 4-21) is on the ARR-36 liaison receiver control panel. The control is operative only when the operation selector switch is in the VOICE or FSK positions. This is a limited-range sensitivity or squelch control for adjusting the noise threshold when receiving voice or frequency shift keying signals.

Normal Operation of the AN/ARR-36 Liaison Receiver

G 3279 ▶ plus TCTO KG206 less TCTO K572 ◀

The AN/ARR-36 liaison receiver is put into standby operation when airplane is airborne as follows:

1. Set channel selector switch to the desired channel.
2. Turn control knob to ON. If control returns to OFF in approximately 40 seconds, select another channel. Repeat this procedure until control remains ON. Do not change channel for 15 minutes. After this warm-up period, proceed with normal operating procedures
3. Turn operation selector switch to the desired type of operation
4. Adjust the noise control knob to the point where characteristic noise is not objectionable when no signals are being received. Reducing the noise too much may prevent hearing signals.

To receive voice signals using the AN/ARR-36 liaison receiver, proceed as follows:

1. Place AUX REC interphone mixer switch ON (up)
2. Set operation selector switch to VOICE
3. While receiving voice signals, adjust the volume for satisfactory loudness of signals in the headphones
4. When no signals are being received, adjust the noise control until the receiver background noise is not objectionable. Reducing the level below this point may result in the loss of weak signals.

NOTE

The CW tuning knob is inoperative during VOICE or FSK operation.

To receive CW signals using the AN/ARR-36 liaison receiver, proceed as follows:

1. Place AUX REC interphone mixer switch ON (up)
2. Set the operation selector switch to the CW-BROAD position
3. While receiving CW signals, adjust the volume knob for satisfactory loudness of signals in the headphones
4. Adjust the CW tuning knob for an easily readable pitch of the received signals
5. If an unusually high noise level from interference or jamming makes reception difficult, switch the operation selector switch to CW SHARP. This may require readjustment of the CW tuning knob for desirable signal pitch

NOTE

The noise control is inoperative during CW operation.

To turn off AN/ARR-36 liaison receiver, proceed as follows:

1. Turn control knob to OFF
2. For emergency shutoff of the receiver, turn control switch to ON then OFF if in the ON position
3. Turn off the airplane power source. The airplane power source can then be turned on again and the receiver will remain off

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 (figure 1-35, sheet 2).

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 4-22) on the pilots' and navigator's radio compass panels 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 panel to the other each time either switch is actuated.

NOTE

Control is indicated to be at the pilots' radio compass 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 pilot's.

LOOP SWITCH. A rotary loop switch (3, figure 4-22) on the pilots' and navigator's radio compass panels 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 4-22) on the pilots' and navigator's radio compass panels selects the desired station, the frequency of which is indicated on the calibrated dial.

LIGHT SWITCH. An indicator light control switch (4, figure 4-22) on the radio compass panel has HI--OFF--LO positions. HI and LO positions vary the indicator light intensity. OFF position turns off the lights.

BAND SWITCH. A band switch (8, figure 4-22) on the pilots' and navigator's radio compass panels selects any one of four receiver operating bands of frequencies. The switch positions are 100 to 200, 200 to 410, 410 to 850, and 850 to 1750 kilocycles. When a band is selected, the dial calibration is selected accordingly.

VOLUME KNOB. A volume knob (5, figure 4-22) on the pilots' and navigator's radio compass panels is provided as a means for adjustment of the audio level to the interphone.

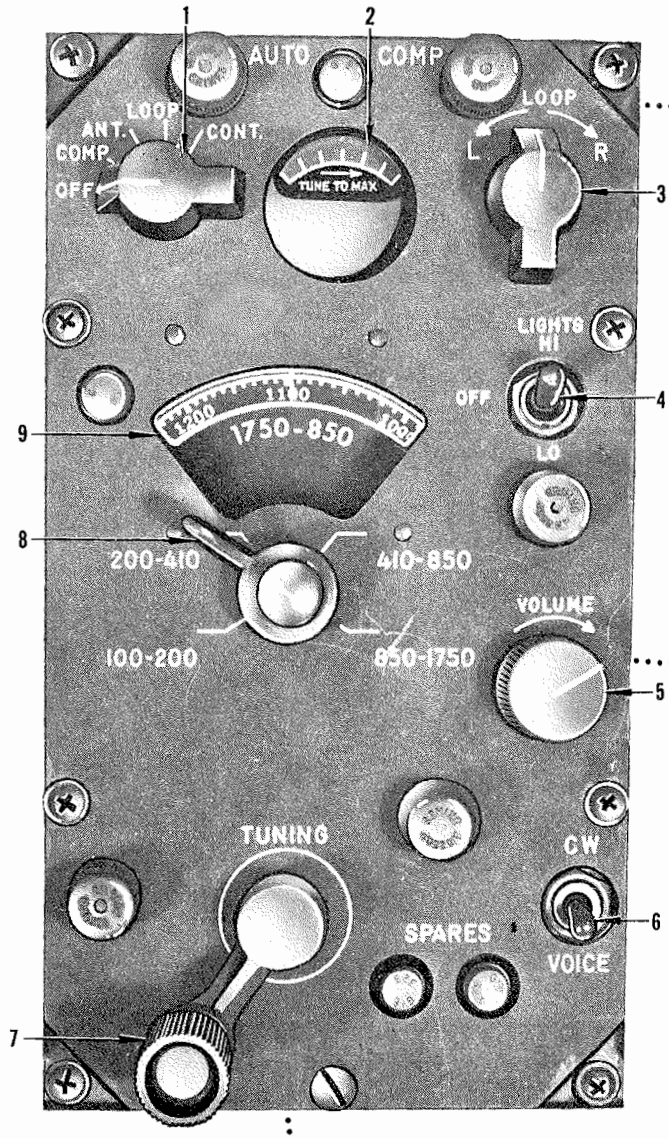
MODULATION SWITCH. A switch (6, figure 4-22) with CW--VOICE positions on the pilot's and navigator's radio compass panels is for selection of either code or voice reception.

Radio Compass Indicators

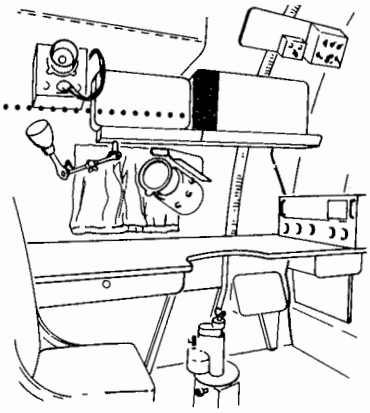
TUNING METER. A tuning meter (2, figure 4-22) is provided on the radio compass panels to indicate maximum signal strength during the process of tuning in a station.

FREQUENCY DIAL. A dial scale (9, figure 4-22) on the pilots' panel shows the frequency to which the radio compass is tuned.

RADIO MAGNETIC INDICATOR (RMI). The ADF bearing indicator on the pilot's and navigator's RMI's indicates the direction of a tuned station relative to the airplane's heading. Refer to RADIO MAGNETIC INDICATOR under VHF NAVIGATION RADIO (VOR) INDICATORS in this Section.



RADIO COMPASS (ADF) CONTROL PANEL



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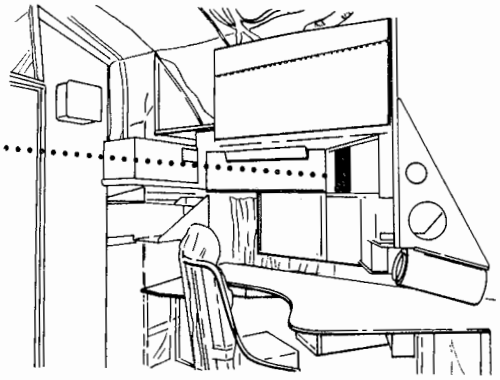

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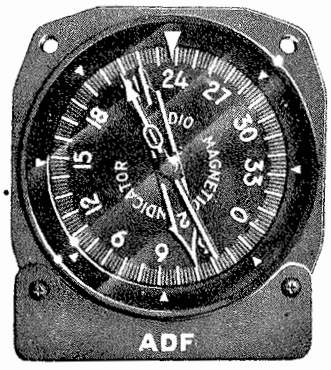
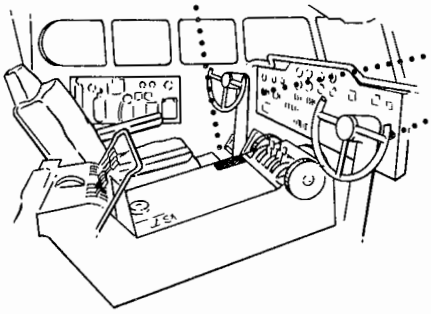


RADIO MAGNETIC INDICATOR (RMI) (TYPICAL)



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

Figure 4-22

Normal Operation of 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:

1. Place the function switch to ANT

CAUTION

Aural and sensing function may be affected by the simultaneous operation of the rendezvous radar sets (AN/APN-12 and APN-76).

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.

2. Place the appropriate interphone controls to the desired positions for reception of the radio compass receiver. See INTERPHONE SYSTEM, this Section
3. Select desired frequency band and use tuning crank to tune station and obtain maximum swing of tuning meter
4. Place function switch in desired (type of operation) position
5. Turn off equipment by placing function switch in 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 (10, figure 4-23). The beacon light is on the pilot's course indicator on the pilot's instrument panel. Control power is 28 volt DC with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

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. Radio magnetic indicators on the pilots' instrument panel, one each for the pilot and copilot, and one for the navigator, indicate bearing to the VOR station. The VHF-NAV interphone mixer switch (11, figure 4-8) must be ON (up) to hear the station identity code on the interphone. A switch (18 or 17, figure 4-23) must be positioned to VOR 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 (figure 1-35, sheet 6).

VOR And Localizer Controls

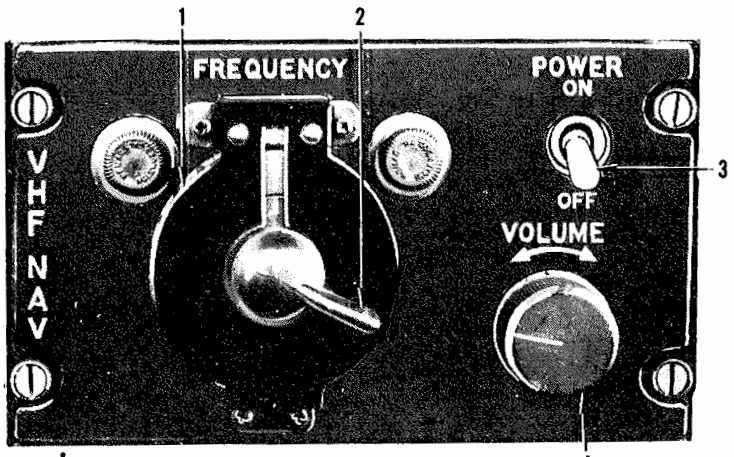
FREQUENCY SELECTOR KNOBS. Two rotary selector knobs (1 and 2, figure 4-23) on the VHF NAV control panel provide control of localizer and VOR frequency selection. The knobs may be turned either clockwise or counterclockwise. Frequencies between 108.0 and 135.9 megacycles provide 280 channels for selection. 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 4-23) on the VHF NAV control panel.

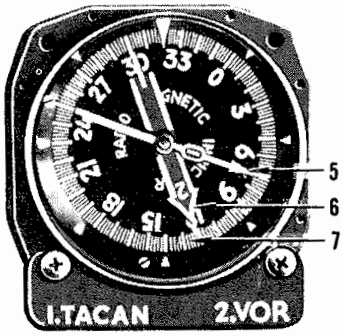
VOLUME KNOB. A volume knob (4, figure 4-23) on the VHF NAV control panel is used to adjust the audio level from the omni receiver to the interphone.

COURSE SET KNOB. A course set knob (15, figure 4-23) on the pilot's course indicator is used to set the magnetic bearing of a desired course in the three upper tab windows (course set window).

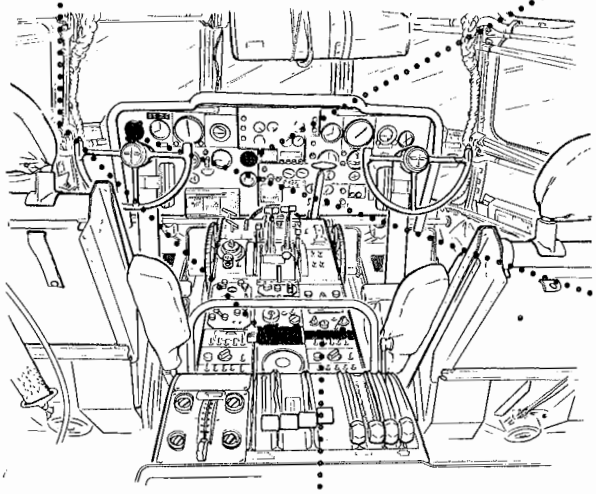
OBD-VOR SELECTOR SWITCH. Airplanes not incorporating TCTO 572. This switch (17, figure 4-23) on the navigation instrument selector panel is on the control stand. The switch which is operative only in the VOR position at this time, allows signals to be fed to the pilot's course indicator (1, figure 1-9) and the radio magnetic indicators (figure 4-23). Information will be furnished for the OBD position when available. Control power is 28 volt dc with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

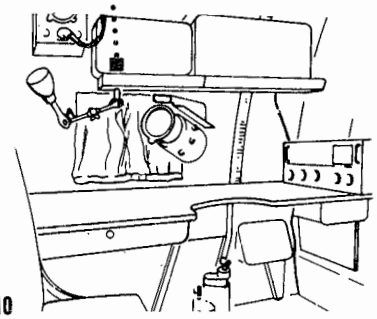


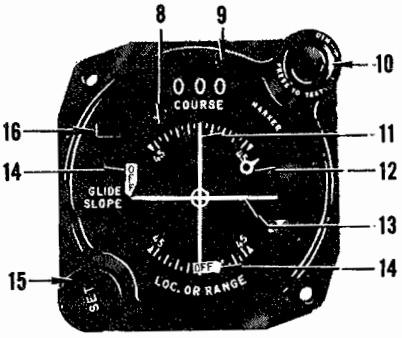
VHF NAVIGATION CONTROL PANEL



RADIO MAGNETIC INDICATOR (RMI) (TYPICAL)



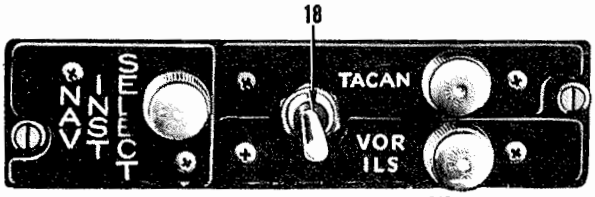




PILOT'S COURSE INDICATOR

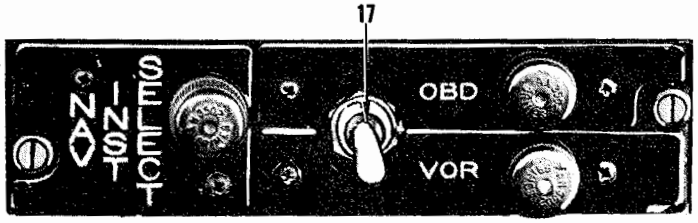
NOTE

On some airplanes, the navigator's RMI indicates bearing to omni station only when instrument select switch is on VOR-ILS.



AIRPLANES INCORPORATING TCTO 572

NAVIGATION INSTRUMENT SELECTOR PANELS



AIRPLANES NOT INCORPORATING TCTO 572

1 FREQUENCY SELECTOR KNOB (WHOLE MEGACYCLE)
2 FREQUENCY SELECTOR KNOB (TENTH MEGACYCLE)
3 POWER SWITCH
4 VOLUME KNOB
5 TACAN BEARING INDICATOR
6 VOR BEARING INDICATOR
7 ROTATING COMPASS CARD
8 HEADING POINTER SCALE
9 COURSE SET WINDOW
10 MARKER BEACON LIGHT
11 COURSE DEVIATION INDICATOR
12 RELATIVE HEADING POINTER
13 GLIDE SLOPE INDICATOR
14 FLAG ALARM (2 PLACES)
15 COURSE SET KNOB
16 TO/FROM WINDOW
17 OBD--VOR SELECTOR SWITCH
18 INSTRUMENT SELECT SWITCH

VHF NAVIGATION RADIO (OMNI) CONTROLS AND INDICATORS

Figure 4-23

INSTRUMENT SELECT SWITCH. Airplanes incorporating TCTO 572. Input signals to the pilot's course indicator are selected by the instrument select switch (18, figure 4-23). When the switch is in the VOR-ILS position, signals from the VHF navigation radio are applied to the pilot's course indicator. 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 instruments.

VHF Navigation Radio (VOR) Indicators

PILOT'S COURSE INDICATOR. The pilot's course indicator on airplanes not incorporating TCTO 572, gives a composite display of VHF navigation or approach information (VOR or ILS). On airplanes incorporating TCTO 572, the course indicators display either VHF (VOR or ILS) or UHF (TACAN) navigation information dependent upon the position of the instrument select switch. The indicator (figure 4-23) is on the pilot's flight instrument panel. The course set knob (15, figure 4-23), 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. The selected course appears in the course set window (9, figure 4-23). The course deviation indicator (11, figure 4-23) 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 (13, figure 4-23), 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 relative heading pointer (12, figure 4-23) 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 relative heading pointer is centered, the heading of the airplane is the same as the course shown in the course set window. If the pointer is deflected to the left or right, the airplane heading is to the left or right the 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 (16, figure 4-23) 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 (14, figure 4-23) 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 de-energized. The flag moves out of sight when the indicator is reliable. Each course indicator has a marked beacon light (10, figure 4-23). 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 set 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 the magnetic slaved operational mode. When the N-1 system is in directional indicator operational mode 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.

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 on airplanes incorporating TCTO 572, and bearing to UHF radio stations (UHF/DF) on airplanes G 3178 plus those incorporating TCTO 321. 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 reference index at the top of the instrument. The No. 2 bearing indicator is the azimuth indicator for the VOR receiver and indicates the bearing to the VOR from the airplane as measured from magnetic North whether N-1 compass system is in magnetic slaved operational mode or directional indicator mode. The No. 2 bearing indicator receives synchro excitation voltage only through the N-1 compass; however, in the event of failure of power to the N-1, a relay is energized which provides an alternate source of excitation voltage. In effect, this makes the No. 2 bearing indicator completely independent of the N-1. When the VOR is operating properly and the C-1 amplifier is receiving power, the No. 2 bearing indicator 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 No. 2 bearing indicator, is to keep the airplane heading at the top of the rotating compass card; that is, the bearing indicator 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 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 OFF position.

Emergency Operation of 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, directional indication from the rotating compass card and the No. 1 and 2 bearing indicators 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)

A 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 4-39 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 (figure 1-35, sheet 2).

Glide Path Receiver Indicator

A glide slope indicator (13, figure 4-23) 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 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 4-23) 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 4-23) 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

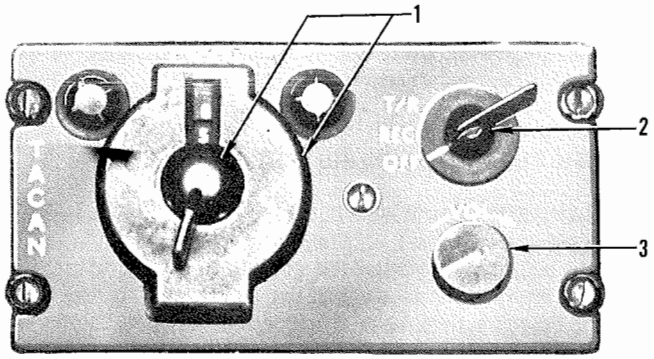
Power to the glide path receiver is turned off when the radar beacon power selector switch (8, figure 4-34) is on EMERG.

Emergency Operation of Glide Path Receiver

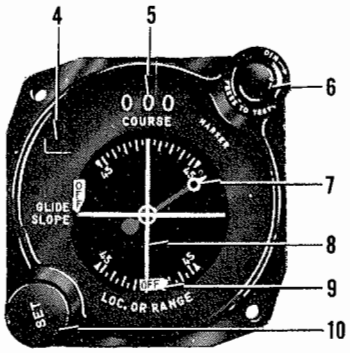
Emergency operation does not differ from normal operating procedure.

UHF NAVIGATION RADIO (TACAN) (AN/ARN-21) TCTO 572

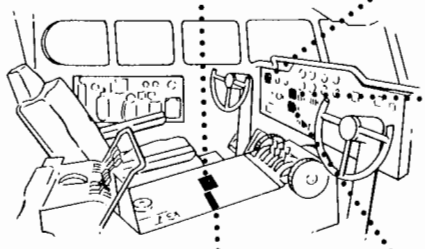
Airplanes incorporating TCTO 572 have a UHF navigation radio that operates in conjunction with surface navigation beacons. The radio and a surface beacon together comprise a radio navigation system, called TACAN, that enables the airplane to obtain continuous indications of distance and bearing to a selected station. The radio has five components: receiver-transmitter, antenna, control panel, range indicator, and azimuth indicators (pilot's course indicators and radio magnetic indicators) (figure 4-24). 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 one hundred twenty six 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 4-24). TACAN information is connected to the pilot's course indicator when the instrument select switch (14, figure 4-24) is in TACAN position. The TACAN mixer switch (13 and 19, 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

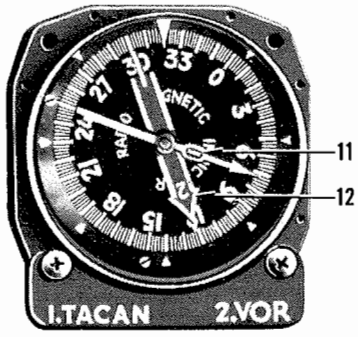


UHF NAVIGATION RADIO CONTROL PANEL

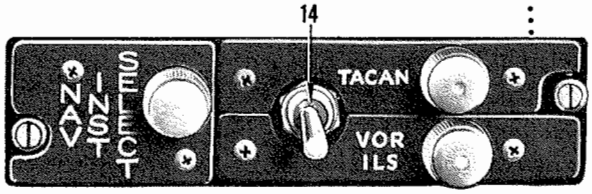


PILOT'S COURSE INDICATOR

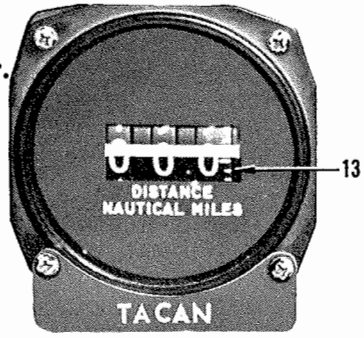




PILOT'S RADIO MAGNETIC INDICATOR (RMI) (TYPICAL)



INSTRUMENT SELECT CONTROL PANEL



RANGE INDICATOR

NAVIGATOR'S RADIO MAGNETIC INDICATOR (RMI)

NOTE: On some airplanes, the navigator's RMI No. 2 bearing indicator indicates bearing to TACAN station when instrument select switch is on TACAN.

1 CHANNEL SELECTOR KNOBS
2 OFF--REC--T/R SWITCH
3 VOLUME KNOB
4 TO/FROM INDICATOR WINDOW
5 COURSE SET WINDOW
6 MARKER BEACON LIGHT
7 RELATIVE HEADING POINTER
8 COURSE DEVIATION INDICATOR
9 FLAG ALARM
10 COURSE SET KNOB
11 RMI NO. 1 BEARING INDICATOR
12 RMI NO. 2 BEARING INDICATOR
13 RANGE INDICATOR WINDOW
14 INSTRUMENT SELECT SWITCH

UHF NAVIGATION RADIO (TACAN) CONTROLS AND INDICATORS WITH TCTO 572

Figure 4-24

in the operation and control of the set with circuit protection through circuit breakers on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

WARNING

On airplanes having both VHF and UHF navigation radios, turn off the UHF navigation radio (TACAN) when making a VOR or ILS approach. There is an automatic change-over to TACAN in the event of power failure to the VOR. This change-over may occur without being noticed by the pilot since there is no distinctive indication of such a failure.

UHF Navigation Radio (TACAN) Controls TCTO 572 TCTO 572

OFF--REC--T/R SWITCH. Placing the OFF--REC--T/R switch (2, figure 4-24) 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.

TCTO 572

CHANNEL SELECTOR KNOBS. The two channel selector knobs (1, figure 4-24) 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.

TCTO 572

VOLUME KNOB. The knob (3, figure 4-24) controls the volume of the three-letter Morse code beacon identification signal.

TCTO 572

INSTRUMENT SELECT SWITCH. Input signals to the radio magnetic indicators and pilot's course indicator are selected by the instrument select switch (14, figure 4-24). 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 4-24) on the pilot's course indicator is used to set the magnetic bearing of a desired course in three-digit display windows.

UHF Navigation Radio (TACAN) Indicators TCTO 572

RANGE INDICATOR. The range indicator 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 (13, figure 4-24) are partially covered by a red bar and the counters move too rapidly for a reading to be obtained. When the equipment has locked on to a reliable range signal, the red bar disappears and the counters move slowly as determined by airplane flight. Maximum reading of the range indicator will be 195 nautical air miles.

PILOT'S COURSE INDICATOR. The pilots' course indicator, (figure 4-24) 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 beacon is shown by the vertical pointer. The selected course to the beacon is shown in the three-digit course set window. The course is selected by turning the SET knob. When the vertical pointer signals are not reliable, a vertical pointer flag alarm labelled OFF appears. A heading pointer shows relationship of the airplane heading to the selected bearing. With the vertical pointer centered, the heading pointer indication is the crab angle of the airplane. An amber indicator light illuminates when the marker beacon receiver operates. A to/from flag indicates whether the course selected is to or from the TACAN beacon 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.

RADIO MAGNETIC INDICATOR (RMI). Bearing information of the UHF navigation radio is displayed on the radio magnetic indicators or RMI's (figure 4-24) one on the pilots' instrument panel and one RMI on the navigator's instrument panel. On the pilots' instrument panel, the radio magnetic indicators which have the marking 1. TACAN show UHF navigation radio bearing with the No. 1 pointer. On some airplanes the navigator's radio magnetic indicator shows UHF navigation radio bearing on the No. 2 pointer when the instrument select switch is in the TACAN position. The pointers rotate continuously when the equipment is not locked on a reliable beacon bearing signal.

AZIMUTH INDICATOR. This indicator is next to the forward power panel in the lower forward compartment. It displays the relative bearing to the TACAN beacon station. Since this information is presented on the radio magnetic indicators, the azimuth indicator is not normally used in flight.

Normal Operation of UHF Navigation Radio (TACAN)

TCTO 572

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 beacon station. To identify the beacon 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 pointers stop rotating, the search cycle of the equipment is completed and the pointers indicate the bearing of the beacon. 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 range to the beacon in nautical air miles on the range indicator after the red bar disappears. To turn the equipment off, move the OFF--REC--T/R switch to the OFF position.

Emergency Operation of UHF Navigation Radio (TACAN)

TCTO 572

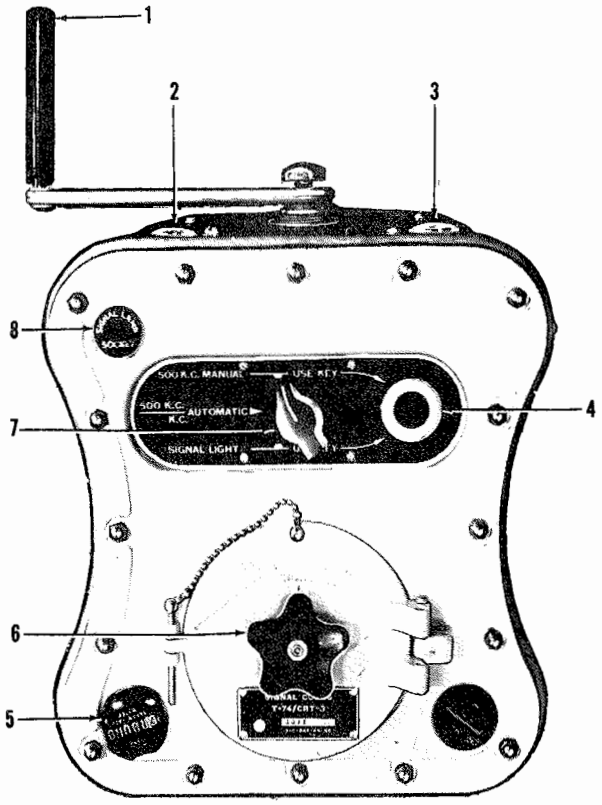
In event of failure of the C-1 signal power amplifier, the pilots' and navigator's radio magnetic indicators will be inoperative. When such a failure occurs, directional indication from the rotating compass card and the No. 1 and No. 2 needles for the radio magnetic indicators will not be available. Under these conditions, bearing information may be obtained from the pilot's course indicator by turning the course set knob until the vertical pointer is centered. Magnetic bearing to or from the beacon can then be read in the course marker window. The to/from flag will indicate whether the bearing is to or from the beacon. Partial failure of the equipment may not impair other functions. If the warning flag is not visible, the indication can be considered reliable.

DINGHY TRANSMITTER (AN/CRT-3A)

Two manually operated dinghy transmitters (6, figure 3-1) are provided for emergency transmission of automatic or manual modulated code or light signals.

Dinghy Transmitter Controls

HAND CRANK. Power is generated by turning a hand crank, (1, figure 4-25) at the top of the transmitter.



DINGHY TRANSMITTER

1 HAND CRANK
2 RADIO OUTPUT LIGHT
3 SPEED INDICATOR LIGHT
4 KEY
5 GROUND LEAD
6 ANTENNA REEL
7 SELECTOR SWITCH
8 SIGNAL LAMP SOCKET

DINGHY TRANSMITTER CONTROLS

Figure 4-25

KEY. The key (4, figure 4-25) on the transmitter is utilized to manually key the transmitter or signal light, when the selector switch is in MANUAL or SIGNAL LIGHT positions respectively.

GROUND LEAD. This lead (5, figure 4-25) on the bottom of the transmitter serves as a ground for the set and can be placed in water or buried in soil.

ANTENNA REEL. The antenna reel (6, figure 4-25) on the transmitter is provided to reel or unreel the desired antenna length.

SELECTOR SWITCH. The selector switch (7, figure 4-25) has AUTOMATIC--MANUAL positions. The switch should be on AUTOMATIC for at least 5 minutes of each of the International Distress Listening periods to enable D/F stations to make an accurate fix of the sets location. The switch should be placed on MANUAL occasionally (2 or 3 times hourly) and the call letters of the distressed airplane keyed to permit D/F stations or search craft homing on 500 kc signal to distinguish between your signals and those of any other set sending out signals on the same frequency.

SIGNAL LAMP SOCKET. This socket (8, figure 4-25) is provided to allow signal lamp to be plugged in. The light is used at night to enable search craft to sight exact location of distress party using it.

Dinghy Transmitter Indicators

RADIO OUTPUT LIGHT. This light (2, figure 4-25) on the transmitter should glow after approximately one minute of operation, indicating that transmission is taking place.

SPEED INDICATOR LIGHT. A speed indicator light (3, figure 4-25) on the transmitter, indicates by illumination when the proper cranking speed has been reached.

Automatic Radio Transmission of the Dinghy Transmittter

To start the transmitter, proceed as follows:

1. Set the selector pointer to 500 K.C.-8364 K.C. AUTOMATIC
2. To start transmission, rotate the crank in a clockwise direction at approximately 80 to 100 revolutions per minute. When sufficient speed has been attained, the lamp marked SPEED INDICATOR KEEP LIGHTED on the top of the transmitter will light. Faster crank speeds are ineffective since the transmitter contains automatic voltage regulation, and undesirable since they speed up the transmitter code characters
3. Continue cranking. Allow at least 20 seconds for the filaments of the vacuum tubes to heat, after which time the radio output light should flash on and off with the keying of the transmitted signal. There are no further adjustments
4. In the 500 K.C.-8364 K.C.-AUTOMATIC selector switch position, the transmitter automatically sends a signal consisting of six groups of SOS followed by a sustained dash of about 20 seconds duration. This occurs first on 500 kilocycles and then on 8364 kilocycles, automatically switching from one frequency to the other about every 40 or 50 seconds

To stop the transmitter, stop cranking.

General Instructions for Transmission:

1. Most shore stations and even some ship and airplane stations maintain continuous watch, therefore, if no timepiece is available the exact time for transmission is not of great concern
2. Transmit for at least 5 minutes at a time to enable stations to determine bearings after the signal is heard
3. Transmit at least once every half hour during the day. Many short transmissions, close together, are better than one continuous transmission for hours followed by a long period of silence. An airplane using the radio transmissions as a guide for the rescue needs frequency signals so it can keep on the correct course
4. Transmit both at night and during the day to take advantage of the changes in range. Always transmit several times in the periods near dawn and near dusk
5. Radio stations engaged in the rescue operation may be far from the life raft and from each other. They must communicate with each other and with rescue agencies close by before the rescue can be accomplished. The operator, therefore, must not use all of his strength the first day
6. Transmit continuously if a ship or airplane is heard or sighted. At night, use both radio transmission and the signal lamp as circumstances warrant
7. Share the work of cranking. Interchange hands to ease the effort. If possible, let others crank the transmitter while one man holds it between his legs

Manual Radio Transmission

To start the transmitter for manual transmission, proceed as follows:

1. Set the selector switch pointer to the 500 KC MANUAL position
2. To start transmission, rotate the crank in a clockwise direction at approximately 80 to 100 revolutions per minute. When sufficient speed has been attained, the lamp marked SPEED INDICATOR KEEP LIGHTED located on the top of the transmitter will light. Faster crank speeds are ineffective, since the transmitter contains automatic voltage regulation. Continue cranking for about 20 seconds to allow the filaments to heat
3. To transmit a signal, the push button marked KEY must be pressed. This button is manipulated most conveniently by the operator with one of the first two fingers of the left hand. If another person is present, he might telegraph with his right hand while the other cranks. The indicator lamp marked RADIO OUTPUT should light when the key is depressed. This light provides a means for visually monitoring the message transmitted. The International Morse Code is printed on the top of the transmitter.

To stop the transmitter, proceed as follows:

1. To stop transmission for a few moments only, release the key button; continue cranking
2. To stop operation completely, merely stop cranking

General Instructions for Manual Transmission:

1. Send slowly, about five words per minute at most. It is difficult to send readable code with this transmitter
2. Monitor the transmission by reading the radio output light as a blinker
3. At intervals transmit a sustained dash to enable planes which may be homing on the transmission to get a bearing
4. Use manual keying only when you have a particular message to send
5. Never use manual keying alone; switch to AUTOMATIC for five minute intervals occasionally. Transmission on 8364 kilocycles, available on automatic keying only, gives the greatest range

OPERATION OF SIGNAL LAMP. A signal lamp may be used for visual signaling at night if an airplane is heard. This does not require the antenna.

1. Obtain the signal lamp from the accessory bag. Plug the cord attached to the signal lamp into the signal lamp socket at the upper left corner of the transmitter panel
2. Strap the transmitter between the legs
3. Set the selector switch knob at the SIGNAL LIGHT position
4. Strap the signal lamp on top of the head with the straps under the chin. The lamp is nondirectional, and its light may be seen from any direction
5. Depress the push-button key
6. Crank the transmitter at a speed where maximum brilliancy of the signal light is obtained

NOTE

If the lamp bulb does not light or if it burns out during use, unscrew the dome of the signal lamp, replace the bulb with the spare bulb supplied in the space clip next to the socket, and then replace the dome.

7. To telegraph with the signal light, manipulate the push-button key

NOTE

No radio transmission occurs when the signal lamp is used.

RADIO ALTIMETER (SCR-718C)

The radio altimeter is used in airplanes for determining height above terrain. The nominal range of the equipment is 0 to 50,000 feet, although the altimeter is only accurate to 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 altimeter (figure 4-22) is at the navigator's station. Operating power is 115 volt ac with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

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. This switch (1, figure 4-26) 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. This knob (2, figure 4-26) on the radio altimeter adjusts the zero lobe to zero when the scale switch is positioned to TIMES TEN.

TIMES ONE ZERO ADJUSTMENT KNOB. This knob (4, figure 4-26) 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 4-26) 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.

REC GAIN KNOB. This knob (6, figure 4-26) on the radio altimeter has ON--OFF positions. The knob serves a double purpose. In the extreme counterclockwise position, the set is OFF and no power is applied. 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.

Radio Altimeter Indicators

INDICATOR FACE. The indicator face (3, figure 4-26) 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. A pilot light (7, figure 4-26) on the radio altimeter will light when the components of the set are energized.

Normal Operation of Radio Altimeter

To start the set, proceed as follows:

1. Turn the rec. gain knob clockwise, about one-half turn from the OFF position to the ON position
2. Check the pilot light on, indicating equipment is energized

NOTE

Power to the radio altimeter is turned off when the radar beacon power selector switch (8, figure 4-34) is on EMERG.

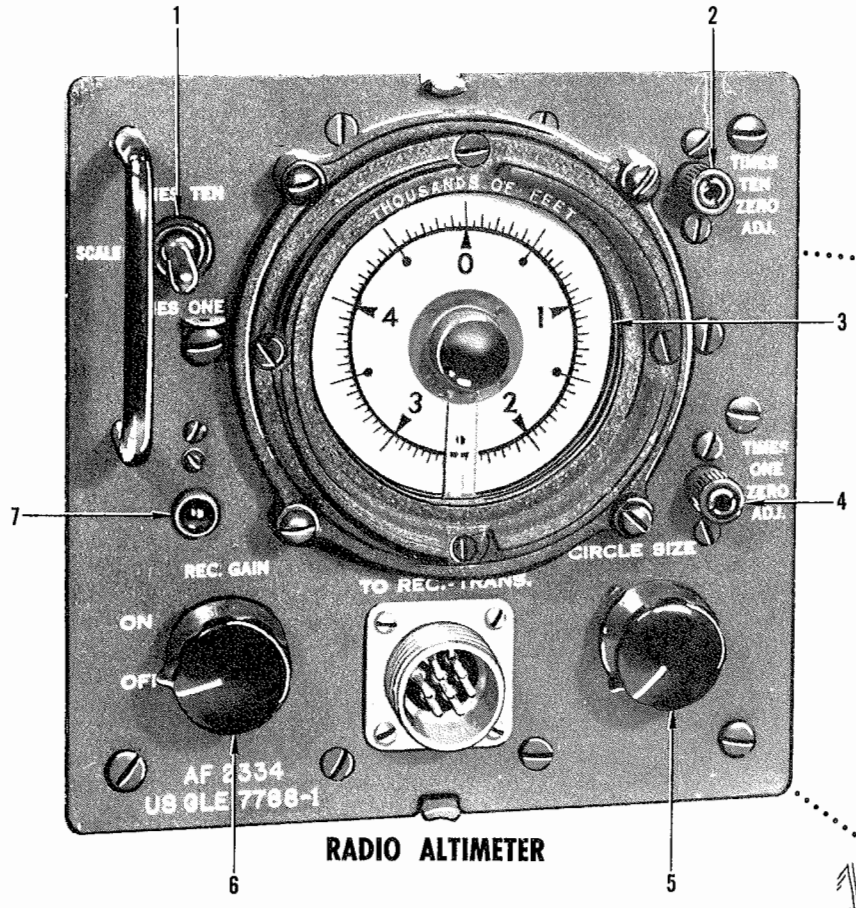
To operate the radio altimeter, proceed as follows:

1. After turning the equipment on, allow about 3 minutes or more, if possible, for the tubes to reach their operating conditions; then turn rec. gain knob until a 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
2. 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
3. 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
4. With the scale switch in the TIMES TEN position, check that the circle trace is about 1/4-inch inside the black calibrated scale
5. Adjust the times ten zero adjustment knob until the reference pulse is at zero

a. 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
b. Set the scale switch to the TIMES ONE position
c. Adjust the times one zero adj. 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
d. As the airplane climbs, the reflected pulse will move away from zero and decrease in amplitude
e. At an altitude of several hundred feet, turn up the rec. gain control so that the reflected pulse (a new pulse appearing near zero) is 1/4-inch high
f. 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 control so that the reflected pulse is 1/4-inch high, disregarding any slight shift of the reference pulse to the left
g. For zero adjustment during flight, adjust the rec. gain control so that the reference pulse is 1/4-inch high. Then use the times one zero adj. knob if necessary to set the pulse to the reading recorded in "f" above. 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 control so that the reflected pulse is 1/4-inch high before reading altitude. Do not add or subtract the reading of the reference pulse

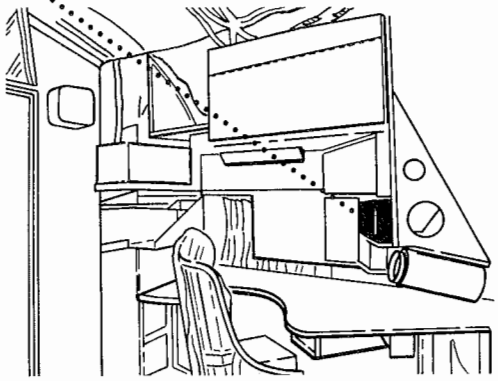
To read altitude, proceed as follows:

1. 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 control 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 positions of the pulse
2. 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
3. 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 of 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



RADIO ALTIMETER

F G 1243 ▶ 3177



G 3178 ▶

1 SCALE SWITCH
2 TIMES TEN ZERO ADJUSTMENT KNOB
3 INDICATOR FACE
4 TIMES ONE ZERO ADJUSTMENT KNOB
5 CIRCLE SIZE KNOB
6 REC. GAIN KNOB
7 PILOT LIGHT

RADIO ALTIMETER CONTROLS

Figure 4-26

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

4. 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

5. 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:

1. Effect of Terrain. Flying over rough terrain will produce fluctuating indications, and flying over water will produce relatively steady indications

2. 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

3. 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

4. Receiver Gain. Turning the rec. gain knob up higher than is necessary for a satisfactory image will result in a blurred or fuzzy trace

5. Dives, Climbs, and Banks. Sharp banks, dives and turns may flatten out the reflected pulse, or the pulse may disappear completely during the bank or dive

6. Observable Defects:
   a. A circle trace which is not truly circular will cause inaccurate readings
   b. A circle trace that is off center will cause inaccurate readings
   c. Shifting of the reference pulse will cause inaccurate readings unless compensated for as stated in Step 4, NORMAL OPERATION OF THE RADIO ALTIMETER, this Section

7. 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, proceed as follows:

1. Turn the rec. gain knob fully counterclockwise to the OFF position

LORAN (AN/APN-9) F

The loran radio receiving set is used by the operator to receive and interpret loran signals. The set serves as a navigational aid and assists the operator in determining geographic location of airplane position. A scope and controls for the set are on the front of the receiver. The receiver (15, figure 4-15) is 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 (figure 1-35, sheet 2).

Trailing Wire Antenna F

1. The trailing wire antenna will be extended only when necessary to accomplish a mission

2. Utilization of the trailing wire antenna will be noted in Form 781 upon completion of flight

WARNING

Do not extend antenna in turbulent air over populated areas unless such operation is deemed necessary. Do not extend antenna during air refueling.

CAUTION

When required to change antenna reels, insure safety wire is tightly inserted through the holes provided in the antenna reels to maintain constant pressure on the antenna wire and to prevent the antenna from extending. Insure both antennas are fully retracted prior to dismounting and during the exchange and remounting.

NOTE

On airplanes incorporating TC10 K228, use of the loran (AN/APN-9) is possible during refueling operations (when the trailing antenna must be retracted) by using the two position switch (COMMAND ANTENNA - TRAILING ANTENNA) on the loran receiver. When this switch is in the COMMAND ANTENNA position, the loran utilizes the MF command radio antenna.

APN-9 Loran Controls

F

LEFT--RIGHT SWITCH. This switch (1, figure 4-27) on the loran receiver is used in shifting pulses to the left or right as may be necessary to frame them on the pedestals.

F

DRIFT CONTROL. The knob (3, figure 4-27), marked DRIFT, on the loran receiver is used to correct movements of signals until they are stationary.

F

STATION RATE SWITCH. This knob (5, figure 4-27) on the loran receiver and the PRR switch are used together to select proper pulse repetition rate and station.

F

FINE DELAY KNOB. This knob (8, figure 4-27) on the loran receiver is used to align the signals vertically.

F

COARSE DELAY KNOB. This knob (7, figure 4-27) on the loran receiver when turned counterclockwise, causes the signal to jump to the right in the event signals are not aligned after using the fine delay knob.

F

FUNCTION SWITCH. This switch (9, figure 4-27) on the receiver has five-positions, The knob controls the receiver-indicator circuits for the operations necessary in taking a loran reading.

F

AMPLITUDE BALANCE CONTROL. This knob (10, figure 4-27) on the loran receiver, adjusts the signal amplitude of the separate traces when a double sweep is used.

F

POWER SWITCH AND GAIN KNOB. This knob (11, figure 4-27) on the loran receiver has POWER OFF--RECEIVER GAIN positions. In the POWER OFF position, the receiver is inoperative. Turning the knob clockwise until it clicks, turns on power. Further clockwise rotation increases the gain of the receiver.

F

CHANNEL SELECTOR SWITCH. This switch (12, figure 4-27) on the loran receiver selects one of six pre-tuned channels.

F

LENS. The lens (2, figure 4-27) on the loran receiver enlarges the image of the cathode-ray indicator screen.

Normal Operation of the APN-9 Loran

1. Turn on the power by turning the power switch and gain knob clockwise until the pilot light above the station rate switch lights up. Allow a few minutes for equipment to warm up. Two traces appear on the scope, with a blip on the lower trace.

NOTE

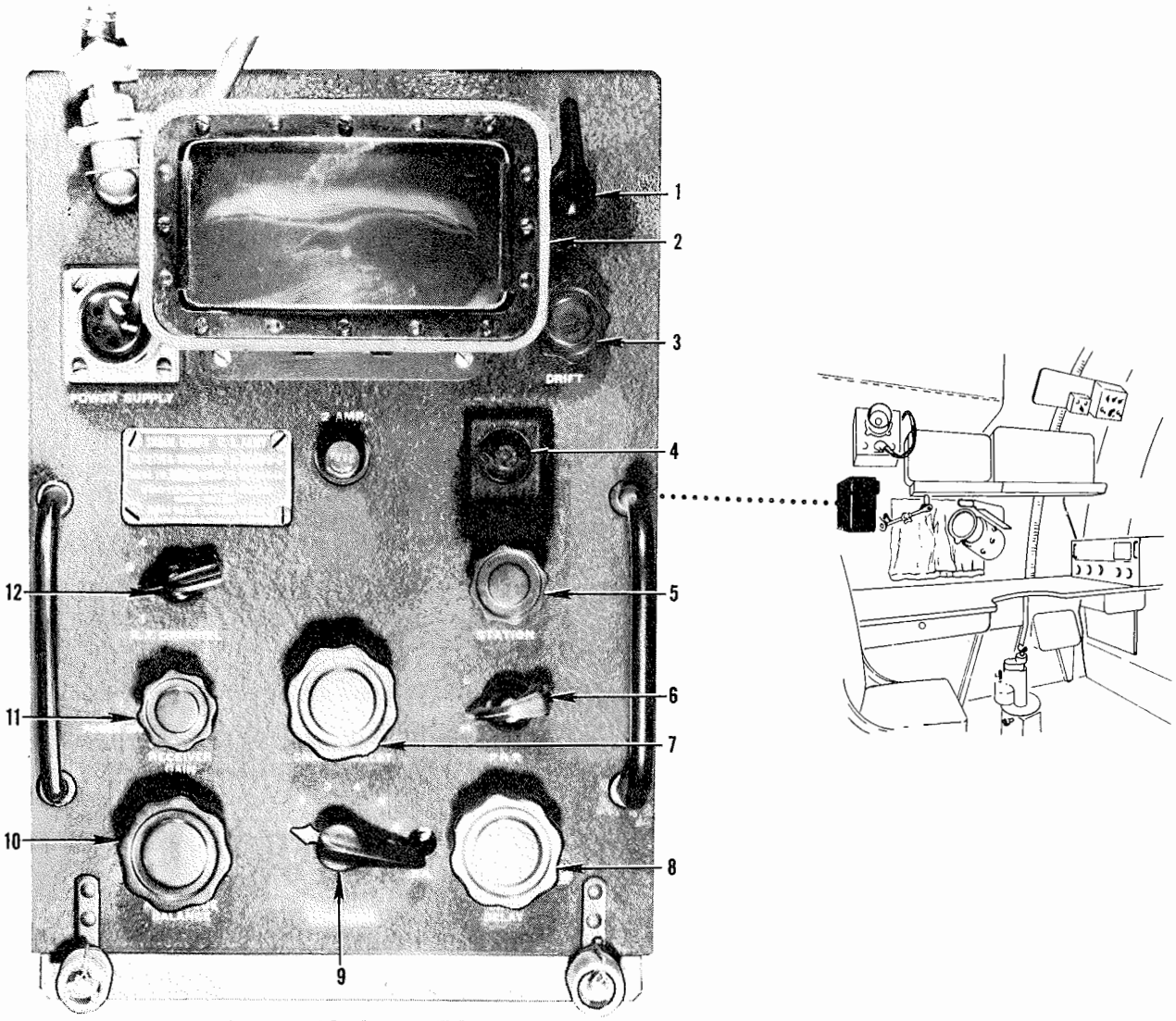
Power to the loran equipment is turned off when the radar beacon power selector switch (8, figure 4-34) is on EMERG.

2. Set the amplitude balance and fine delay controls to their respective center positions
3. Set the channel selector, PRR, and station rate switches at the proper positions to receive the desired station pair
4. Set the function switch to position 1
5. Rotate the gain knob clockwise until the signals appear on the scope
6. Move both signals to the lower trace with the left--right switch. Signals may first appear on the top trace, or on the bottom trace; or one signal may appear on each trace. Position both signals on the lower trace, with the left signal set at the extreme left end of the trace
7. Adjust the coarse delay until the variable delay marker is under the righthand signals

NOTE

Amplitude balance control will not effect signals when function switch is at position 1.

8. Turn the function switch to position 2
9. Adjust the gain and amplitude balance until the signals are of the same height and of the correct amplitude
10. Use the left--right switch to move the signals toward the left side of the trace until they open out. If the signals tend to drift, stop trace movement with the drift control
11. Align the signals vertically with the fine delay knob. If they do not line up when the fine delay has reached the limit of its clockwise rotation, slowly turn the coarse delay knob counterclockwise until the signal on the lower trace jumps one step to the right. You can now line up the signals by turning the fine delay knob counterclockwise. As the signals are moved from the right side of the scope to the left side, the fine delay, amplitude balance, gain, and drift controls become increasingly sensitive. This happens because the left side of the scope is a gradual expansion of only a small part of the right side
12. Turn the function switch to position 3. Position 3 superimposes the master and slave signals for final matching. You may need to adjust the fine delay and amplitude balance slightly.



AN/APN-9 LORAN RECEIVER

1 L--R (LEFT-RIGHT) SWITCH
2 LENS
3 DRIFT CONTROL
4 PILOT LIGHT
5 STATION RATE SWITCH
6 PRR SWITCH
7 COARSE DELAY KNOB
8 FINE DELAY KNOB
9 FUNCTION SWITCH
10 AMPLITUDE BALANCE CONTROL
11 POWER SWITCH AND GAIN KNOB
12 CHANNEL SELECTOR SWITCH

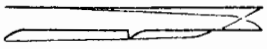
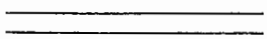
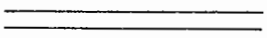
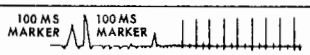
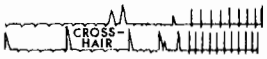
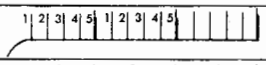
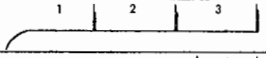
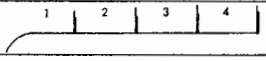
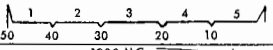
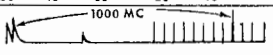
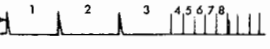
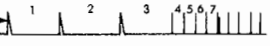
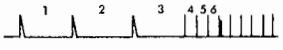
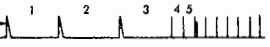
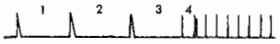
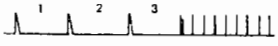
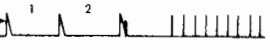
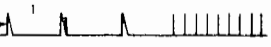
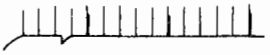
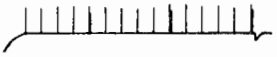
NOTE

The loran receiver has additional controls (not shown) that are adjusted with a screwdriver.

LORAN (AN/APN-9) CONTROLS

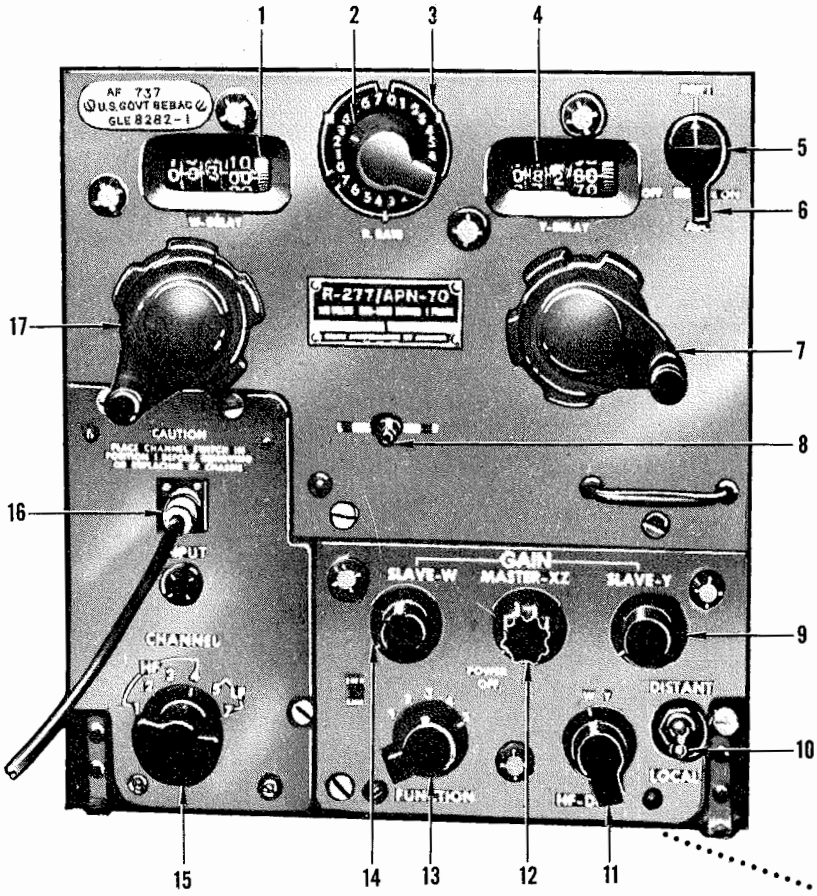
F

Figure 4-27

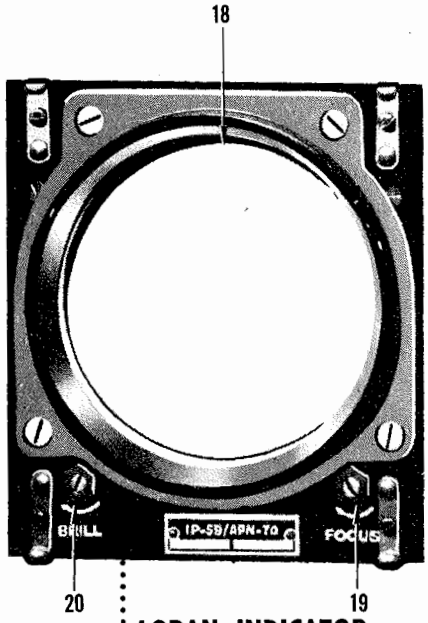
Funct.	Stn.	PRR	Scope Pattern	Remarks	Adj.	Crse.	Fine
5	0	L or H		Adjust for distinct picture	Focus		
5	0	L or H		Adjust to operator's desire	Brill		
1	0	L or H		Adjust alternately for length & position	Sl. Swp. H Cent & Ampl.		
2	0	L or H		Adjust alternately for length & position	Fa. Swp. H Cent & Ampl.		
2	0	L or H		Adjust to center vertically	Vert. Center		
5	0	L or H		Adjust 1000MS mkrs 1/8"-1/4" above 100MS Mkrs	Marker Ampl.		
5	0	L or H		Adjust until cross-hair barely touches 10 MS markers on upper trace	Cross Hair		
4	0	H		5 (1000 Spaces) between (5000 Mkrs)	C		
4	0	H		3 (5000 MS Markers)	D		
4	0	L		4 (5000 MS Markers)	E		
5	0	H	Bottom Trace 	4 (10 MS Mkrs) between (50 MS Mkrs)	A		
5	0	H	Top Trace 	9 (100 MS Mkrs) between (1000 MS Mkrs)	B		
5	0	H	Cross Hair → 	Count 8 spaces from cross-hair on left to first stn rate on right (BTM trace)	B		
5	1	H	Cross Hair → 	Count 7 spaces from cross-hair to STN rate marker	B		
5	2	H		Count 6	2		
5	3	H	Cross Hair → 	Count 5	2		
5	4	H		Count 4	4		
5	5	H		Count 3	4		
5	6	H	Cross Hair → 	Count 2	F 6		
5	7	H	Cross Hair → 	Count 1	F 6		
5	4	H	Move L-R switch to right, stn. rate marker should jump two spaces left		B R-L		
4	0	H		Marker reads between 11,000 & 11,500	5th hole Right Side	C.C.W.	C.W.
4	0	H		Marker just off screen recheck previous step	2nd hole Right Side	C.W.	C.W.
4	0	L		Marker reads between 13,500 & 14,000	4th hole Right Side	C.C.W.	C.W.
4	0	L		Marker just off screen Recheck previous step	3rd hole Right Side	C.W.	C.W.
5	0	H	Rotate fine delay C.W. to C.C.W. and count hundreds; read no less than 700 nor more than 1500		1st hole Right Side	Set on 5000	C.W. & C.C.W.

APN-9 LORAN CALIBRATION CHART F

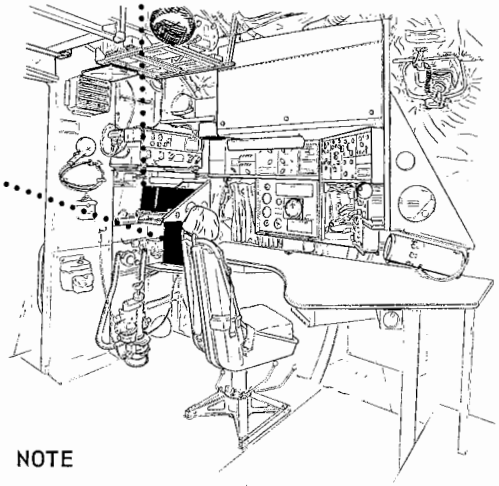
Figure 4-28



LORAN CONTROL UNIT



LORAN INDICATOR



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

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 screw driver. 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)

APN-70 LORAN CONTROLS G

Figure 4-29

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 (15 and 18, figure 4-16) 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 (figure 1-35, sheet 2).

APN-70 Loran Controls

W-DELAY AND Y-DELAY CRANKS. These cranks (7 and 17, figure 4-29) 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 one thousand units per revolution of the crank. One revolution will cause a change of one hundred units in the reading when the crank shaft is pulled out.

R-RATE SWITCH. This switch (2, figure 4-29) 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 4-29) 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 4-29), with ON--OFF positions, is on the lower portion of the drift control, and operates independently.

L--R SWITCH. This switch (8, figure 4-29) 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. This switch (12, figure 4-29) 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. Power is disconnected when the control is returned the extreme counterclockwise position. The master-xz gain control sets the level of the master pulse, or pulses, as viewed on the indicator screen.

SLAVE-Y AND SLAVE-W GAIN CONTROLS. These controls (9 and 14, figure 4-29) 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. This switch (13, figure 4-29) on the loran control unit determines the presentation on the loran scope. (See figure 4-30.)

LOCAL--DISTANT SWITCH. This switch (10, figure 4-29) 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. This switch (11, figure 4-29) 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 4-29) is on the loran control unit. The switch along with the R-rate switch selects desired station.

FOCUS ADJUSTMENT. This knob (19, figure 4-29) on the loran indicator is used to focus signals on the loran scope.

BRILLIANCE ADJUSTMENT. The brill knob (20, figure 4-29) on the loran indicator is used to adjust brilliance of the signal displayed on the loran scope.

APN-70 Loran Indicators

W-DELAY AND Y-DELAY REVOLUTION COUNTERS. These counters (1 and 4, figure 4-29) are on the loran control unit. The counters indicate a direct reading of delay time in microseconds.

R-RATE INDICATOR. This indicator (3, figure 4-29) on the loran control unit indicates channel selected by use of channel and R-rate switches.

LORAN SCOPE. The scope (18, figure 4-29) on the loran indicator displays the signals to be interpreted by crew members.

Normal Operation of the APN-70 Loran

To start the loran set, proceed as follows:

1. 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 4-34) is on EMERG.

2. Allow the equipment to warm up for about one minute. As soon as the presentation on the loran scope becomes stable, the equipment is ready for use

For HF (High Frequency) reception, proceed as follows:

1. 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.

2. Turn the ADC switch to the OFF position
3. 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
4. Set the channel and R-rate switches as determined from the chart
5. 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 4-30.
6. 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 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.

7. 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.

8. 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
9. If the ADC action is satisfactory, proceed with Step 10; 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
10. 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.

11. Turn to FUNCTION 2
12. Use the W-delay crank in the slow-speed position (shaft pulled out), to vertically align the expanded pulses
13. Turn to FUNCTION 3
14. Adjust the master-XZ and slave-W gain controls so that the two pulses are of the same height as nearly as possible
15. 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 FUNCTION 4.

16. The Indicated Time Difference may now be read on the W-delay counter
17. Using the Indicated Time Difference established on the W-delay counter, locate the position of the airplane on one loran line-of-position
18. Select another pair of loran transmitting stations which have a service area including the approximate location of the airplane
19. Set the channel and R-rate switches to the values obtained from the chart
20. Turn the ADC switch to the OFF position
21. Set the HF-delay switch to the Y position
22. Repeat Steps 7 through 20 to obtain the second Indicated Time Difference. Use the Y-delay crank and slave-Y gain control whenever the W-delay crank and slave-W gain control are mentioned
23. 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:
1. 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 FUNCTION 1 at channel positions 5 and 7 (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 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 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 positions 2 and 4 has no effect on operation.

2. After the loran has been turned on and allowed to warm up for approximately one 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
3. 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.

4. Refer to the loran charts and determine the settings of the channel and R-rate switches from the approximate geographical location of the airplane
5. Set the channel and R-rate switches to the positions determined from the charts
6. Set the function switch to position 1. Two traces and four pedestals (two on each trace) should be present on the loran scope

NOTE

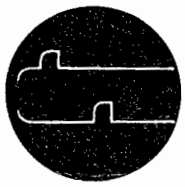
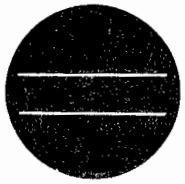
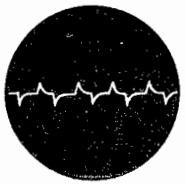
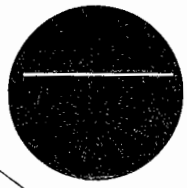
If a delay setting is past either end of the range for a given setting of the R-rate switch, no slave delay pedestal for that delay control will be seen in FUNCTION 1, and the trace corresponding to that pedestal will not appear in positions 2, 3, or 4 of the function switch. If only one pedestal should 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.)

7. 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 investiga-

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 11,000 11,000 1 1 HO W		Adjust until 2 traces appear. Adjust for clear and distinct traces. M. trace has a pedestal about 5/16" tall. Center traces vertically and horizontally. Adjust traces until ends are 1/4" 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" apart Center them and adjust ends for 1/4" from edge of screen	MED TO FAST SW HOR CENTER MED SW AMPL
3	Function	3		Adjust for right edge of trace 1/4" from edge of scope.	FAST SW AMPL
4	Function	4		Traces separated by 1/4" 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 11,000 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

APN-70 LORAN CALIBRATION CHART G

Figure 4-30 (Sheet 1 of 2)

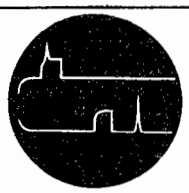
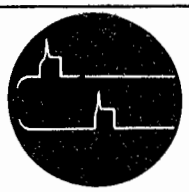
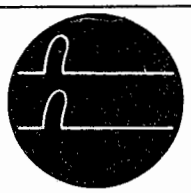
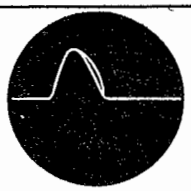
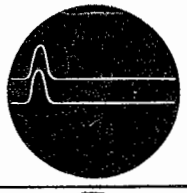
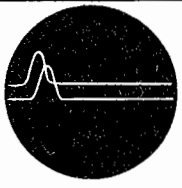
STEP	SWITCH	SWITCH POSITION	SCOPE	REMARKS	ADJUSTMENTS
8	Function R–Rate HF–Delay	5 H7 W		Markers must be superimposed and appear as one trace for W–delay values of: 00500 02000 05000 08500 11500	W–DELAY CRANK
9	HF–Delay	Y		Markers must be superimposed and appear as one trace for Y–delay values of: 00600 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–DELAY 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 4-30 (Sheet 2 of 2)

ting 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.

8. 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.

9. 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

10. If the ADC action is satisfactory, proceed with Step 11; 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
11. 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.

12. 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.

13. 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
14. Turn the function switch to position 2
15. Use the W-delay crank in the slow-speed position to vertically align the expanded pulses on the two upper traces
16. Use the Y-delay crank in the slow-speed position to vertically align the expanded pulses on the two lower traces
17. Turn the function switch to position 3
18. 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
19. 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.

20. 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

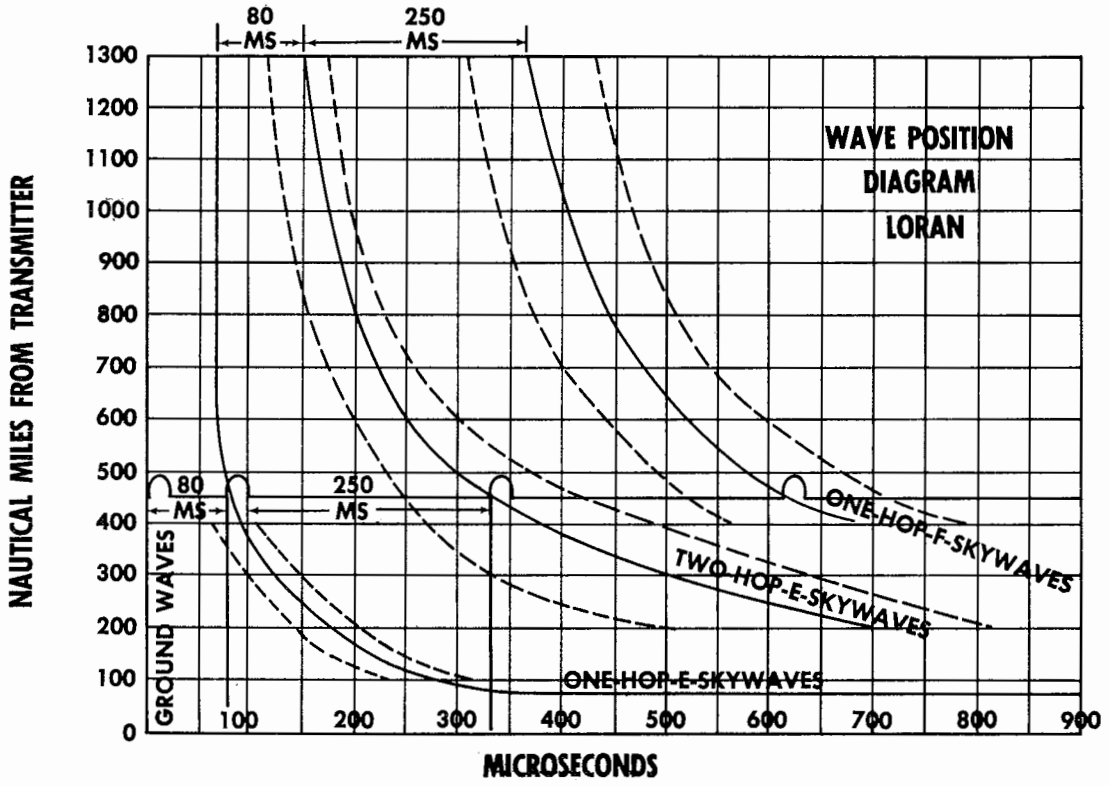
To turn off the loran set, proceed as follows:
1. Turn the master-xz gain and power switch in a counterclockwise direction until the switch operates and the panel lights go out

Emergency Operation of the APN-70 Loran G

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 from. 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 4-31

For reception of HF signals:

1. Place the HF-delay switch to the position which still functions properly and take the first reading using the normal procedure
2. Set the channel switch and R-rate switch to receive the second transmitting system
3. 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:

1. 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)
2. Return the function switch to position 1.
3. 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
4. Using the good delay channel, take the second reading

5. Determine the location of the airplane, making allowance for the time elapsed between the two readings

IF THE ANTENNA COUPLER UNIT IS DEFECTIVE: The antenna for the loran receiver is also used by the MF command transmitter on airplanes G 17260 ▶ 3177 less those incorporating TCTO KG211 or the liaison radio and the liaison receiver on airplanes G 3178 ▶ less those incorporating TCTO KG513 . It may be possible to operate on one or more of the HF channels by utilizing the antenna coupler outputs provided for these other radios. Channel 1 is the closest to the band of frequencies which the antenna coupler is designed to pass. Channels 3, 2, and 4 are progressively farther from this band.

1. If the antenna coupler is accessible, remove the plug from the LORAN jack and connect it to the COMM or AUX jack. When using either the COMM or AUX jack, the radio equipment normally connected to the jack must be turned on to energize some circuits in the coupler. If the antenna coupler is not accessible, it may be possible to disconnect the antenna from the MF command or a liaison radio (as applicable) and reconnect it to the jack, marked INPUT, on the loran control unit

NOTE

The local--distant switch will be inoperative when using an antenna connection that is different from the normal connection.

2. If the reception of the other radio equipment, having the same antenna as the loran, is affected by a defective antenna coupler, it will be necessary to bypass the coupler. If the antenna lead-in is accessible, connect the antenna directly to the jack, marked INPUT, on the loran control unit. Also, it may be possible to use any other antenna in the same way.

IF THE SCOPE PRESENTATION IS UNUSABLE: Determine whether or not the condition is external to the set by:

1. 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)

2. 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)

3. 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 APN-70 Loran G

IF SWEEP LENGTH IS DEFECTIVE IN FUNCTION 1: Adjust the traces to a length of approximately four inches with the SLOW SW. AMPL. control

IF SWEEP LENGTH IS DEFECTIVE IN FUNCTIONS 2, 3, 4, or 5:

1. Turn the function switch to the 2 or 4 position and adjust the MED. SW. AMPL. control for a trace length of approximately four inches

2. Turn the function switch to the 3 or 5 position and adjust the FAST SW. AMPL. control to obtain a trace of approximately four 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:

1. Turn the function switch to position 5

2. 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)

3. 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:

1. 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)

2. Turn the function switch to position 1

3. Turn the slave-W and the slave-Y gain controls full CCW

4. Turn the master-XZ gain and power switch to its minimum gain position (CCW), but do not turn off the set

5. Use the FOCUS and ASTIGMATISM adjustments to obtain the best overall definition of the traces

6. Rotate the function switch through the rest of its positions, noting the trace definition in each position

7. Repeat step 5

IFF (AN/APX-25) (Airplanes incorporating TCTO 590)

Airplanes can be detected at great ranges by means of radar echoes, but radar echoes do not identify the targets (as friend or foe). The IFF transponder (receiver-transmitter) is a signalling device for radar echo identification. The receiver turns on the transmitter momentarily each time it picks up coded challenges from suitably equipped surface or airborne radar. The reply from the transmitter accompanies the display of the associated echo on the indicators of the challenging radar, thereby identifying the echo.

The three functions of the IFF are: (1) to automatically identify the airplane whenever it is challenged by friendly radar, (2) to identify a specific friendly airplane within a group and (3) to serve as a means of indicating a distress condition.

Transponder operation may be in an emergency code or a combination of three normal codes - called "modes." The normal codes may be changed by use of the SIF coder control panel. Transponder operation is controlled by the IFF control panel. The IFF control panel (figure 4-32) has three switches for selection of modes: IFF Master (MODE 1), MODE 2 and MODE 3, and one switch for an "identification of position" feature: I/P-MIC switch. Checkout of the IFF on the ground requires special equipment; therefore, the set is normally tested in flight. The transponder requires 28 volt dc control power and 115 volt ac operating power. Circuit protection is through circuit breakers or fuses on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

IFF Master Switch

A master switch (2, figure 4-32) on the IFF control panel has EMERGENCY--NORM--LOW--STDBY--OFF positions. Any of the five positions may be selected by rotating the master switch clockwise. When the switch is in the OFF position, no electrical power is supplied to the set. In the STDBY position, the set is turned on, and the tubes will heat in approximately 45 seconds, making the set ready for operation; however, the receiver is not sensitized and no replies can be transmitted. In the LOW position, the set operates at reduced sensitivity and replies will be transmitted only upon receipt of strong interrogation signals, ordinarily from nearby interrogator--responders. In the NORM position, the transponder receiver is given full sensitivity and the transponder operates with maximum performance. In the EMERGENCY position, the set is fully sensitized, and the distinctive emergency reply is transmitted upon receipt of any mode of interrogation, regardless of the settings of the mode switches (3 and 5, figure 4-32) on the IFF control panel. To move the switch to EMERGENCY, depress the dial stop (6, figure 4-32) and rotate the switch.

Mode 2 and Mode 3 Switches

The mode switches (3 and 5, figure 4-32) marked MODE 2--OUT and MODE 3--OUT, are on the IFF control panel. Placing a switch in a mode position causes the transponder to reply in the selected mode when challenged by friendly radar. The OUT function prevents the transponder from replying in the respective mode. For example, with the MODE 3 switch in the MODE 3 position, the transponder replies to MODE 3 interrogations; and when the MODE 3 switch is in the OUT position, the transponder does not reply to MODE 3 challenges. The IFF must be on LOW or NORM for the switches to be operative. The various combinations of modes available are:

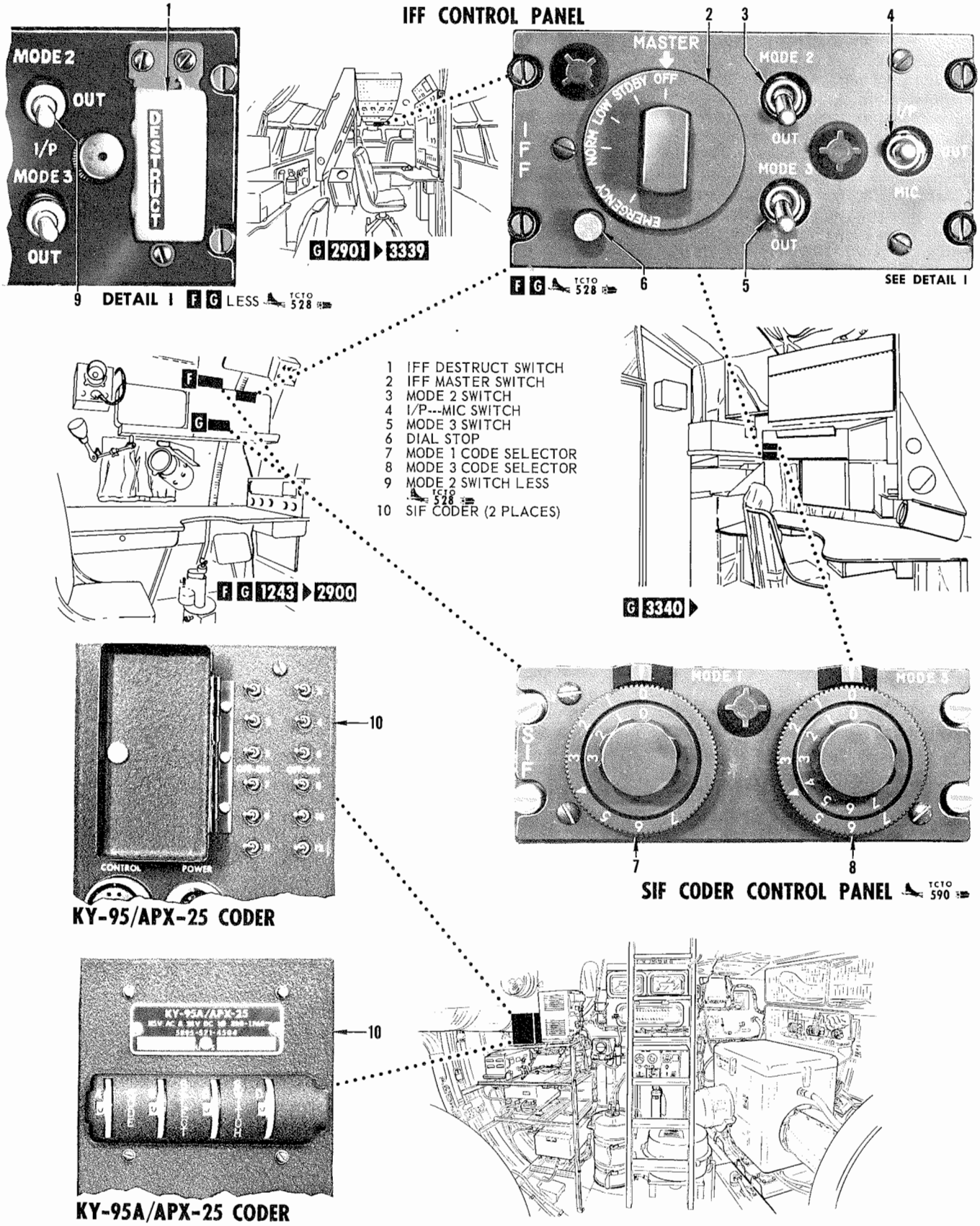
Mode or Modes	Master Switch	Mode 2 Switch	Mode 3 Switch
None	OFF or STDBY	Not Affected	Not Affected
1 only	LOW or NORM	OUT	OUT
1 and 2	LOW or NORM	MODE 2	OUT
1 and 3	LOW or NORM	OUT	MODE 3
1, 2 and 3	LOW or NORM	MODE 2	MODE 3
Emergency only	EMERGENCY	Not Affected	Not Affected

The following code words will be used when referring to IFF operations:

Code	Meaning
Parrot	IFF Mark X
Squawk	Turn IFF on NORM (Mode 1)
Squawk 2	Turn IFF to Mode 2
Squawk 3	Turn IFF to Mode 3
Squawk Emergency	Turn IFF to EMERGENCY
Squawk Flash	Turn IFF to I/P
Squawk Low	Turn IFF to LOW
Squawking	Showing IFF in Mode and Position Indicated
Parrot Lazy	Turn IFF to STDBY
Parrot Bent	IFF inoperative
Strangle Parrot	Turn off IFF

I/P--MIC Switch

The I/P--MIC switch (4, figure 4-32) is a three position switch, I/P--OUT--MIC. When the switch is in the "OUT" (OFF) position, the equipment operates as controlled by the mode switches. In the "I/P" (identification



IFF CONTROLS

Figure 4-32

of position) position, the equipment responds, (for MARK X IFF only), to each mode 2 interrogation with a normal mode 2 reply, while the switch is held in "I/P" position, and for 30 seconds after release. The I/P response with SIF is a double mode 1 pulse train reply to mode 1 interrogations when Coder KY-95/APX-25 is installed. If Coder KY-95A/APX-25 is installed, mode 1 and mode 3 responses will be made to these respective interrogations. In "MIC" position, I/P replies are transmitted while the UHF radio is keyed (microphone switch closed) and for 30 seconds after the microphone switch is released, provided the command radio is operating, and the interphone control panel associated with the microphone switch has the UHF radio selected.

SIF Coder and Control

The coder equipment gives the transponder a "selective identification feature" known as SIF. The SIF is a system of signals consisting of coded mode 1, 2 and 3 transponder replies. It is possible to select one of 32 different mode 1 replies, one of 400 mode 2 replies and one of 64 mode 3 replies. The SIF coder is controlled by the SIF coder control panel located at the navigator's station; see figure 4-32. Either the KY-95/APX-25 or KY-95A/APX-25 SIF coder may be installed; for the differences in operating characteristics see I/P--MIC switch in this Section. The mode 2 code selector switches are on the SIF coder located on the auxiliary radio rack; see figure 4-32. The switches for coding mode 2 are not normally adjusted by the flight crew. A switch, S-103, on the transponder unit must be in the MOD position to permit SIF operation. The SIF coder is operative when the IFF master switch is on LOW or NORM and a mode (or modes) is selected. Electrical power for the SIF coder is obtained from the IFF transponder.

MODE 1 CODE SELECTOR. The Mode 1 code selector (7, figure 4-32) consists of two concentric knobs. The outer knob has eight positions (0 thru 7 inclusive) and the inner knob has four positions (0 thru 3 inclusive). One of the 32 Mode 1 codes available can be selected by positioning the knobs with respect to the pointer above the knob. For a numerical code designation such as "52," the outer knob would be positioned to 5 and the inner knob at 2. For the selector to be operative, the IFF master switch must be on LOW or NORM.

MODE 3 CODE SELECTOR. The mode 3 code selector (8, figure 4-32) consists of two concentric knobs. Both knobs have eight positions (0 thru 7 inclusive). To select one of the 64 mode 3 codes, position the knobs with respect to the pointer above the knob. For a numerical code designation such as "45" set the outer knob to 4 and the inner knob to 5. For the selector to be operative, the IFF master switch must be on LOW or NORM and the Mode 3 switch must be on MODE 3.

IFF (AN/APX-6) (Airplanes not incorporating TCTO 590)

On airplanes incorporating TCTO 528, this set operates in the same manner as the IFF (AN/APX-25) without the SIF provisions.

On airplanes not incorporating TCTO 528, this set operates in the same manner as the IFF (AN/APX-25) without SIF provisions and with the following differences:

a. The mode 2 switch has MODE 2--OUT--I/P positions (9, figure 4-32). For operation, refer to MODE 2 and MODE 3 SWITCHES and I/P--MIC switch in this Section.

b. The IFF control panel has a destruct switch (1, figure 4-32). This switch is a two position ON--OFF switch protected against accidental operation by a guard, which is normally wired down.

NOTE

The IFF destruct switch, if installed, is operative even though the IFF master switch is in the OFF position.

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 4-33) on the radio and radar control consoles, is used to operate the set. Indications from the set are fed to a scope (figure 4-33) at the navigator's station and to a second scope at the pilots' station. Control power is 28 volt DC, operating power is 115 volt AC with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

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 interference with the search radar set in the other airplane(s). The interference makes the scope presentation unreliable.

Search Radar Controls

ANTENNA HEATER SWITCH. This switch (9, figure 4-33), with HTR and OUT positions, is on the search radar control panel. The switch energizes a resistance heater on airplanes F G 1243 ▶ 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 airplanes G 2860 ▶, no heaters are installed in the antennas, and radar functions are de-energized in these airplanes, when the switch is positioned to HTR.

FUNCTION SWITCH. This switch (13, figure 4-33) 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 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. 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. A scan switch (11, figure 4-33) on the search radar control panel has STOP--SECTOR--FULL positions. In the STOP position, the search radar antenna mechanism is de-energized 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. This knob (12, figure 4-33) 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 4-33) 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. This switch (10, figure 4-33) 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. This switch (8, figure 4-33) 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.

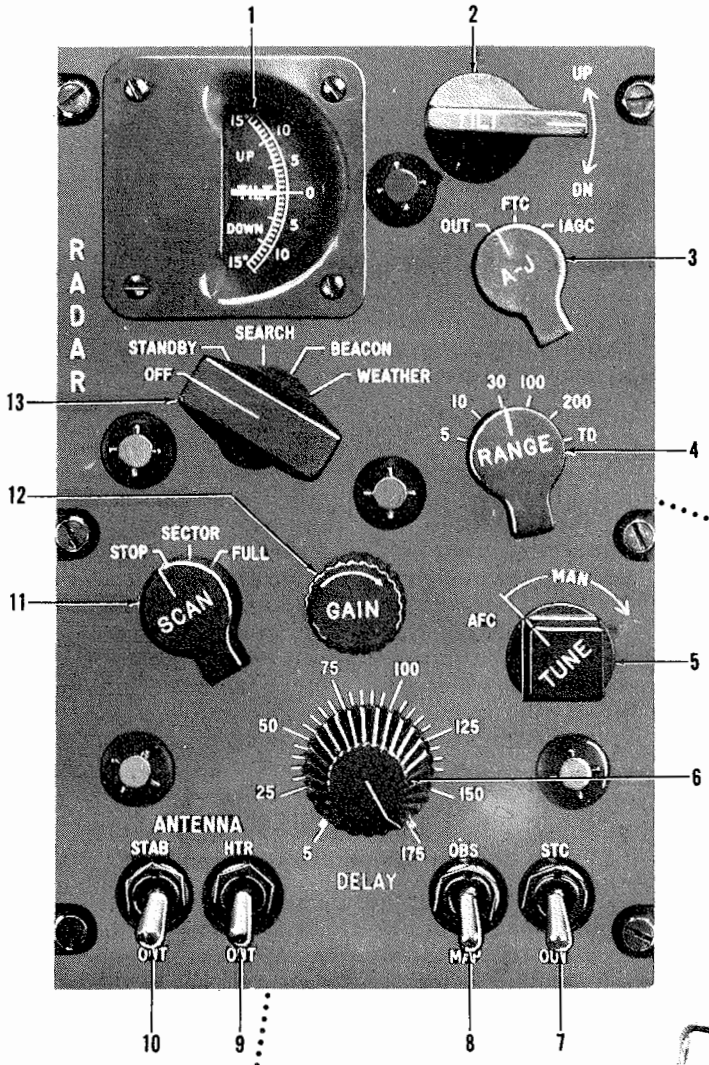
TILT SWITCH. This switch (2, figure 4-33) with UP--DOWN positions is on the search radar control panel. The UP and DOWN positions are momentary, whereas the switch is spring-loaded to the center position. In the center or rest position, the tilt mechanism of the search radar is inoperative. In the UP position, the antenna is tilted upward continuously, elevating the beam. In the DOWN position the antenna is tilted downward continuously, depressing the beam.

NOTE

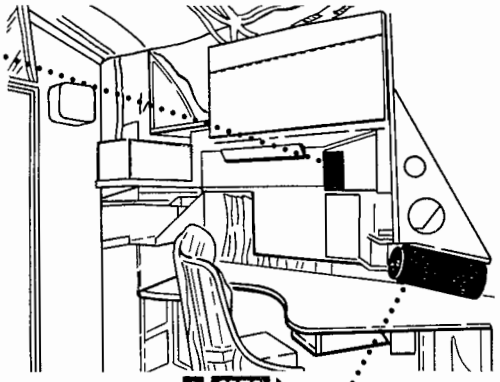
The limits of elevation and depression are reached by holding the tilt switch in the UP and DOWN positions respectively. Releasing the tilt switch causes the antenna to remain in the elevated or depressed position arrived at when the tilt switch was released. The degree of elevation or depression is 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. This switch (4, figure 4-33) 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 and 175 miles in range.

1 TILT METER
2 TILT SWITCH
3 A--J SWITCH
4 RANGE SWITCH
5 TUNE SWITCH
6 DELAY KNOB
7 STC SWITCH
8 OBS--MAP SWITCH
9 ANTENNA HEATER SWITCH
10 ANTENNA STAB SWITCH
11 SCAN SWITCH
12 GAIN KNOB
13 FUNCTION SWITCH
14 SEARCH RADAR SCOPE
15 SCOPE INTENSITY KNOB
16 SCOPE LIGHT KNOB
17 FOCUS KNOB
18 CURSOR SCREEN-ROTATING KNOB



SEARCH RADAR CONTROL PANEL



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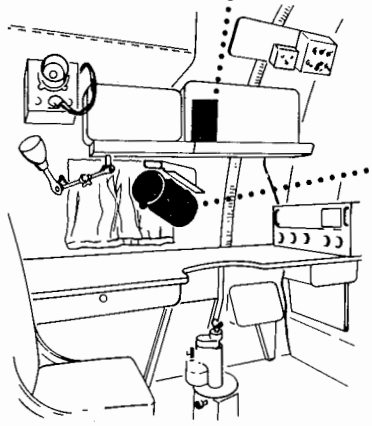

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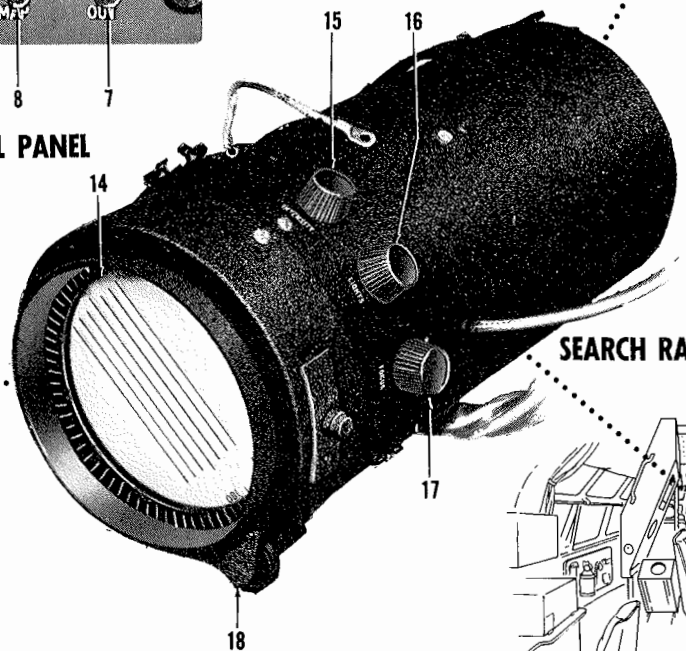
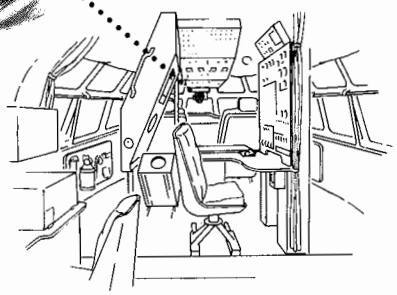


SEARCH RADAR INDICATOR



SEARCH RADAR CONTROLS AND INDICATORS

Figure 4-33

DELAY KNOB. The delay knob (6, figure 4-33) is on the search radar control panel. This control, which is calibrated in nautical miles, provides manual adjustment in range of a marker spot which appears in presentation with first five settings of range switch. The control also provides manual adjustment of start of 30-mile range sector when the range switch is in the TD position.

TUNE SWITCH. This switch (5, figure 4-33) on the search radar control panel has AFC--MAN positions. With the control in the AFC position (full 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. This switch (7, figure 4-33) 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 three to four miles of range with a 10-mile maximum adjustment.

SCOPE INTENSITY KNOB. The scope intensity knob (15, figure 4-33) on the search radar indicator is used to adjust the intensity of the display on the search radar scope.

SCOPE LIGHT KNOB. This knob (16, figure 4-33) 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. This knob (17, figure 4-33) on the search radar indicator is used for focusing or sharpening the display on the search radar scope.

CURSOR SCREEN-ROTATING KNOB. This knob (18, figure 4-33) 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 4-33) 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:

1. Place the antenna heater switch to OUT
2. Turn the function switch from OFF to STANDBY. Wait until the normal operating delay of approximately three 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 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 4-33A.

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 five minutes (ten minutes at ambient temperature below -20 degrees C) 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.

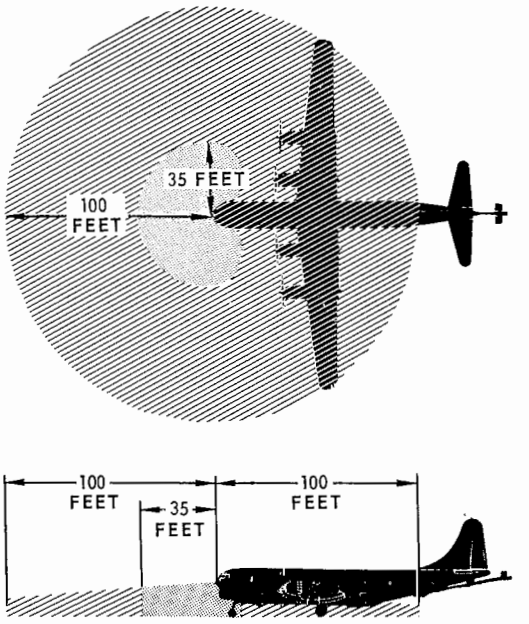
NOTE

There is no sweep on the search radar scopes during the time delay period.

3. Adjust the scope intensity knob on the search radar indicators so that the sweep line appears plainly on the scope

4. 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

5. 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



NOTE

Accidental entry into the hazard area does not result in injury. It is only through prolonged exposure that the possibility of danger exists.

ANTENA RADIATION PATTERN

Figure 4-33A

Search operation is accomplished by the following procedure:

1. Set the function switch to the SEARCH position
2. 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
3. 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
4. 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
5. 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 over-all sensitivity of the video circuits and makes small objects, such as approaching airplanes more difficult to detect on the longer ranges
6. 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
7. 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
8. 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
9. 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
10. Adjust the light control on the indicator for satisfactory illumination of range-marker lights and cursor
11. 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
12. Turn the tune switch to MAN and check whether sharper tuning may be obtained manually than with AFC
13. 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:

1. Set the function switch to BEACON
2. 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 se-

cured 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

3. Utilize antenna stabilization by placing the antenna stab switch in the STAB position
4. 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 presentations and the azimuth scale
5. 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
6. Adjust the gain control for the best presentation of beacon signals
7. Adjust the tilt switch for best signal response
8. 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

The 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:

1. Place the function switch in the WEATHER position
2. 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
3. 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
4. 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.
5. 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
6. 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
7. 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.

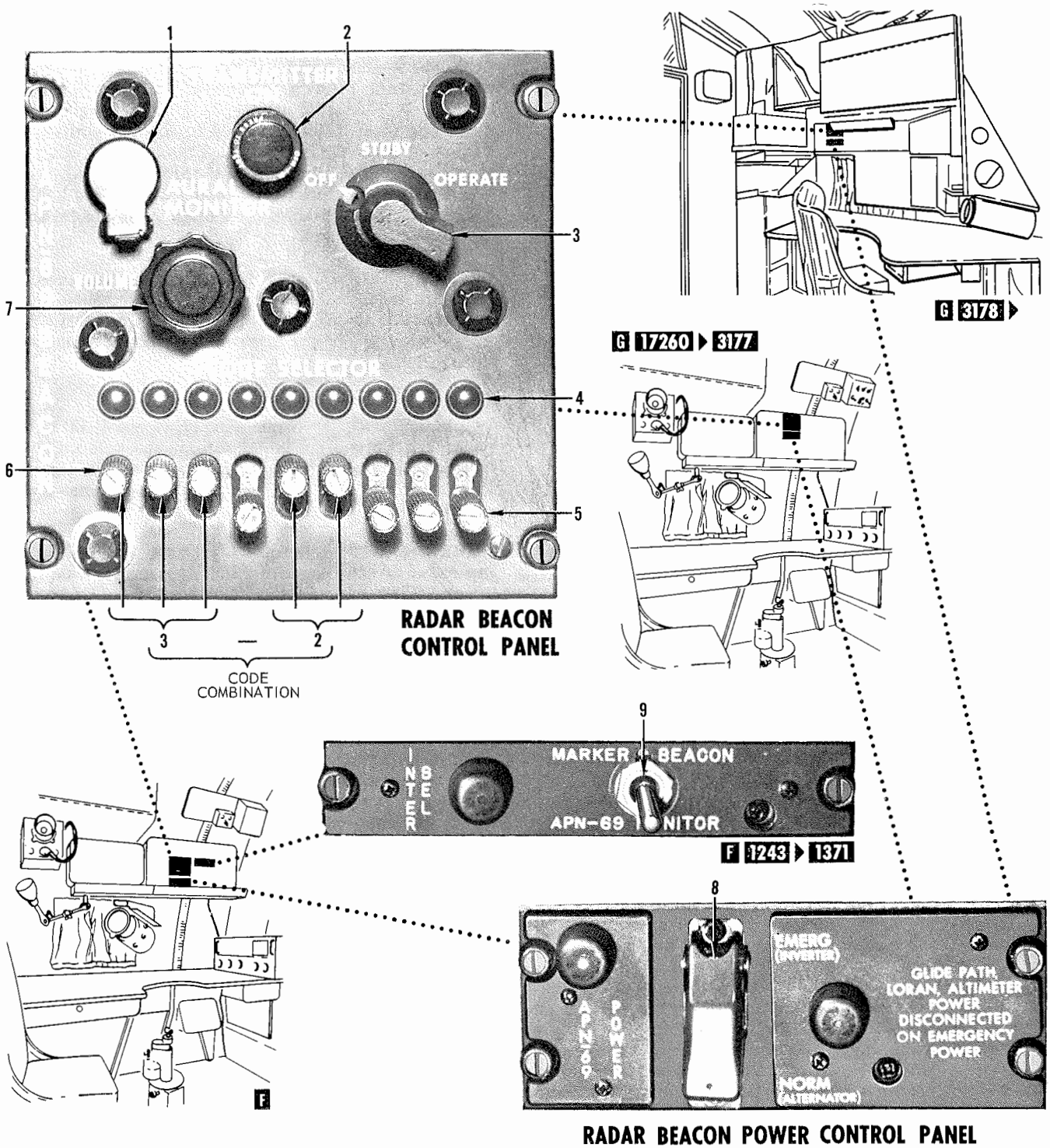
Securing the Search Radar

The search radar set is turned off by the following procedure:

1. Range switch on 10
2. Gain knob full CCW
3. Scan switch stopped with trace at 180 degrees
4. Tilt Switch in UP
5. Antenna stab switch in OUT
6. Intensity knobs full CCW
7. Delay knob full CW
8. A--J switch in OUT
9. Tune switch in AFC
10. Function in the OUT position to completely deenergize the equipment

RADAR BEACON (AN/APN-69)

The radar beacon is used primarily as a navigational aid for air refueling rendezvous. Two control panels (11 and 12, figure 4-17) 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 whenever 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 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. On airplanes F 1243 ▶ 1371, the tone can be heard by the navigator if the MARKER interphone mixer switch is ON (up) and the marker beacon--APN-69 monitor interphone switch (8, figure 4-15) is on APN-69 MONITOR. On airplanes F G 1372 ▶, 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
9 MARKER BEACON--APN-69 MONITOR INTERPHONE SWITCH

RADAR BEACON CONTROLS

Figure 4-34

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 4-34. (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 (figure 1-35, sheet 2) and the alternator relay shield (figure 1-35, sheet 3).

NOTE

The radar beacon may trigger itself occasionally which will be indicated on the interphone by an intermittent click on 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. This switch (3, figure 4-34) has three positions: OFF--STDBY--OPERATE. When the switch is OFF, the beacon equipment is de-energized except for the panel lights and the code selector indicators. Refer to CODE SELECTOR INDICATORS in this Section. Placing the switch on 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 three 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 4-34) 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. A common code selector (6, figure 4-34) 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. A volume knob (7, figure 4-34) 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.

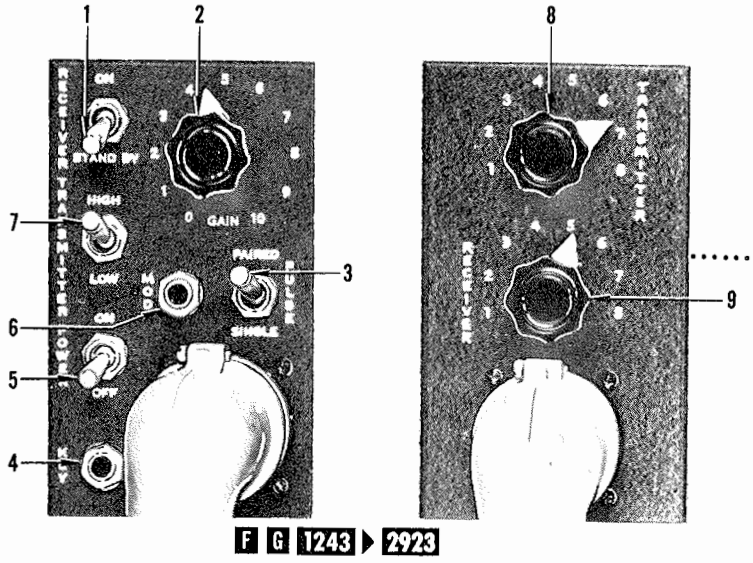
AURAL MONITOR JACK. A jack (1, figure 4-34) on the radar beacon control panel is used for test purposes. When a headset is connected to the jack, random noise (or periodic triggering of the system) may be heard and is indicative of beacon operation.

POWER SELECTOR SWITCH. This switch (8, figure 4-34) 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 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, and the radio altimeter will be disconnected. When the switch is in the NORM position, circuit protection is from the alternator relay shield (figure 1-35). When the EMERG position is selected, circuit protection is from the AC power panel (figure 1-35, sheet 3). When the switch is in either position operating power is 115 volt AC.

+ Coffee Pot

F 1243 ▶ 1371

MARKER BEACON--APN-69 MONITOR INTERPHONE SWITCH. This switch (9, figure 4-34), on the radio and radar control panel, selects the signal to be heard when the MARKER interphone mixer switch (4, figure 4-8) on the navigator's interphone panel is ON. With the switch on MARKER BEACON, the identity code transmitted by a beacon will be heard when the airplane passes over the beacon. Placing the switch on APN-69 MONITOR permits the navigator to hear the tone which indicates that the radar beacon is transmitting.



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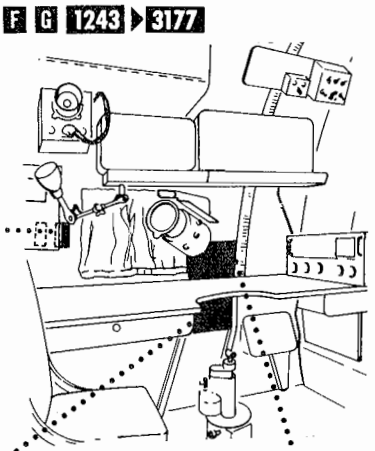
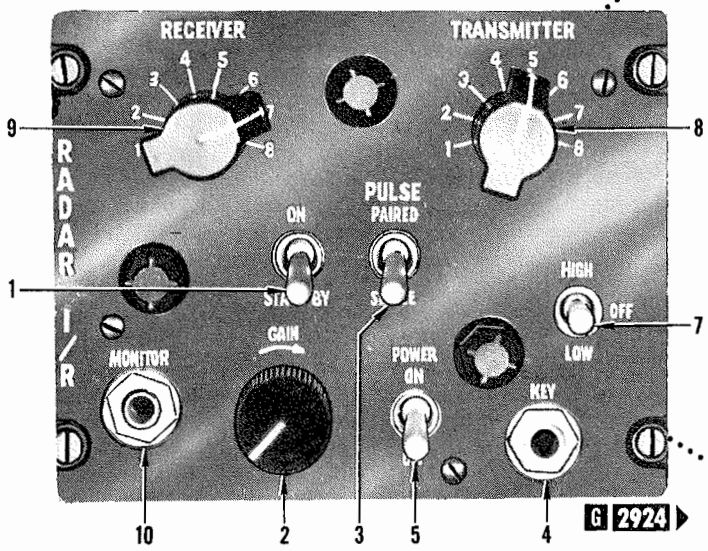
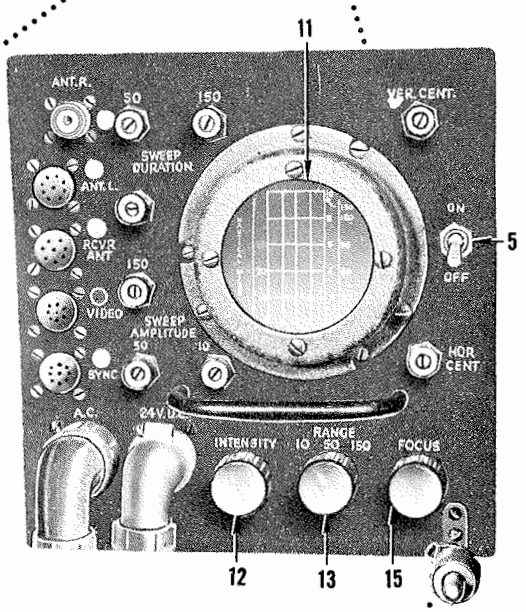
RENDEZVOUS RADAR CONTROL PANELS



F G 1243 ▶ 3177

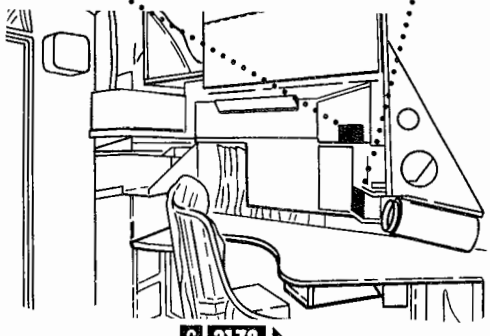


G 2924 ▶



RENDEZVOUS RADAR INDICATOR PANEL

1 RECEIVER SWITCH (2 PLACES)
2 GAIN KNOB (2 PLACES)
3 PULSE SELECTOR SWITCH (2 PLACES)
4 KEY JACK (2 PLACES)
5 POWER SWITCH (2 PLACES)
6 MODULATOR JACK
7 TRANSMITTER SWITCH (2 PLACES)
8 TRANSMITTER CHANNEL SELECTOR SWITCH (2 PLACES)
9 RECEIVER CHANNEL SELECTOR SWITCH (2 PLACES)
10 MONITOR JACK
11 RENDEZVOUS RADAR INDICATOR
12 INTENSITY KNOB
13 RANGE SELECTOR SWITCH
14 DELAY KNOB
15 FOCUS KNOB



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RENDEZVOUS RADAR (AN/APN-12) CONTROLS

Figure 4-35

Radar Beacon Indicators

TRANSMITTER-ON INDICATOR LIGHT. A green indicator light (2, figure 4-34), marked TRANSMITTER ON, is on the radar beacon control panel. When the master power switch is turned to OPERATE, and a three 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 4-34) 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 4-34) 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:

1. Place the off--stdby--operate switch to STDBY
2. Allow approximately 3 minutes for warmup and place off--stdby--operate switch to OPERATE. After the warmup period, the transmitter-on light is energized and the system is ready for automatic operation and will reply to interrogating pulses of the proper characteristics
3. 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. Do not insert more than six code elements, including the first stationary element, at one time
4. If it is desirable to monitor the beacon system operation, the navigator may do so by use of the interphone mixer switch
5. If it is desired to discontinue operation temporarily, turn off--stdby--operate switch to STDBY. In this manner, the equipment is kept ready for immediate use
6. To make inoperative, reset code selector switches to down position and turn 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.

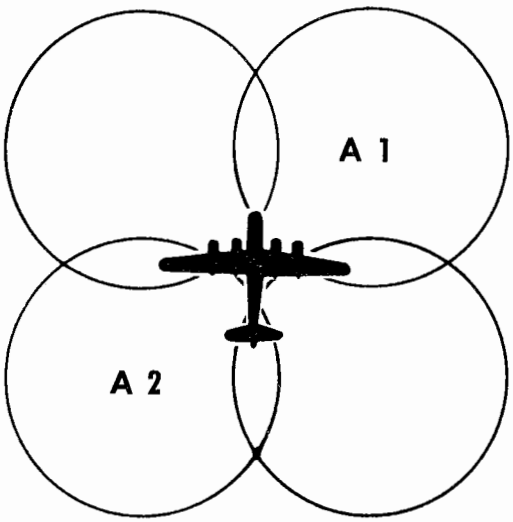
RENDEZVOUS RADAR (AN/APN-12)

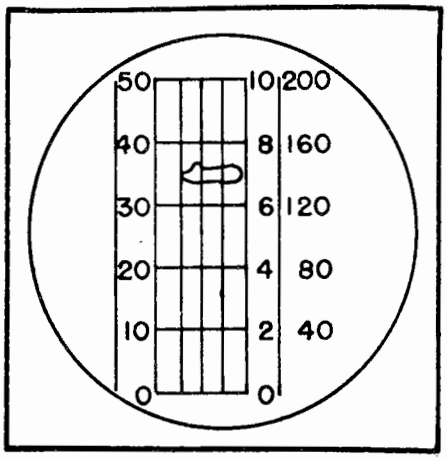
The AN/APN-12 rendezvous radar is used for recognition and navigation by interrogation of ground beacons or transponders (AN/APN-76). The return signal is displayed on the rendezvous radar indicator (figure 4-35), indicating range and quadrantal location of the transponder with respect to the AN/APN-12. The AN/APN-12 receiving antennas give the receiving pattern illustrated in figure 4-36. The signals received by the AN/APN-12 receiving antennas are displayed on an indicator with an L-type scan. The center vertical trace indicates range, with zero range at the bottom except when operating on 10D and 50D. When operating on 10D and 50D (10NM and 50NM Delay), the center vertical trace indicates range, the starting point of which is determined by the delay setting and increases up the scope either 10 NM or 50 NM dependent upon which delay setting is selected. Range is read from the bottom of the scope to the bottom of the received signal using the etched lines on the face of the scope as range markers. Signals will appear as horizontal indications unbalanced to the left, unbalanced to the right or centered across the vertical trace. By comparison of left and right signal amplitude, quadrantal position of the receiver airplane may be determined. If the signal is centered on the vertical trace, the receiver airplane is in one of four possible positions; dead ahead, dead astern, or directly abeam of either wing. When the signal is unbalanced to the right, the receiver airplane is located in quadrants A_1 or A_2. In this situation, with the receiver airplane approaching the tanker airplane, the receiver should be directed to correct to the right in order to balance the received signal across the vertical trace of the scope. When the signal becomes balanced, the receiver should be directed to turn to the heading or reciprocal heading of the tanker airplane, whichever is applicable. Conversely, when the signal is unbalanced to the left the receiver should be directed to correct to the left until the received signal is balanced or centered across the vertical trace. Control power is 28 volt DC, operating power is 115 volt AC, with circuit protection on the radio junction box circuit breaker panel (figure 1-35, sheet 2).

AN/APN-12 Rendezvous Radar Controls

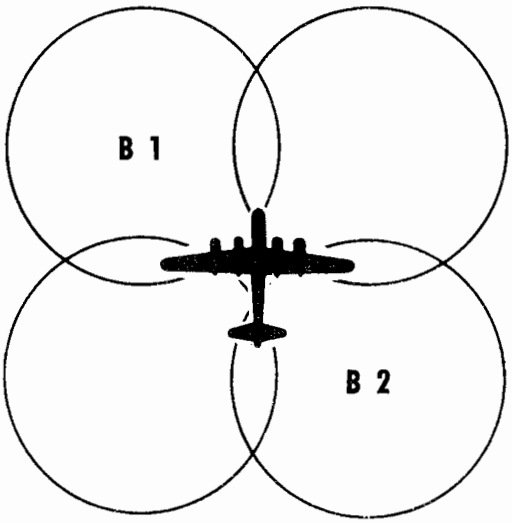
POWER SWITCH. The switch (5, figure 4-35) on the AN/APN-12 rendezvous radar control and indicator panels has ON--OFF positions. The switch is used to turn the set on and off.

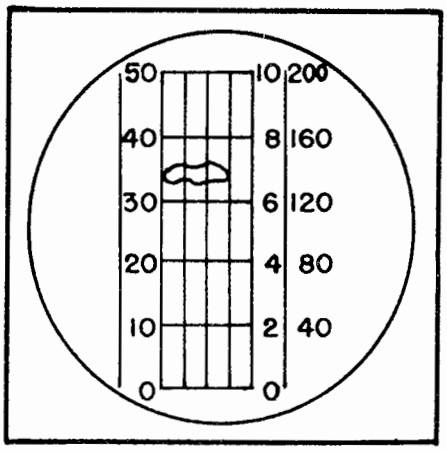
TRANSMITTER SWITCH. This three-position toggle switch (7, figure 4-35) on the control panels has HIGH--OFF--LOW positions. The switch is used to select high or low operating ranges when in the desired position. When the switch is in the center or OFF position, no transmission is possible.





TRANSPONDER LOCATED IN ONE OF QUADRANTS LABELED A





TRANSPONDER LOCATED IN ONE OF QUADRANTS LABELED B

RECEIVING PATTERNS (AN/APN-12) SCOPE

Figure 4-36

RECEIVER SWITCH. This switch (1, figure 4-35) on the control panels has ON and STANDBY positions. ON position energizes the receiver. When in STANDBY, the receiver tubes are kept hot and the receiver is in readiness for instant operation.

PULSE SELECTOR SWITCH. This switch (3, figure 4-35) on the control panels has PAIRED and SINGLE positions. The switch is used to provide paired pulse or single pulse operation.

GAIN KNOB. The gain control (2, figure 4-35) on the control panels is a knob controlled potentiometer. The control is used for the purpose of controlling receiver gain.

TRANSMITTER CHANNEL SELECTOR SWITCH. This switch (8, figure 4-35) on the control panels is used to select any of the eight preset frequencies. Each channel position is labeled on the panels to inform the operator on which channel the transmitter is operating.

RECEIVER CHANNEL SELECTOR SWITCH. This switch (9, figure 4-35) on the control panels is used for selecting any one of the eight preset frequencies of the receiver. Each channel position is labeled.

G 2924

KEY JACK. This jack, (4, figure 4-35) on the control panels allows a keying device to be plugged into the panel and automatically switches the beacon transmitter on and off in accordance with a predetermined code.

MODULATOR JACK. This jack (6, figure 4-35) on the panels permits audible monitoring of the transmitter triggering circuits. The jack is also used when the radar set is being operated as a beacon without the use of the indicator, by plugging a headphone into the jack and listening to a popping noise.

AN/APN-12 Rendezvous Radar Indicator

RENDEZVOUS RADAR INDICATOR. This indicator (10, figure 4-35) is on the rendezvous radar indicator panel. The indicator provides a visual representation of distance and direction, with respect to the line of flight and a ground beacon station.

Normal Operation of AN/APN-12 Rendezvous Radar

To start the AN/APN-12 set, proceed as follows:

1. Place the transmitter switch on the control panels in the OFF (mid) position
2. Place the power switch on the control panels in the ON position
3. When operating as an interrogator-responser, place the on--off switch, on the rendezvous radar indicator panel in the ON position. (This step applies only to those indicator panels which have an on--off switch - some panels do not have this switch.)

NOTE

Allow one minute for warmup before attempting to operate the equipment.

To stop the AN/APN-12 set, proceed as follows:

1. Turn gain and intensity knobs full counterclockwise
2. Place the power switches in the OFF position

To operate the AN/APN-12 set as an interrogator-responser, proceed as follows:

1. Remove the top cover of Receiver-Transmitter RT-316/APN, by loosening the four slide fasteners
2. Using a screwdriver, rotate the BEACON--IR switch, located in the top of Receiver-Transmitter RT-316/APN, to the IR position
3. Replace the top cover of Receiver-Transmitter RT-216/APN
4. Start the equipment
5. Place the pulse selector switch in the SINGLE position
6. After approximately one minute, place the transmitter switch in the HIGH position
7. Adjust the focus and intensity controls, on rendezvous radar indicator panel until a clear, well-defined trace is obtained on the display screen
8. Place the receiver switch in the ON position
9. Adjust the gain control until grass appears in the trace on the display screen on the rendezvous radar indicator. The appearance of grass indicates proper operation of the receiver, and the rectangular-shaped pulse at the base line indicates proper operation of the transmitter
10. Check operation of the receiver for each position of the receiver channel selector switch
11. Place the receiver and transmitter channel selector switches on the assigned channels
12. When the airplane is within the range of a ground transponder beacon, a signal should appear on the rendezvous radar indicator, showing the distance from the beacon and whether or not the airplane is on course. (See figure 4-36) If the signal on the right of the center line is larger, the beacon is to the right of the airplane and the pilot should be directed to the right until the right- and left-hand signals are equal

NOTE

Range is read to the bottom edge of the receiver signal pulse.

13. As the airplane approaches the beacon, the received signal gradually approaches the zero line on the indicator. At the time the airplane is directly over the beacon, the received signal collapses

To operate the AN/APN-12 set as beacon (transponder), proceed as follows:

1. Perform operations 1 through 10 as mentioned for interrogator-responser operation.
2. Remove the top cover of receiver-transmitter RT-316/APN, by loosening the four slide fasteners
3. Using a screwdriver, rotate the BEACON--IR switch, located on the top of receiver-transmitter RT-316/APN, to the BEACON position

4. Replace the top cover of receiver-transmitter RT-316/APN
5. Place the receiver and transmitter channel selector switches on the assigned channels
6. Set the gain knob to maximum (10) position. If the flashing of the base line on the rendezvous radar indicator exceeds an average of once per second, reduce the setting of the receiver gain knob until this condition exists. When the radar set is being operated as a beacon without the indicator, it will be necessary to listen to the popping noise with headphones plugged into the MOD jack. When the beacon is interrogated by weak signals, it may be necessary to set the receiver gain control higher than herein described. Reliable beacon operation can be obtained with random noise triggering rates considerable in excess of once per second; however, the gain knob setting should be held at a minimum which will give satisfactory operation with the weakest signals expected. Lower settings of the gain knob will eliminate random noise triggering, but will also limit operation of the beacon to strong signals

NOTE

Since receiver sensitivity may vary from one channel to another, it will probably be necessary to reset the gain control in accordance with above instructions when the receiver is switched to another channel.

7. Place the pulse selector switch in either the SINGLE or PAIRED position as desired
8. The MOD jack, also permits audible monitoring of the transmitter triggering circuits. It is thus possible for the operator to determine when his beacon is being interrogated by listening for the steady tone in the headphones

Operation of the AN/APN-12 set for communication:
1. Insert a plug which is attached to a key, into the key jack
2. Operate AN/APN-12 as interrogator-responsor
3. The associated ground equipment can be keyed for a reply and the keyed response observed on the rendezvous radar indicator

NOTE

A suppressor cable connecting the AN/APN-76 and AN/APN-12 rendezvous radar units, prevents the AN/APN-76 set from firing when the AN/APN-12 set interrogates.

RENDEZVOUS RADAR (AN/APN-76) less TCTO K572

This radar set is an airborne radar beacon. When properly interrogated, the beacon responds automatically to airplanes equipped with rendezvous radar AN/APN-12 or an equivalent interrogator-responser radar unit operating within the frequency range of 160 to 240 megacycles. The airplane equipped with the interrogator-responser unit can thereby home on the beacon signal to aid in a rendezvous. The control panel(s) for the set (figure 4-37) are at the navigator's station. Control power is 28 volts DC, operating power is 115 volts AC with circuit breakers on the radio junction box circuit breaker panel (figure 1-35).

AN/APN-76 Rendezvous Radar Indicator less TCTO K572

AC POWER INDICATOR LIGHT. This light (12, figure 4-37) on the rendezvous radar control panel will illuminate when ac power is available for the equipment.

AN/APN-76 Rendezvous Radar Controls less TCTO K572

TRANSMITTER SWITCH. This three-position switch (8, figure 4-37) on the rendezvous radar control panel (AN/APN-76) provides a means of using high or low transmitter power or placing the transmitter on standby. In the HIGH or LOW position it energizes the keying relay, permitting the transmitter modulator circuit to operate. In the center position, the OFF position, the transmitter is on standby.

POWER SWITCH. This switch (6, figure 4-37) with ON--OFF positions is on the rendezvous radar control panels (AN/APN-76). The switch when positioned to ON controls the a-c and d-c voltage to the receiver transmitter.

PULSE SELECTOR SWITCH. G 3213 ▶ plus TCTO KG502. This switch (3, figure 4-37) has PAIRED--SINGLE positions and is on the rendezvous radar control panel (AN/APN-76). The switch allows the operator to transmit either single or paired p ulses from the set.

RECEIVER SWITCH. This switch (1, figure 4-37) on the rendezvous radar control panels (AN/APN-76) has ON--STANDBY positions. Movement of the switch places the receiver in either a standby or operating condition.

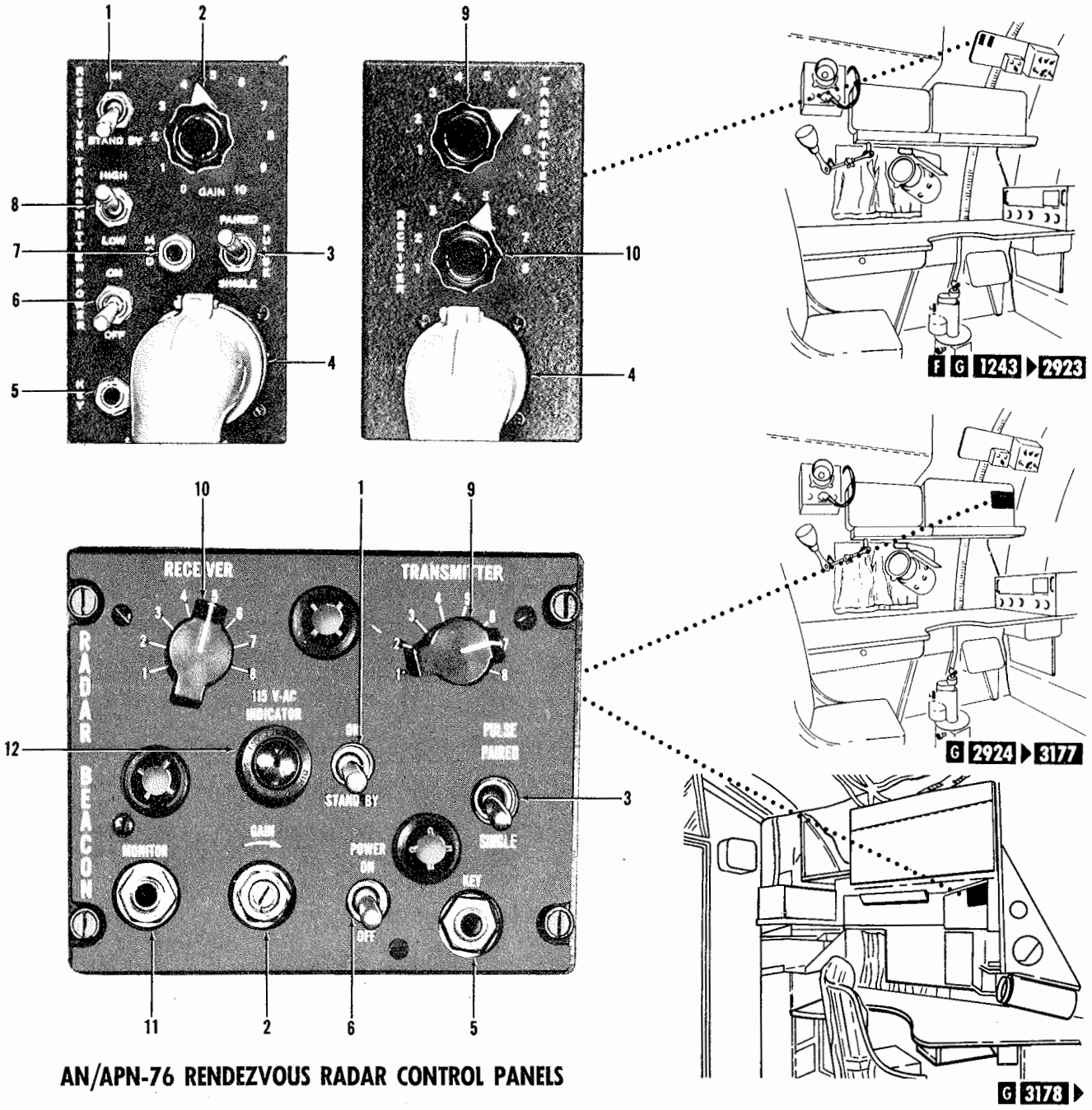
GAIN KNOB. The gain knob (2, figure 4-37) on the rendezvous radar control panel (AN/APN-76) varies the sensitivity of the receiver.

TRANSMITTER CHANNEL SELECTOR SWITCH. This switch (9, figure 4-37) on the rendezvous radar control panel (AN/APN-76) permits selection of any one of eight preset transmitter frequencies.

RECEIVER CHANNEL SELECTOR SWITCH. This switch (10, figure 4-37) on the rendezvous radar control panel (AN/APN-76) permits selection of any one of eight preset receiver frequencies.

Normal Operation of AN/APN-76 Rendezvous Radar less TCTO K572

The radar set is made operative and inoperative by the following procedure:
1. Place the power switch to ON
2. Allow approximately 3 minutes for warmup and place the receiver switch to ON
3. To make inoperative, place the power switch to OFF and the receiver switch to STANDBY

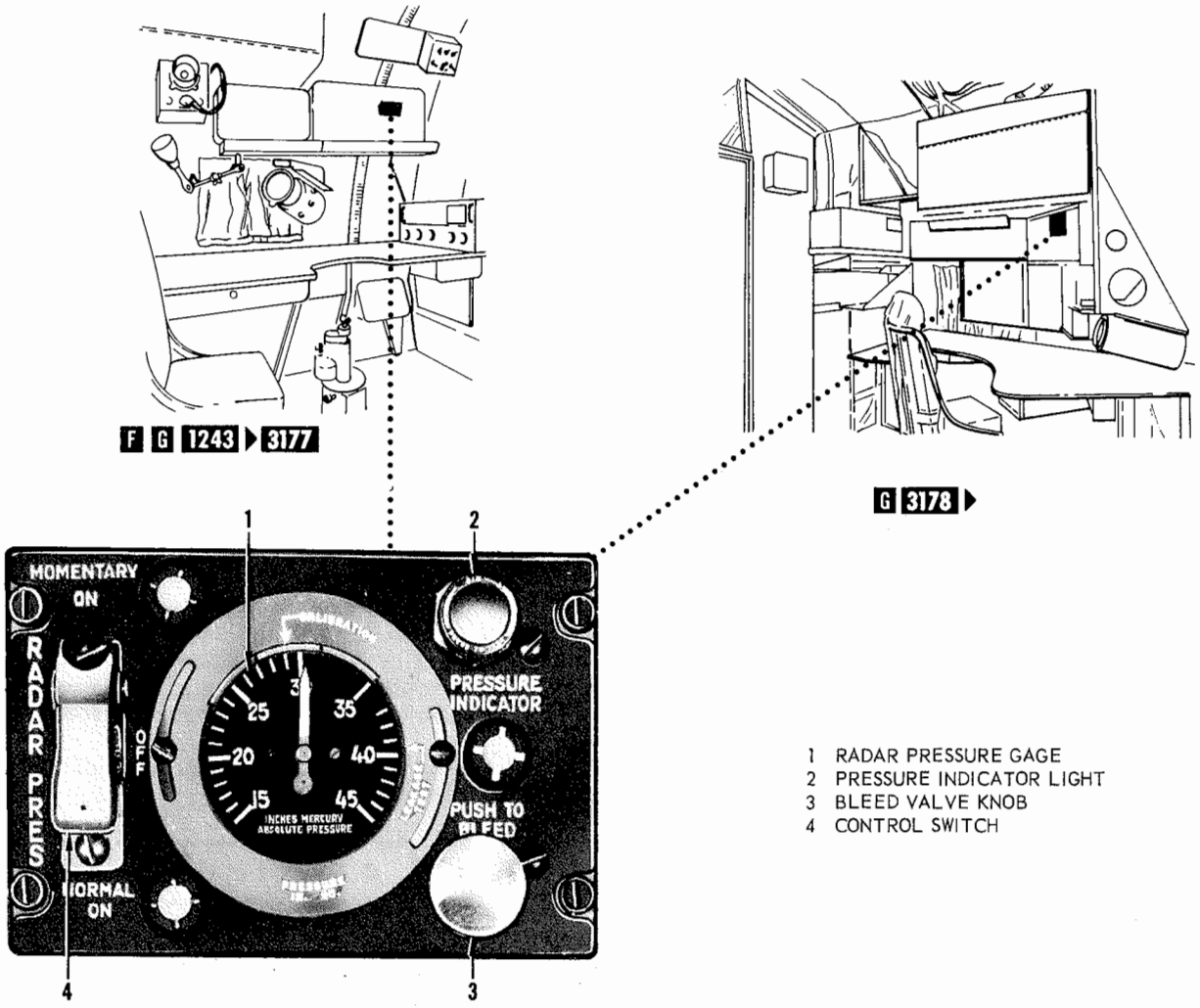


AN/APN-76 RENDEZVOUS RADAR CONTROL PANELS

1 RECEIVER SWITCH (2 PLACES)
2 GAIN KNOB (2 PLACES)
3 PULSE SELECTOR SWITCH (2 PLACES) G 3213 ▶ PLUS TCTO KG502
4 RECEPTACLE (2 PLACES)
5 KEY JACK (2 PLACES)
6 POWER SWITCH (2 PLACES)
7 MODULATOR JACK
8 TRANSMITTER SWITCH
9 TRANSMITTER CHANNEL SELECTOR SWITCH (2 PLACES)
10 RECEIVER CHANNEL SELECTOR SWITCH (2 PLACES)
11 MONITOR JACK
12 AC POWER INDICATOR LIGHT

RENDEZVOUS RADAR (AN/APN-76) CONTROLS LESS TCTO K572

Figure 4-37



1 RADAR PRESSURE GAGE
2 PRESSURE INDICATOR LIGHT
3 BLEED VALVE KNOB
4 CONTROL SWITCH

RADAR PRESSURIZING CONTROL PANEL

RADAR PRESSURIZING CONTROLS

Figure 4-38

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 (7, figure 4-17) 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 (figure 1-35, sheet 2).

Radar Pressurizing System Controls

CONTROL SWITCH. This switch (4, figure 4-38) 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. A knob (3, figure 4-38) 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. A green indicator light (2, figure 4-38) on the radar pressurizing control panel, when illuminated, indicates that the compressor is operating.

RADAR PRESSURE GAGE. A radar pressure gage (1, figure 4-38) 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 whenever 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:

1. 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
2. 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.

1. Place the radar pressurizing control switch in OFF
2. 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
3. Whenever 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:

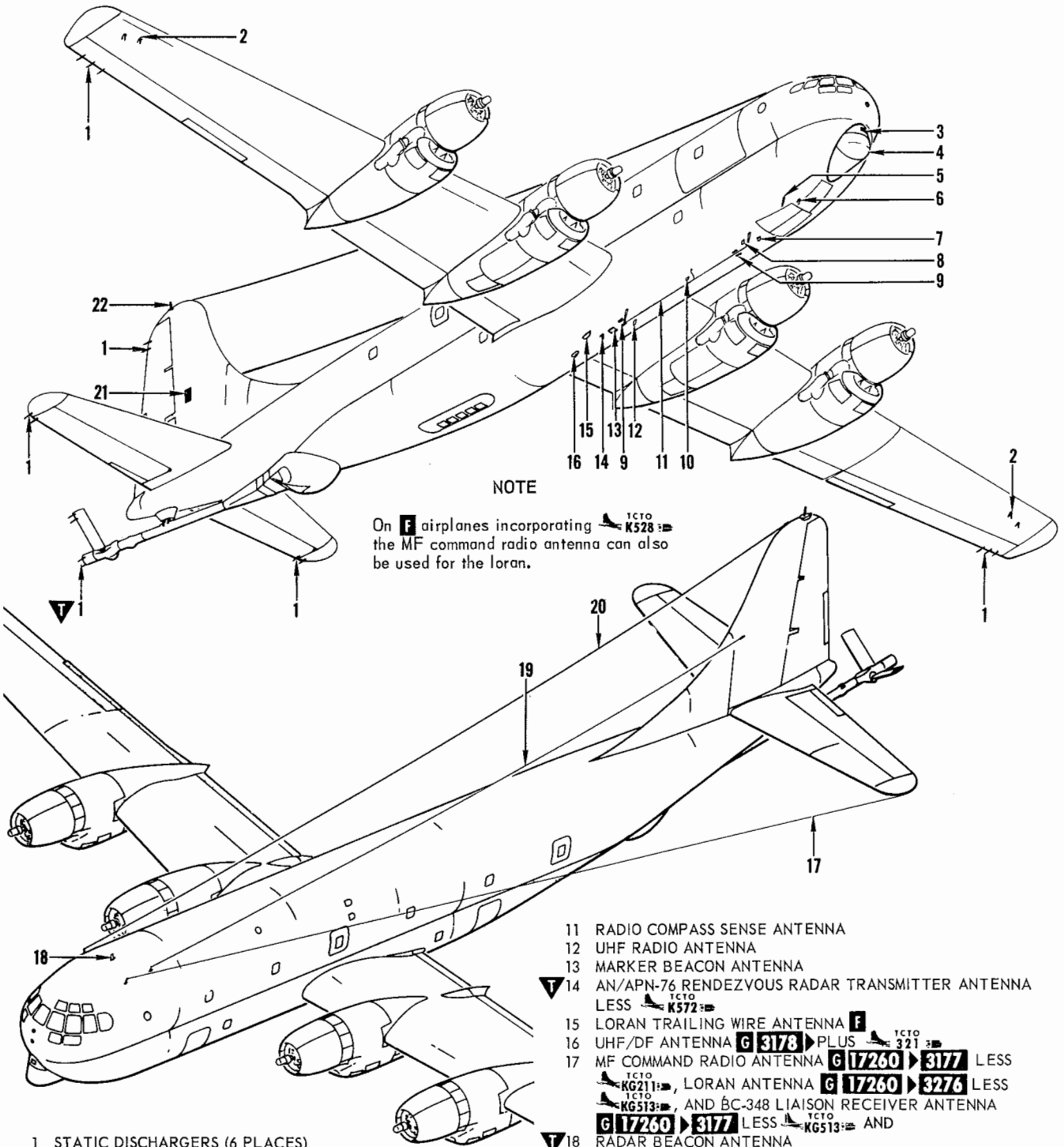
1. Place the radar pressurizing control switch in OFF
2. Turn off the search radar set

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.



1 STATIC DISCHARGERS (6 PLACES)
▼T 2 AN/APN-12 RENDEZVOUS RADAR RECEIVER ANTENNAS (2 PLACES)
3 GLIDE SLOPE ANTENNA
4 SEARCH RADAR ANTENNA
5 VHF RADIO ANTENNA
▼T 6 AN/APN-12 RENDEZVOUS RADAR TRANSMITTING ANTENNA
7 RADIO COMPASS LOOP ANTENNA
8 UHF NAVIGATION RADIO (TACAN) ANTENNA TCTO 572
9 RADIO ALTIMETER ANTENNA (2 PLACES)
10 IFF ANTENNA
11 RADIO COMPASS SENSE ANTENNA
12 UHF RADIO ANTENNA
13 MARKER BEACON ANTENNA
▼T 14 AN/APN-76 RENDEZVOUS RADAR TRANSMITTER ANTENNA LESS TCTO K572
15 LORAN TRAILING WIRE ANTENNA F
16 UHF/DF ANTENNA G 3178 ▶ PLUS TCTO 321
17 MF COMMAND RADIO ANTENNA G 17260 ▶ 3177 LESS TCTO KG211, LORAN ANTENNA G 17260 ▶ 3276 LESS TCTO KG513, AND BC-348 LIAISON RECEIVER ANTENNA G 17260 ▶ 3177 LESS TCTO KG513 AND
▼T 18 RADAR BEACON ANTENNA
19 ARC-8 LIAISON RADIO ANTENNA F, ARC-21 OR ARC-65 LIAISON RADIO ANTENNA G, LORAN G 3277 ▶ PLUS TCTO KG513, BC-348 LIAISON RECEIVER ANTENNA G 3178 ▶ 3278 LESS TCTO KG206 PLUS TCTO KG513, AND ARR-36 LIAISON RECEIVER ANTENNA G 3279 ▶ PLUS TCTO KG513
20 MF COMMAND RADIO ANTENNA F AND G 3178 ▶ PLUS TCTO KG211
21 VHF NAVIGATION RADIO (VOR) ANTENNA
▼T 22 AN/APN-76 RENDEZVOUS RADAR RECEIVER ANTENNA LESS TCTO K572

ANTENNA LOCATIONS

Figure 4-39

EQUIPMENT	SYSTEM	AMP	TYPE	LOCATION
AN/APS-42 Search Radar				
Radar nav	DC	5	Circuit breaker	Radio rack
Radar nav	AC	15	G 17260 ▶ 22700 Fuse	Radio rack
		15	F & G 22701 ▶ Circuit breaker	Radio rack
Radar press	DC	5	Circuit breaker	Radio rack
Radar feed	AC	25	F G 1243 ▶ 22700 Fuse	AC power panel
		25	G 22701 ▶ Circuit breaker	AC power panel
801	AC	5	Fuse	Synch, unit, left front
802	AC	3	Fuse	Synch, unit, right front
401	AC	10	Fuse	RT unit, top
(NOTE: Fuse 401 is inactive on later sets)				
402	AC	8	Fuse	RT unit, middle
403	AC	3	Fuse	RT unit, bottom
AN/APN-12 Rendezvous Radar				
Intgtr	DC	5	Circuit breaker	Radio rack
Intgtr	AC	3	G 17260 ▶ 22700 Fuse	Radio rack
		5	F & G 22701 ▶ Circuit breaker	Radio rack
Radar feed	AC	25	F G 1243 ▶ 22700 Fuse	AC power panel
		25	G 22701 ▶ Circuit breaker	AC power panel
AN/APN-76 Rendezvous Radar				
Less TCTO K572				
Respndr	DC	5	Circuit breaker	Radio rack
Respndr	AC	3	G 17260 ▶ 22700 Fuse	Radio rack
		5	F & G 22701 ▶ Circuit breaker	Radio rack
Radar feed	AC	25	F G 1243 ▶ 22700 Fuse	AC power panel
		25	G 22701 ▶ Circuit breaker	AC power panel
AN/APN-69 Radar Beacon				
Rdz beacon	DC	5	Circuit Breaker	Radio rack
Rdz beacon	AC	10	G 17260 ▶ 22700 Fuse	Radio rack
		10	F & G 22701 ▶ Circuit breaker	Radio rack
Radar beacon APN-69	AC	15	G 17260 ▶ 22700 Fuse	Alternator relay shield
		15	F & G 22701 ▶ Circuit breaker	Alternator relay shield
Radio feed	AC	15	F G 1243 ▶ 22700 Fuse	AC power panel
		15	G 22701 ▶ Circuit breaker	AC power panel
501	DC	1	Fuse	Front RT unit
502	AC	4	Fuse	Front RT unit
503	AC	3	Fuse	Front RT unit
504	AC	3	Fuse	Front RT unit
Radio Altimeter				
Altimeter	AC	3	G 17260 ▶ 22700 Fuse	Radio rack
		5	F & G 22701 ▶ Circuit breaker	Radio rack
Radio feed	AC	15	F G 1243 ▶ 22700 Fuse	AC power panel
		15	G 22701 ▶ Circuit breaker	AC power panel
Line ampl	AC	1 1/2	Fuse	RT unit
B-3 Driftmeter F G 1243 ▶ 22628				
Less TCTO K235				
Driftmeter	AC	1	F G 1243 ▶ 22628 Fuse	AC power panel
B-6A Driftmeter G 22629 ▶				
Plus TCTO K235				
Driftmeter A	AC	2	G 22629 ▶ 3141 plus TCTO K235 Fuse	AC power panel
		2	G 3142 ▶ Fuse	Autopilot power panel
Driftmeter C	AC	2	G 22629 ▶ 3141 plus TCTO K235 Fuse	AC power panel
		2	G 3142 ▶ Fuse	Autopilot power panel

NAVIGATION EQUIPMENT CIRCUIT BREAKERS AND FUSES

Figure 4-40 (Sheet 1 of 2)

EQUIPMENT	SYSTEM	AMP	TYPE	LOCATION
AN/APN-9 Loran F				
Loran	DC	5	Circuit breaker	Radio rack
Radio feed	AC	15	Fuse	AC power panel
Loran	AC		Fuse	Radio rack
AN/APN-70 Loran G				
Loran	DC	5	G 17260 ▶ 22700 Circuit breaker	Radio rack
Rec ant	DC	5	G 22701 ▶ Circuit breaker	Radio rack
Loran	AC	5	G 17260 ▶ 22700 Fuse	Radio rack
		5	G 22701 ▶ Circuit breaker	Radio rack
Radio feed	AC	15	G 17260 ▶ 22700 Fuse	AC power panel
		15	G 22701 ▶ Circuit breaker	AC power panel
Periscopic Sextant G 2860 ▶ Plus TCTO 133	DC	5	Circuit breaker	Overhead circuit breaker panel
AN/ARN-14 VHF Navigation Radio (VOR)				
VOR Rec		10	Circuit breaker	Aft radio rack (tail cone)
VOR test		5	Circuit breaker	Aft radio rack (tail cone)
Emp-gnd blower & VOR	DC	35	Circuit breaker	Aft power panel
OBD-VOR nav without TCTO 572	DC	5	Circuit breaker	Radio rack
VOR-ILS nav with TCTO 572	DC	5	Circuit breaker	Radio rack
AN/ARN-21 UHF Navigation Radio (TACAN) TCTO 572				
Tacan	AC	5	G 22701 ▶ Circuit breaker	Radio rack
		5	F G 1243 ▶ 22700 Fuse	Radio rack
Tacan	DC	5	Circuit breaker	Radio rack
VOR-ILS nav	DC	5	Circuit breaker	Radio rack
AN/ARN-6 Radio Compass				
No. 1 compass	DC	5	Circuit breaker	Radio rack
Outside Air Temperature Gage, Temp cabin, OAT and heaters	DC	5	Circuit breaker	Overhead circuit breaker panel
N-1 compass				
Autopilot repeat	AC	3	F G 1243 ▶ 22700 Fuse	AC power panel
		5	G 22701 ▶ Circuit breaker	AC power panel
Autopilot A	AC	5	F G 1243 ▶ 22700 Fuse	AC power panel
		5	G 22701 ▶ 3177 Circuit breaker	AC power panel
		5	G 3178 ▶ Circuit breaker	Autopilot power panel
Autopilot C	AC	5	F G 1243 ▶ 22700 Fuse	AC power panel
		5	G 22701 ▶ 3177 Circuit breaker	AC power panel
		5	G 3178 ▶ Circuit breaker	Autopilot power panel
Autopilot	DC	10	Circuit breaker	Overhead circuit breaker panel
Autopilot inv	DC	5	Circuit breaker	Overhead circuit breaker panel
Panel Lights				
Panel lights	DC	5	Circuit breaker	Radio rack
Nav Table and Instrument Lights				
Control Cabin				
Left red-white	DC	15	Circuit breaker	Overhead circuit breaker panel

Figure 4-40 (Sheet 2 of 2)

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 C/B 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 TCTO 591	8	Top and bottom of fuselage, opposite wing leading edge	Overhead panel	Overhead panel (lights) AC power panel (motors)
T **Boom Marking**	4	In boom nozzle hood	Two switches on boom operator's panel	Boom operator's panel
T **Boom Nozzle**	2	In boom nozzle hood	Two switch type rheostats on boom operator's panel	Boom operator's panel
T **Boom Chock**	1	Beside boom stowing chock	Boom operator's panel	Boom operator's panel (Same as switch)
T **Receiver Director Sta. 350**	10	Fuselage underside	Boom operator's panel	Boom operator's panel
T **Receiver Director Sta. 750** TCTO K526	18			
T **Inboard Nacelle Underwing**	4	Fuselage underside	Boom operator's panel	Boom operator's panel
T **Outboard Nacelle Underwing**	2	Fuselage underside	Boom operator's panel	Boom operator's panel
T **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)
T **Rendezvous Beacon** G 3196 ▶ PLUS TCTO K231	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 4-41

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
● **Pilot's Instrument Panel (Center Red)**	5	Top of panel under crash pad hood	Switch type rheostat on overhead panel	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
● **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	F 21 G 22	On control panels for interphone, radio compass, VHF radio, liaison, UHF radio, and VHF navigation radio	Same rheostat on overhead panel as for control stand lights	Radio junction box
	G 2901 ▶ 6	On control panels for IFF and auxiliary liaison receiver	Same rheostat used for red overhead panel lights	Overhead panel

INTERIOR LIGHTING

Figure 4-42 (Sheet 1 of 5)

LIGHTS	QUANTITY	LOCATION	SWITCH LOCATION	CIRCUIT BREAKER
Navigator's . . .				
Navigator's Table Flood G 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 F G 1243 ▶ 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 G 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 G 3178 ▶	14	In individual instruments	Switch type rheostat on navigator's interphone and light panel	Overhead panel
Navigator's Radio Panel F G 1243 ▶ 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 F G 1243 ▶ 3177	21 to 27	On control panels for interphone, radio compass, and IFF	Switch type rheostat on navigator's instrument	Radio junction box
Navigator's Radio Panel G 3178 ▶		In individual electronic equipment	Switch typre rheostat on navigator's interphone and light panel	Radio junction box
Navigator's Auxiliary G 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

INTERIOR LIGHTING (CONT)

Figure 4-42 (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	F Switch and switch type rheostat on engineer's instrument panel G 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	F Switch and switch type rheostat on engineer's instrument panel G Switch and switch type rheostat on engineer's auxiliary overhead panel	Overhead panel
Engineer's Instrument Spot (Red or White)	1	On support post at engineer's station and ceiling	F Switch type rheostat on engineer's instrument panel G Switch and switch type rheostat on engineer's auxiliary overhead panel	Overhead panel
Engineer's Instrument Flood (Red)	1	At ceiling near center of fuselage	F 1375 ▶ Switch type rheostat on engineer's instrument panel G 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	F 1243 ▶ 1371 Switch type rheostat on overhead panel F 1372 ▶ switch and switch type rheostat on engineer's instrument panel G 17260 ▶ Switch and switch type rheostat on engineer's auxiliary 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 panel	F Rheostat and color switch on engineer's A/R panel G Rheostat and color switch on engineer's auxiliary overhead panel	Overhead panel
● **Engineer's Interphone Control Panel**	4	On interphone control panel	F Same switch and switch type rheostat on engineer's instrument panel as for engineer's instrument panel spot lights G Same switch and switch type rheostat on engineer's auxiliary overhead panel as for engineer's instrument panel spot lights	Overhead panel

Figure 4-42 (Sheet 3 of 5)

LIGHTS	QUANTITY	LOCATION	SWITCH LOCATION	CIRCUIT BREAKER
Boom Operator's . . .				
▼T **Boom Operator's Dome Lights (Same as Main Compartment Dome Lights)**				
▼T **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
▼T **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
▼T **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
▼T **Boom Operator's Oxygen Panel Floodlights (Red) F G 1279 ▶ 22806**	2	Right and left side of boom operator compartment	Switch type rheostat on boom operator's panel	Boom operator's panel
▼T **Boom Operator's Oxygen Panel Floodlights (Red) G 3106 ▶**	1	Left side of boom operator's compartment	Switch type rheostat on boom operator's panel	Boom operator's panel
Compartment . . .				
▲ **Main Compartment Fluorescent F G 1243 ▶ 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 F G 1243 ▶ 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 rheostat switch 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

INTERIOR LIGHTING (CONT)

Figure 4-42 (Sheet 4 of 5)

LIGHTS	QUANTITY	LOCATION	SWITCH LOCATION	CIRCUIT BREAKER
Compartment . . . (Cont)				
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 panel	On overhead panel	Overhead panel
Toilet Compartment Dome	1 red 1 white	Overhead in toilet compartment	***In toilet compartment	Overhead panel

NOTE

* The master light switch at the aft side of control cabin door must be ON to operate these lights

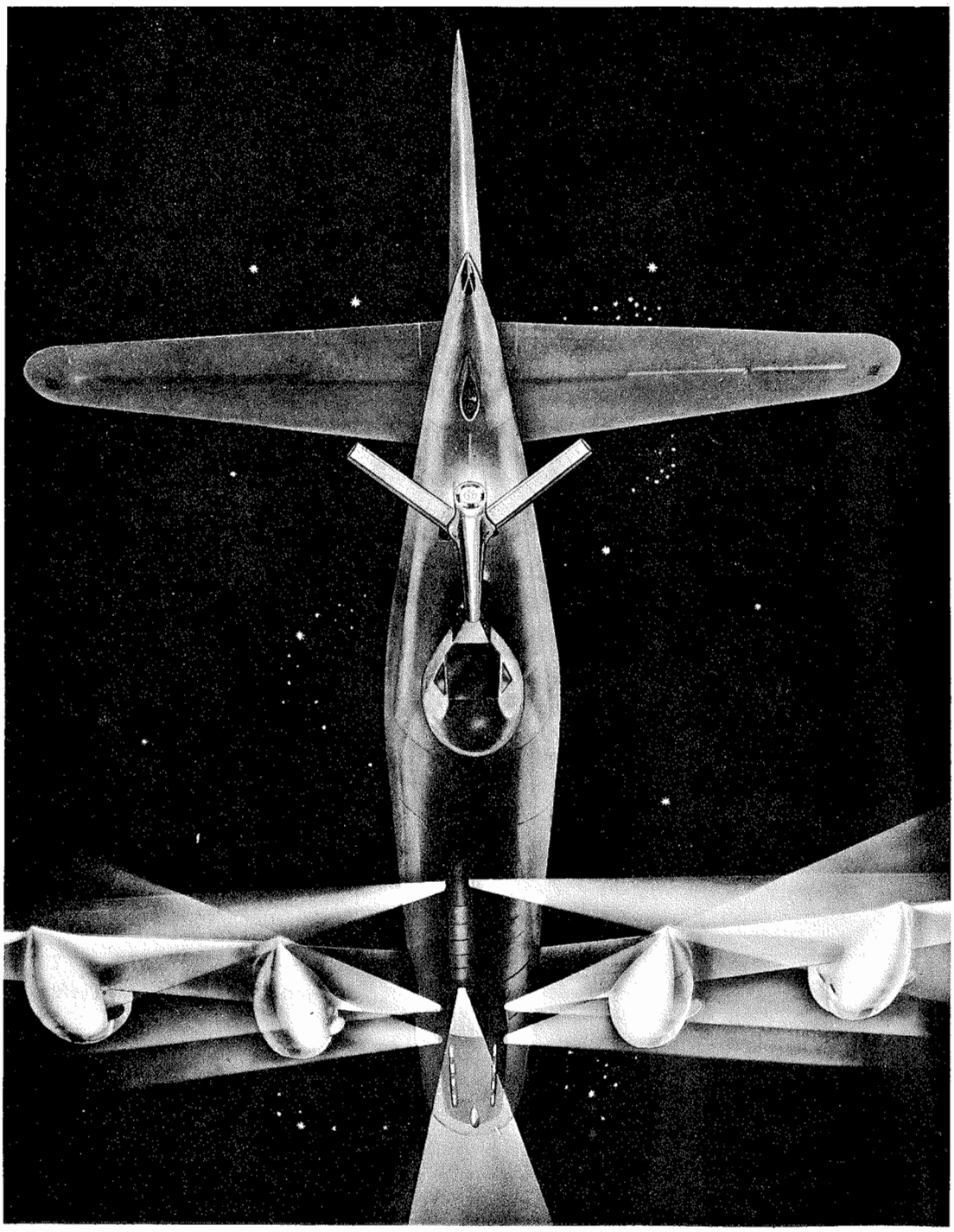
** Lights will illuminate to full intensity regardless of rheostat position when a master control cab lights switch on the overhead panel is positioned to WHITE BRIGHT

*** White lights will illuminate only when the master control cab aft light switch on the overhead panel is positioned to AFT WHITE

● On airplanes G 2930 ▶ plus those incorporating TCTO 239 ◀ these lights can be operated from battery power when the gyro instrument emergency power switch is in the BATTERY position

▲ Fluorescent lights are inoperative when the airplane is in the tanker configuration

Figure 4-42 (Sheet 5 of 5)



Lighted Area as Seen From Receiver Airplane

A/R FLOODLIGHTS ILLUMINATION V

Figure 4-43

LIGHTING EQUIPMENT

EXTERIOR LIGHTS

The exterior lights all operate on DC power. See figure 4-41 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 4-43 shows tanker A/R floodlighting as seen from a receiver airplane. On airplanes with TCTO 591 incorporated, two sets of anti-collision lights, one set on top and one set on bottom, are mounted on the fuselage opposite the wing leading edge. These lights are used as anti-collision and rendezvous lights.

NOTE

TCTO 591

- 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.

TCTO 591

- To prevent blistering or melting the fairing due to excessive heat from the anti-collision lights, do not operate these lights for more than 5 minutes while the airplane is on the ground.

TCTO 591

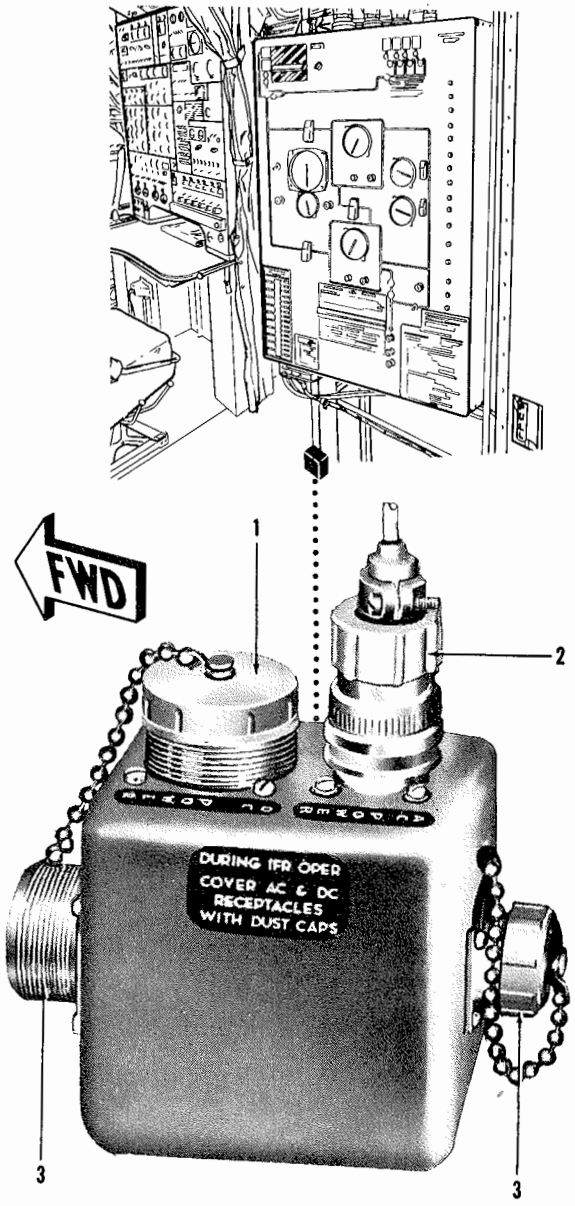
- The anti-collision lights operate on DC power. The motors driving the rotating light assembly operate on AC power from the secondary inverter. Therefore the secondary inverter switch must be in SEC INV during operation of the anti-collision lights on the ground or in flight.

INTERIOR LIGHTS

See figure 4-42 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. Only the fluorescent lights operate on AC power. (See figure 4-44.)

NOTE

Airplanes G 3268 ▶ do not have fluorescent lights, and on all other airplanes, the fluorescent lights are inoperative when the airplane is in the tanker configuration.



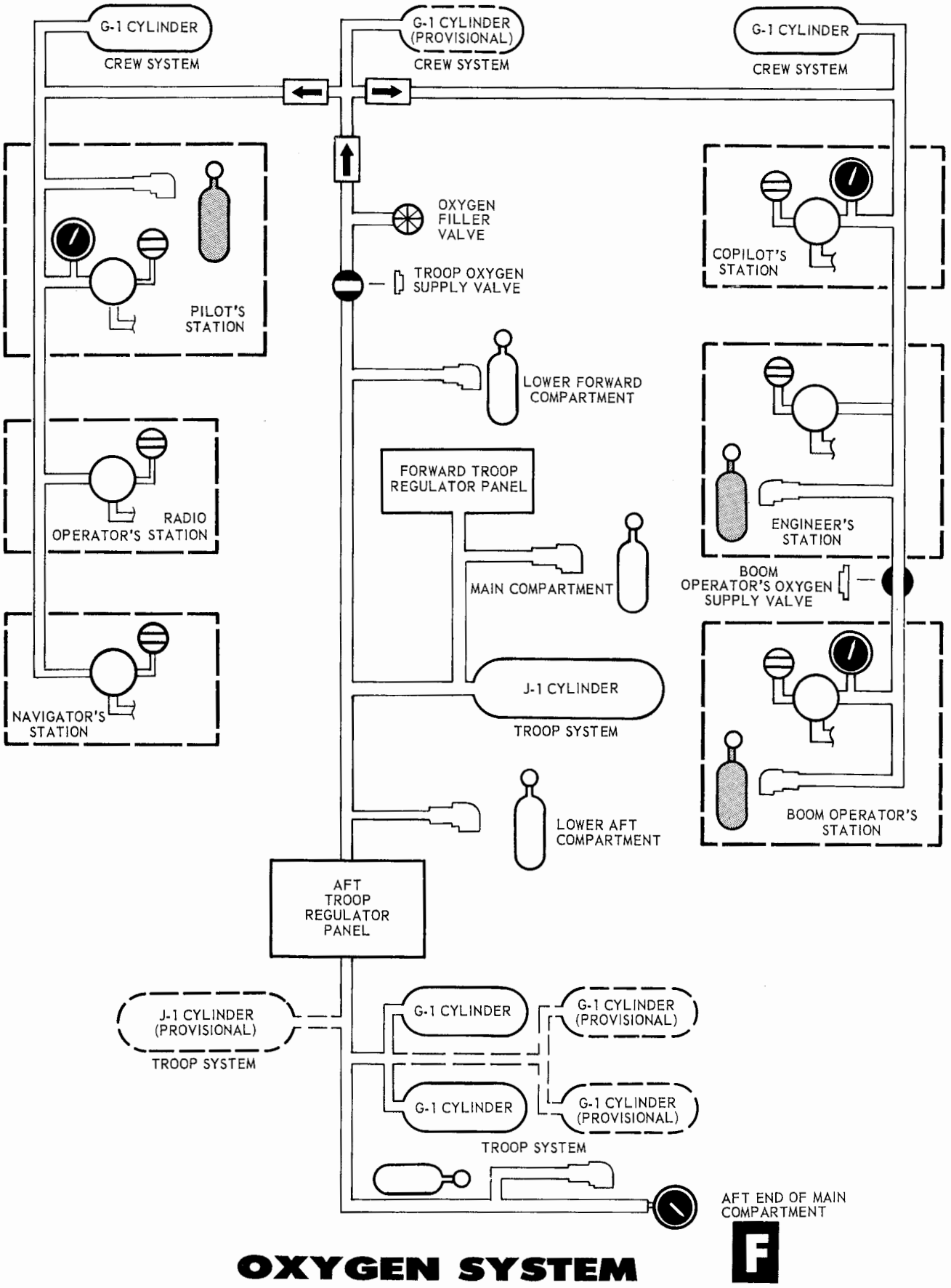
NOTE:

To transfer power from the engineer's A/R panel to the fluorescent light box, unscrew the two cannon 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

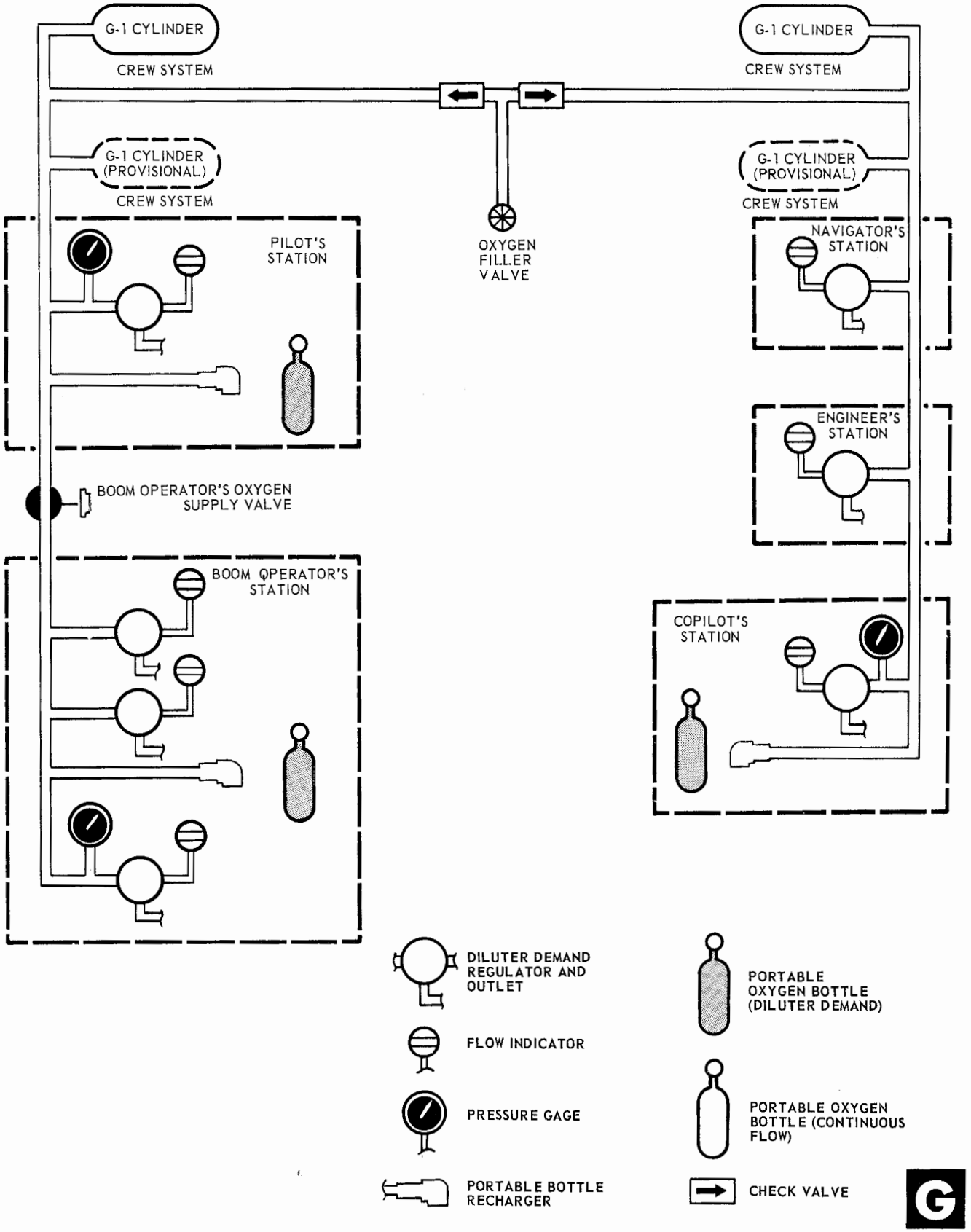
Figure 4-44



OXYGEN SYSTEM

F

Figure 4-45 (Sheet 1 of 2)



G

Figure 4-45 (Sheet 2 of 2)

OXYGEN SYSTEM

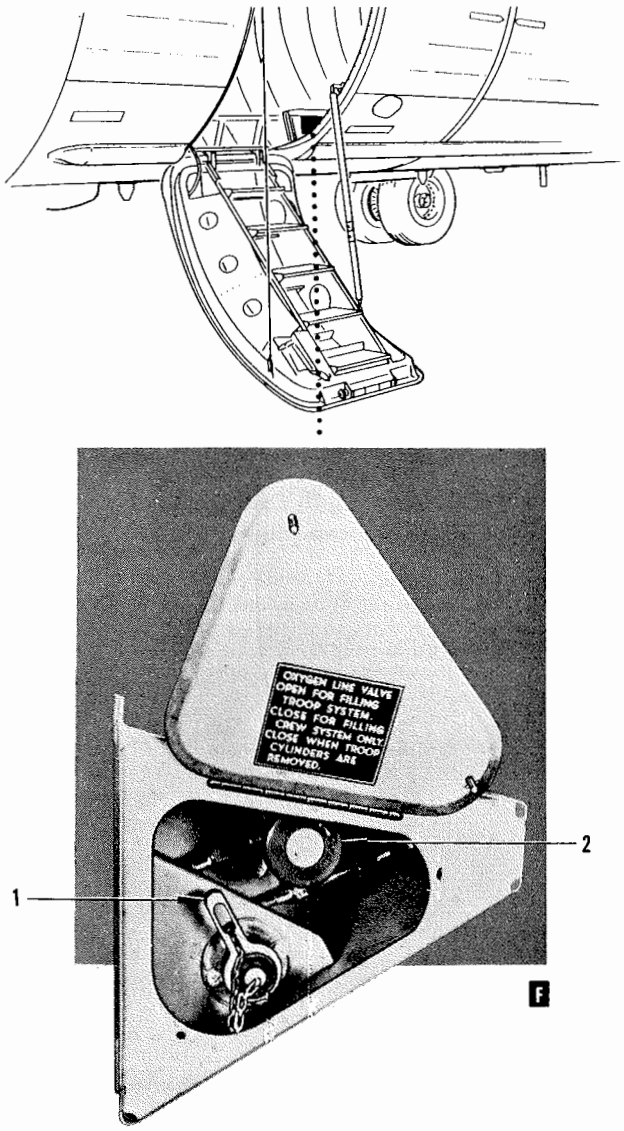
The 400 psi gaseous oxygen system consists of the following components; an oxygen filler valve (1, figure 4-46) located in the lower forward compartment just aft of the forward entry door, oxygen supply cylinders, oxygen regulators, oxygen pressure gages and oxygen flow indicators. A pressure of 450 psi should not be exceeded when filling the oxygen system to 425 psi. Before takeoff a minimum of 400 psi system pressure is required.

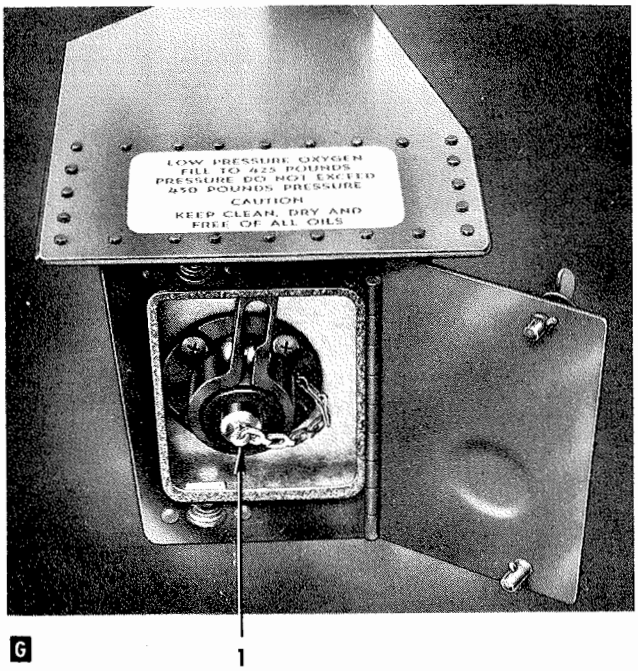
F

The oxygen system on F airplanes consists of two complete systems, a crew oxygen system and a troop oxygen system, separated by the troop oxygen supply valve. (See figure 4-45.) The oxygen filler valve is used to service both systems. The crew oxygen system is divided into two separate systems by the use of two check valves, one mounted on each of the two G-1 cylinders which normally supply crew oxygen. The check valves allow the oxygen of one cylinder to be used by the pilot, navigator and radio operator and the oxygen of the other cylinder to be used by the copilot, engineer, and (when the boom operator's oxygen supply valve in the boom operator's line is open) to the boom operator. These two G-1 cylinders of the crew systems are located in the lower nose compartment. Provision is also made for the installation of an additional G-1 cylinder near the top and to the rear of the control cabin if additional oxygen is needed for the crew systems. A check valve is not used with this cylinder. However, another check valve is mounted in the oxygen filler line between this cylinder and the oxygen filler valve, which allows this cylinder to be filled and permits its oxygen to be used in both of the crew systems. This check valve in the crew filler line allows the crew systems to utilize the oxygen of the troop system (when the troop oxygen supply valve is open), but automatically prevents the oxygen of the crew systems from going back into the troop system at any time. A pressure gage, a blinker type flow indicator, and a diluter-demand regulator are located at crew stations as shown in figure 4-45. Six portable oxygen bottles are provided as shown in figure 3-1. 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. In the main compartment one bottle is on the ceiling near the forward bulkhead and one on the right side near the tail. Two more portable bottles are located in the lower compartments; one on the left hand side of the lower forward compartment, another on the left hand side of the lower aft compartment. Passengers, troops, or litter patients are supplied by one Type J-1 and two Type G-1 oxygen cylinders. Space provision has been allowed for an additional Type J-1 and two additional Type G-1 oxygen cylinders as required for any special mission. A pressure indicator for the troop oxygen system is located on the right aft wall of the main compartment. A continuous flow portable oxygen unit and recharger facilities are provided at the forward and aft ends of the main compartment, in the lower forward compartment and in the lower aft compartment. Continuous flow regulators provide outlets for each troop and litter station as well as the toilet compartment. Continuous flow oxygen mask containers are installed throughout the main, lower forward and lower aft compartments. The passenger regulators are automatic and supply the proper amount of oxygen required with altitude. Only continuous flow oxygen masks will be used. The approximate oxygen duration in man hours are shown in figure 4-48.

G

The oxygen system on G airplanes consists of two completely independent systems. One system supplies the navigator, engineer, and copilot. The other system supplies the pilot, and on tanker configuration airplanes, the boom operator, boom instructor, and boom trainee. The pilot can be isolated in his system by a line shutoff valve. On airplanes G 17260 ▶ 3177, no oxygen outlet is provided for the radio operator, therefore he must utilize a walk-around bottle, provided at the pilot's and copilot's stations, in the event use of oxygen becomes necessary. 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. On cargo airplanes, a blinker type flow indicator and a diluter-demand regulator are provided for at each crew station. In addition to the aforementioned equipment, the pilot and copilot have an oxygen pressure gage provided for at their stations. On tanker airplanes, 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. 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. On T airplanes, a third portable bottle and recharger assembly is located forward of the boom operator's panel. Approximate oxygen duration in manhours is shown in figure 4-48.





1 OXYGEN FILLER VALVE (2 PLACES)
2 TROOP OXYGEN SUPPLY VALVE HANDLE

OXYGEN FILLER VALVE

Figure 4-46

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 left in the NORMAL position except when treating for hypoxia, shock, noxious fumes or for denitrogenation.

Regulator Emergency Valve Knob

An emergency valve knob (16, figure 1-11) 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.

NOTE

This illustration shows the procedure for connecting the oxygen hose and does not necessarily reflect the type of head gear, oxygen mask and oxygen mask straps to be used.

1 WRAP MASK MALE CONNECTOR TIE-DOWN STRAP TWICE AROUND CHEST STRAP AS CLOSE TO SNAP AS POSSIBLE, AND FASTEN TO CONNECTOR

WARNING

- Failure to double loop the connector tie-down strap around the parachute chest strap may permit the tie-down strap to slip into and open the chest strap snap during egress.
- Do not wrap the tie-down strap around the chest strap snap.

2 CONNECT HOSE, LISTEN FOR CLICK AND CHECK THAT SEALING GASKET IS ONLY HALF EXPOSED

OXYGEN HOSE CONNECTION

Figure 4-47 (Sheet 1 of 2)

3 ATTACH ALLIGATOR CLIP TO THE END OF THE MASK MALE CONNECTOR STRAP

WARNING

Do not attach alligator clip to the parachute harness as this may prevent quick separation during egress. The force required to pull the clip loose from the parachute harness is considerably greater than from the tie-down strap.

4 PUT ON OXYGEN MASK AND CHECK OXYGEN FLOW INDICATOR
ATTACH BAILOUT BOTTLE HOSE TO MALE CONNECTOR (IF CARRIED)

Figure 4-47 (Sheet 2 of 2)

Troop Oxygen Supply Valve Handle F

Rotating this valve handle (2, figure 4-46) in the counterclockwise direction opens the valve and allows simultaneous recharging of the complete oxygen system, and also permits the crew to draw oxygen from the troop system. This valve is normally closed to prevent oxygen flow from the troop section to the crew sections of the oxygen system. The troop oxygen supply valve handle is located next to the oxygen system filler valve in the lower forward compartment just aft of the forward entry door.

Boom Operator's Oxygen Supply Valve

F

On F airplanes this handle operated valve is above the control cabin door and is in the oxygen line of the system which supplies the copilot. When opened, this valve allows the boom operator to use oxygen from the copilot's oxygen system. When the valve is closed, no oxygen will flow to the boom station.

G

On G airplanes this handle operated 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 1-11) are provided at the pilot's and copilot's station on all airplanes, and also at the boom operator's station on tanker airplanes. The gages indicate system pressure in psi.

Oxygen Flow Indicators

A blinker-type oxygen flow indicator (12, figure 1-11) is provided near each crew member's oxygen regulator unit. Opening and closing of luminescent segments as the crew member breathes indicates normal flow of oxygen.

OXYGEN SYSTEM NORMAL OPERATION

Oxygen Equipment Check

NOTE

The following procedure applies to each member unless otherwise noted.

1. Oxygen Pressure - 400 psi (minimum) (P, CP, BO)
2. Oxygen Hose - Blow gently into end of hose

If there is a resistance to blowing, the regulator is satisfactory, little or no resistance indicates a faulty demand diaphragm, diluter air valve or leaking mask to regulator hose.

WARNING

When performing the oxygen equipment check at low ambient temperatures, caution must be observed when blowing into the end of the oxygen hose. At temperatures near or below freezing the cold metal connector on the end of the oxygen tubing may stick to the operator's lips causing injury.

3. Mask - Don and connect mask hose to regulator
4. Diluter Lever - NORMAL, check for free flow of oxygen
5. Diluter Lever - 100% OXYGEN, check for free flow of oxygen
6. Diluter Lever - NORMAL
7. Emergency Valve - Closed and safetied
8. Oxygen Bottle - Serviced (if applicable) (BO)

In Flight

The regulator diluter lever on each crew member's pressure regulator should be in the NORMAL OXYGEN position except when operating under emergency conditions. On F airplanes, when the passengers use oxygen, a proper flow is automatically provided to the mask when the mask bayonet is attached to the oxygen outlet coupling. The coupling will automatically close when the mask bayonet is removed.

Heavy Figures Indicate Diluter Lever 100%
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	EMERGENCY Descend to Altitude Not Requiring Oxygen
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	

Oxygen Duration – MAN HOURS

Passenger

Cylinders: 1 Type J-1, 2 Type G-1

CABIN ALTITUDE—FEET	GAGE PRESSURE—PSI 400	350	300	250	200	150	100	BELOW 100
30,000	60	52	43	34	26	17	9	EMERGENCY Descend to Altitude Not Requiring Oxygen
25,000	66	56	47	38	28	19	9	
20,000	72	62	52	41	31	21	10	
15,000	80	69	57	46	34	23	11	
10,000	90	77	64	51	39	26	13	

NOTE

- To find the oxygen duration for a crew of three using oxygen from one type G-1 cylinder, divide oxygen man hours in upper chart by three.
- As an 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 4-48

OXYGEN SYSTEM EMERGENCY OPERATION

With symptoms of hypoxia, or if smoke or fumes should enter the cabin, set the regulator diluter lever to 100% OXYGEN. If the regulator becomes inoperative, open the emergency valve by turning the red emergency knob counterclockwise.

WARNING

When the regulator diluter lever is placed in the 100% OXYGEN position or the emergency valve control knob is turned on, 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 (figure 1-35, sheet 1). Circuit protection is provided for the operating power circuits on the AC power panel (figure 1-35, sheet 3).

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 magnetic operation or directional indicator operation. See N-1 COMPASS SYSTEM OPERATION in this Section.

Copilot's Turn and Slip Indicator

The copilot's turn and slip indicator (18, figure 1-9), which is calibrated for two 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 attitude indicator (14, figure 1-9), 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 whenever displacement occurs with reference to the vertical seeking gyro. A caging knob located on the lower right corner of the unit is used to erect the axis of the gyros in the vertical gyro control unit and the remote gyro flux gage compass 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 direction 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 switch (47, figure 1-16) 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 de-energized.

Autopilot Clutch Switch

A push button switch (46, figure 1-16), located 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 direction indicator, are engaged. This connects the autopilot to the airplane control surfaces and permits signals from the master direction indicator to control the heading of the airplane.

Autopilot Release Switches

A push button type switch (5, figure 1-7 and 2, figure 1-8), located 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 1-16), located 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.

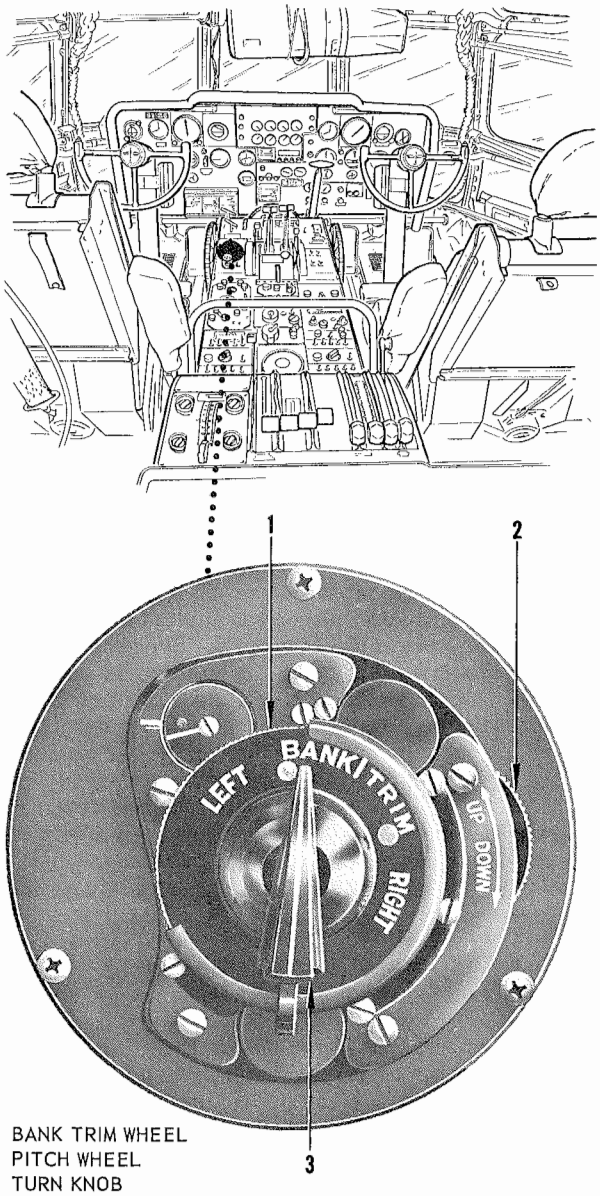
Autopilot Turn and Pitch Controller

An autopilot turn and pitch controller (figure 4-49) is provided on the control stand for maneuvering the airplane when the autopilot is engaged.

PITCH WHEEL. A knurled pitch wheel (2, figure 4-49) is located 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 4-49), marked LEFT--RIGHT is located 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 4-49), located 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.



1 BANK TRIM WHEEL
2 PITCH WHEEL
3 TURN KNOB

AUTOPILOT TURN AND PITCH CONTROLLER

Figure 4-49

AUTOPILOT NORMAL OPERATION

In order to prevent the autopilot from inadvertently engaging during critical flight conditions, the following precautions must be observed.

1. Do not place the autopilot master switch in the ON position until a safe altitude has been reached
2. The autopilot master switch must be in the OFF position during all refueling contacts
3. 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.

Slave Magnetic Autopilot Operation

During slaved magnetic operation of the N-1 compass system, the airplane, when on autopilot control, will fly a magnetic heading. Operation of the autopilot during slaved magnetic operation of the N-1 compass is as follows:

1. Check that the N-1 compass system is on slaved magnetic operation. See N-1 COMPASS SYSTEM OPERATION in this Section
2. 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° off from the correct magnetic heading. This can be checked by comparing the master direction indicator heading with the magnetic compass. Synchronizing 180° off from the correct heading is an unstable condition which, if left alone, will correct itself at a rate of approximately 3° 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.

Direction Indicator Autopilot Operation

During directional indicator 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). Directional indicator 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. Directional indicator autopilot operation is as follows:

1. Check that the N-1 compass system is on directional indicator operation. See N-1 COMPASS SYSTEM OPERATION in this Section
2. Set the desired reference heading on the indicator
3. Engage the autopilot as described below

NOTE

During directional indicator operation the heading on the master direction 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

1. Check copilot's attitude indicator erected and uncaged
2. Check clutch switch out. Check autopilot inverter switch at AUTOPILOT INV
3. Turn autopilot master switch ON. Allow 1 minute for amplifier warm-up
4. Center the turn control and pitch controller
5. Trim airplane to fly hands off
6. Engage autopilot by pushing clutch switch in

CAUTION

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, or 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 eight 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 cannot 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 direction indicator, and on airplanes G 22629 ▶ plus those incorporating TCTO K235, 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 airplanes G 32350 ▶, 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 airplanes F G 1243 ▶ 3177, the navigator's instrument panel (figure 4-50) has a master direction 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 direction indicator. The direction indicator only appears on airplanes F G 1243 ▶ 2859. On airplanes G 3178 ▶, the same instruments appear on the navigator's instrument panel; however, the light rheostats as well as the direction 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 (16, figure 4-15) on airplanes F G 1243 ▶ 3177, now appears on this navigator's instrument panel.

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: (1) Magnetic-slaved operation whereby the gyro is used to stabilize magnetic heading indications and (2) Directional gyro 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 directional 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 magnetic-slaved operation. When operated as a magnetic 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 direction indicator (figure 4-51). The system is energized whenever there is 28 volt DC and 115 volt AC power on the airplane and the autopilot inverter in ON. The N-1 compass system furnishes heading data to the autopilot, navigator's master direction indicator (figure 4-51), copilot's directional indicator (13, figure 1-9), and the radio magnetic indicators (RMI) at the pilot's, copilot's, and navigator's stations (15, figure 1-9 and 8, figure 4-50). Circuit protection is on the overhead circuit breaker panel (figure 1-35), marked FLIGHT INSTRUMENT, AUTO PILOT and the AC power panel (figure 1-35) marked DIRECTIONAL GYRO.

WARNING

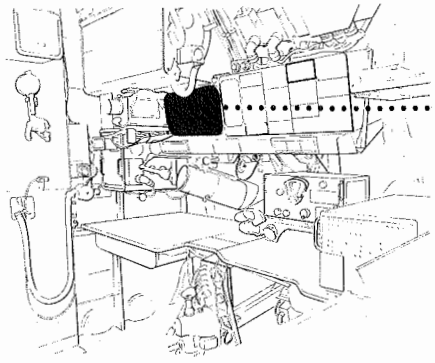
The synchronizer knob should not be adjusted at any time the autopilot is engaged, since the autopilot reacts very rapidly to the signals received from the N-1 compass and an uncontrolled action of the airplane may result.

NOTE

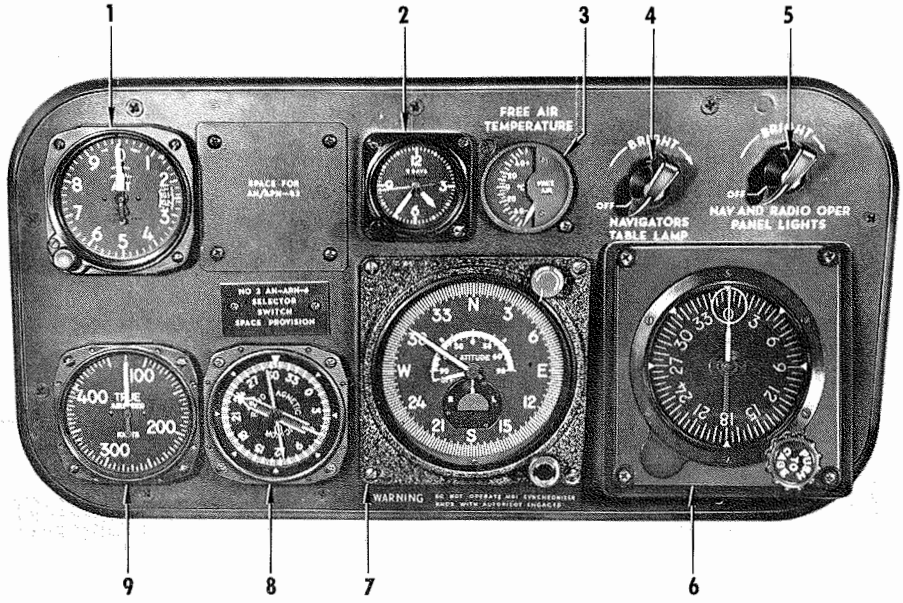
The copilot's direction indicator displays the same heading as the master direction indicator within two degrees and the radio magnetic indicator headings are within 2-1/2 degrees of the master direction indicator.

Master Direction Indicator Controls

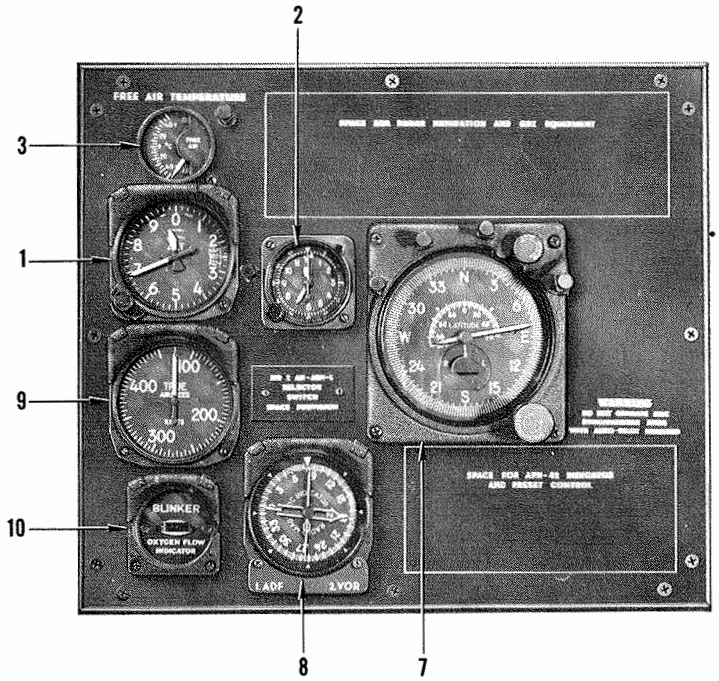
HEADING POINTER. The heading pointer (2, figure 4-51) indicates the correct magnetic heading while the compass is in magnetic-slaved operation (providing the pointer is properly synchronized), or deviations from a preselected heading during directional gyro operation. Heading indications are accurate within ± 1/2 degree.

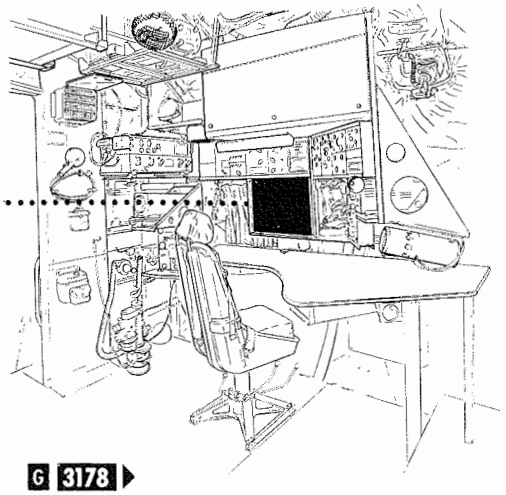


F G 1243 ▶ 3177



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 DIRECTION INDICATOR F G 1243 ▶ 2859
7 MASTER DIRECTION INDICATOR (N-1 COMPASS SYSTEM) (2 PLACES)
8 RADIO MAGNETIC INDICATOR (RMI) (2 PLACES)
9 TRUE AIRSPEED INDICATOR (2 PLACES)
10 OXYGEN FLOW INDICATOR





G 3178 ▶

NAVIGATOR'S INSTRUMENT PANEL

Figure 4-50

LATITUDE CORRECTION CONTROL KNOB. The function of this knob (1, figure 4-51) is to switch from magnetic-slaved operation to directional-gyro operation or vice versa, and to adjust the latitude correction setting. Refer to LATITUDE CORRECTION POINTER.

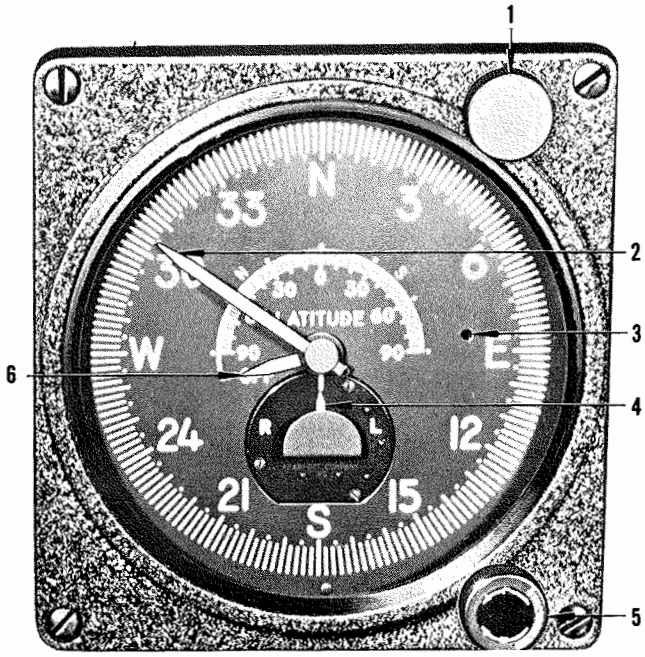
LATITUDE CORRECTION POINTER. The latitude correction control knob (1, figure 4-51) positions the latitude correction pointer (6, figure 4-51) with respect to the latitude scale at the center of the master indicator dial face. The scale has an OFF position and is marked in 2 degree increments clockwise from 90 degrees N through 0 degrees to 90 degrees S. When the pointer is in the OFF position, the compass operates as a magnetic slaved compass. Moving the pointer to the latitude scale switches the compass to the directional gyro 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 directional-gyro operation, the synchronizer knob (5, figure 4-51) is used to set the heading pointer to any desired position (usually repositioned for grid navigation reference). During magnetic-slaved operation, the compass maintains synchronization automatically; however, when the compass is first energized or changed from DG to MAG operation, the annunciator 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.

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 magnetic-slaved operation, consists of a dial and pointer (4, figure 4-51). 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.



1 LATITUDE CORRECTION CONTROL KNOB
2 HEADING POINTER
3 CORRECTION INDICATOR PORT
4 ANNUNCIATOR POINTER
5 SYNCHRONIZER KNOB
6 LATITUDE CORRECTION POINTER

MASTER DIRECTION INDICATOR

Figure 4-51

CORRECTION INDICATOR PORT. The intermittent appearance of the small white dot behind the correction indicator port (3, figure 4-51) indicates that the compass system is being corrected. During directional gyro 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 magnetic-slaved operation keeps 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 whenever 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 MAGNETIC OPERATION. The N-1 compass is put into slaved magnetic operation as follows:

1. Check that the autopilot inverter is operating
2. Allow 10 minutes for the system to warm-up and the gyros to stabilize.
3. Rotate the latitude correction control knob on the master direction indicator so that the latitude correction pointer is at the OFF position. This slaves the indicator to the remote compass transmitter
4. 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.

5. 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° off the correct magnetic heading. This is an unstable condition which will correct itself if left alone, at an approximate rate of 3° per minute. If the airplane is on autopilot control, it will change its heading at approximately 3° per minute and assume the new heading. See AUTOPILOT NORMAL OPERATION in this Section. Do not synchronize the heading pointer during or immediately after turns, or whenever the autopilot is engaged.

6. Check the correction indicator (white dot) occasionally. Rotation of the dot indicates the system is operating properly

DIRECTION INDICATOR OPERATION. Direction indicator 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. Direction indicator operation is initiated as follows:

1. 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 direction indicator operation.

2. As the airplane changes position, the latitude correction pointer should be reset progressively to the new latitude

NOTE

Setting the mid-latitude every 2° will generally be sufficient for proper operation.

3. 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.

4. Observe the correction indicator (white dot) occasionally, for proper operation. The dot will rotate clockwise in north latitudes and counterclockwise in south latitudes

PERISCOPIC SEXTANT AND MOUNT

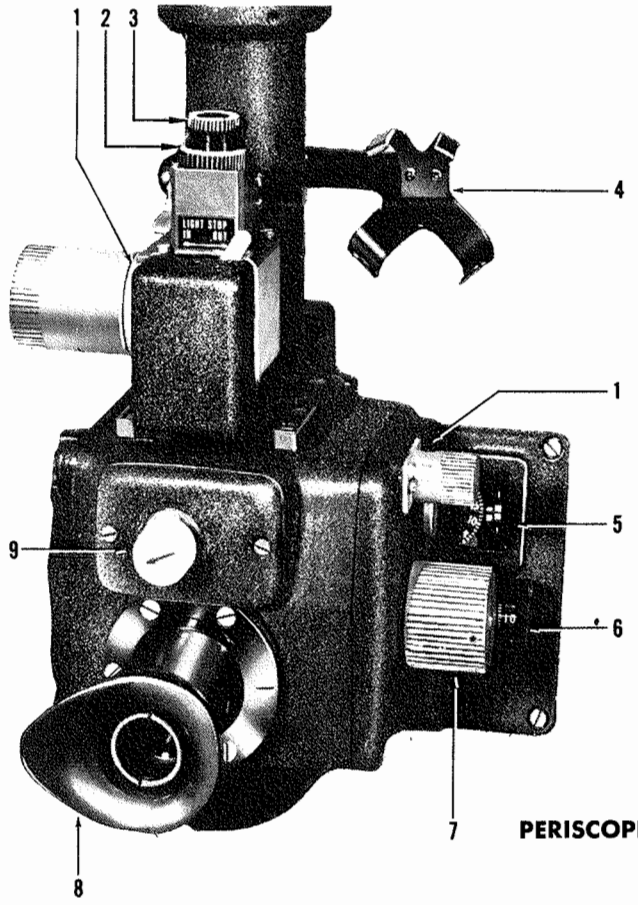
G 2860 ▶ PLUS TCTO 133

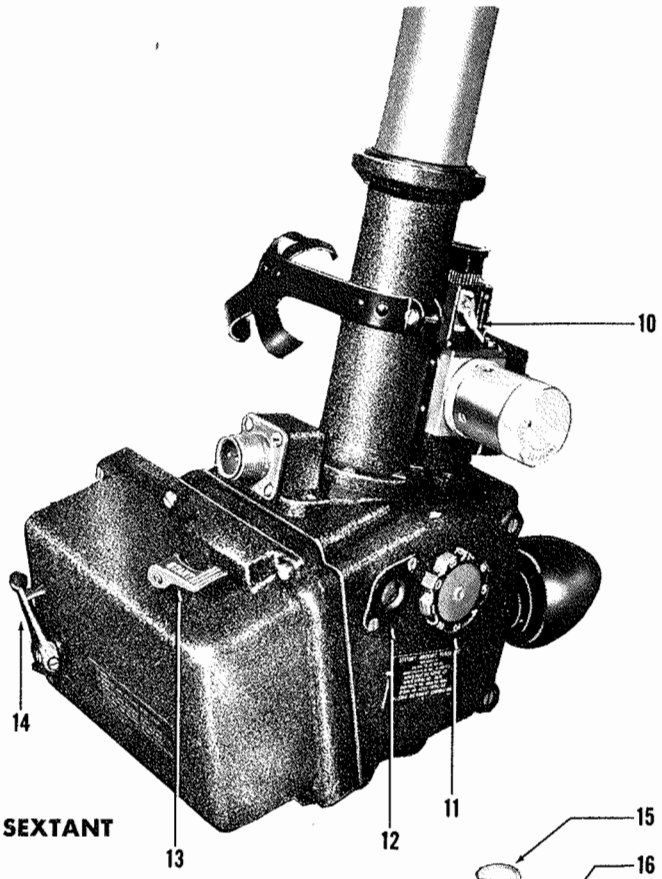
A periscopic sextant is stowed on the lower forward side of the engineer's instrument panel support, just aft of the copilot's seat. Access to the periscopic sextant is from the crew passageway outboard of the engineer's panel. When being used, the sextant is mounted on a support on the ceiling of the 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 volt DC with circuit protection on the overhead circuit breaker panel (figure 1-35, sheet 1).

Periscopic Sextant And Mount Controls

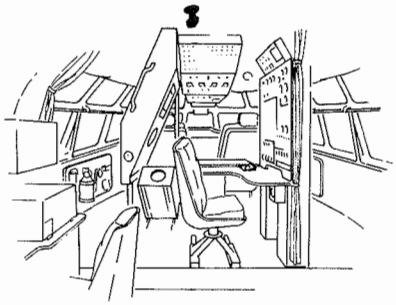
ILLUMINATION SWITCH. This on-off toggle switch (21, figure 4-52) on the mount controls illumination. The illumination of the bubble and the azimuth scale of the mount is adjustable by rheostat. No adjustment is provided to control the illumination of the mount counter, sextant counter, averager indices or the navigator's watch.

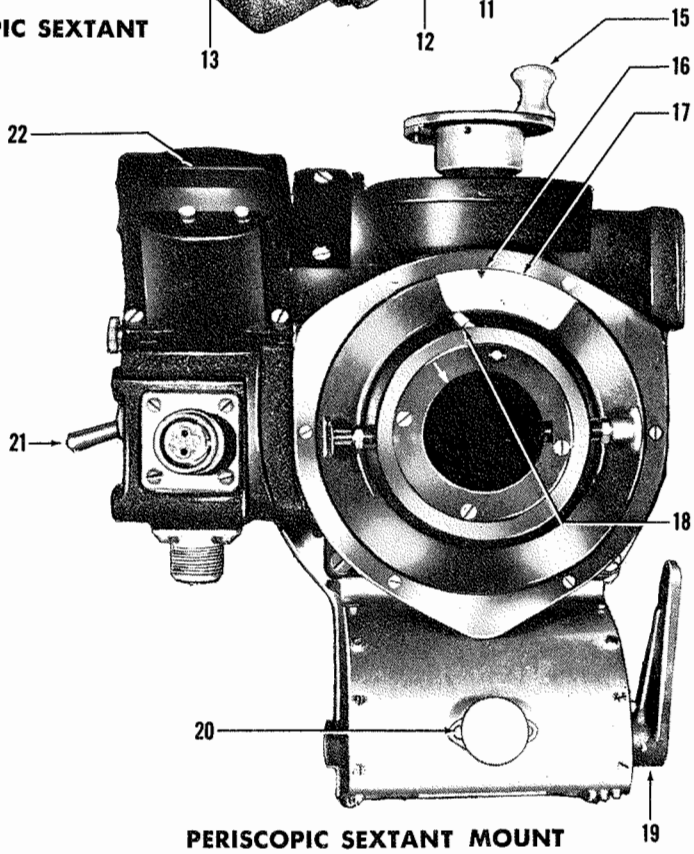
EYEPIECE. The eyepiece (8, figure 4-52) on the sextant is adjustable from -2 to +2 diopters for focusing.





PERISCOPIC SEXTANT





PERISCOPIC SEXTANT 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

G 2860 PLUS TCTO 133

Figure 4-52

FILTER ADJUSTMENT SELECTOR. This selector (11, figure 4-52) 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. This plug (20, figure 4-52) on the mount is provided at the two point in the shutter retraction well for draining any water which might have collected in the mount.

CRANK. A crank (15, figure 4-52) 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° mark - a useful feature when a setting is to be made.

LOCKING LEVER. This lever (18, figure 4-52) 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. This lever (10, figure 4-52) 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. This lever (14, figure 4-52) is on the sextant and allows the operator to wind the averager.

ACTUATION LEVER. This lever (13, figure 4-52) on the sextant is provided to start and stop the averager.

SHUTTER LEVER. This lever (19, figure 4-52) on the mount when operated opens the mount shutter and allows the sextant to be further inserted into the mount.

RHEOSTAT. This rheostat (9, figure 4-52) on the sextant, allows the operator to control the illumination of the bubble and azimuth scale.

WATCH CLIP. The watch clip (4, figure 4-52) on the sextant is provided to securely hold special navigator watches. 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. A desiccant (12, figure 4-52) is located on the sextant and aids in preventing moisture.

ALTITUDE KNOB. This knob (7, figure 4-52) 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

HALF TIME DIAL AND AVERAGER INDICATOR. This indicator (5, figure 4-52) is on the periscopic sextant. This is a time dial graduated in seconds indicating the half time 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. This counter (6, figure 4-52) on the sextant allows the operator to read the average altitude.

AZIMUTH COUNTER. This counter (22, figure 4-52) is on the mount. This counter indicates the position of the azimuth scale with respect to the lubbers line.

LUBBERS LINE. A lubbers line (16, figure 4-52) on the mount which may be aligned with the airplanes longitudinal axis to establish a lubbers line, provides indications of azimuth on the scale.

AZIMUTH SCALE. An independently rotatable azimuth scale (17, figure 4-52) is on 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
2. Forming and adjusting the bubble
3. Time dial check
4. Altitude average check
5. Alignment of sextant and mount in the airplane
6. Removal of the sextant from the mount

INSERTING THE SEXTANT IN THE MOUNT
1. With the line of sight locking lever on mount unlocked, insert the sextant as far as possible with arrows on tube and mount aligned
2. Hold the sextant firmly to prevent dropping and rotate the lower ring of mount counterclockwise (looking up, toward mount) until it hits a stop
3. Pull out knob marked, To Insert, Remove--Pull
4. 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.

5. Open the mount shutter with lever
6. Insert sextant further until knob marked To Retract Sextant-Pull snaps into place
7. 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 switch on the mount in the ON position, adjust the intensity of illumination with 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:
1. Set increase bubble knob to minimum position
2. Tilt sextant to the right
3. Slowly rotate the knob
4. A bubble will be formed at the notch, visible on the right hand side of the field of view
5. Rotate knob slowly back and forth until proper size bubble is obtained
6. Move sextant to vertical position, i.e. when the bubble is in the center of the field of view
7. Slowly rotate knob to maximum increase position

Bubble Already Formed And Of The Desired Size:
1. Under this condition, there is nothing to do except to put the bubble in focus by turning the eyepiece
2. Check to be sure the increase bubble knob is in maximum increase position

Bubble In Field Of View Is Too Large:
1. With sextant in the vertical position, rotate increase bubble knob to maximum position
2. Tilt sextant to the right and center the bubble in the notch
3. Slowly rotate the knob to reduce the size of the bubble

4. If the travel of the knob is reached without reducing bubble to the desired size, repeat cycle
5. When desired bubble size is obtained, move sextant to vertical (bubble located near intersection of reticle)
6. Slowly rotate knob to maximum increase position

Bubble In The Field Of View Is Too Small:
1. Knob is rotated to minimum increase position with sextant vertical
2. Tilt sextant to right and center the bubble in the notch
3. Slowly rotate the knob, to increase size of bubble
4. If the travel of the knob is reached without increasing bubble to the desired size, repeat cycle
5. 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 one 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 rewind lever and release slowly. Averager will operate for three seconds, then stop automatically. Time dial should indicate zero. Depress and release the averager actuating button, 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 two 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 two seconds.

ALTITUDE AVERAGER CHECK. To check the accuracy of the altitude averager, proceed with the following steps:
1. Depress and release the averager rewind lever

CAUTION

This should wind the averager, zero the time dial and raise the shutter. Do not change altitude setting during three-second interval immediately after releasing the averager rewind lever.

2. Turn the altitude knob until exactly 13°00' is set in the altitude counter
3. Start the sextant by depressing and releasing the averager actuating button
4. Stop sextant when time reads exactly 15
5. Reset altitude counter to exactly 12°00' and restart sextant
6. Stop sextant when time dial reads 30
7. Reset altitude counter to exactly 8°00' and restart sextant
8. Stop sextant when time dial reads 45
9. Reset altitude counter to exactly 7°00' and restart sextant. When time cycle for averager is complete, the averager stops automatically
10. Rotate altitude knob until red blocks on altitude counter are aligned. Altitude counter should read 10°00' plus or minus 2 minutes

Alignment Of Sextant And Mount With Airplane

ADJUSTMENT OF AZIMUTH COUNTER AND SCALE ON MOUNT

1. Set 000.0 degrees in the azimuth counter
2. With the sextant in the operating position, the diffuser lever in out position, 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 lubbers 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 aximuth counter reading has not been changed inadvertently

OPTICAL ADJUSTMENT OF PROJECTION LENS ASSEMBLY

1. 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
2. Rotate sextant until lubbers line and vertical reticle line are coincident or nearly coincident. Ignore all other objects in the field of view
3. Lock line of sight locking lever
4. Check for parallax between lubbers 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 lubbers 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.

5. If satisfied that no parallax exists, the sextant and mount are to be considered as optically adjusted but not aligned. If no satisfied, proceed as follows:
   a. Loosen the projection lens locking ring and rotate the projection lens so that it moves either up or down. The lubbers line will appear to move in an elliptical path, making a complete cycle for each revolution of the lens
   b. Rotate the lens as many times as necessary to position the lubbers line at one of the uppermost positions in its elliptical path, and at the same time produce a sharp image of the lubbers line plus a distinct lack of parallax as described in the above note
   c. With the locking ring loosened, be sure the lubbers 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 lubbers line. Lock the projection lens locking ring without further movement of the projection lens

ALIGNMENT OF SEXTANT AND MOUNT

1. The relative bearing of the vertical stabilizer is 180°00' 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).

2. 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)
3. Crank the azimuth counter to read exactly 000.0 degree
4. 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 aximuth. 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 C-4 type 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

5. When sighting as described above, the vertical line of the reticle, stabilizer and 180° on the azimuth scale should coincide
6. 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:
   a. Loosen the projection lens locking ring.
   b. 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 lubbers 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.

c. Secure the projection lens with the lock ring
d. 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 lubbers line of the mount not being in alignment with the longitudinal axis of the airplane

Removal Of Sextant From The Mount

1. Turn switch to the OFF position, and disconnect the electrical cable
2. Holding the sextant securely with one hand, pull out knot marked. To Retract Sextant--Pull and lower the sextant to the retracted position
3. Close the mount shutter
4. 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
5. Sextant will then be free to be lowered until completely removed
6. Turn it to the carrying case and secure as shown

CAUTION

Before replacing sextants in the carrying case always press actuating lever or button, allowing the averager to run down and always rotate bubble knob to maximum increase position.

DRIFTMETERS

An electrically driven gyro-stabilized driftmeter (figure 4-53 or figure 4-55) 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 airplanes F G 1243 ▶ 22628 less those with TCTO K235 incorporated, the B-3 driftmeter is used. On airplanes G 22629 ▶ plus those with TCTO K235 incorporated, the B-6A driftmeter replaces the type B-3. On airplanes F G 1243 ▶ 3177 , the driftmeter gyromotor is turned on and off by an ON--OFF switch on the navigator's auxiliary panel (17, figure 4-15) at the navigator's station. On airplanes G 3178 ▶ , the gyromotor driftmeter switch (5, 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 (figure 1-35).

B-3 Driftmeter F G 1243 ▶ 22628 less TCTO K235

RHEOSTAT KNOB. A rheostat knob and pointer (2, figure 4-53) on the top of the upper gyro housing, is used to turn the three-volt lamp on and off and to control its brightness.

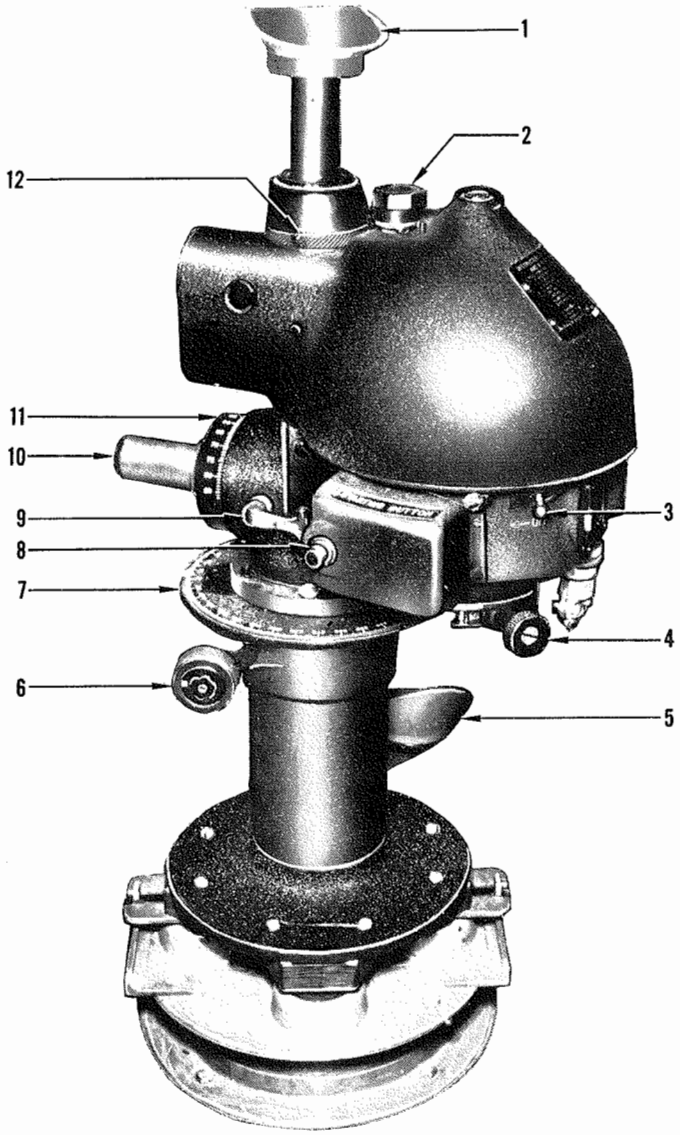
GYRO SWITCH. A switch (3, figure 4-53) for starting and stopping the gyro is mounted on the side of the lower gyro housing.

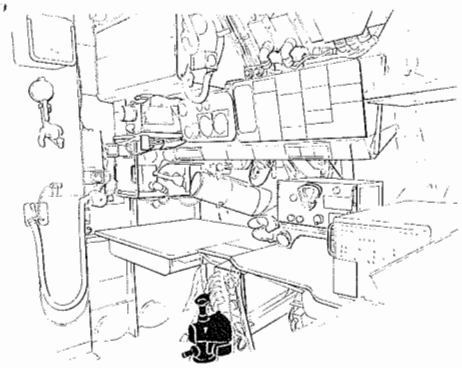
GYRO CAGING KNOB. The caging knob (4, figure 4-53) located at the bottom of the lower gyro housing operates a mechanism which holds the gyro in a vertical position when it is not in use, or when it is tipped too far from the vertical during maneuvers.

SLOW-MOTION KNOB. The slow-motion knob (6, figure 4-53) mounted 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 ADJUSTING RING. Mounted on top of the gyro optics case and holding whichever of the alternate eyepiece assemblies is in use is the eyepiece adjusting ring (12, figure 4-53). Turn as required for clarity of focus.

SHADE GLASS LEVER. The lever (9, figure 4-53) mounted 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.





DRIFTMETER B-3

1 EYEPIECE
2 RHEOSTAT KNOB
3 GYRO SWITCH
4 GYRO CAGING KNOB
5 HIGH ALTITUDE EYEPIECE
6 SLOW-MOTION KNOB
7 AZIMUTH SCALE
8 PUSH-BUTTON SWITCH
9 SHADE GLASS LEVER
10 LINE OF SIGHT HANDLE
11 LINE OF SIGHT DIAL
12 EYEPIECE ADJUSTMENT RING

DRIFTMETER B-3 F G 1243 ▶ 22628 less TCTO K235

Figure 4-53

PUSH-BUTTON SWITCH. When pressed, the push button switch (8, figure 4-53) on the transformer housing momentarily provides power to start the gyro.

LINE OF SIGHT HANDLE. This handle (10, figure 4-53) 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. This dial (11, figure 4-53) 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. An azimuth scale (7, figure 4-53) graduated in 1-degree increments through 360 degrees, is on the driftmeter. This scale remains fixed when the instrument is rotated.

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. $\frac{\text{ABSOLUTE ALT}}{\text{Time in sec's}} = \frac{\text{GS in Knots}}{\text{Factor K}}$

K FACTORS FOR GROUND SPEED BY TIMING ZERO ANGLE METHOD

(B-3 DRIFTMETER) F G 1243 ▶ 22628 less YCTO K235

Figure 4-54

Operation Instructions Of The B-3 Driftmeter

BEFORE TAKEOFF

1. 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
2. To prevent possible breakage of the driftmeter glass by stones, set the instrument at zero on the drift scale before takeoff (or landing)
3. 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

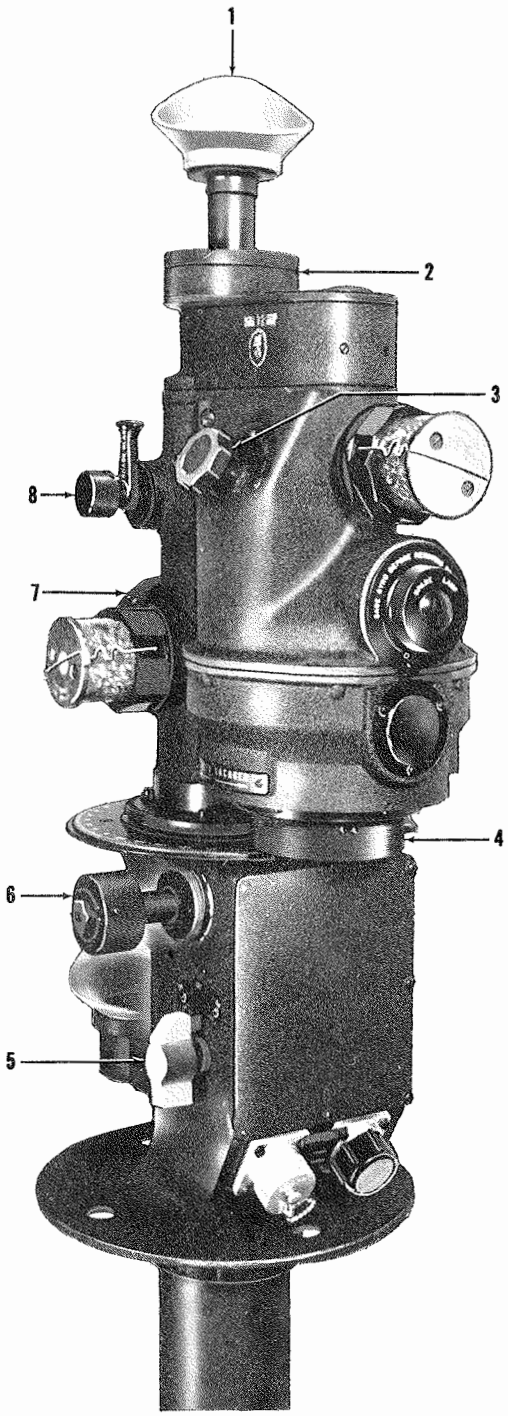
1. With the airplane in normal level flight, close the switch on the junction box to start the inverter
2. Switch on the gyro, and allow it to run for from 3 to 5 minutes before uncaging
3. Uncage the gyro by pulling out the caging knob and moving it to the uncaged position. Do not uncage the gyro when 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
4. Always cage the gyro before switching off power to the instrument and keep it caged when it is not in use
5. When sighting through the eyepiece, turn the rheostat knob to adjust the illumination of the reticle lines
6. 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
7. 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 shown in figure 4-54.

B-6A Driftmeter G 22629 ▶ plus YCTO K235

Operation of the 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:



1 EYEPIECE
2 EYEPIECE ADJUSTING RING
3 RETICLE LIGHT SWITCH
4 GYRO CAGING KNOB
5 ROTARY SWITCH
6 AZIMUTH DRIVE KNOB
7 LINE-OF-SIGHT HANDLE
8 FILTER SELECTOR KNOB AND HANDLE

G 3178 ▶

G 22629 ▶ 3177 PLUS TCTO K235

DRIFTMETER B-6A G 22629 ▶ PLUS TCTO K235

Figure 4-55

ROTARY SWITCH. The rotary switch, (5, figure 4-55) located 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 pointer knob as ON, 28 volt DC and the right position as ON, 115 volt 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 driftmeter in operation, turn switch to applicable ON position and allow a ten minute warm-up period prior to uncaging gyro.

RETICLE LIGHT SWITCH. The reticle light switch (3, figure 4-55) located on the pedestal case operates a rheostat to control the brightness of the reticle field. Switch knob turns left to dim and right to brighten 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 4-55) is located on the under side of the gyro case between the gyro case and the electrical box of the pedestal case. Except when the driftmeter is in use, gyro must remain caged. When gryo is caged, gyro caging knob is turned full right. Turn knob left to uncage. Uncage gyro ten minutes after rotary switch has been turned on.

CAUTION

Driftmeter is designed for use during reasonably level flight. Do not uncage gyro during taxi, takeoff or landing. Do not uncage gyro when roll or pitch exceeds 35 degrees.

AZIMUTH DRIVE KNOB. The azimuth drive knob (6, figure 4-55) is located on the side of the pedestal case and is mounted on a worm gear shaft. When the worm gear 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 shaft through keyway to disengage the gear. This permits the rotating section to swing free in the pedestal case and rotate until the desired line-of-signt is obtained. Replace knob in original position to engage gears and obtain final fine adjustment by turning knob.

LINE-OF-SIGHT HANDLE. The handle assembly (7, figure 4-55) 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 lubbers line at the base of the handle, the prisms in the objective head of the driftmeter reflect an image which is straight down and perpendicular to the center line of the airplane. A pulley assembly in the handle assembly 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 handle and knob assembly (8, figure 4-55) 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 worm gear, 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 4-55). Turn as required for clarity of focus.

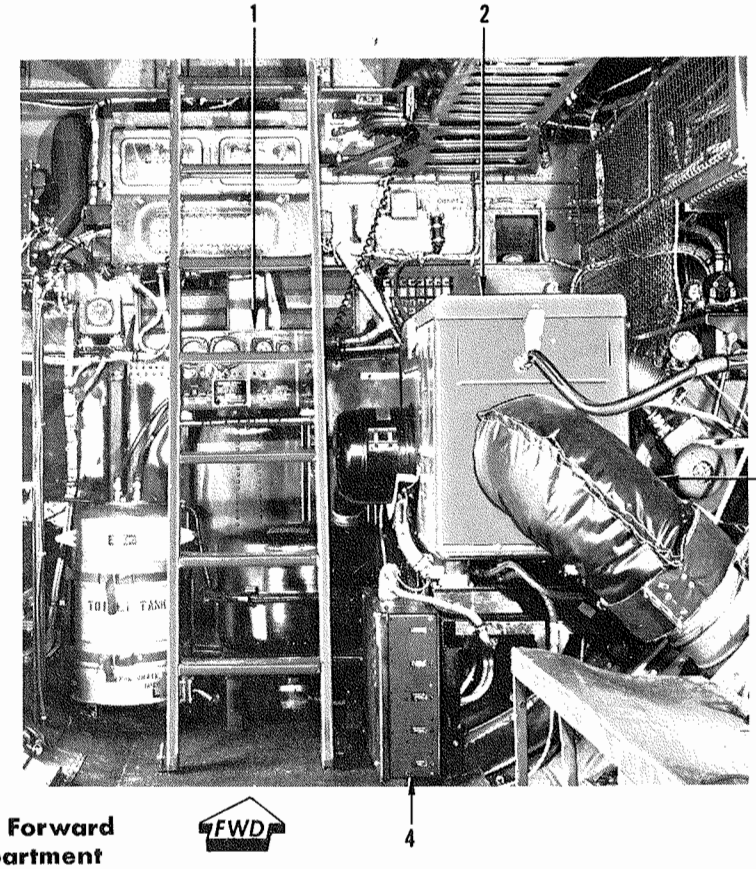
B-3 And B-6A Driftmeter Alignment Check

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.

1. Correctly align the periscopic sextant as outlined in this Section
2. Set 000.0 degree in azimuth counter of periscopic sextant
3. Sight on object approximately 045 degrees left of the nose, at least 400 feet from the airplane using the periscopic sextant. Record 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 one degree. Using this distance will compensate for the offset distance of the driftmeter location from the sextant mount.



1 APU CONTROL PANEL
2 AUXILIARY POWER UNIT
3 EXHAUST DUCT
4 APU CIRCUIT BREAKER PANEL

Lower Forward Compartment

AUXILIARY POWER UNIT

Figure 4-56

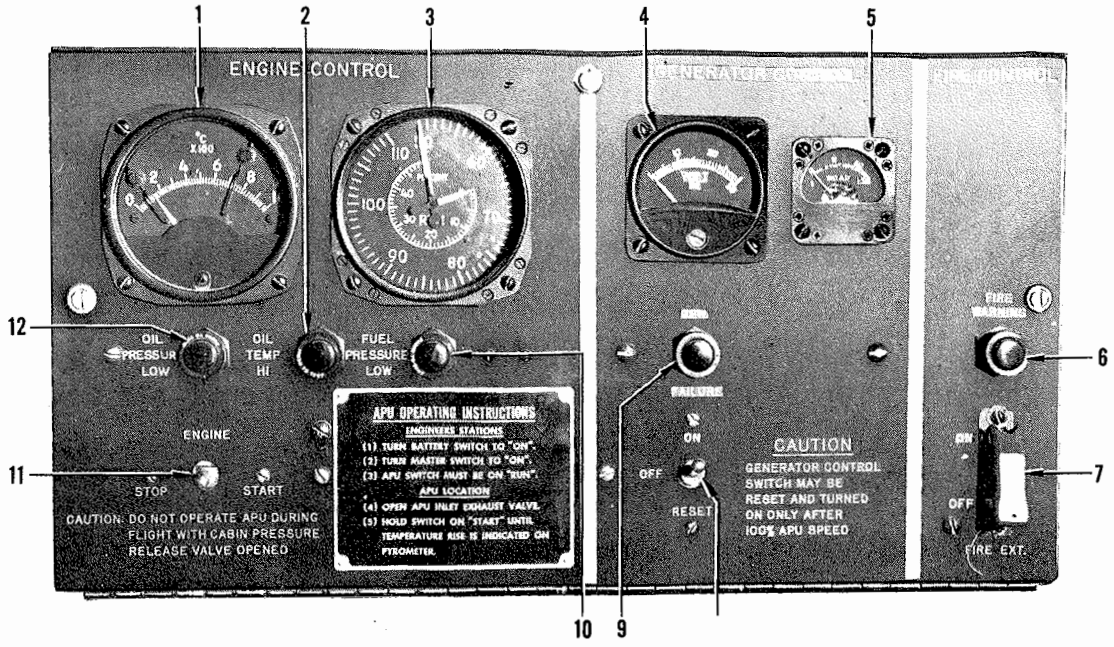
4. Rotate trail angle knob of driftmeter to maximum trail position
5. Disengage azimuth drive knob and sight on previously selected object
6. Compare this bearing with relative bearing obtained from periscopic sextant
7. If bearings do not agree, loosen set screws on driftmeter pointer and adjust to read same bearing obtained from periscopic sextant
8. 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:

1. Bearing obtained from periscopic sextant is 045 degrees to the left of the nose
2. 360 minus 045 equals 315 degrees relative bearing
3. Bearing obtained from driftmeter is 313 degrees relative bearing
4. 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 4-56) 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 volt DC. At altitudes under 10,000 feet, the generator can provide a five minute supply of 17.4 kilowatts at 28 volt DC (approximately 620 amp). Fuel is supplied from the tank No. 2 or from the fuel manifold and is automatically shutoff whenever 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. Tne 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



1 TURBINE DISCHARGE TEMPERATURE INDICATOR
2 OIL HIGH TEMPERATURE WARNING LIGHT
3 TACHOMETER
4 DC VOLTMETER
5 DC LOADMETER
6 FIRE DETECTION 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 4-57

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. For cold weather engine preheating instructions, refer to COLD WEATHER PROCEDURES in 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 (cabin must be depressurized). On airplanes with TCTO K538 incorporated, a blower is installed in the airplane to pressurize the turbine compartment. The turbine compartment is pressurized to prevent exhaust fumes from entering control cabin. The blower also aids in cooling the APU compartment. The blower as incorporated by TCTO K538 is operable only when the airplane is in flight. With TCTO K554 incorporated in the airplane, the blower may also be ground operated. Circuit protection for the APU is on the APU circuit breaker panel (figure 1-35, sheet 4) through two 325-amp current limiters wired in parallel, giving a total of 650-amp circuit protection. The APU generator will continuously deliver 500 amps. Fuel consumption is between 8 and 12 gallons per hour, dependant upon the generator load.

NOTE

When operating continuously, shutdown and check oil level once daily.

APU CONTROLS AND INDICATORS

The operating controls and indicators for the APU are located on a panel below the forward power panel. The panel (figure 4-57) is divided in three sections. The sections are engine control, generator control, and fire control. The engine control section governs the operation of the turbine while the generator control provides for starting and stopping the generator, provides visual indication of generator voltage level, load level and failure. The fire control provides fire warning and a switch for actuating the APU fire extinguisher.

APU Switch

A OFF--RUN switch (41, figure 1-22) on the engineer's instrument panel controls power to the APU. With the switch in RUN position, the battery switch (1, figure

1-12) and electrical master switch (40, figure 1-12) on the overhead panel are in ON positions, and the duct valves are open, 28 volt DC power from the forward power panel will energize the APU circuit. On airplanes with TCTO K554 incorporated, power from the forward power panel thru 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 APU. The blower will operate while airplane is on the ground or in the air. With APU switch OFF, the APU circuit is de-energized.

Engine Start--Stop Switch

This switch (11, figure 4-57) on the APU control panel controls the operation of the turbine. In the ON position the generator functions as a motor to start the turbine, provided the APU switch (41, figure 1-22) on the engineer's instrument panel is in the ON (RUN) position, the battery switch (1, figure 1-12) is in the ON position and the electrical master switch (40, figure 1-12) 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 OFF 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

This ON--OFF--RESET switch (8, figure 4-57) 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 thrown in the RESET position momentarily and then to the ON position. On airplanes with TCTO K538 incorporated, with the generator control switch in the ON position, the ventilating blower will energize through the oleo relay switches, provided the airplane is in flight. On airplanes with TCTO K554 incorporated, and 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

This indicator (3, figure 4-57) on the APU control panel presents the speed of the turbine in percentage of rated speed.

Turbine Discharge Temperature Indicator

This gage (1, figure 4-57) 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 gage, the APU will automatically shutoff.

DC Loadmeter

This indicator (5, figure 4-57) 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

This indicator (4, figure 4-57) 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

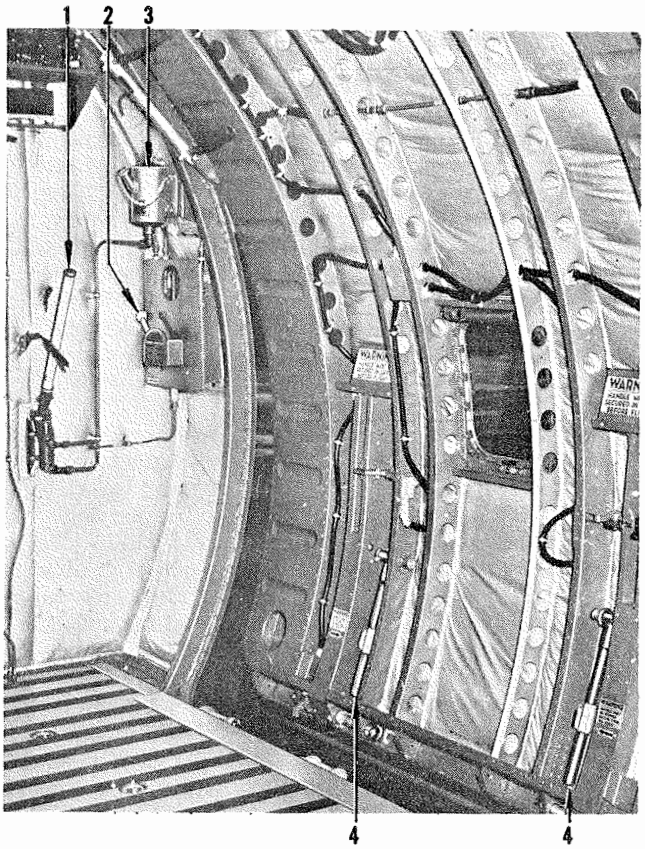
This red press-to-test light (9, figure 4-57) on the APU control panel will glow when the generator has failed.

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 (41, figure 1-22) on the engineer's instrument panel is in the ON (RUN) position, the battery switch (1, figure 1-12) and electrical master switch (40, figure 1-12) on the overhead panel are in the ON positions, and the duct valves are open. The fuel pressure and oil pressure warning light (10 and 12, figure 4-57) 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 light comes on, the APU must be shutdown manually. (High oil temperatures warning light (2, figure 4-57) 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.



1 HAND PUMP
2 SELECTOR HANDLE
3 RESERVOIR
4 LOCK HANDLES (2 PLACES)

FORWARD CARGO DOOR CONTROLS

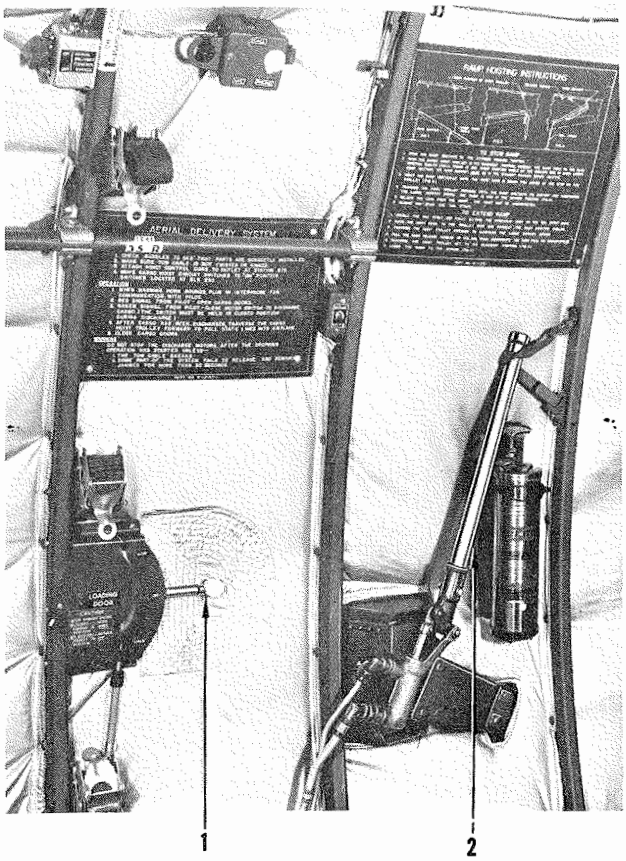
Figure 4-59

FORWARD CARGO DOOR CONTROLS AND OPERATION

The forward cargo door is located on the right side of the main compartment. See figure 4-59 for 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 hand pump. The system is controlled by a OPEN--NEUTRAL--CLOSE selector handle located adjacent to the door (figure 4-59). 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 hand pump 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 hand pump, the door will move to a full 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 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 on CLOSE position, and hydraulic pressure up.



1 SELECTOR HANDLE
2 HAND PUMP

AFT CARGO DOOR CONTROLS

Figure 4-60

AFT CARGO DOOR CONTROLS AND OPERATION

The aft cargo door is located in the aft end of the main compartment. See figure 4-60 for controls. Hydraulic pressure for operating the aft cargo doors is furnished by its own electric pump, controlled by a CLOSE--OFF--OPEN cargo door selector handle on the right rear side of the main compartment (figure 4-60). The cargo door selector handle is connected both electrically and mechanically to the power unit. In the event of pump failure, a hand pump (figure 4-60) is provided near the cargo door selector handle. The hydraulic oil reservoir is contained within the power unit in the aft stowage compartment.

DOOR WARNING SYSTEM

A door warning system indicates when the forward entry door, forward cargo door, aft entry door, and on C airplanes, aft cargo doors are not closed and locked. The forward and aft entry doors each have one door closed warning switch and one door locked warning switch. The aft cargo door has three door locked warning switches and the forward cargo door has two door locked and two handle closed warning switches and two door latch switches. All are push button 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 (21, figure 1-9) on the pilots' instrument panel will illuminate. The door warning circuit is protected by a circuit breaker on the overhead panel. Prior to takeoff, check that all doors are closed and locked. If a warning light illuminates before takeoff, all doors should be unlocked, opened, closed, and locked. If the warning light remains on and all door controls are found to be in the locked position, the circuit should be checked for a malfunction before takeoff. 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 on G airplanes, leaves room for carrying cargo or troops while the airplane is fully equipped with refueling provisions. Figure 4-61 illustrates the basic dimensions of available cargo space for both tanker and cargo configuration airplanes.

CAUTION

Cargo and personal equipment will not be placed closer than six inches to heater ducts in the main compartment.

CARGO RAMPS C

There are two cargo-loading ramps which are lowered for use through the aft cargo doors and provide a ramp from the ground to the floor of the compartment. The two ramps are adjustable laterally to accommodate rolling equipment with different treads. The support in the center of the ramp is also adjustable and will provide either a constant 24-degree slope, or a 15-degree slope of the lower part of the ramp and a 30-degree slope of the upper part of the ramp to accommodate rolling equipment requiring large vertical clearance. The cargo-loading ramps are lowered with the cargo hoisting equipment as shown in figure 4-62.

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 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:

1. Fully extend jack
2. 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:

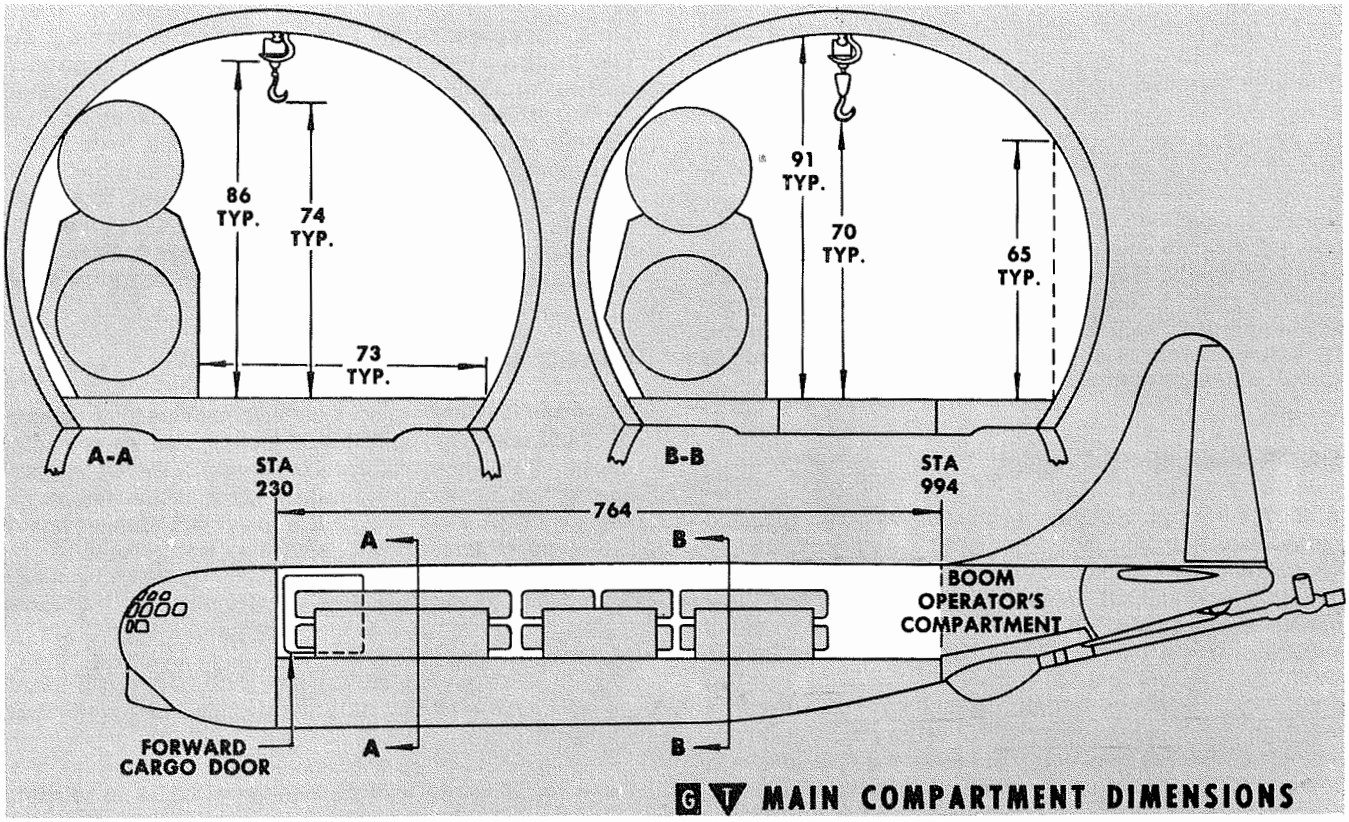
1. Lower jack by releasing hydraulic pressure
2. Remove and stow cargo loading support strut

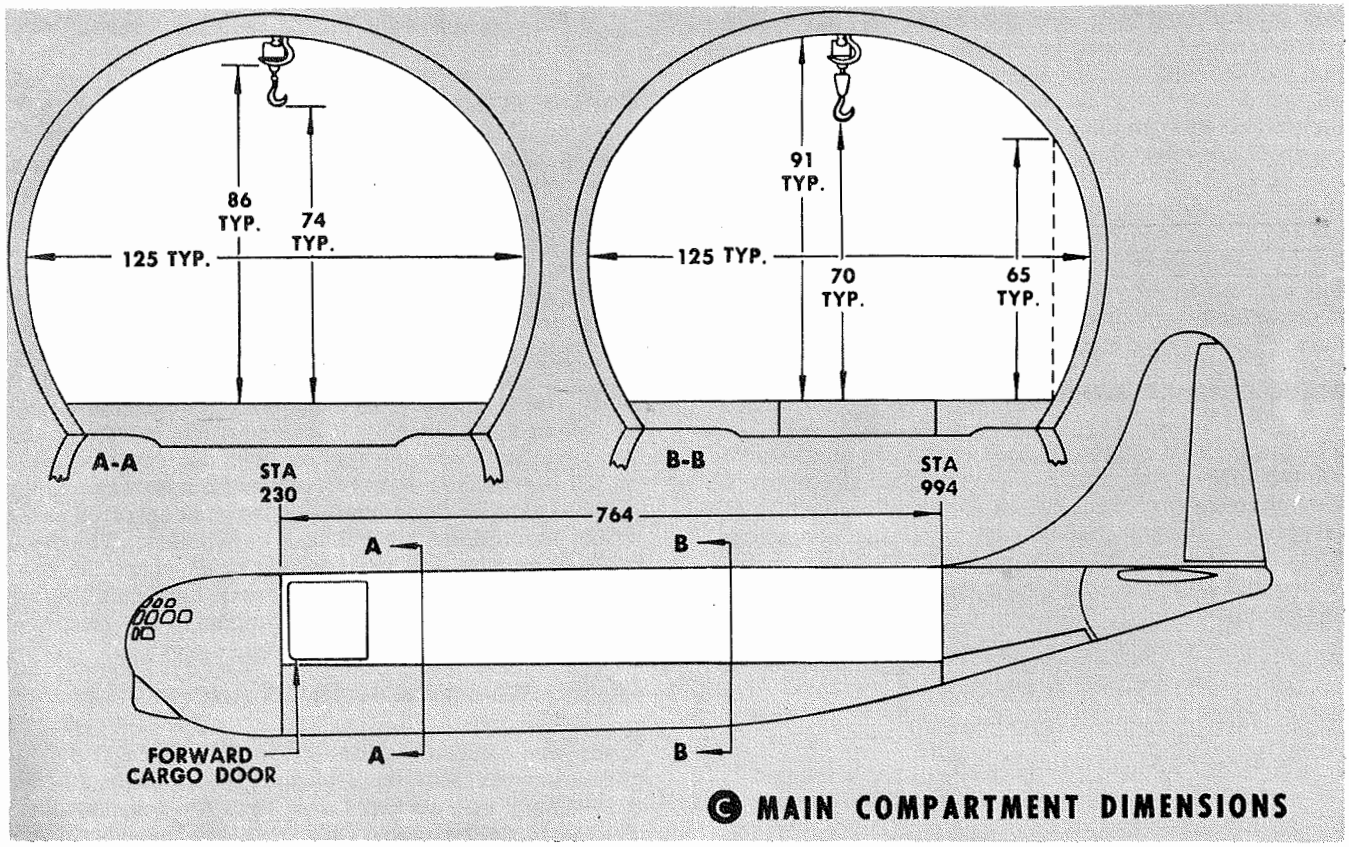
CARGO FLOOR

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 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 and the seats 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 TIE-DOWN FITTINGS AND DEVICES

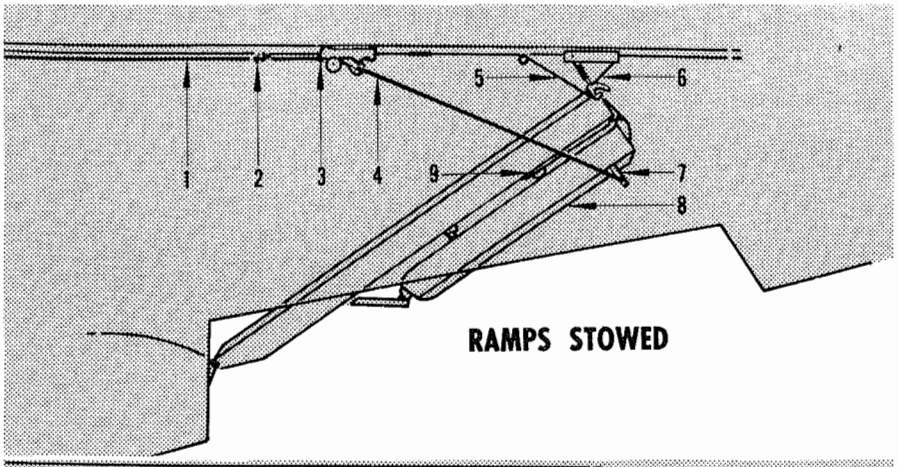
There are several hundred tie-down fittings of nine different types, located throughout the airplane. Cargo is tied down with standard Air Force tie-down devices. Four different types are used to secure the cargo from moving. There are the 1250 pound capacity type A-1 web straps, the 5000 pound capacity B-1 cables, the 10,000 pound capacity type C-2 chains with turnbuckles, and the 25,000 pound capacity D-1 chains with turnbuckles. Stowage is provided for all devices. The A-1



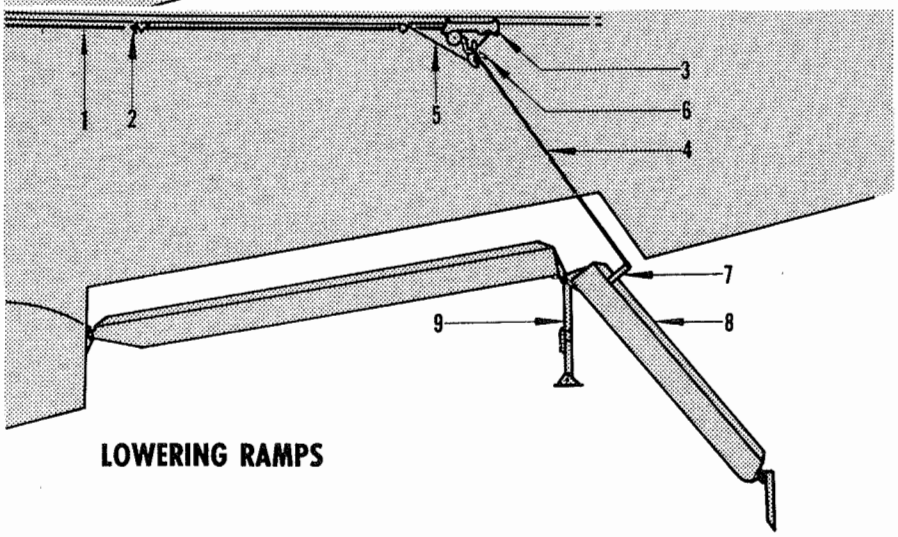


MAIN COMPARTMENT DIMENSIONS

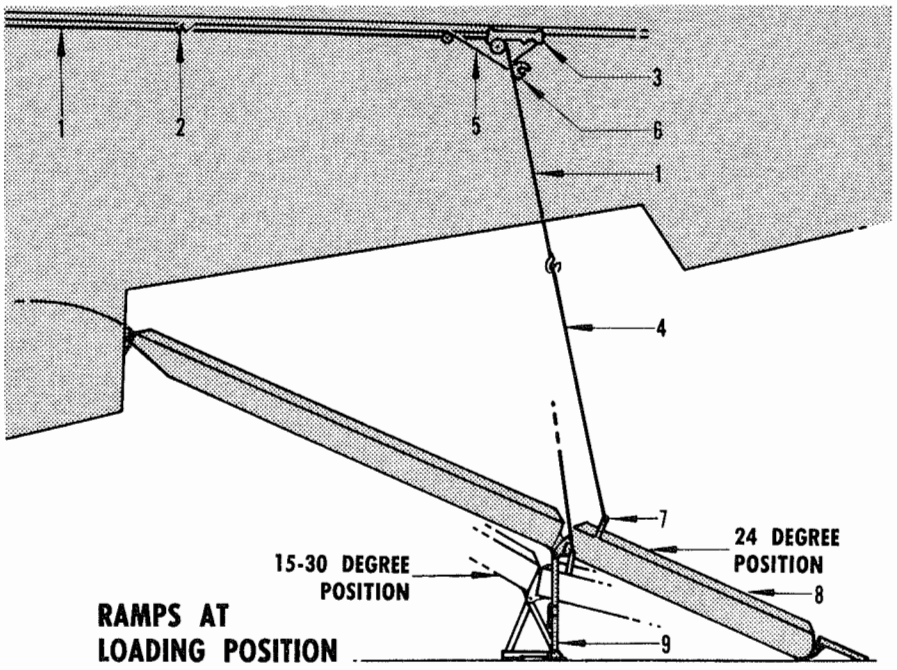
Figure 4-61



RAMPS STOWED



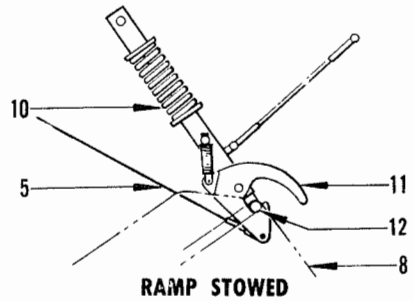
LOWERING RAMPS



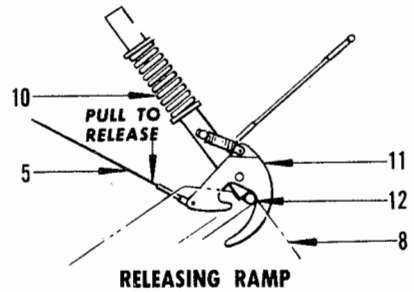
RAMPS AT LOADING POSITION

1 CARGO HOIST CABLE (4 PLACES)
2 RAMP RELEASE HANDLE (3 PLACES)
3 CARGO HOIST TROLLEY (3 PLACES)
4 RAMP HOISTING CABLE (3 PLACES)
5 RAMP RELEASE CABLE (6 PLACES)
6 RAMP STOWAGE SUPPORT (3 PLACES)
7 RAMP HOISTING TUBE (3 PLACES)
8 RAMP (6 PLACES)
9 RAMP SUPPORT STRUT (3 PLACES)
10 RAMP STOWAGE SUPPORT SPRING (3 PLACES)
11 RAMP LOCK (3 PLACES)
12 RAMP LOCK PIN (3 PLACES)

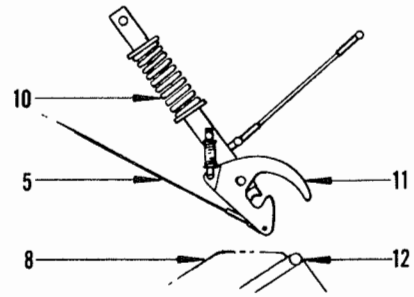
DETAIL I RAMP STOWAGE SUPPORT



RAMP STOWED



RELEASING RAMP



RAMP RELEASED

CARGO LOADING RAMPS ©

Figure 4-62

FORWARD CARGO DOOR C

INCHES

INCHES	6	12	18	24	30	36	42	48	54	60	66	72
6	714	—			—	714	667	611	557	529	431	291
12		578	564	546	517	499	471	439	414	383	338	246
18		564	419	409	396	379	365	347	328	309	280	214
24		546	409	327	319	309	298	286	273	254	238	190
30		517	396	319	267	261	252	244	234	225	208	171
36	714	499	379	309	261	225	219	213	205	198	181	157
42	667	471	365	298	252	219	194	189	183	177	167	144
48	611	439	347	286	244	213	189	170	166	161	153	131
54	557	414	328	273	234	205	183	166	152	148	141	117
60	529	383	309	254	225	198	177	161	148	135	128	113
66	431	338	280	238	208	181	167	153	141	128	117	107
70	372	288	253	219	193	174	158	145	133	121	110	101
72	291	246	214	190	171	157	144	131	117	113	107	92
76	282	239	207	184	166	151	139	125	112	107	101	83

AFT CARGO DOOR – 30° RAMP C

INCHES

INCHES	6	12	18	24	30	36	42	48	54	60	66	72	78	84
6	730	—											—	730
12	730	—											—	730
18	730	—											—	730
24	730	—											—	730
30	730	—											—	730
36	730	—		—	730	630	630	620	620	610	594	578	569	545
42	730	—		—	730	630	500	495	494	485	472	455	440	350
48	730	—		—	730	620	495	408	402	394	382	371	359	263
54	730	—		—	730	620	494	402	339	331	323	313	303	206
60	730	—		—	730	610	485	394	331	287	280	271	239	157
66	730	—		—	730	594	472	382	323	280	245	237	185	123
72	730	—		—	730	578	455	371	313	271	237	200	151	100
78	730	—		—	730	569	440	359	303	239	185	151	100	
84	730	—		—	730	545	350	263	206	157	123	100		
90	730	—	—	730	500	300	196	150	106					
96	730	730	712	270	166	100								

FORWARD ENTRY DOOR F and G C

INCHES

INCHES	4	8	12	16	20	24	28	32	34
4	214	214	214	214	214	214	210	180	160
8	214	214	214	214	214	214	210	150	135
12	214	214	190	190	180	170	170	130	120
16	214	214	190	140	130	125	120	115	110
20	214	214	180	130	120	115	110	110	105
24	214	214	170	125	115	105	100	95	95
28	210	210	170	120	110	100	95	90	85
32	180	150	130	115	110	95	90	80	80
36	140	130	110	100	100	90	80	75	70
40	130	110	110	100	95	85	70	65	65
44	120	110	100	95	90	80	70	60	60
48	100	80	70	70	70	65	60	55	55
52	90	80	70	50	50	50	50	40	40

AFT ENTRY DOOR F and G C

INCHES

INCHES	4	8	12	16	20	24	28	32	34
4	200	200	200	200	200	200	185	160	150
8	200	200	200	200	200	180	160	145	130
12	200	200	190	180	165	155	140	130	115
16	200	200	180	155	145	135	125	115	110
20	200	200	165	145	125	120	115	105	95
24	200	180	155	135	120	110	105	95	90
28	185	160	140	125	115	105	95	90	80
32	160	145	130	115	105	95	90	80	70
36	140	125	115	105	95	90	85	75	
40	120	120	110	100	90	85	80	65	
44	120	110	100	90	85	80	70		
48	100	95	90	85	80	75	60		

NOTE

The charts are based on clearances only and do not consider the difficulties of loading heavy cargo which would require use of the cargo hoist. It has also been assumed that packages may be turned to any position without damage to their contents. A minimum clearance of one inch has been allowed between any package and the structure or fixed equipment of the airplane.

EXAMPLE

INCHES

INCHES	4	8	12	16	20	24	28
4	168	168	167	167	167	166	166
8	168	166	166	166	166	165	164
12	167	166	153	152	152	151	150
16	167	166	152	132	132	131	130
20	167	165	152	132	117	117	117
24		165	152				

USE OF CHART

To determine if a package 12x20x140 will go through the forward cargo hatch, locate the 12 and 20 dimensions in the left vertical and, top horizontal rows of figures on the chart (See example.) The intersection of rows headed by 12 and 20 gives the maximum length package of this cross section which can be loaded - in this case 152 inches. Since the package being checked is only 140 inches long, it can be loaded.

PACKAGE DIMENSIONS

Figure 4-63 (Sheet 1 of 2)

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 F C and G

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 G T

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-97G airplane (with tanker kit) 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.

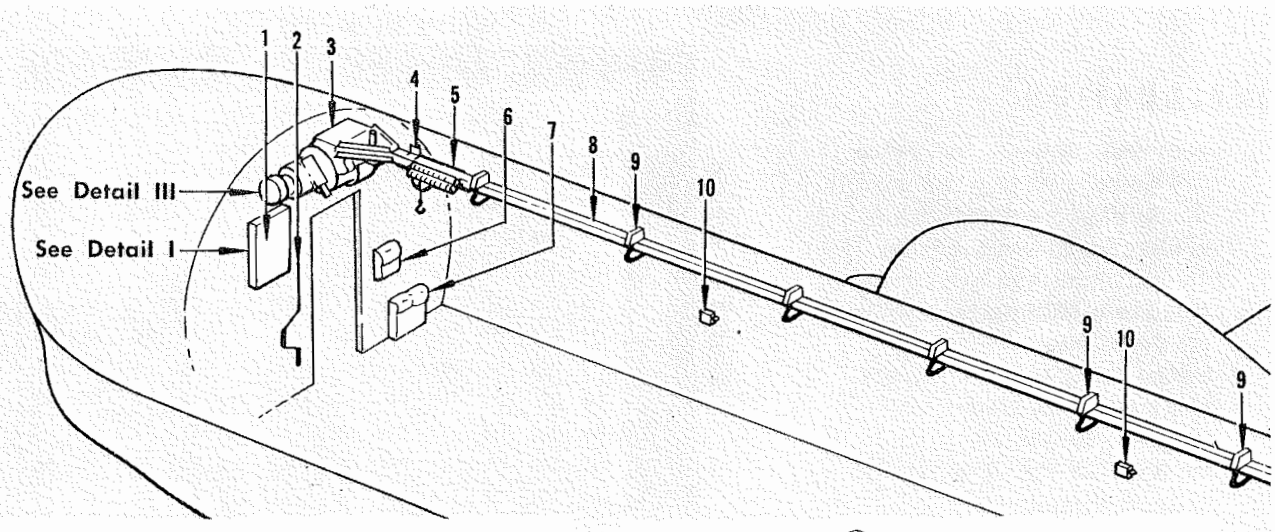
USE OF CHART *

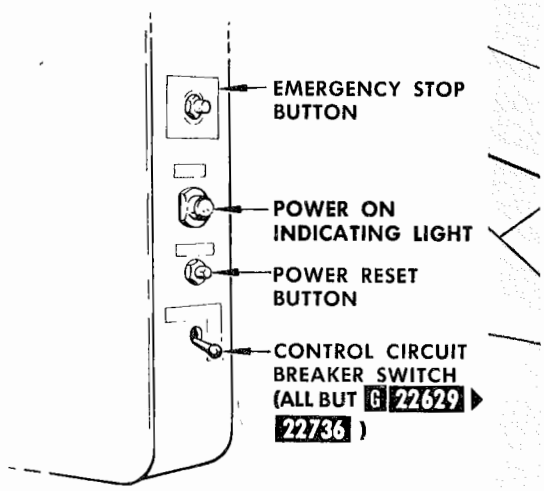
The left side of the chart contains values for the vertical dimension as cargo enters the door. The top of the chart contains values for the horizontal dimension as cargo enters the door. It will be noted that a 30 in. high by 60 in. wide box cannot exceed approximately 99 in. in length while a 60 in. high by 30 in. wide box cannot exceed approximately 163 in. in length. Irregular shaped objects can be approximated by entering the chart with the outside dimensions of the objects concerned.

* Applicable to G airplanes in tanker configuration only

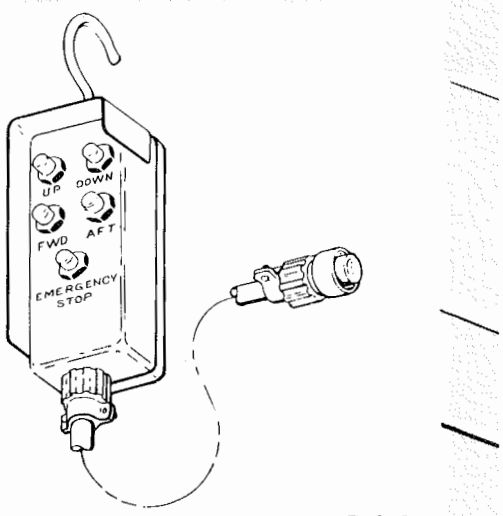
Figure 4-63 (Sheet 2 of 2)

1 CARGO HOIST SHIELD
2 CARGO HOIST HAND CRANK (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 CABLE (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 HAND CRANK 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 4-64 (Sheet 1 of 2)

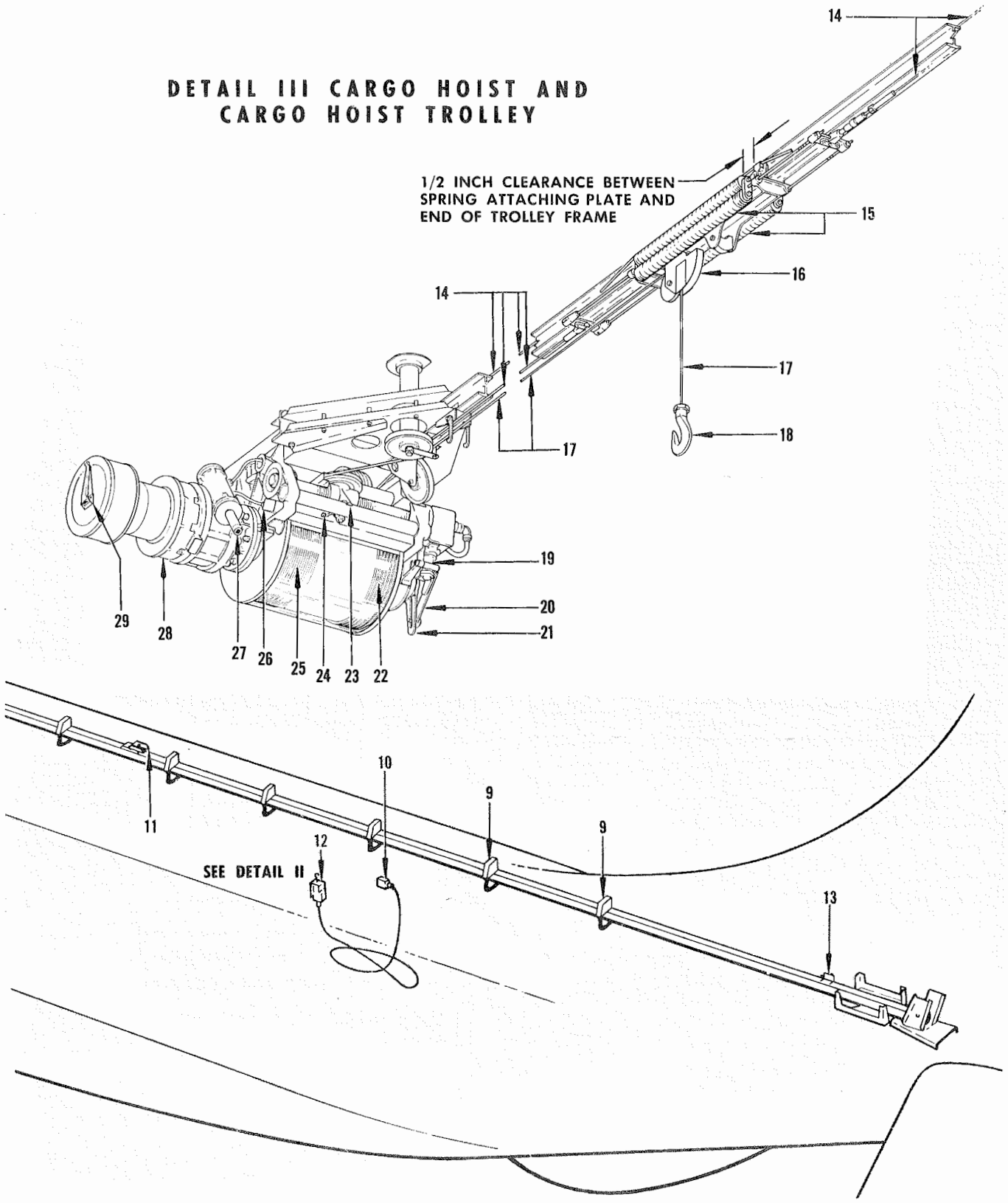


Figure 4-64 (Sheet 2 of 2)

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 tie-down devices.

AERIAL DELIVERY SYSTEM F G 1243 ▶ 22628

Provisions are made on this airplane for the kit installation of an aerial delivery system, when the airplanes are in the cargo configuration.

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 push-buttons; 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 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 4-64) on the left end of the hoist motor, can be lifted to release the friction disc brake to lower a load on ths 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.

HAND CRANK. The cargo hoist hand crank (2, figure 4-64) is used when the hoist is operated manually by inserting the hand crank into the receptacle on the motor (27, figure 4-64) and rotating it in either a clockwise or counterclockwise direction. The hand crank is stored 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 4-64) on the right end of 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 is down.

EMERGENCY STOP BUTTON. An EMERGENCY STOP button (Detail I, figure 4-64) is located on the cargo hoist shield and another is located on the portable control box. 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 4-64) 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 4-64) 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 airplanes G 22629 ▶ 22736 is through a circuit breaker on the forward power panel (figure 1-35, sheet 4). On all other airplanes, control circuit protection is on the cargo hoist shield (Detail I, figure 4-64) through an ON--OFF switch type circuit breaker.

POWER ON LIGHT. An amber light (Detail I, figure 4-64), located on the cargo hoist is in use if the power reset button is in and the circuit breaker switch is on.

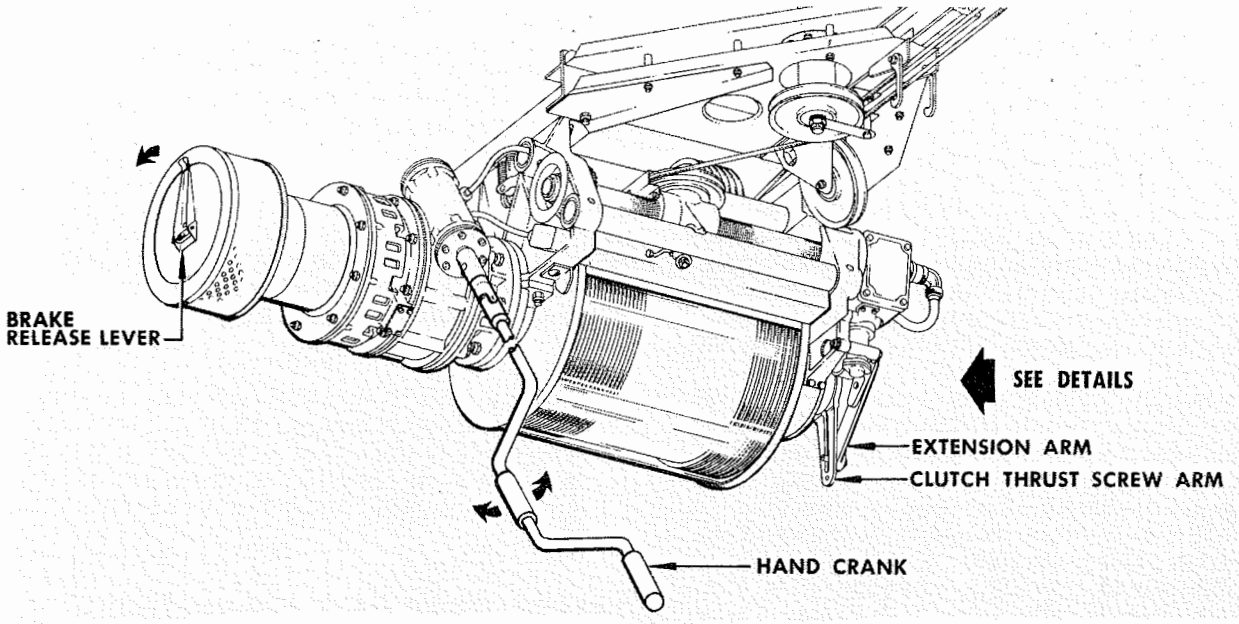
Cargo Hoist Electrical Operation

WARNING

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:

1. On the cargo hoist shield, position the control circuit breaker switch to ON and press power reset switch. The amber power on light will illuminate.

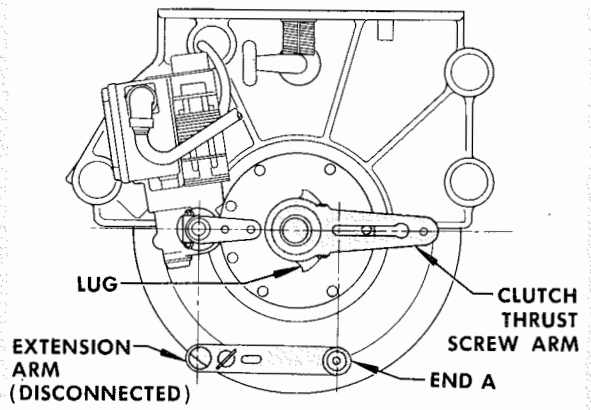


MANUAL OPERATION

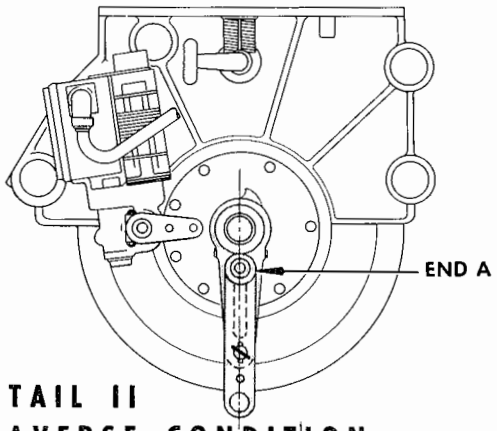
1. Remove extension arm
2. Position clutch thrust screw arm to desired condition
3. Install end A behind lug to hold clutch thrust screw Arm Desired Position
4. Operate hand crank or pull out release lever

NOTE

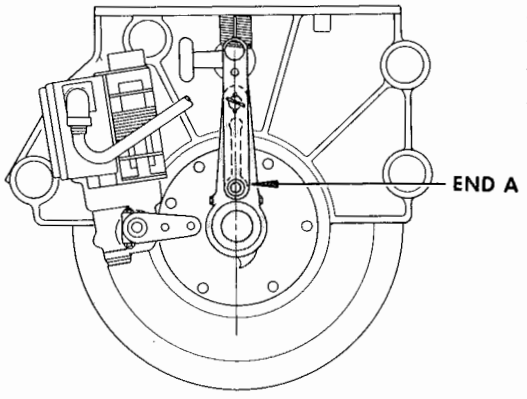
SEE CARGO HOIST MANUAL OPERATION IN TEXT



DETAIL I NEUTRAL



DETAIL II
TRAVERSE CONDITION



DETAIL III HOIST CONDITION

CARGO HOIST MANUAL OPERATION

Figure 4-65

2. 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

3. To operate the hoist, press the desired push button 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 hoist, press power reset button on cargo hoist shield

4. 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

5. 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

6. Do not jam hoisting hook against the trolley

7. 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

8. Before lifting a heavy load over six 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 one inch length, hoist is not safe to operate under maximum rated load. Cable replacement is necessary.

9. 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 switch 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:

1. 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

2. 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 4-65. Pull out on the brake release lever thrust on the end of the cargo hoist motor and the load will lower at a moderate lowering speed

3. If the load is not in a desired location for lowering and was being traversed at the time of failure, attach and operate hand crank as shown in figure 4-65 to screw arm on the right end of the hoist as shown in Detail III and follow procedure 1 above

4. 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 4-65. Attach and operate the hand crank to position load at desired location. Reposition the clutch thrust screw arm to a hoisting condition as shown in Detail III. 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 4-65, Detail III (hoist condition), operating the hand crank as shown in figure 4-65, Detail I will provide slack in the hoisting cable to disconnect the hoisting hook.

TROOP CARRYING EQUIPMENT

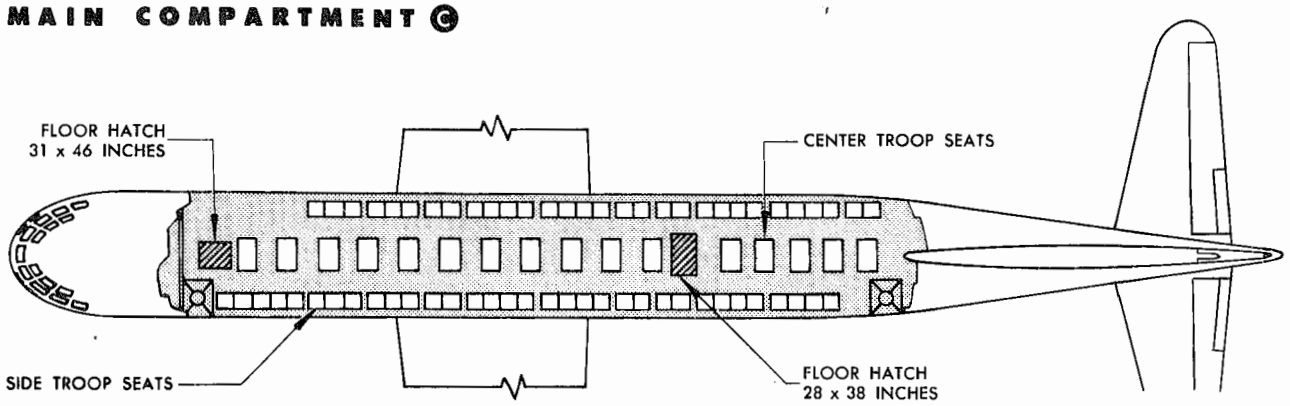
F

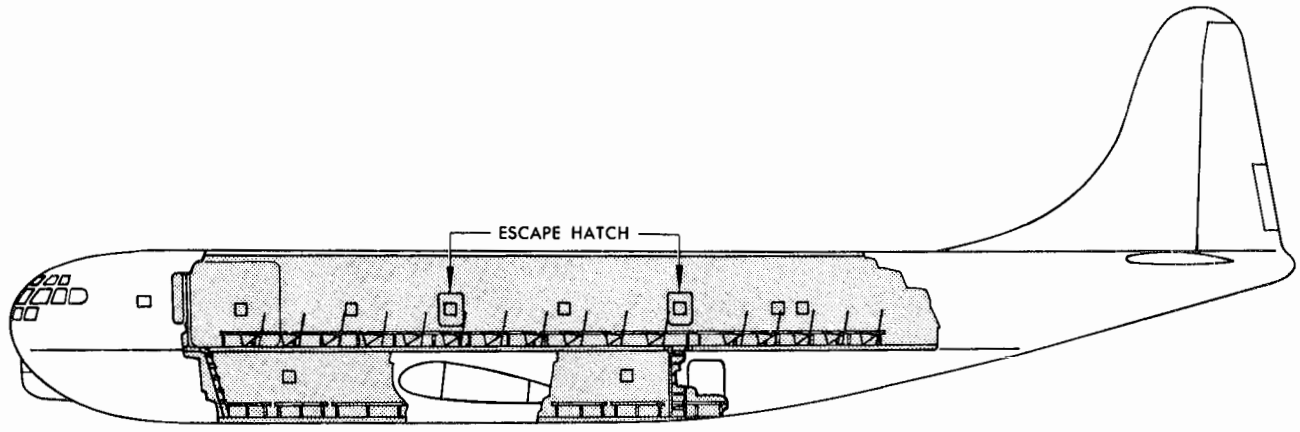
Airplanes in the cargo configuration can carry 130 fully-equipped troops; 96 in the main compartment, 18 in the lower forward compartment and 16 in the lower aft compartment. For troop seating arrangement, see figure 4-66. These troops are seated on three types of seats in the airplane; 32 men are seated on roll up canvas seats along each side of the main compartment (total of 64), 32 men in removable tube and wood folding seats in the center of the main compartment, and 34 men in permanent bench type seats along the sides of the lower forward and lower aft compartments. Each seat is provided with a lap type safety belt. When the airplane is in the tanker configuration it can only carry 34 fully-equipped troops. These men are seated in the permanent bench type seats along the sides of the lower forward and lower aft compartments. When carrying large troop loads for extended ranges, a curtained toilet compartment equipped with toilet and urinal can be readily installed in the aft end of the main compartment.

G

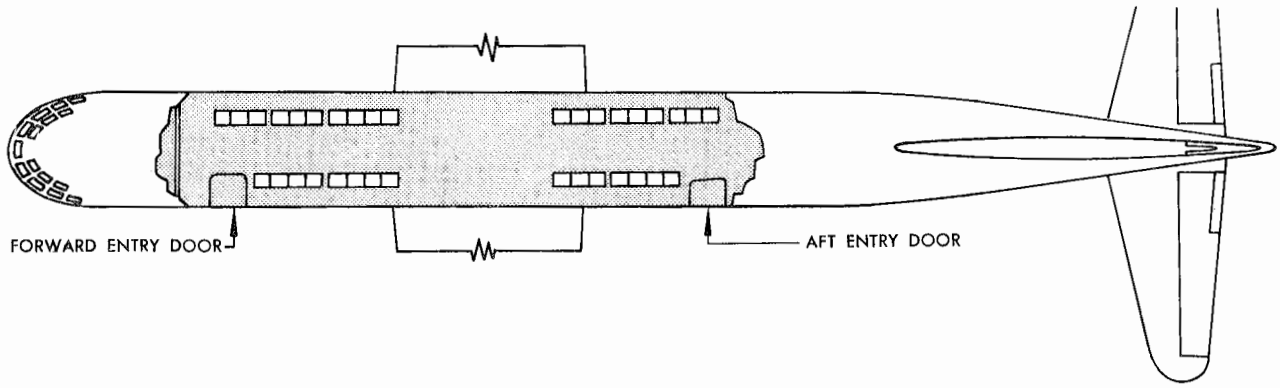
On V airplanes, in addition to carrying cargo, troop seats may be installed to carry personnel. There are permanently installed roll-up type troop seats attached to the right side of the fuselage and fold-up type troop seats which can be installed in the center of the main compartment next to the refueling tanks. Due to the installation of A/R tanks in the lower forward and lower aft compartment, no space is available to carry troops in these sections. The total seating capacity of these airplanes is 63. Cargo configuration airplanes can carry 96 fully equipped troops in the main compartment. These troops are accommodated by two types of seats; 64 men are seated in roll-up canvas seats along each side of the main compartment, and 32 men in removable tube and wood folding seats in the center of the main compartment. Each seat is fitted with a safety belt. Due to the configuration of C airplanes, no provisions have been made to carry troops in either the lower forward or lower aft compartments. For troop seating arrangement, see figure 4-66.

MAIN COMPARTMENT ©





SEATING CAPACITY	
MAIN COMPARTMENT	96
LOWER FORWARD COMPARTMENT	18
LOWER AFT COMPARTMENT	16
TOTAL	130



LOWER COMPARTMENTS

TROOP SEATING ARRANGEMENT

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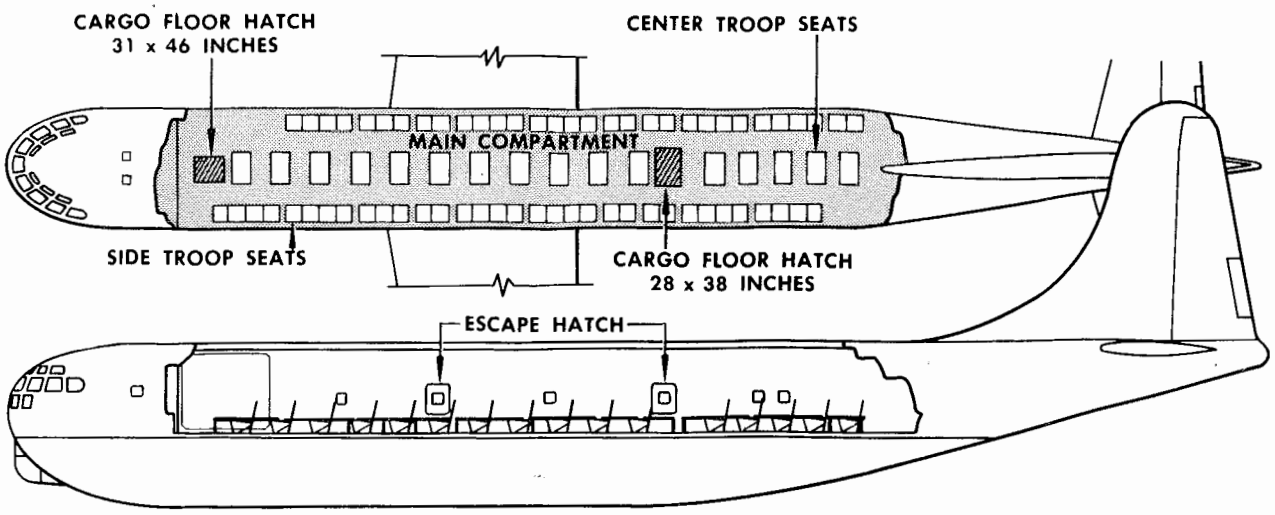
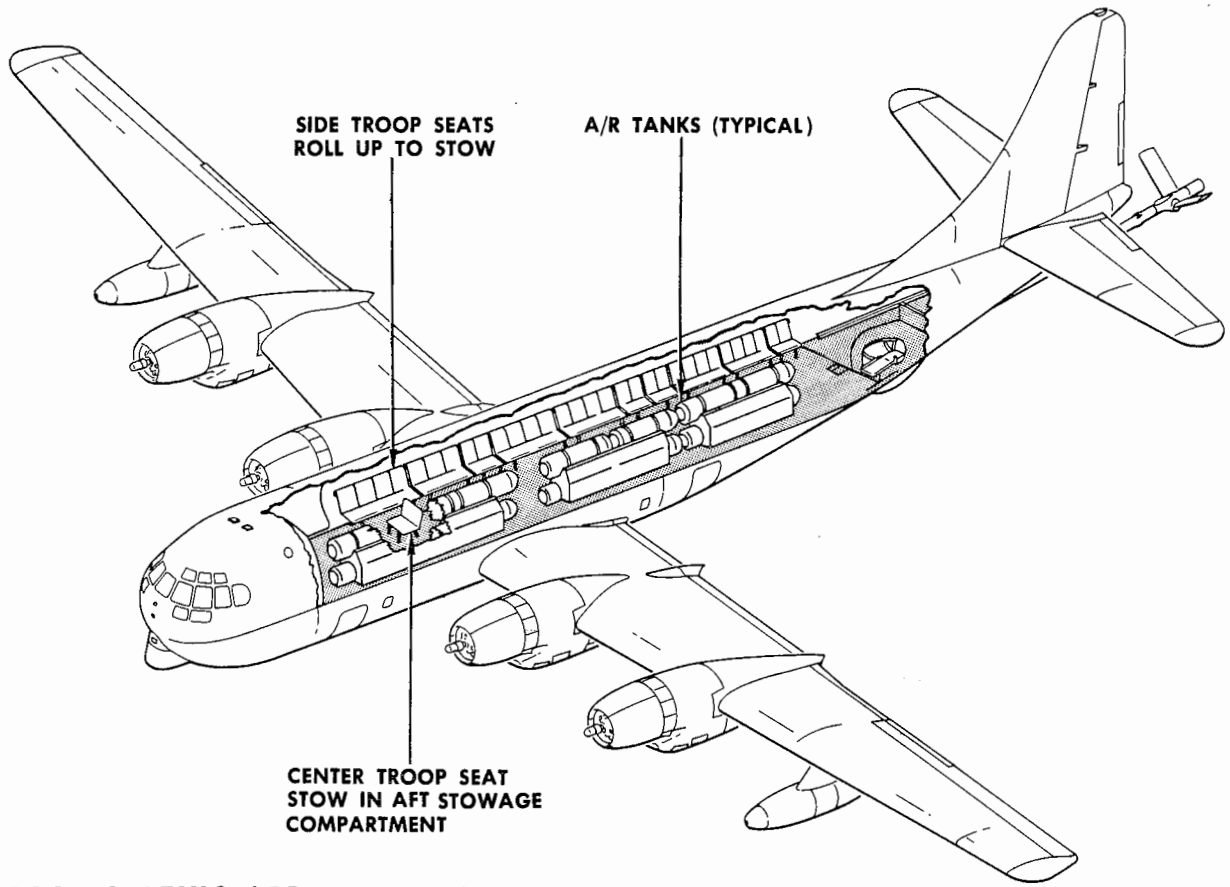
Figure 4-66 (Sheet 1 of 2)



G TROOP SEATING ARRANGEMENT



V TROOP SEATING ARRANGEMENT

TROOP SEATING ARRANGEMENT (CONT)

G

Figure 4-66 (Sheet 2 of 2)

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 4-77), A/R hydraulic system (figure 4-67), A/R Boom hydraulic system (figure 4-69), and the A/R signal system (figure 4-72). Fuel on F airplanes is carried in four, 1800 US gallon cylindrical fuselage tanks, (figure 4-75), which are interconnected to form two tank systems, a forward and an aft tank system. Fuel on G airplanes is carried in 15 fuselage tanks. The fuel tanks on G airplanes are also interconnected to form two tank systems. Additional fuel can be pumped into the A/R tanks from the main tanks, center wing tank, and on G airplanes the external fuel tanks, provided certain valves are properly positioned. Only on G airplanes incorporating TCTO KGT507 have provisions for transferring fuel from the A/R tanks into the main tanks. 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 pm. 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 (13, figure 4-68), which is actuated by the isodraulic (isolated hydraulic) system (figure 4-67). 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 chock 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 component systems; hydraulic pressure system, hydraulic fuel pump system, isodraulic system, and the A/R boom hydraulic system. See figure 4-67 for the interrelationship of these systems.

F G 1243 ▶ 22736

The A/R hydraulic system (figure 4-67) is independent of the airplane main hydraulic system and is used to pump fuel and to pressurize the A/R boom hydraulic system.

G 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 4-67). The A/R boom hydraulic system is pressurized by the airplane main hydraulic system through a motor pump combination which provides the high level pressure required for boom operation.

A/R HYDRAULIC PRESSURE SYSTEM

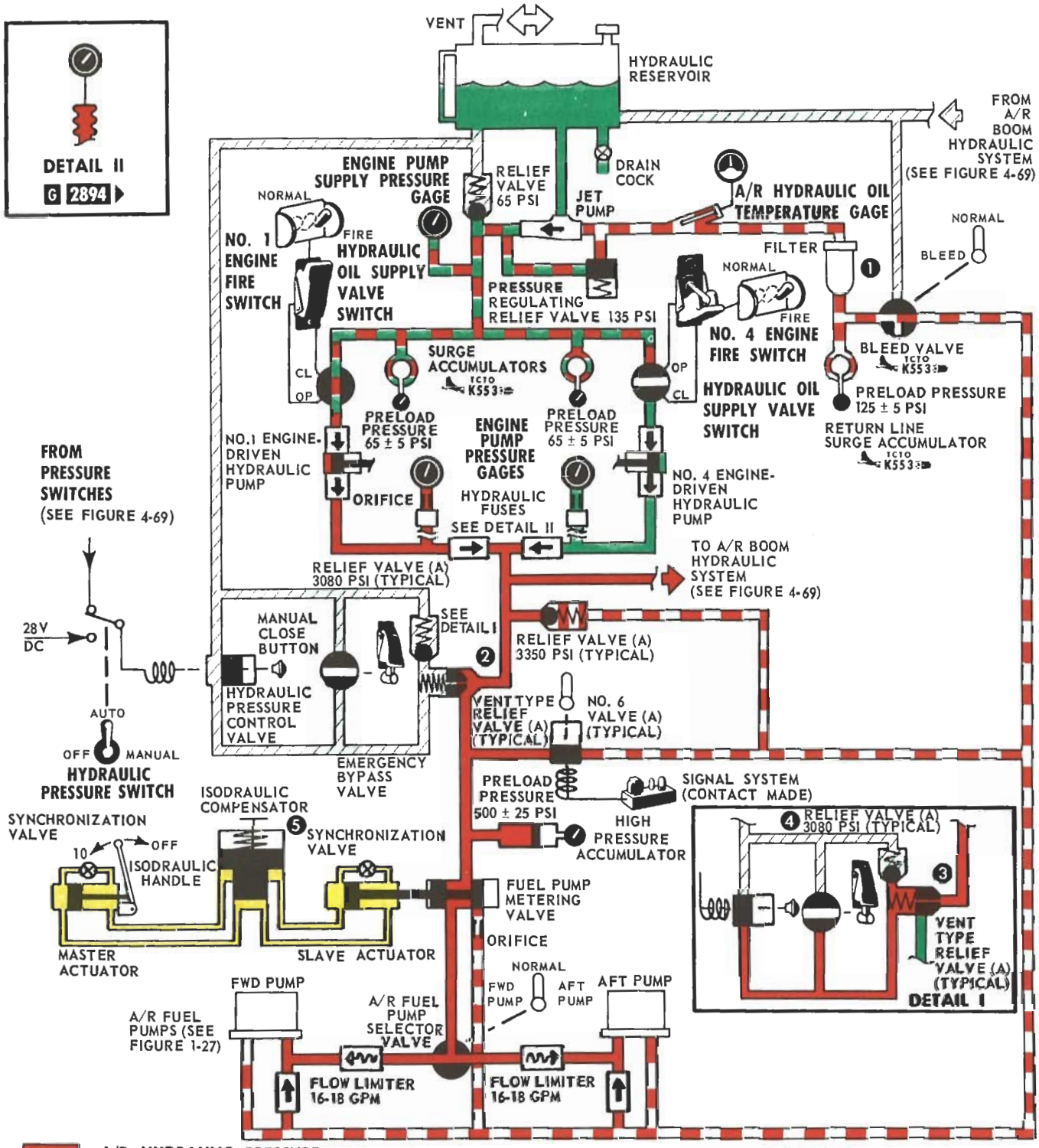
The basic components of the A/R hydraulic pressure system (figure 4-67) are; an 8 US gallon reservoir which supplies hydraulic fluid to two engine-driven pumps, one on each of the outboard engines, two oil-coolers one each in No. 1 and No. 4 nacelles that automatically control the oil temperature, and a jet type hydraulic pump (8, figure 4-68) to provide a positive supply of hydraulic oil to the engine-driven pumps. Airplanes with TCTO K553 incorporated have three surge accumulators installed in the A/R hydraulic system. One accumulator is added in the supply line upstream from the hydraulic oil supply shutoff valve in each of the outboard nacelles. The other accumulator is added in the return line between the bleed valve (10, figure 4-68) and the filter (3, figure 4-68) on the A/R hydraulic panel. This accumulator replaces an existing low pressure accumulator in the system. On airplanes F G 1243 ▶ 22736 the hydraulic reservoir is serviced to a maximum of 6 gallons, and on airplanes G 22737 ▶ the reservoir is serviced to 3-1/2 gallons.

NOTE

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.

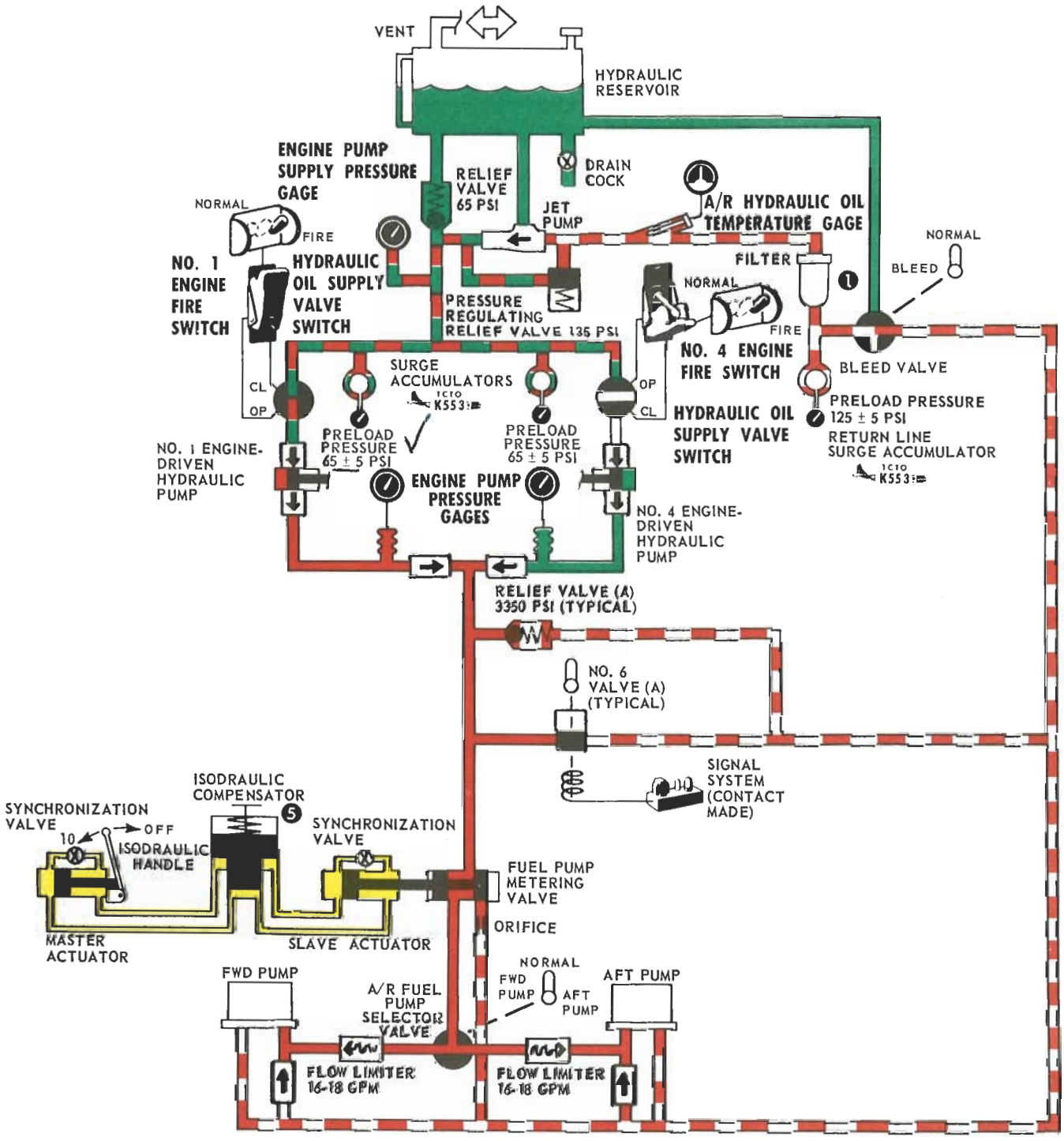
A/R Hydraulic Oil Supply Valve Switches

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 (18, figure 1-12) on the overhead panel control the shutoff valves. See also POWER PACKAGE FIRE SWITCHES in Section I. The valves can be closed



A/R HYDRAULIC SYSTEM

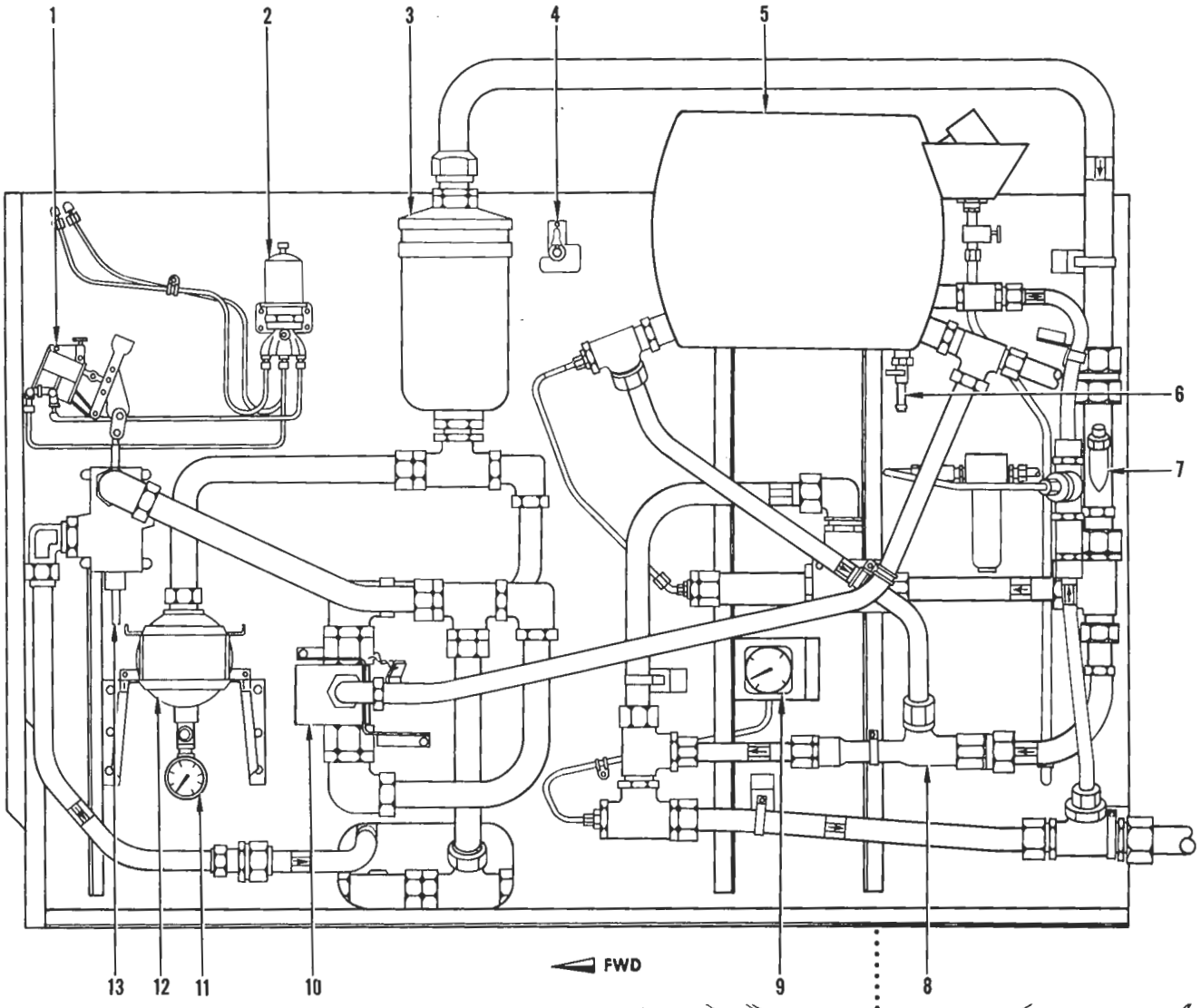
Figure 4-67 (Sheet 1 of 2)



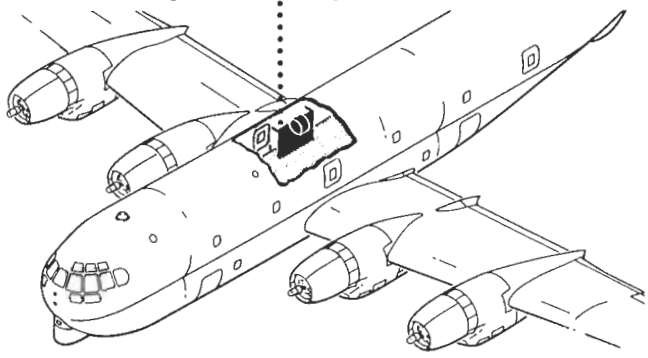
1. Filter contains internal bypass valve which opens when pressure drop across filter exceeds 35 psi.
2. Fluid bled thru vent creates a differential pressure and A/R hydraulic pressure holds valve open
3. When hydraulic pressure control valve closes, fluid bled thru the vent equalizes pressure allowing 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

Figure 4-67 (Sheet 2 of 2)

G 22737



1 ISODRAULIC SLAVE ACTUATOR (2 PLACES)
2 ISODRAULIC COMPENSATOR
3 FILTER (2 PLACES)
4 EMERGENCY BYPASS VALVE HANDLE (2 PLACES)
5 RESERVOIR (2 PLACES)
6 RESERVOIR DRAIN VALVE (2 PLACES)
7 HYDRAULIC OIL TEMPERATURE BULB (2 PLACES)
8 JET PUMP (2 PLACES)
9 ENGINE PUMP SUPPLY PRESSURE GAGE (2 PLACES)
10 BLEED VALVE TCTO K553 (2 PLACES)
11 ACCUMULATOR PRESSURE GAGE TCTO K553
12 SURGE ACCUMULATOR TCTO K553
13 A/R FUEL PUMP METERING VALVE
14 VENT TYPE RELIEF VALVES (2 PLACES)
15 HYDRAULIC PRESSURE CONTROL VALVE (2 PLACES)
16 ACCUMULATORS
17 NO. 6 VALVE (3 PLACES)
18 RELIEF VALVES (3 PLACES)
19 A/R FUEL PUMP SELECTOR VALVE
20 FUEL DENSITOMETER



A/R HYDRAULIC PANELS

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Figure 4-68 (Sheet 1 of 4)

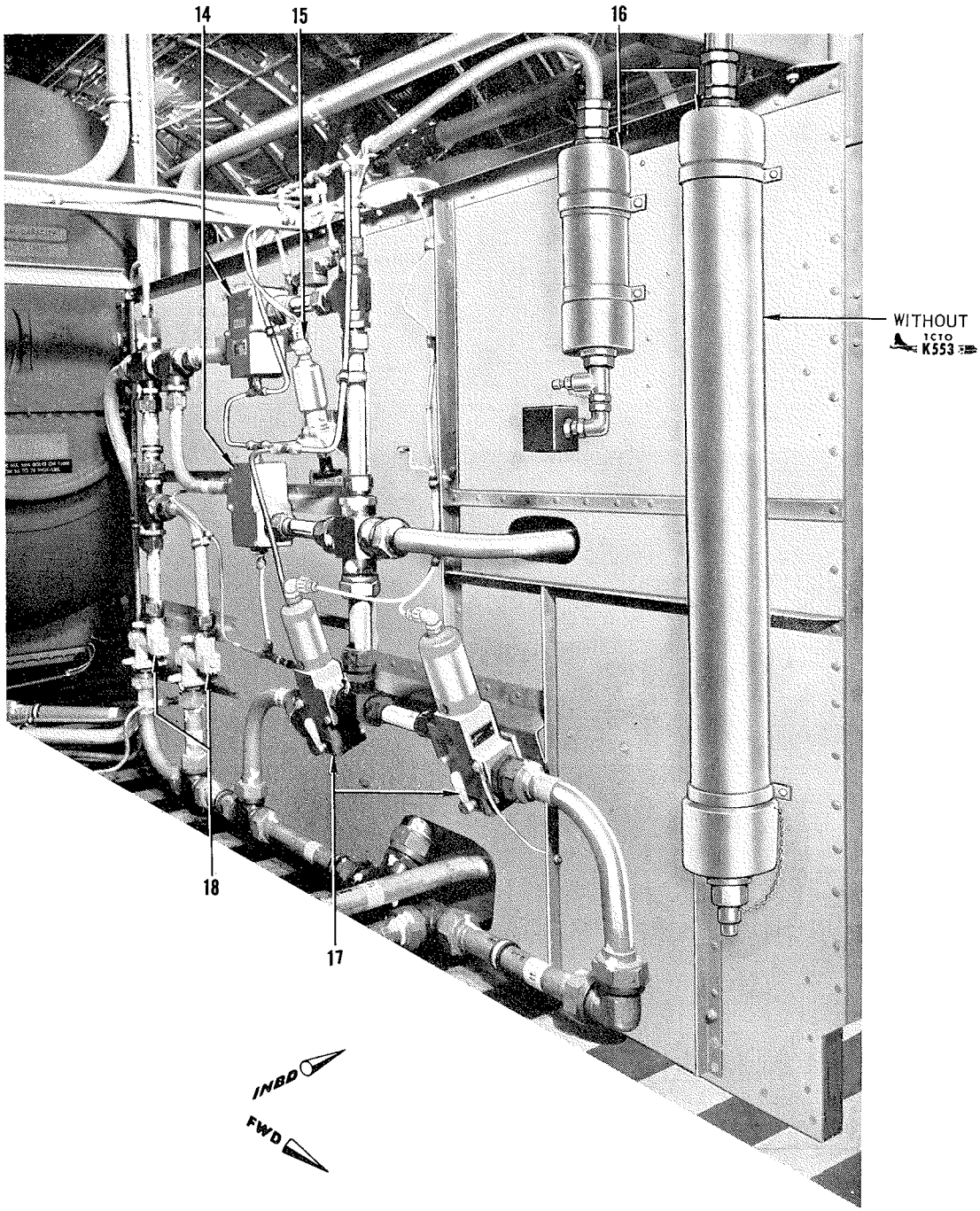
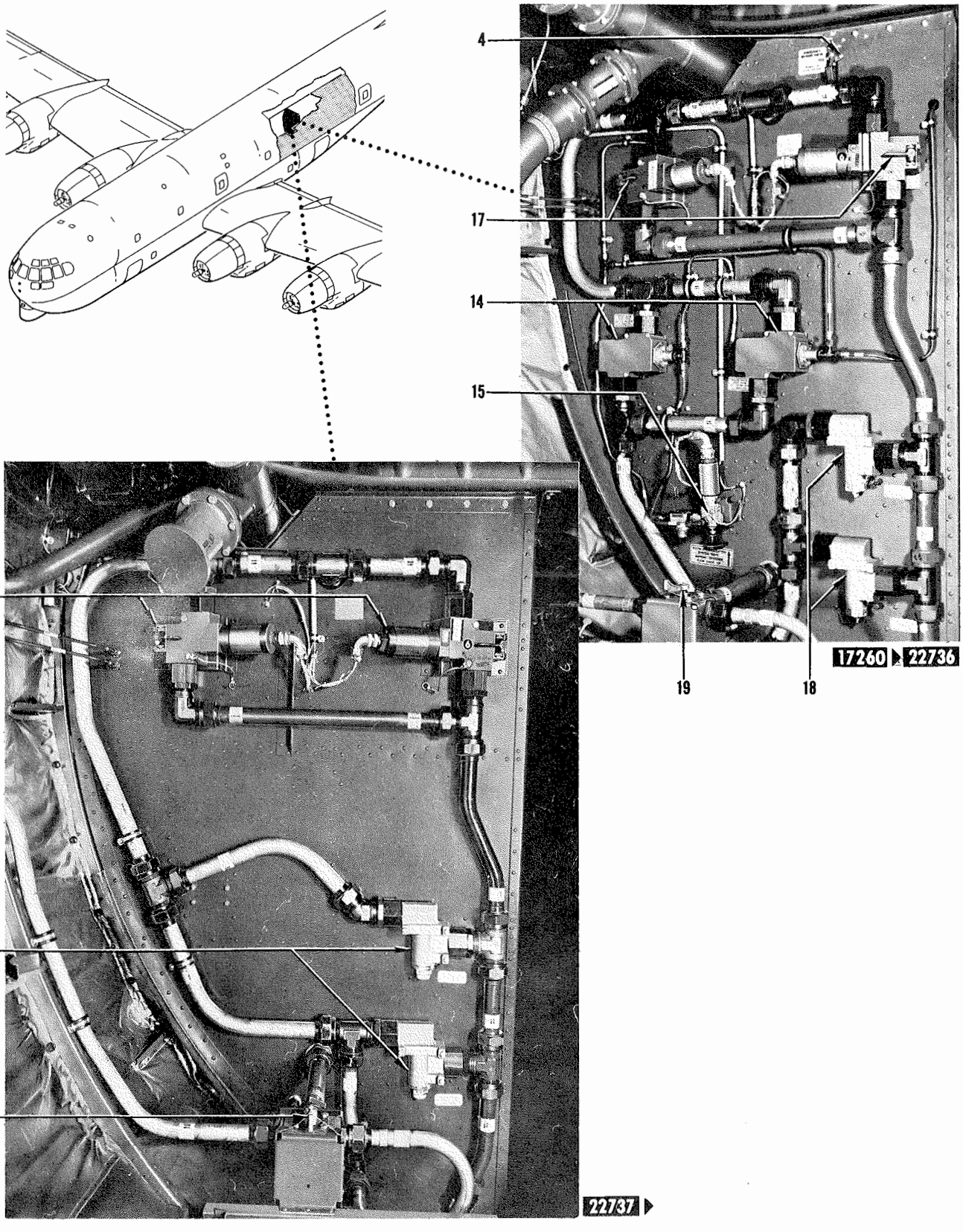


Figure 4-68 (Sheet 2 of 4)



A/R HYDRAULIC PANELS

G

Figure 4-68 (Sheet 3 of 4)

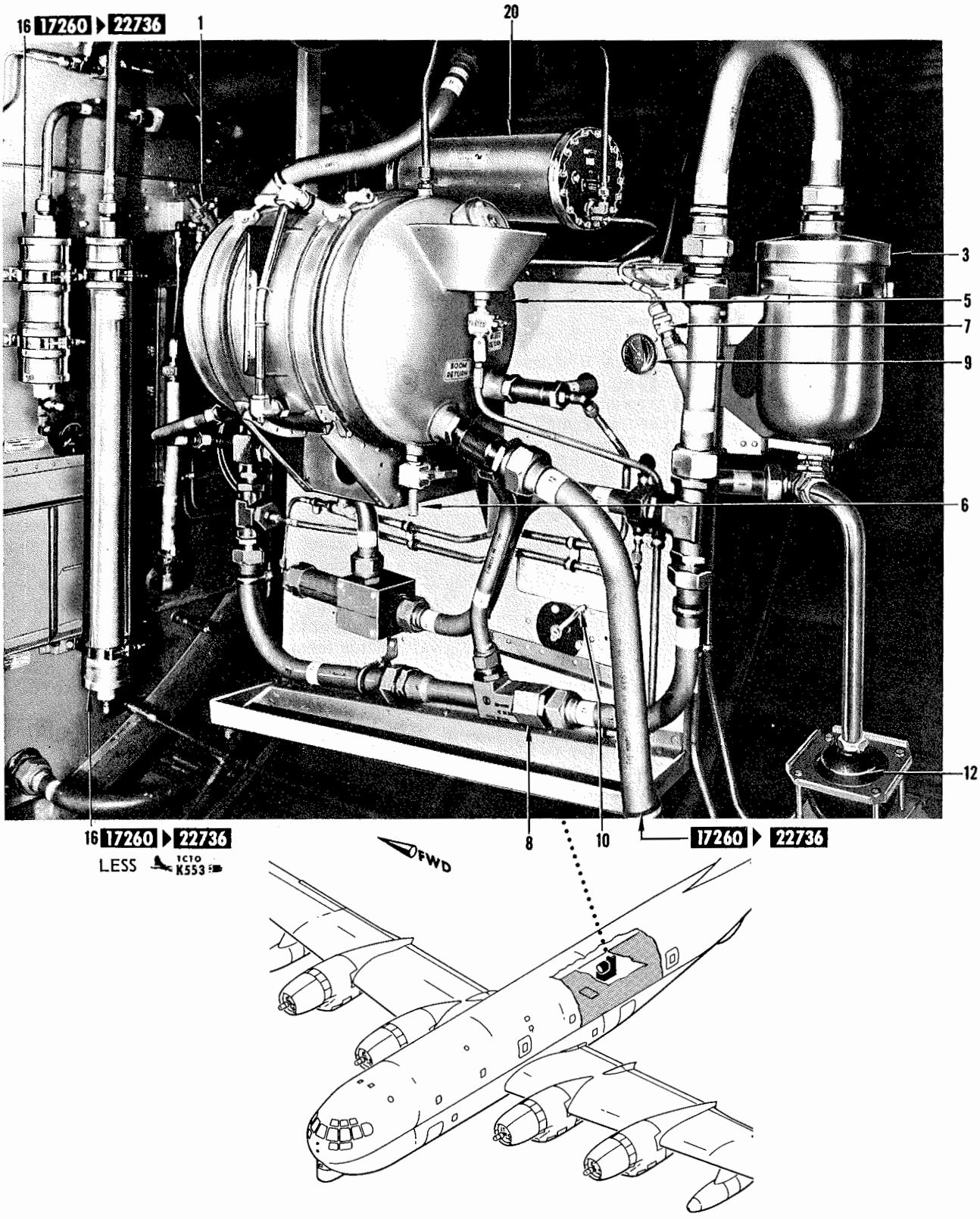


Figure 4-68 (Sheet 4 of 4)

with the two hydraulic oil supply valve switches (4, figure 4-76) 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 volt 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 (5, figure 4-76). On airplanes F G 1243 ▶ 2893 the gages are direct reading and on airplanes G 2894 ▶ the gages are electrically operated.

Engine Pump Supply Pressure Gage

A pressure gage (9, figure 4-68) on the A/R hydraulic panel in the main compartment on F airplanes and in the lower aft compartment on G airplanes indicates engine pump supply pressure. Pressure reading during cruise operation should be above 50 psi.

A/R Hydraulic Oil Temperature Gage

This gage (28, figure 1-22) on the engineer's instrument panel shows the temperature of the return oil in the A/R hydraulic system. The temperature bulb (7, figure 4-68) 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 4-67) which are mechanically engaged to the two fuel pumps. Each pump and motor unit is enclosed in a fuel pump chamber. On F airplanes one pump chamber is located in each right hand A/R tank. On G airplanes 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 restrictors. 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 unit (2, figure 4-68), and into a slave unit (1, figure 4-68), which actuates the fuel pump metering valve through a mechanical linkage. The compensator acts as a reservoir and pressure accumulator; and the slave unit acts as a simple actuating cylinder.

Isodraulic Handle

This handle (4, figure 1-20 and figure 4-67) 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 4-67) which, in turn controls the fuel pump rpm. The handle also has an OFF position.

A/R Fuel Pump Selector Valve Handle

On F airplanes this handle (figure 4-67) is located to the right of the A/R hydraulic panel between the two right hand A/R tanks in the main compartment. On G airplanes this handle (19, figure 4-68) is located in the lower aft compartment. This handle operates a 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 shutoff fluid flow to both pump motors simultaneously. Handle positions are FWD PUMP--NORMAL--AFT PUMP.

A/R BOOM HYDRAULIC SYSTEM

F G 1243 ▶ 22736

The A/R boom hydraulic system (figure 4-69) 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 (14, figure 4-68) assure a constant pressure supply to the A/R boom hydraulic system. A manually operated emergency bypass valve (4, figure 4-68) 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 close position. If the solenoid valve will not actuate to the close position it can be held closed manually by the manual close button (15, figure 4-68).

G 22737 ▶

The A/R boom hydraulic system is connected to the airplane main hydraulic system through a hydraulic motor-pump combination which raises airplane hydraulic system pressure to the high pressure level required for boom operation (figure 4-69).

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 hydraulic 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 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 hand pump located in the boom operator's compartment. This operation will be performed only if failure of the hydraulic system should occur.

Boom Hoist Lever

The hoist lever (42, figure 4-74 and figure 4-69) 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° below the stowed position. On the ground, full elevation travel is controlled by the hoist lever. In this condition the snub switch is de-energized 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 4-69 and 3, figure 4-74) with RETRACT--NEUTRAL--EXTEND positions is located 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 EXTENDED 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 (18, figure 4-70) with an OPEN--CLOSED control handle in the boom operator's compartment, 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

F G 1243 ▶ 22736

An AUTO--OFF--MANUAL switch (7, figure 4-74) 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 restrictor, the boom system pressure can be maintained by holding the switch in MANUAL as required.

G 22737 ▶

An ON--OFF switch (7, figure 4-74) 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 Hand Pump

The emergency hand pump (16, figure 4-70) located in the boom operator's compartment can be used to retract, extend and hoist the boom in the event of failure of the engine-driven A/R hydraulic pumps. On F airplanes, fluid is supplied to the hand pump from a separate reservoir. The reservoir has a capacity of 2 gallons, but is filled only to 1.5 gallons. Since the reservoir is isolated from the A/R boom hydraulic system, it must be filled manually. After use of the hand pump, refill the hand pump reservoir by draining sufficient fluid from the A/R hydraulic system reservoir (5, figure 4-68). On G airplanes, fluid is supplied to the hand pump from a reservoir which is an integral part of the A/R boom hydraulic system.

NOTE

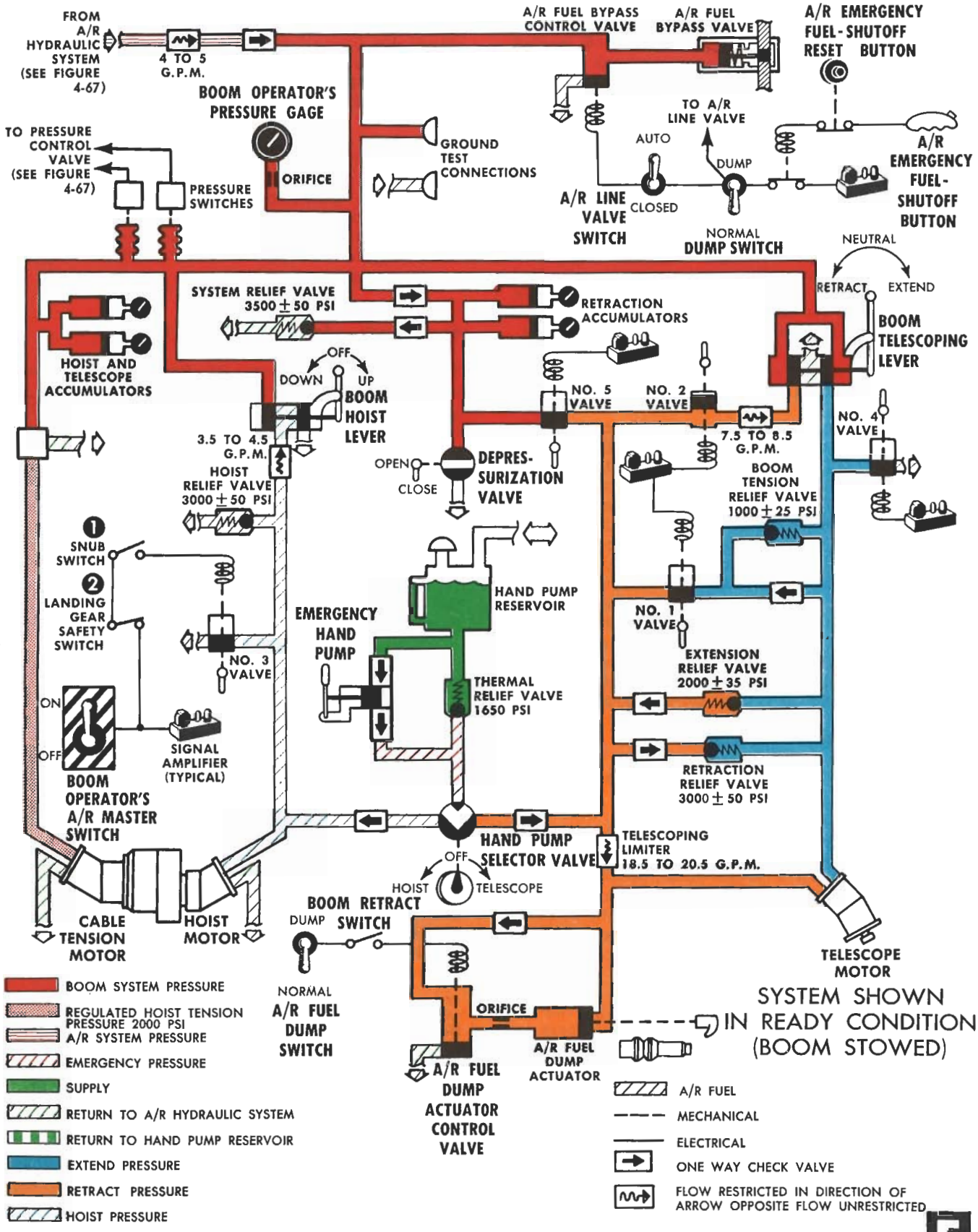
Before attempting to hoist or retract boom during flight using the boom system emergency hand pump, the boom operator's A/R master switch must be in the OFF position.

Emergency Hand Pump Selector Valve Knob

This selector valve knob (14, figure 4-70) in the boom operator's compartment is used to control the flow of fluid from the emergency hand pump. 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 hydraulic pressure gage graduated in 100 psi increments, (6, figure 4-74) 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 airplanes F G 1243 ▶ 2893 the pressure gages are direct pressure reading and on airplanes G 2894 ▶ the gages are electrical. Power for the electrical gages is supplied from the 26 volt AC instrument transformer.



A/R BOOM HYDRAULIC SYSTEM

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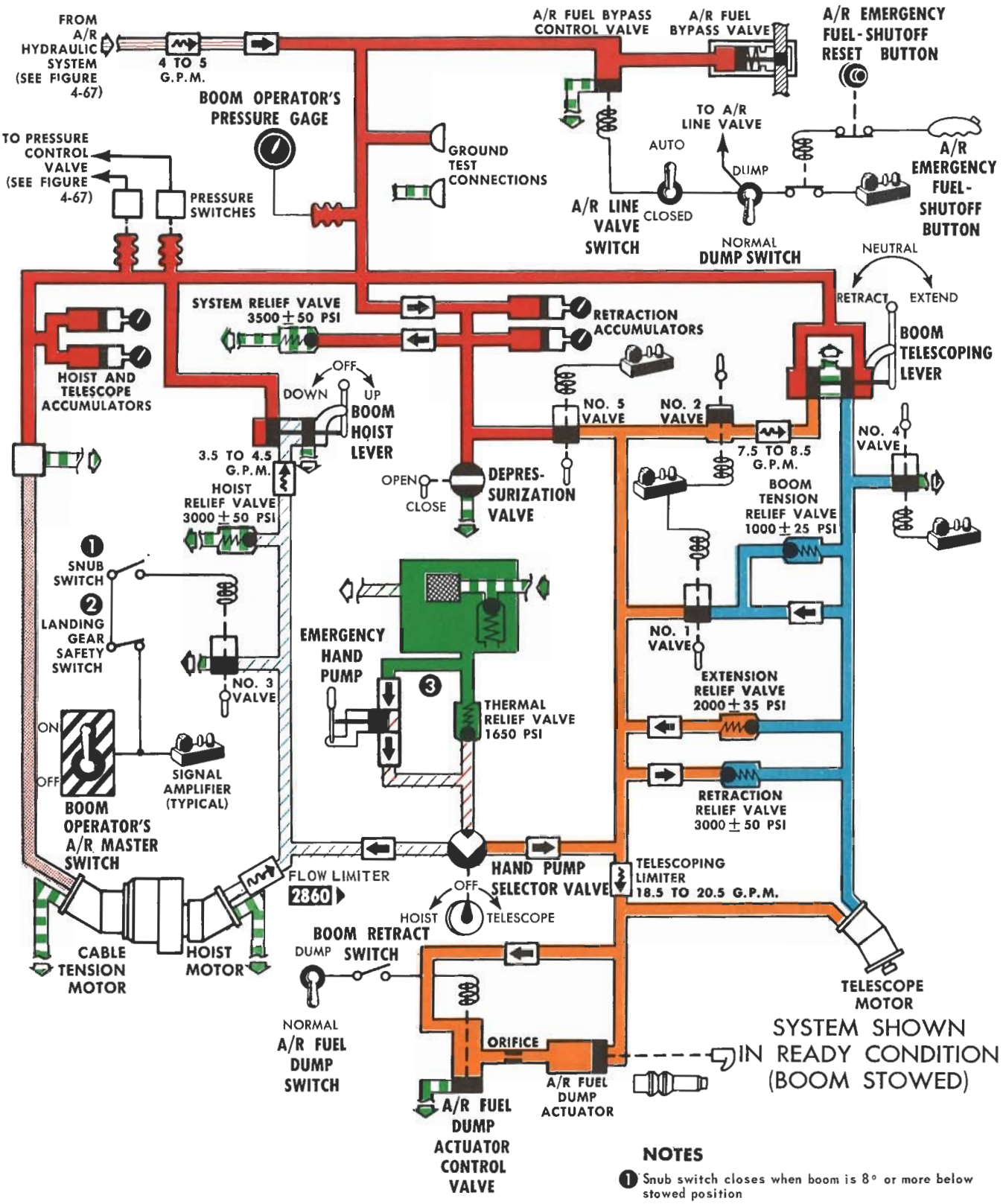
Figure 4-69 (Sheet 1 of 3)



NOTES

1. Snub switch closes when boom is 8° or more below stowed position
2. Landing gear safety switch opens when landing gear is on ground and oleos are compressed
3. Supply to hand pump is by hand pump suction

Figure 4-69 (Sheet 2 of 3)

G 17260 ▶ 22736

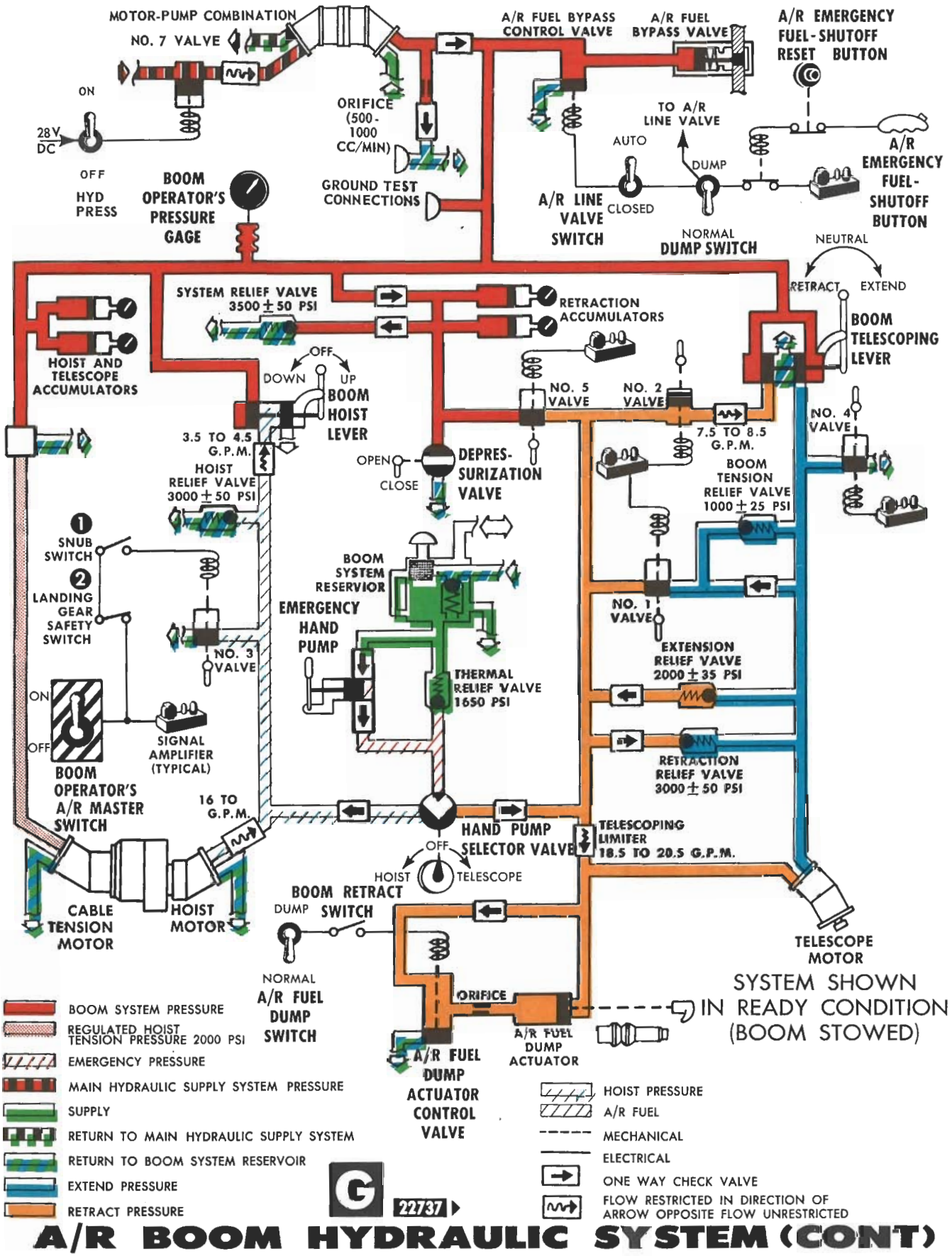


Figure 4-69 (Sheet 3 of 3)

Boom Hydraulic Low Pressure Warning Light

An amber warning light (5, figure 4-74) on the boom operator's panel will illuminate when boom system pressure falls below 2500 psi and goes out when boom system pressure returns to 2650 psi. Power is supplied from the 28 volt DC aft power panel.

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 aximuth 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 (figure 4-82). Voluntary disconnects may be initiated by either the receiver pilot or the boom operator. The receiver director lights which are installed on the under side 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° of upward travel while in flight is 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 4-71) 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. On airplanes G 32501, the boom envelope has an azimuth of 30° and an elevation of 43°. 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° of stowed position, care should be exercised by boom operator of the aerodynamic forces on ruddevators.

CAUTION

Boom operator should turn elevation assist trim wheel approximately one revolution downward from the full decrease position when boom is approximately 10° from stowed position to prevent boom slamming into stowage support. Failure to do so will result in structural damage to boom and stowage support.

Ruddevator Control Stick Lock

The ruddevator control stick lock located 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 4-74) 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

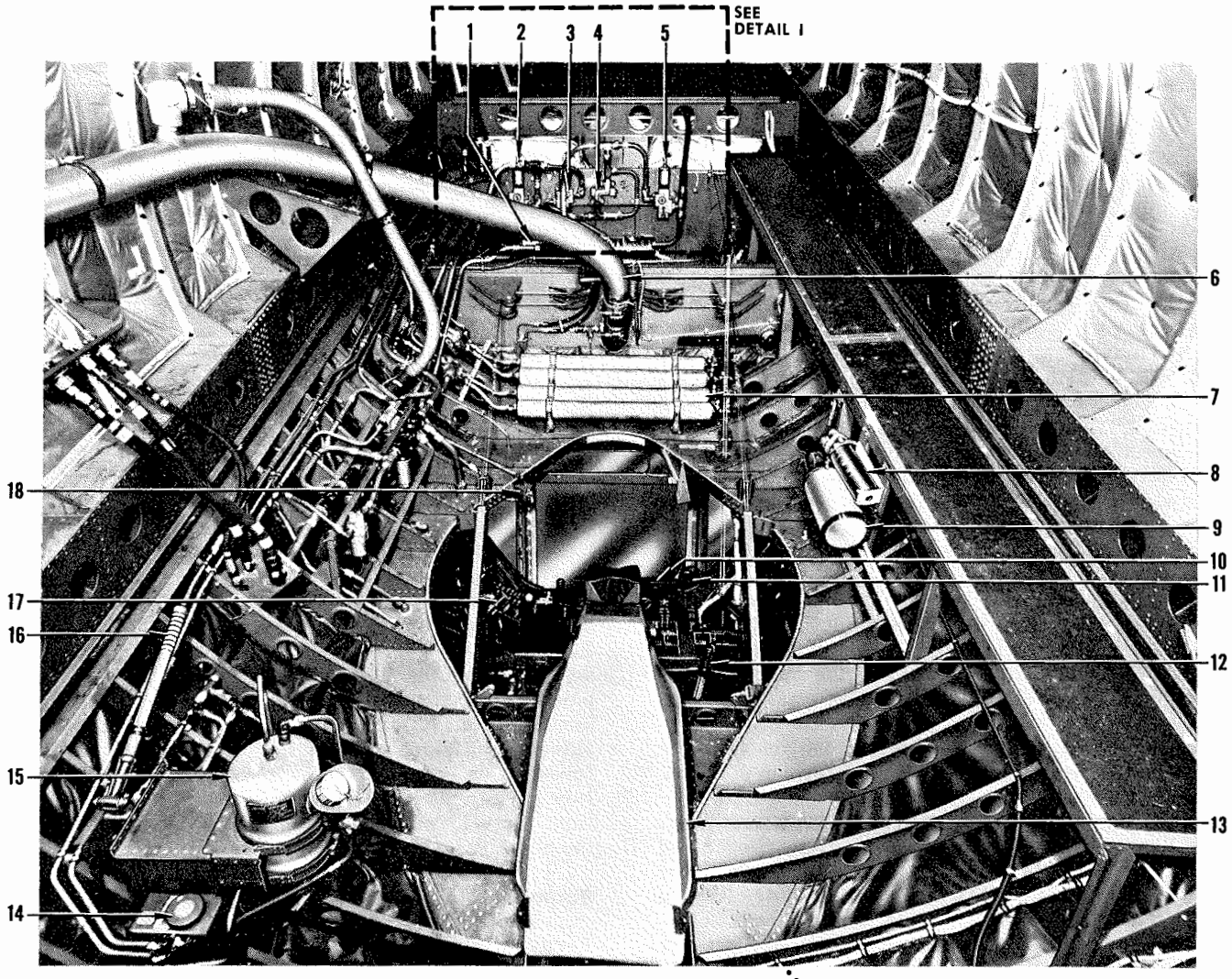
Three instruments (9, 11, 13, figure 4-74) on the boom operator's panel indicate azimuth, elevation and telescoping positions of the boom. A circuit breaker on the boom operator's panel protects the electrical circuit connecting the indicators and their respective transmitters.

A/R ELECTRICAL SYSTEM

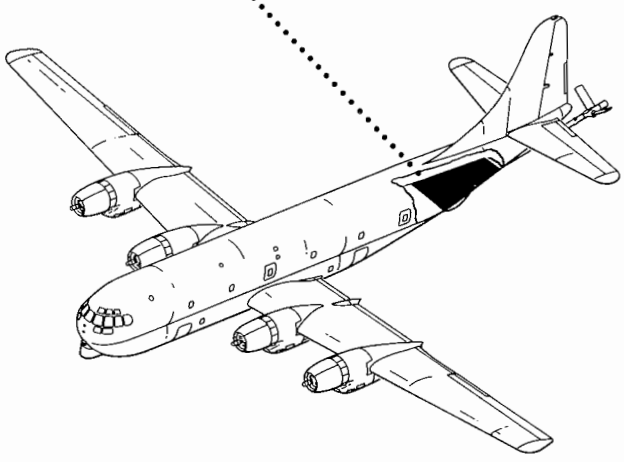
The A/R electrical system operates on power received from the airplane main 28 volt DC system and the 115 volt AC system. Electrically powered units in the A/R system include fuel-shutoff valves, hydraulic valves, lighting and a signal amplifier.

A/R Signal System

The tanker signal system (figure 4-72) 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 de-energizes the fuel pump and the line valve circuits. Upon contact

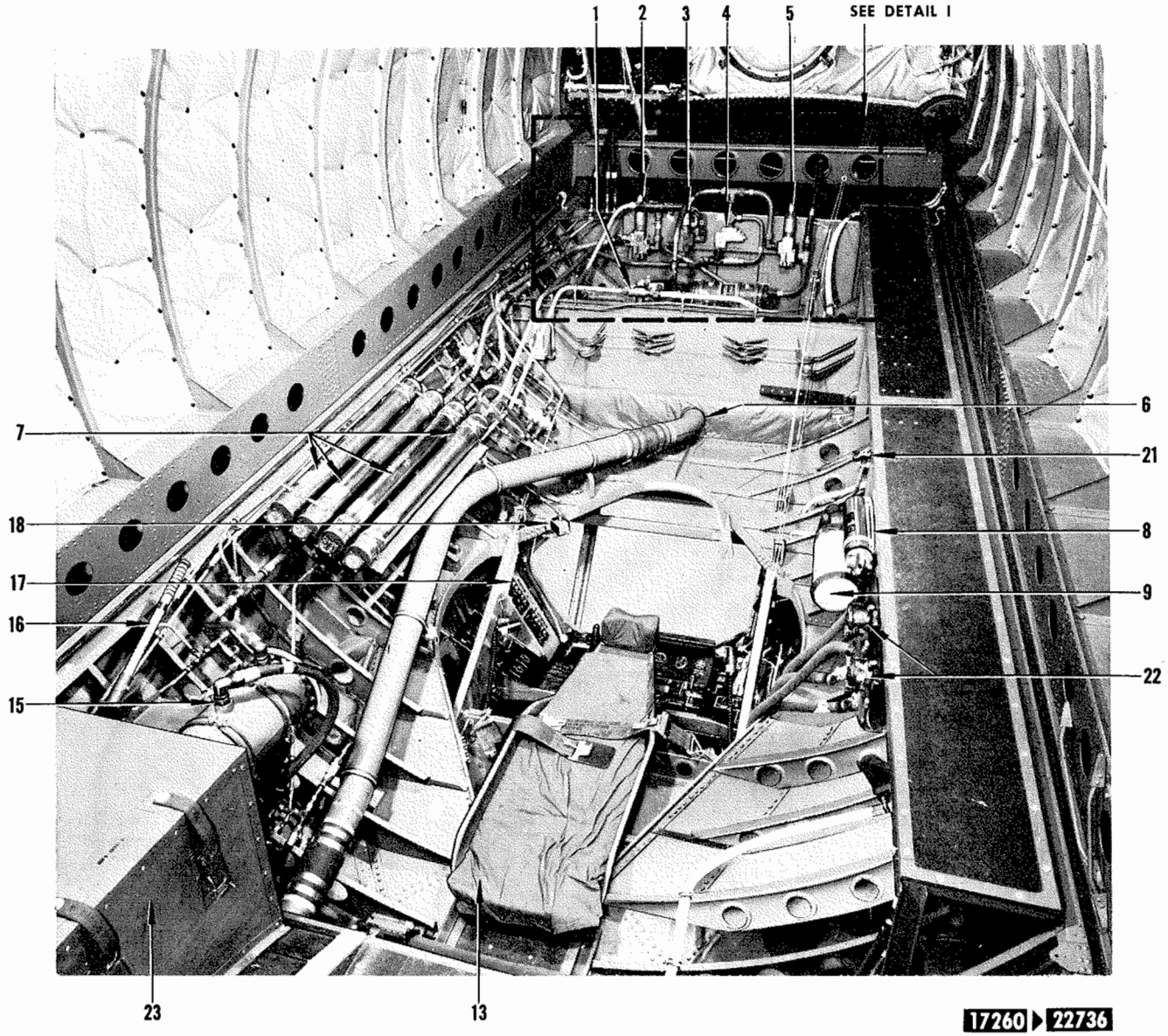


1 NO. 2 VALVE (5 PLACES)
2 NO. 5 VALVE (5 PLACES)
3 NO. 1 VALVE (5 PLACES)
4 BOOM TENSION RELIEF VALVE (1000 PSI) (3 PLACES)
5 NO. 4 VALVE (5 PLACES)
6 FUEL LINE TO BOOM (3 PLACES)
7 ACCUMULATORS (3 PLACES)
8 FIRE EXTINGUISHER (3 PLACES)
9 OXYGEN CYLINDER (3 PLACES)
10 INSTRUMENT PANEL AND CONTROLS (3 PLACES)
11 BOOM STOWING MIRROR
12 RUDDEVATOR CONTROL STICK
13 BOOM OPERATOR'S PLATFORM (3 PLACES)
14 BOOM EMERGENCY HAND PUMP SELECTOR VALVE KNOB
15 BOOM SYSTEM EMERGENCY HAND PUMP RESERVOIR (2 PLACES)
16 BOOM SYSTEM EMERGENCY HAND PUMP (3 PLACES)
17 INTERPHONE CONTROL PANEL(S) (3 PLACES)
18 BOOM HYDRAULIC SYSTEM DEPRESSURIZATION VALVE HANDLE



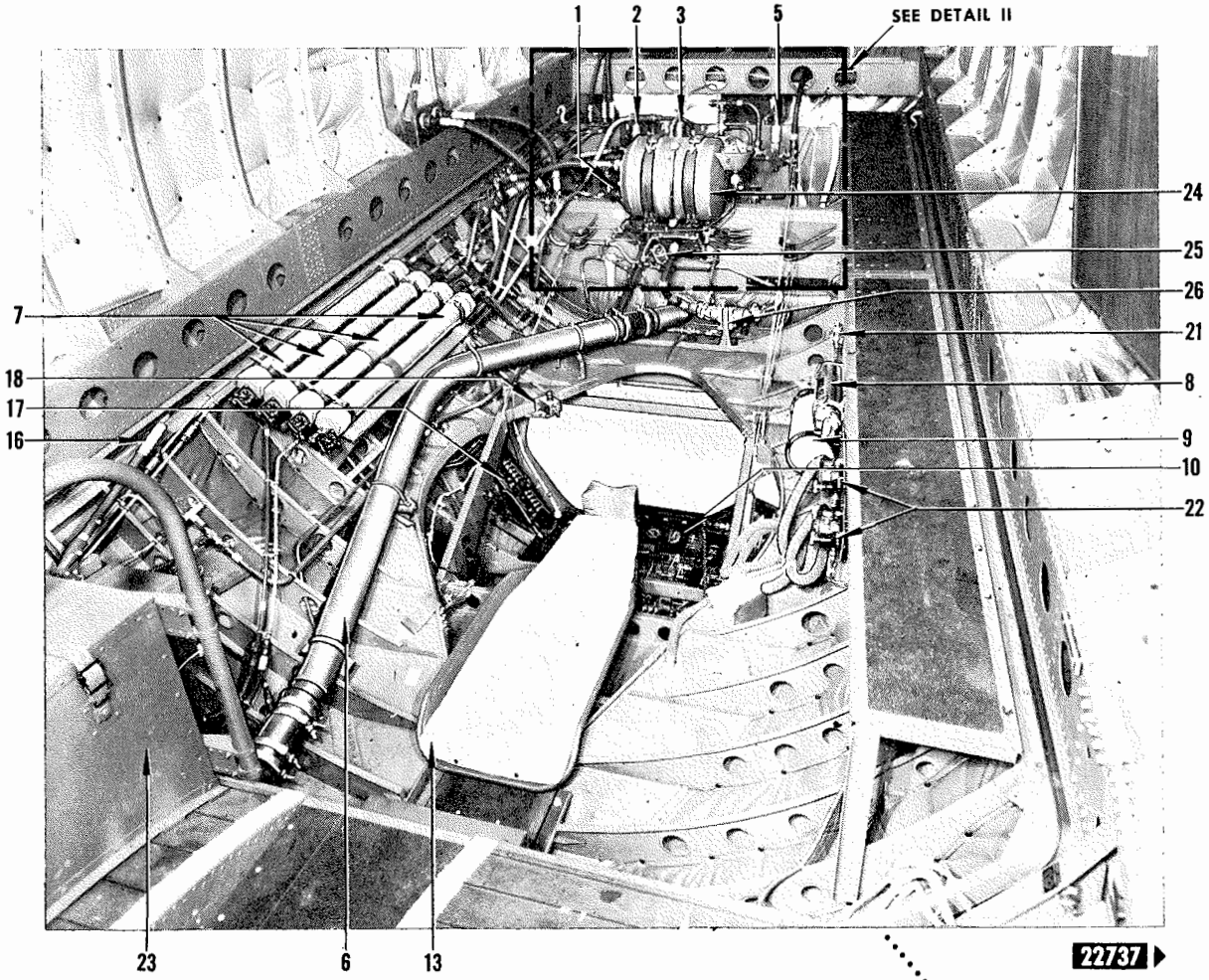
BOOM OPERATOR'S COMPARTMENT F

Figure 4-70 (Sheet 1 of 4)



19 AZIMUTH TRANSMITTER
20 FUEL PRESSURE TRANSMITTER
21 OXYGEN BOTTLE RECHARGER (2 PLACES)
22 OXYGEN REGULATORS (2 PLACES)
23 CARGO TIEDOWN EQUIPMENT STOWAGE (2 PLACES)
24 BOOM SYSTEM HYDRAULIC RESERVOIR (2 PLACES)
25 NO. 7 VALVE (2 PLACES)
26 MOTOR-PUMP COMBINATION (2 PLACES)

Figure 4-70 (Sheet 2 of 4)



1 NO. 2 VALVE (5 PLACES)
2 NO. 5 VALVE (5 PLACES)
3 NO. 1 VALVE (5 PLACES)
4 BOOM TENSION RELIEF VALVE (1000 PSI) (3 PLACES)
5 NO. 4 VALVE (5 PLACES)
6 FUEL LINE TO BOOM (3 PLACES)
7 ACCUMULATORS (3 PLACES)
8 FIRE EXTINGUISHER (3 PLACES)
9 OXYGEN CYLINDER (3 PLACES)
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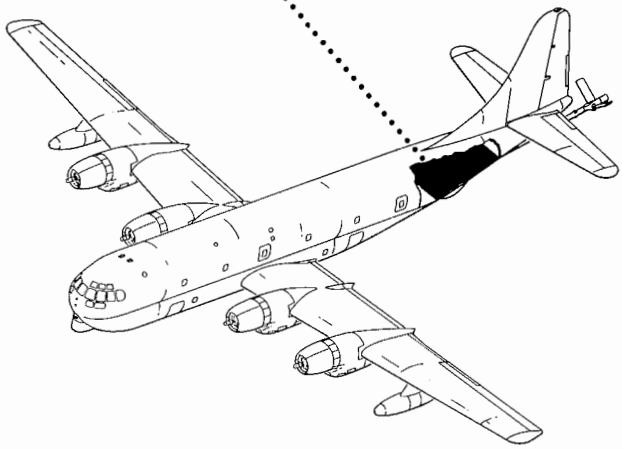
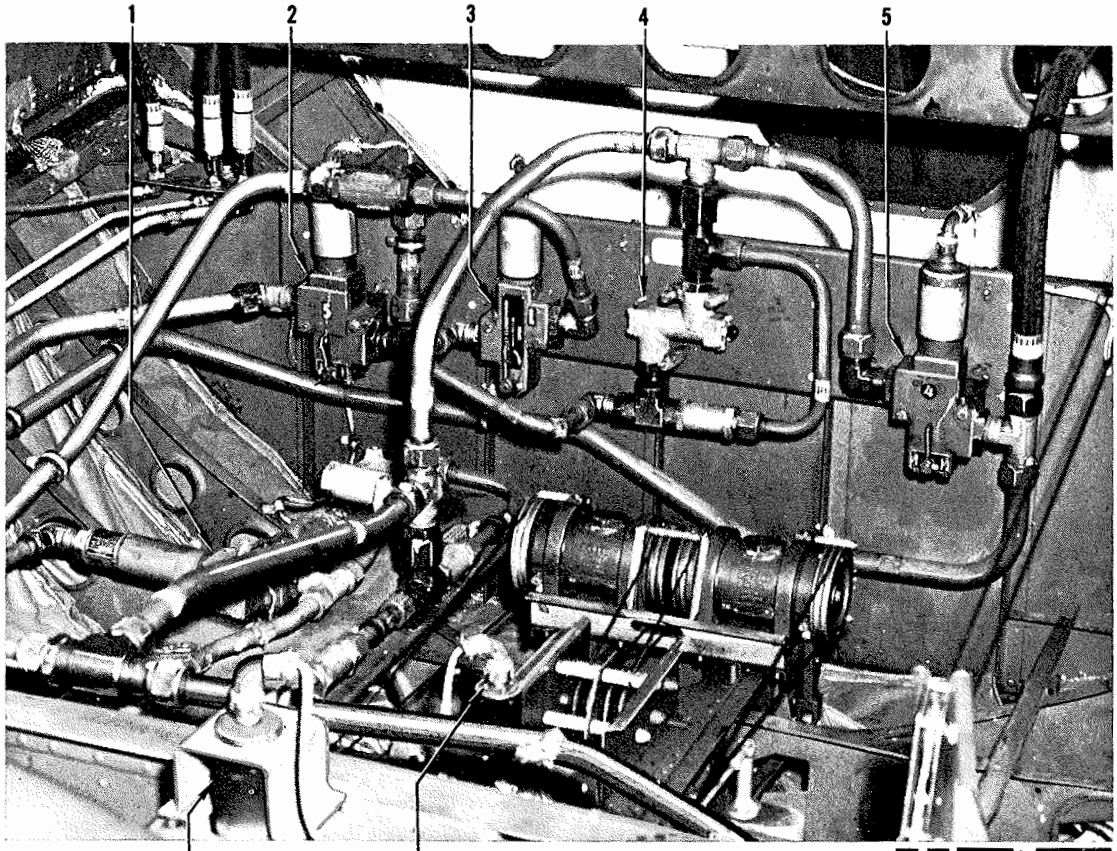
16 BOOM SYSTEM EMERGENCY HAND PUMP (3 PLACES)
17 INTERPHONE CONTROL PANEL(S) (3 PLACES)
18 BOOM HYDRAULIC SYSTEM DEPRESSURIZATION VALVE HANDLE
19 AZIMUTH TRANSMITTER
20 FUEL PRESSURE TRANSMITTER



21 OXYGEN BOTTLE RECHARGER (2 PLACES)
22 OXYGEN REGULATORS (2 PLACES)
23 CARGO TIEDOWN EQUIPMENT STOWAGE (2 PLACES)
24 BOOM SYSTEM HYDRAULIC RESERVOIR (2 PLACES)
25 NO. 7 VALVE (2 PLACES)
26 MOTOR-PUMP COMBINATION (2 PLACES)

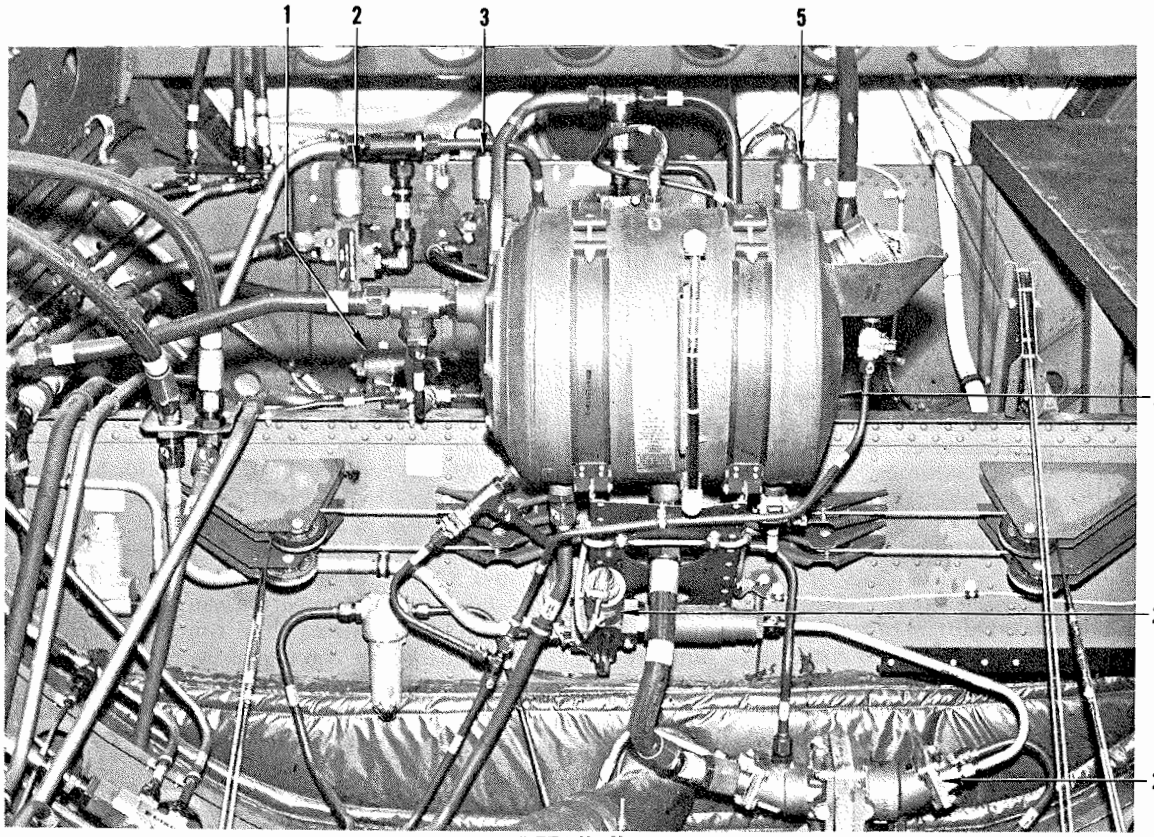
BOOM OPERATOR'S COMPARTMENT (CONT) G

Figure 4-70 (Sheet 3 of 4)



DETAIL I

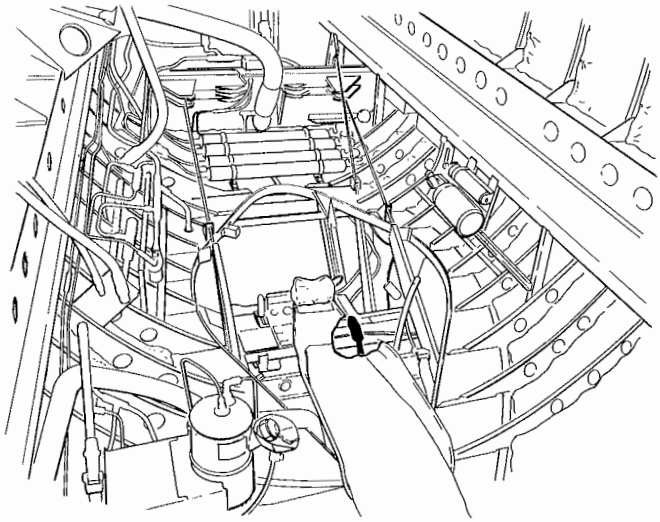
F G 1243 ▶ 22736

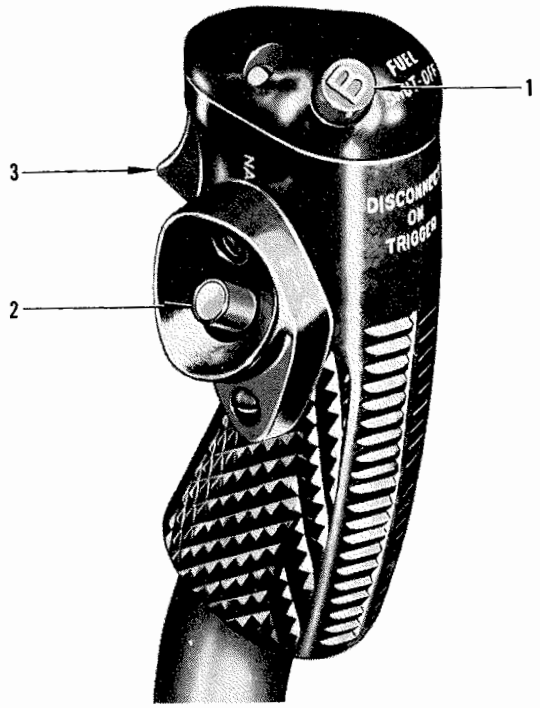


DETAIL II

G 22737 ▶

Figure 4-70 (Sheet 4 of 4)





1 A/R EMERGENCY FUEL-SHUTOFF BUTTON
2 MICROPHONE BUTTON
3 DISCONNECT SWITCH

RUDDEVATOR CONTROL STICK

Figure 4-71

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 4-74) is in AUTO the boom will automatically retract.

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 4-67 and 4-69.) On all airplanes hoisting of the boom is controlled by the normally closed valve No. 3, snub switch, and the boom opera-

tor's hoist control lever. While in flight, and the signal system in either the ready or disconnect condition, the boom is lowered approximately 8° from the stowed position with the hoist motor. Beyond this 8° 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° 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 4-72 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 de-energized, 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.

A/R Signal System Override

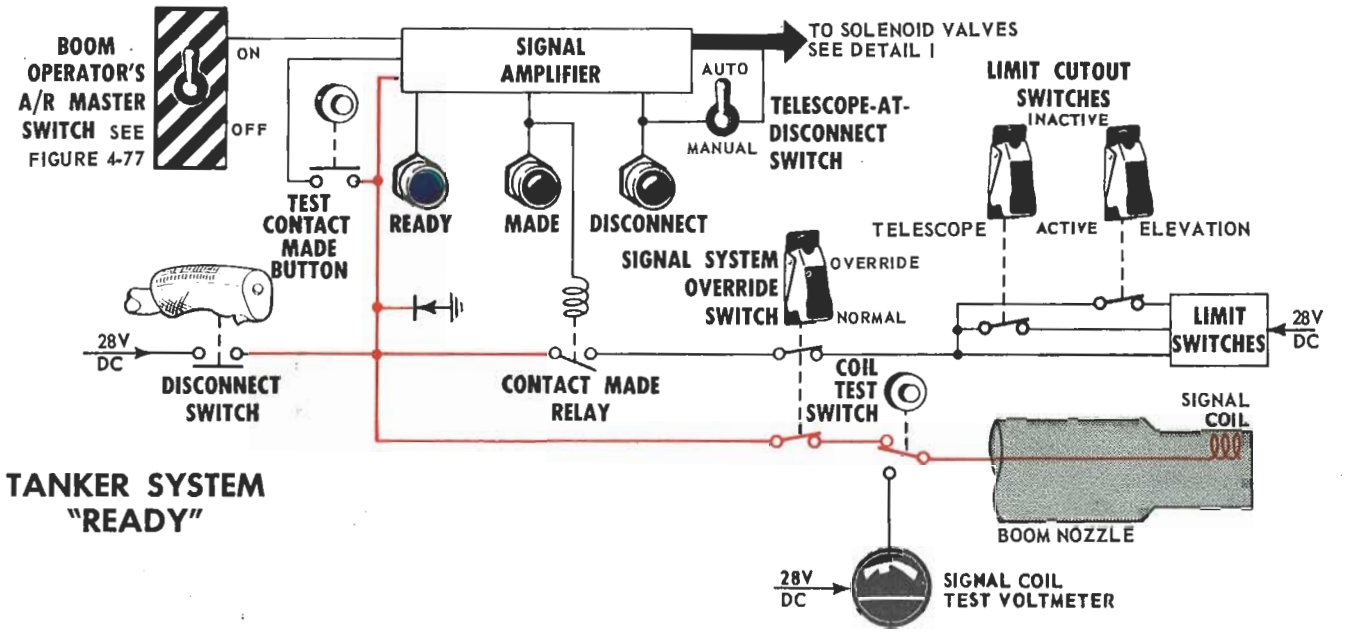
A signal system override has been installed to serve as a secondary system in event of failure of the signal system. An override switch on the boom operator's panel when placed at OVERRIDE will allow manual control of the refueling operation by the boom operators, thus replacing the signal amplifier's 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 airplanes F G 1243 ▶ 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, thus 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 airplanes G 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 the No. 7 valve which controls hydraulic pressure to the boom system. To prevent accumulators from becoming depleted and to insure system pressure available, manually override the No. 7 valve.

Filter Diode TCTO K576

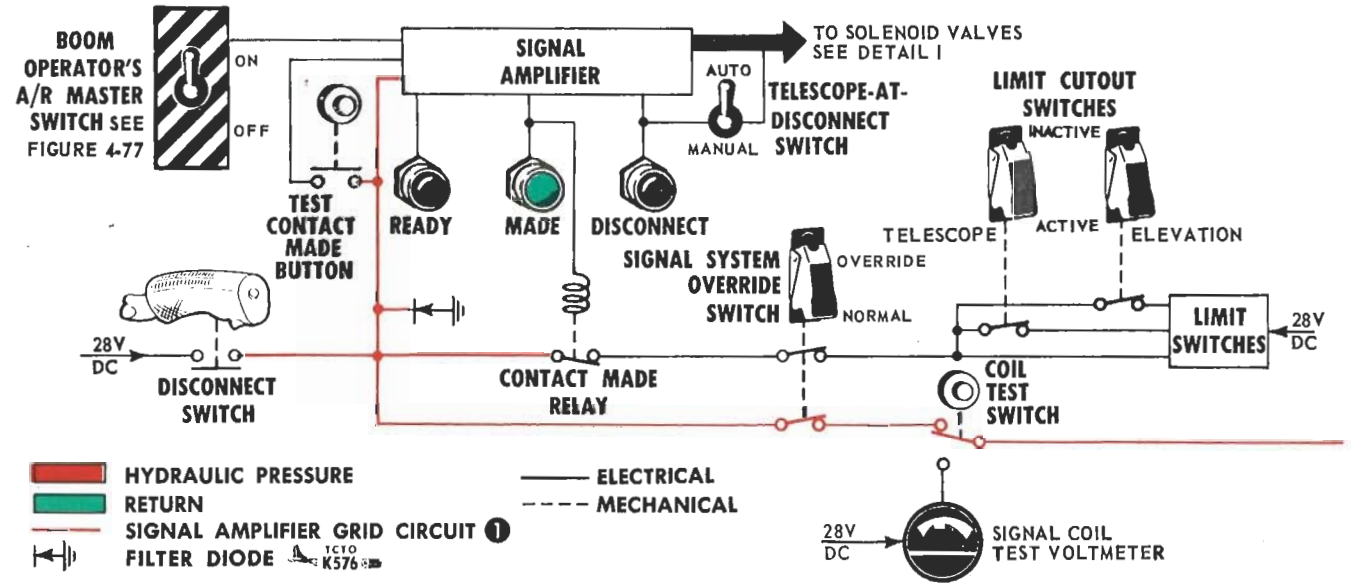
A filter diode (figure 4-72) is installed in the signal amplifier grid circuit. This filter bypasses transient or spurious electrical currents which would otherwise cause the signal amplifier to cycle to the next condition.

A/R EXTERIOR LIGHTS

Lights (figure 4-43) are installed on the fuselage and boom to illuminate the exterior of the airplane and boom for night operations. Four lights, flush mounted in the fuselage skin, illuminate the underside of the wing to the inboard nacelles. A flush mounted boom chock light illuminates the stowage chock. The boom nozzle hood contains lights to illuminate the nozzle and boom color bands. On airplanes G 3196 ▶ plus those with TCTO K231 incorporated, two A/R rendezvous beacon lights are mounted in the tail cone, one vertically and one horizontally. On airplanes incorporating TCTO 591 , two sets of anti-collision lights, one set on top and one set on bottom, are mounted on the fuselage opposite the wing leading edge. These lights are used as anti-collision and rendezvous lights. The anti-collision light switch (22, figure 1-12) on the overhead panel has UPPER ON--OFF--BOTH ON positions. The anti-collision light color selector switches (21, figure 1-12) provide a means for individual or multiple color selection. Four colors, red, blue, green and amber with ground changing provisions only are provided with two filters of each color. The two color selector switches are decalled UPPER and LOWER and each switch has three position COLOR A--BOTH--COLOR B. The light and color combination are self explanatory as decalled. Three lights mounted on the aft receiver director lights assembly illuminate the fuselage and trailing edges of the wings. These lights provide visual identification for the receiver airplanes. Receiver director lights assemblies, (figure 4-73) which provide visual command signals for the receiver pilots, are mounted on the underside of the fuselage aft of the wing. On airplanes incorporating TCTO K526 , additional receiver director lights assemblies are installed on both sides of the under-fuselage forward of the wing. A selector switch (46, figure 4-74) on the receiver director lights panel, located at the boom operator's station, permits selection of either the aft receiver director lights assemblies or the receiver director lights assemblies of the forward installation. The receiver director lights are normally actuated automatically, during contact, by movements of the A/R boom (figure 4-73), however, manual override switches are installed on the boom operator's panel to permit manual operation if necessary. Circuit protection is provided through a circuit breaker on the aft power panel. Care must be exercised in the usage of some lights.



TANKER SYSTEM "READY"



TANKER SYSTEM "CONTACT MADE"

VALVE NO.	NORMAL DE-ENERGIZED POSITION	READY FOR CONTACT	CONTACT MADE	TOWING RECEIVER	EMERGENCY FUEL DUMP	MANUAL DISCONNECT	MANUAL DISCONNECT	AUTO DISCONNECT
1	Closed	Closed	Open	Open	Closed	Closed	Closed	Closed
2	Open	Open	Closed	Closed	Closed	Open	Closed	Closed
3	Closed	▷	Open	Open	Open	▷	▷	▷
4	Open	Closed	Open	Open	Open	Closed	Closed	Open
5	Closed	Closed	Closed	Closed	Open	Closed	Open	Open
6	Open	Open	Closed	Closed	Closed	Open	Open	Open

DETAIL I

A/R NUMBERED VALVE POSITIONS
SEE FIGURE 4-67 AND 4-69

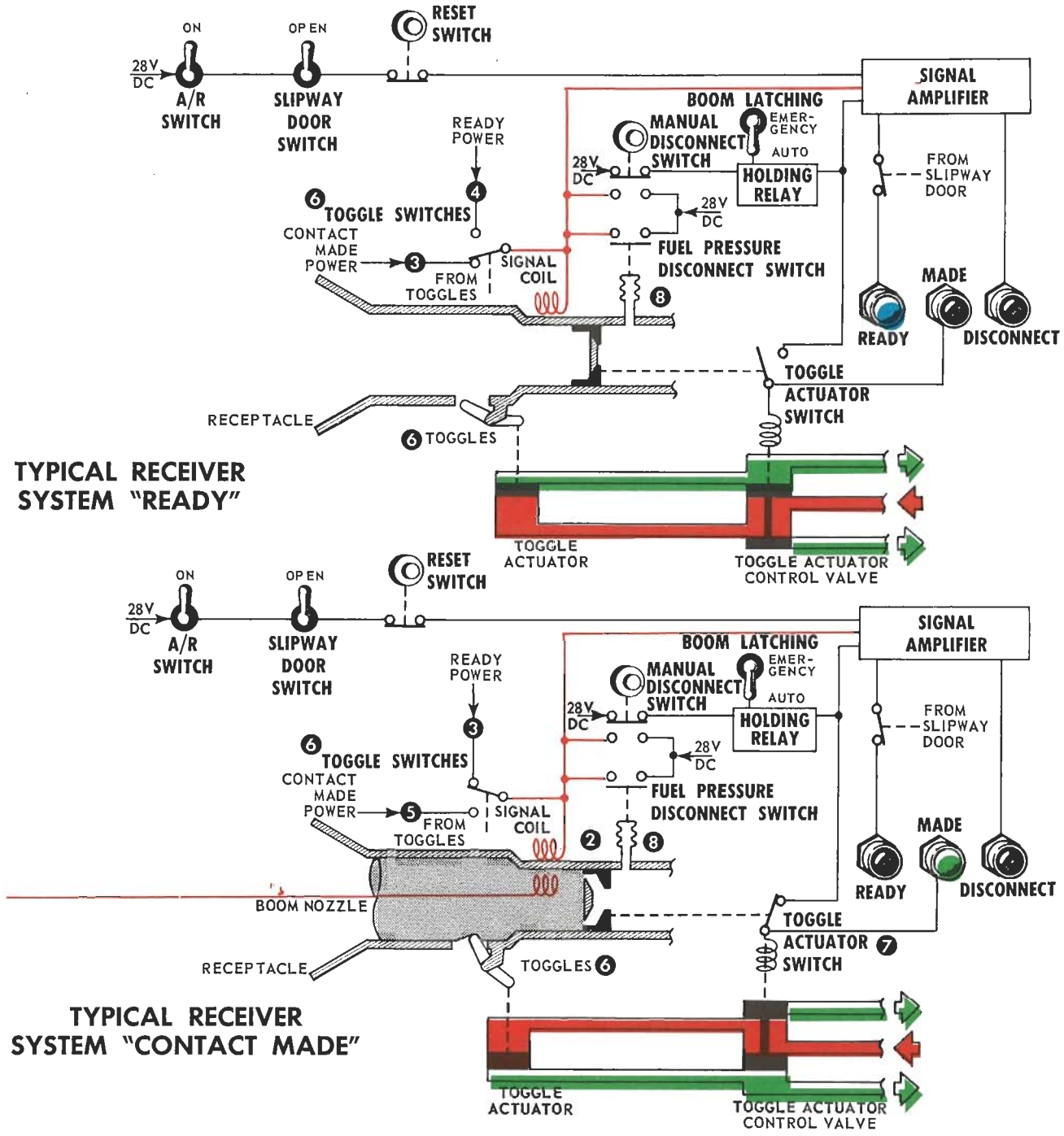
▷ Open in flight when boom is more than 8 degrees below stowed position, closed at all times on ground

▶ Applicable to airplanes without signal coil test voltmeter

▶ Applicable to airplanes with signal coil test voltmeter

A/R SIGNAL SYSTEM

Figure 4-72 (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: B-52 – 68 ± 2 PSI, B-47 – 55± 2 PSI

Figure 4-72 (Sheet 2 of 2)

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.

NOTE

- 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. TCTO K231

- To prevent blistering of the plastic cone due to excessive heat from the anti-collision lights, do not operate these lights for more than 5 minutes while the airplane is on the ground. TCTO 591

- The anti-collision lights operate on DC power. The motors driving the rotating light assembly operate on AC power from the secondary inverter. Therefore the secondary inverter switch must be SEC INV during operation of the anti-collision lights on the ground or in flight. TCTO 591

All lights are controlled by ON--OFF switches, rheostats, and rheostat type switches on the boom operator's panel (figure 4-74). The boom operator also has an ON--OFF switch to operate a compartment dome light.

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.

Engineer's A/R Master Switch

When in the ON position, this ON-OFF switch (21, figure 4-76) on engineer's A/R panel supplies power to all switches and indicator lights on the panel, except for the three boom contact 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 de-energized, 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 engineer's A/R panel are de-energized (except the AC continuous reading hydraulic pressure gages on airplanes G 2894 ▶) when 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 (40, figure 4-74) located on the boom operator's panel performs the following functions:

1. Supplies power to the signal amplifier
2. Illuminates the ready for contact indicator light
3. Energizes solenoid valve No. 4, permitting manual telescoping of the boom
4. 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
5. Supplies power to the A/R hydraulic circuitry

Signal System Manual Contact Switch

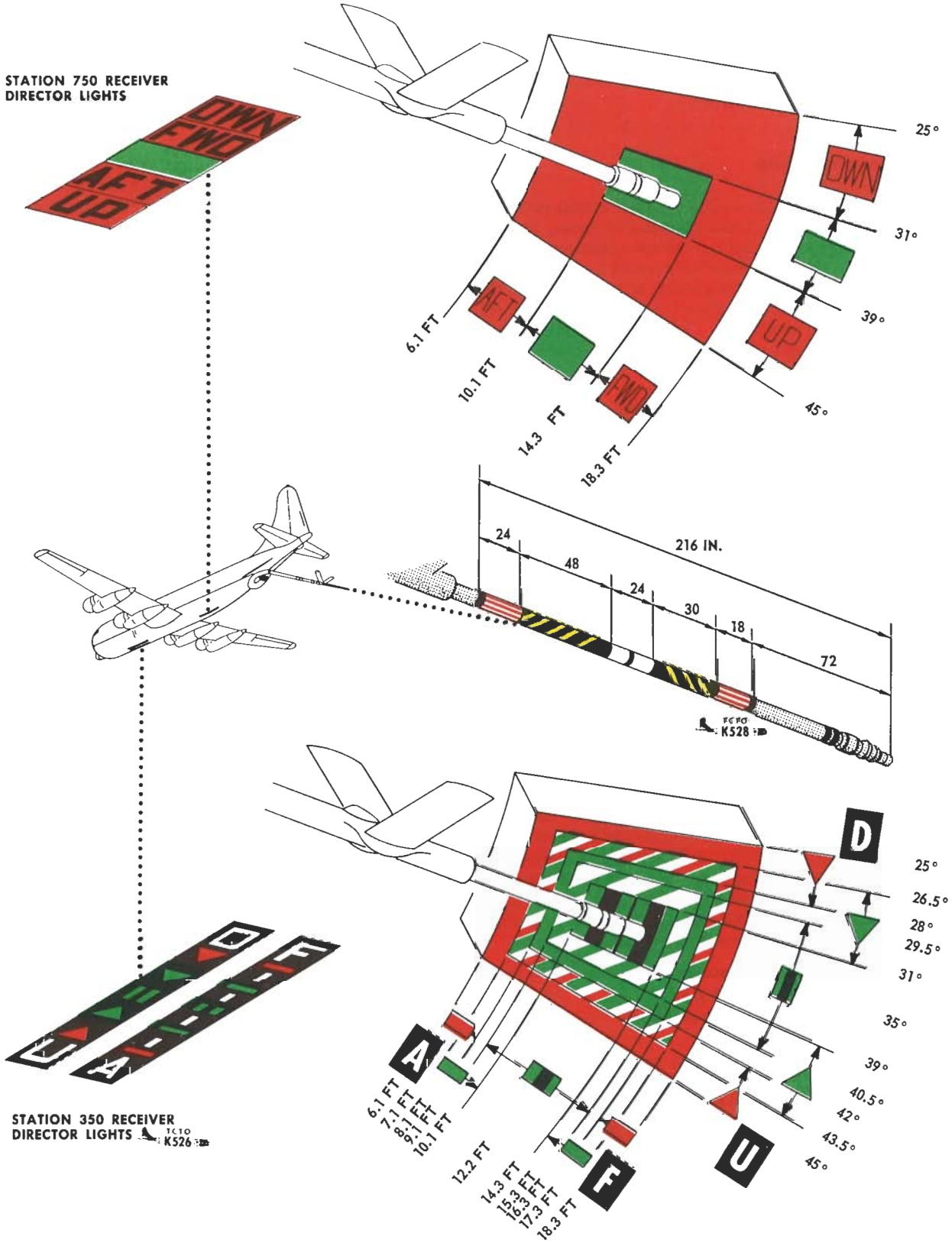
The trigger type contact switch (4, figure 4-74) on the telescope control handle is used to manually put the signal system into a contact made condition when the signal system manual override switch is placed in the OVERRIDE position. The manual override switch permits the signal system to operate without 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 4-74) on the hand grip of the ruddevator control stick initiates a disconnect in the signal system whether in ready for contact or contact made.

Signal Amplifier Test Button

A push-to-test button (39, figure 4-74) 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. If pushed while in contact made condition the signal system will advance to disconnect.



BOOM MARKINGS AND RECEIVER DIRECTOR LIGHTS

Figure 4-73

Signal System Reset Button

A push-to-reset button (37, figure 4-74) on the boom operator's panel, when depressed, will advance the signal system to the ready condition from either the made or disconnect condition.

Limit Cutout Switches

Two guarded INACTIVE--ACTIVE limit cutout switches (18, figure 4-74) on the boom operator's panel, when in the INACTIVE position will cut out the elevation and extension limits on the boom for ground test purposes. The extension limit cutout switch will not cut out the retraction limit switch, and 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

- On airplanes with ICTO K526 incorporated, when the extension limit cutout switch is positioned to INACTIVE, the retraction and extension limit switches are de-activated.
- On airplanes without ICTO K526 incorporated, when the extension limit cutout switch is positioned to INACTIVE, the extension limit only is deactivated.

Telescope-At-Disconnect Switch

The AUTO--MANUAL telescope-at-disconnect switch (8, figure 4-74) 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.

Signal System Override Switch

This NORMAL--OVERRIDE switch (2, figure 4-74) 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 operations 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.

Boom Signal Coil Test Voltmeter

This instrument (26, figure 4-74) is used in conjunction with the push-to-test signal coil button (27, figure 4-74) 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 (10, figure 4-76) on the engineer's A/R panel, and three similar lights (10, figure 4-74) on the boom operator's 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 a circuit breaker on the aft power panel.

A/R FUEL SYSTEM

F

A/R fuel is carried in 4 fuselage tanks (figure 4-75) with usable capacity of 7200 US gallons. Additional fuel may be transferred into the A/R fuel system from the center wing tank, giving a total usable A/R fuel capacity of 8410 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 forward portion of each right hand fuselage tank into which fuel is gravity fed from the tanks. A fuel leveling line between the forward and aft tanks interconnects the two systems.

G

A/R fuel is carried in 15 fuselage tanks (figure 4-66) with usable capacity of 5819 US gallons. Additional fuel may be transferred into the A/R fuel system from the center wing tank and from the two external fuel tanks, giving a total usable A/R fuel capacity of 8379

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 airplanes F G 1243 ▶ 22664 ◀, two A/R transfer valves isolate the A/R tanks from the other fuel tanks when fuel is not being transferred. On airplanes G 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 inform pilot and engineer. Engineer will close line valve. 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 Switch

This OPEN--CLOSED switch (16, figure 4-76) on the engineer's A/R panel is used to open and close the leveling valve between the forward and aft A/R tanks. The switch is guarded in the CLOSED position. In the OPEN position the fuel in the forward and aft A/R tanks will seek its own level.

NOTE

The 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 let-downs.

A/R Line Valve Switch

An AUTO--CLOSED switch (9, figure 4-76) 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. Whenever the switch is positioned to CLOSED, the No. 6 valves 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 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 and contact-made, and is opened at disconnect. The bypass valve is also opened by the emergency fuel-shutoff button when in contact-made and remains open until the emergency fuel-shutoff reset button is depressed. See figure 4-77.

A/R Transfer Valve Switches

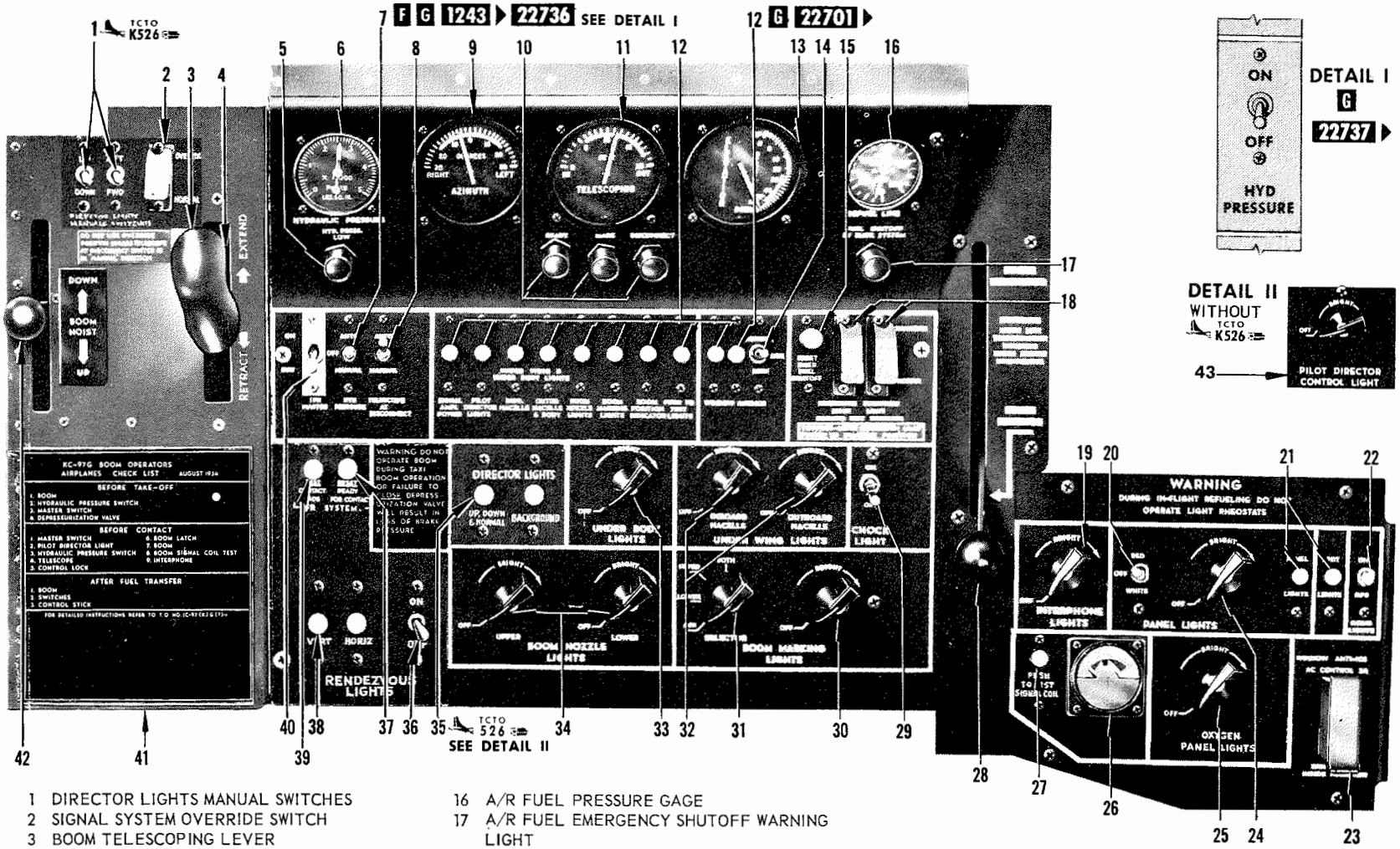
F G 1243 ▶ 22664

Two OPEN--CLOSED switches (15, figure 4-76) 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.

G 22665 ▶

The A/R transfer valve switches control the secondary valves of the A/R single point refueling system as well as the external tank manifold transfer valve. 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 and the external tank manifold transfer 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.

BOOM OPERATOR'S PANEL



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 (2 PLACES)
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 LIGHT RHEOSTAT
20 PANEL LIGHT SWITCH
21 CIRCUIT BREAKERS
22 DOME LIGHT SWITCH
23 WINDOW ANTI-ICE FUSE F G 1243 ▶ 22700
24 PANEL LIGHT RHEOSTAT
25 OXYGEN PANEL LIGHTS RHEOSTATS
26 BOOM SIGNAL COIL TEST VOLTMETER
27 PUSH TO TEST SIGNAL COIL BUTTON
28 BOOM LATCHING LEVER
29 CHOCK LIGHT SWITCH
30 BOOM MARKING LIGHT RHEOSTAT
31 BOOM MARKING LIGHT SELECTOR SWITCH
32 UNDERWING LIGHT RHEOSTATS
33 UNDERBODY LIGHT RHEOSTAT
34 BOOM NOZZLE LIGHT RHEOSTATS
35 RECEIVER DIRECTOR LIGHTS CIRCUIT BREAKERS
36 RENDEZVOUS LIGHTS SWITCH
37 SIGNAL SYSTEM RESET BUTTON
38 RENDEZVOUS BEACON LIGHT CIRCUIT BREAKERS G 3196 ▶ PLUS TCTO K231
39 SIGNAL AMPLIFIER TEST BUTTON
40 BOOM OPERATOR'S A/R MASTER SWITCH
41 CHECKLIST
42 BOOM HOIST LEVER
43 RECEIVER DIRECTOR LIGHT RHEOSTAT

Figure 4-74 (Sheet 1 of 2)

44 RECEIVER DIRECTOR LIGHTS TEST SWITCH
45 RECEIVER DIRECTOR LIGHTS RHEOSTAT (TYPICAL)
46 RECEIVER DIRECTOR LIGHTS ASSEMBLY SELECTOR SWITCH
47 BACKGROUND LIGHTS RHEOSTAT (TYPICAL)
48 BOOM OPERATOR'S RADIO LOUDSPEAKER F G 1372 ▶
49 RADIO LOUDSPEAKER SWITCH F G 1372 ▶

Figure 4-74 (Sheet 2 of 2)

A/R Fuel Quantity Gages And Test Buttons

Two fuel quantity gages (6, figure 4-76) on the engineer's A/R panel indicate the quantity of fuel in pounds in the two A/R tank systems. A test button (7, figure 4-76) is located adjacent to each quantity gage.

Manual Fuel-Shutoff Valve

F

A manually operated OPEN--CLOSED fuel-shutoff valve (figure 4-77) is in the fuel line leading from the center wing tank to the main fuel manifold. When the valve is CLOSED the main fuel manifold is isolated from the center wing tank and the A/R tanks. With the center wing tank and A/R tanks isolated, jet fuel may be carried in the center wing tank for air refueling. However, the valve must be safety wired in the CLOSED position to prevent any possible contamination of the main fuel manifold. When the valve is OPEN, the following fuel flow conditions are possible; fuel flow from the center wing tank to the main fuel manifold and fuel flow between A/R tanks and main fuel manifold.

G

These OPEN--CLOSED valves are manually operated. The No. 1 manual fuel-shutoff valve (see figure 4-77) controls fuel flow from the center wing tank manifold to the main airplane fuel manifold. The No. 2 manual fuel-shutoff valve controls fuel flow from the external tanks to the center wing tank manifold. On airplanes with TCTO KGT507 incorporated the No. 3 manual fuel-shutoff valve controls fuel flow from the A/R fuel pumps to the main airplane fuel manifold.

External Tank Manifold Shutoff Valve G 22665 ▶

This motor operated valve (figure 4-77) is actuated by either of the transfer valve switches (15, figure 4-76) on the engineer's A/R panel. When this valve is closed and No. 1 and No. 2 manual fuel-shutoff valves are open, the external fuel tanks are connected to the airplane fuel system. With No. 1 and No. 2 manual fuel-shutoff valves closed and this valve open, the external fuel tanks are connected to the A/R fuel system. This valve must be open when it is desired to transfer fuel between the airplane and the A/R fuel system. See also A/R TRANSFER VALVE SWITCHES in this Section.

A/R Emergency Fuel-Shutoff Button

A thumb operated button (1, figure 4-71) 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

This button (15, figure 4-74) 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 valve 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 fuel pressure gages (18, figure 4-76 and 16, figure 4-74) 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 fuel flow and totalizer indicator (20, figure 4-76) 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. A totalizer NORMAL--RESET switch (19, figure 4-76) 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 Emergency Fuel-Shutoff 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 light (17, figure 4-74) is on the boom operator's panel and the other (17, figure 4-76) is on the engineer's A/R panel.

A/R Fuel Low Pressure Warning Lights

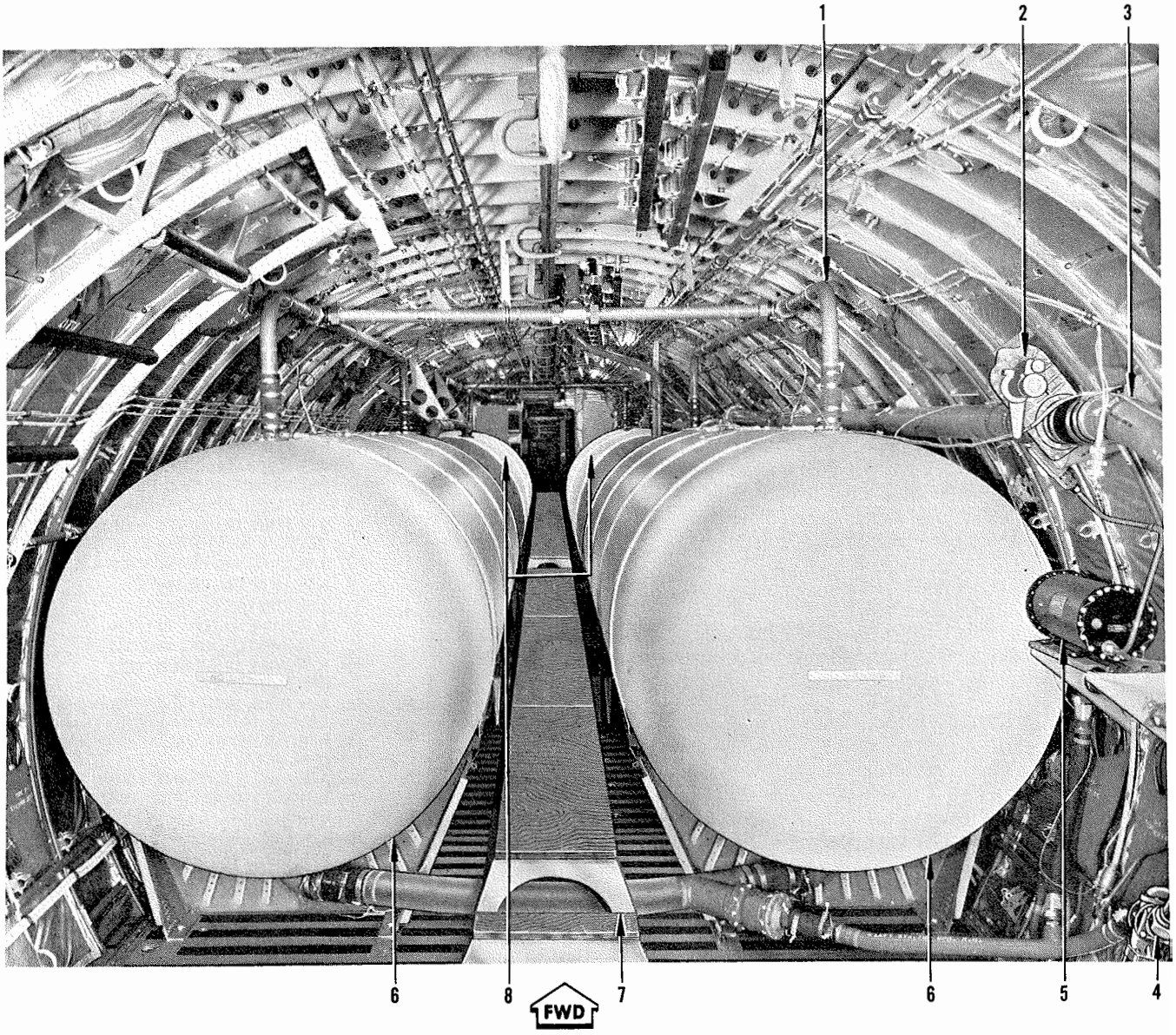
Two amber lights (3, figure 4-76) on the engineer's A/R panel will illuminate when the fuel pressure drops below 10 psi at the forward and aft A/R fuel pumps.

A/R Fuel High Level Warning Lights F G 1243 ▶ 22664

Two amber lights (14, figure 4-76) on the engineer's A/R panel will illuminate when the forward and aft A/R tanks are full and the transfer valves are open. These lights are used by the engineer during transfer of fuel from center wing, main tanks and on G airplanes the external fuel tanks to the A/R tank system.

A/R Line Valve Position Light

An amber light (8, figure 4-76) on the engineer's A/R panel, will illuminate when the A/R line valve is open.

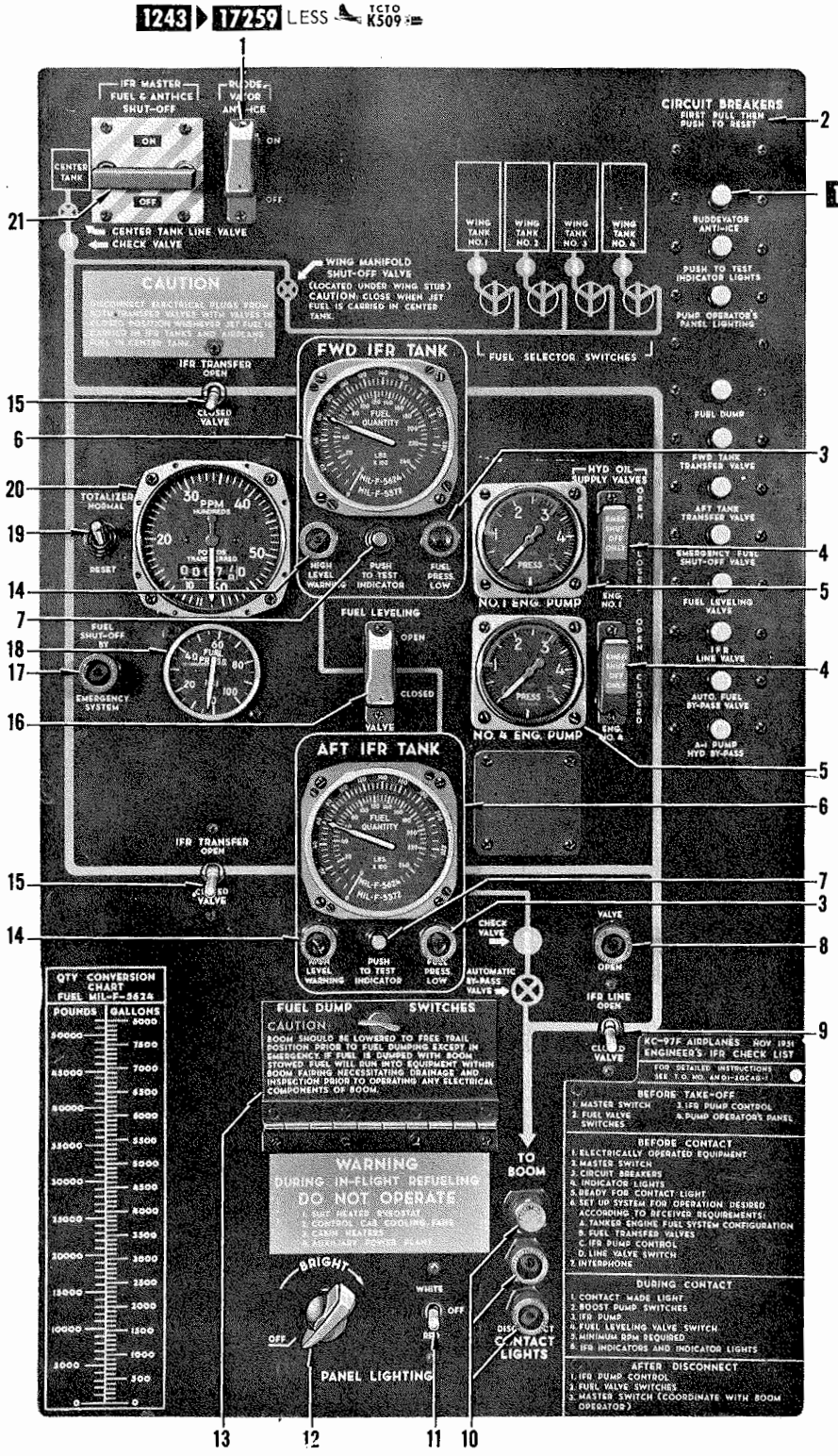


1 VENT LINES
2 A/R LINE VALVE
3 FUEL LINE TO BOOM
4 FUEL BYPASS VALVE
5 DENSITOMETER
6 AFT A/R TANK SYSTEM (2 PLACES)
7 CATWALK
8 FORWARD A/R TANK SYSTEM

A/R FUEL TANK INSTALLATION

F

Figure 4-75



1 RUDDEVATOR ANTI-ICE SWITCH
2 CIRCUIT BREAKERS
3 A/R FUEL LOW PRESSURE WARNING LIGHT (2 PLACES)
4 HYDRAULIC OIL SUPPLY VALVE SWITCHES (2 PLACES)
5 A/R HYDRAULIC SYSTEM PRESSURE GAGES (2 PLACES)
6 A/R FUEL QUANTITY GAGES (2 PLACES)
7 A/R FUEL QUANTITY INDICATOR PUSH-TO-TEST BUTTONS (2 PLACES)
8 A/R LINE VALVE POSITION LIGHT
9 A/R LINE VALVE SWITCH
10 A/R CONTACT LIGHTS
11 A/R PANEL LIGHT SWITCH
12 A/R PANEL LIGHT RHEOSTAT
13 A/R FUEL DUMP SWITCHES (BEHIND COVER)
14 A/R FUEL HIGH LEVEL WARNING LIGHTS (2 PLACES) F G 1243 ▶ 22664
15 A/R TRANSFER VALVE SWITCHES (2 PLACES)
16 A/R FUEL LEVELING VALVE SWITCH
17 A/R EMERGENCY FUEL-SHUTOFF LIGHT
18 A/R FUEL PRESSURE GAGE
19 A/R FUEL TOTALIZER RESET SWITCH
20 A/R FUEL FLOW AND TOTALIZER INDICATOR
21 ENGINEER'S A/R MASTER SWITCHES
22 A/R FUEL LEVELING VALVE LIGHT G

ENGINEER'S A/R PANEL F

Figure 4-76 (Sheet 1 of 2)

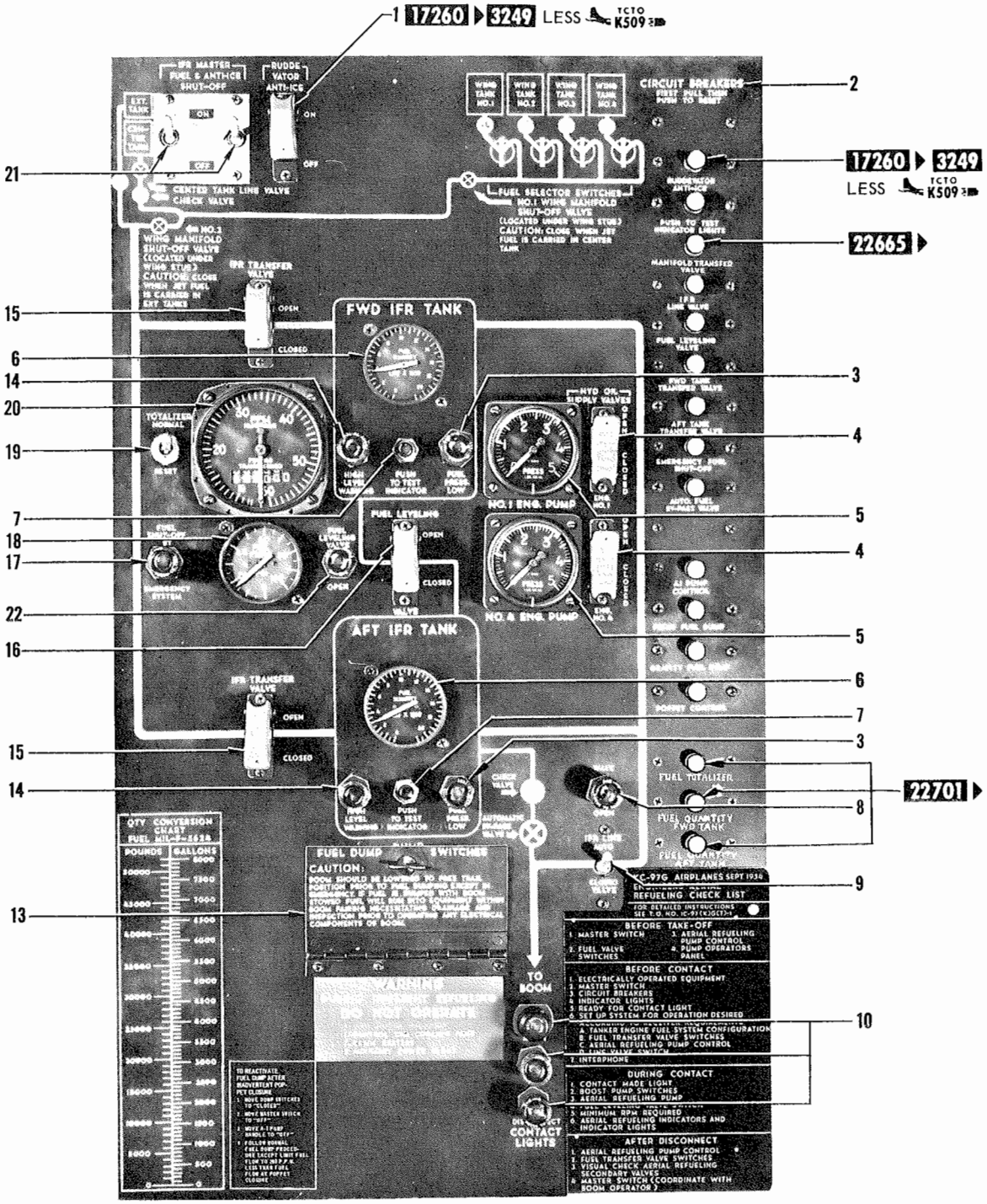


Figure 4-76 (Sheet 2 of 2)

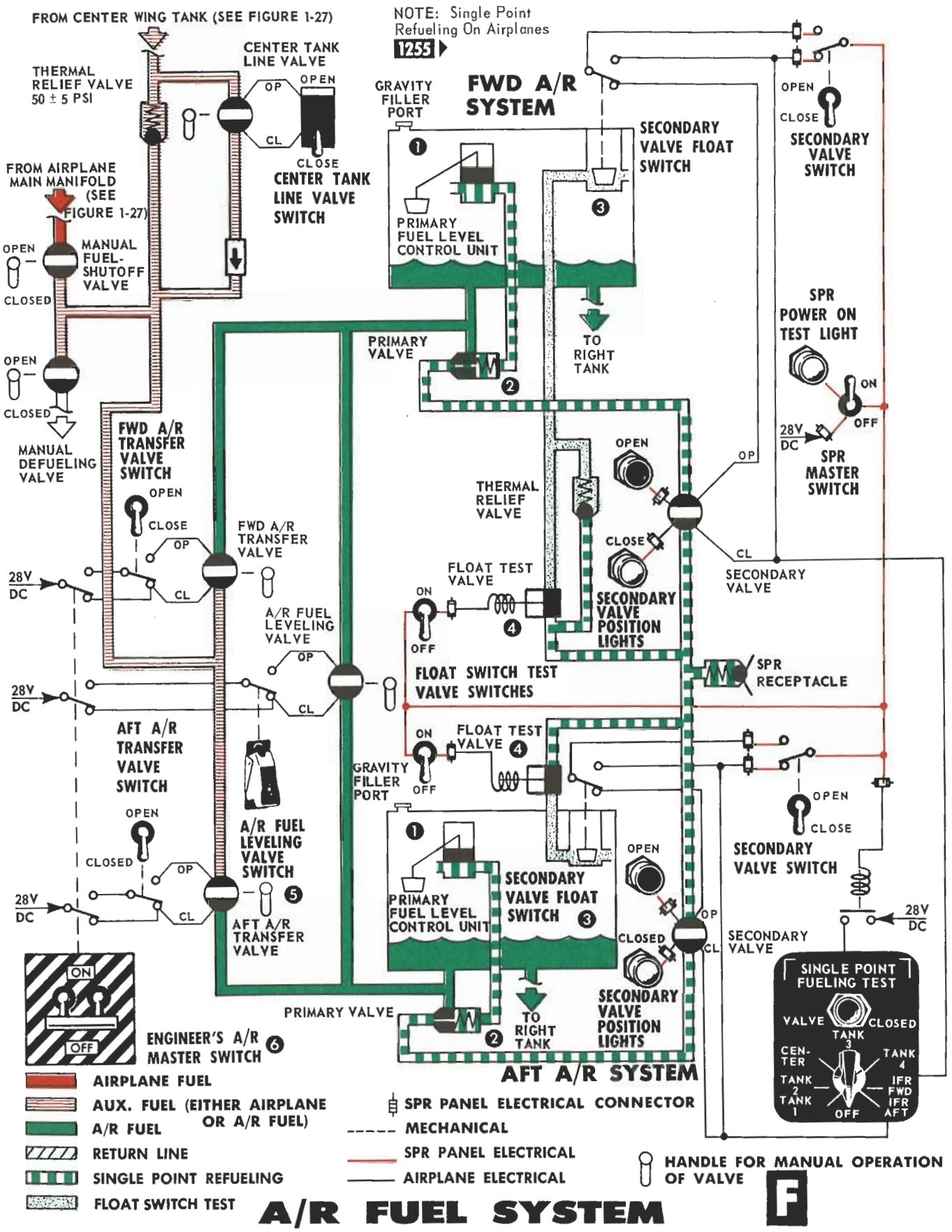
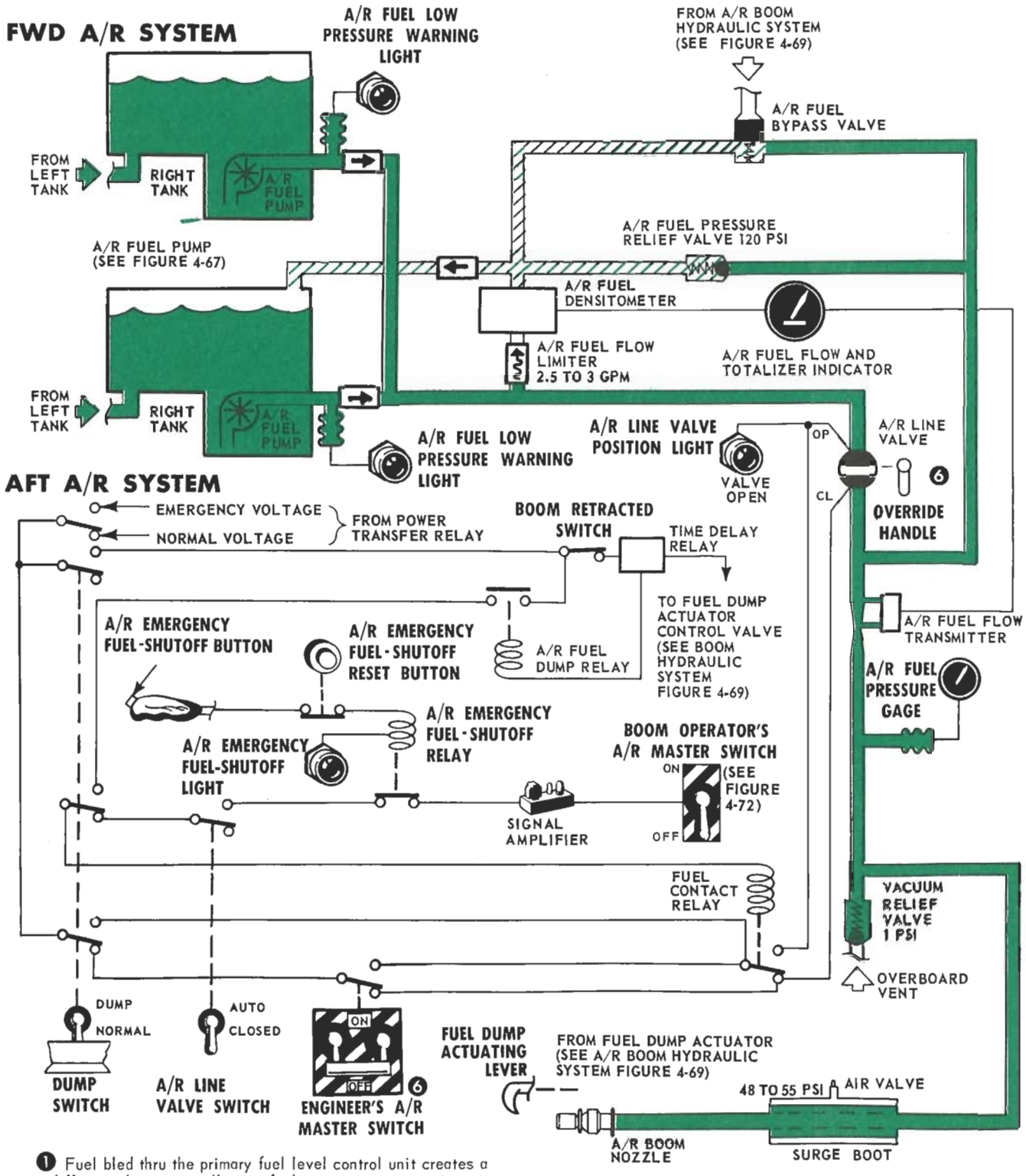


Figure 4-77 (Sheet 1 of 6)



❶ Fuel bled thru the primary fuel level control unit creates a differential pressure allowing fuel pressure to open primary valve

❷ When the primary fuel level control unit closes, equalization of pressures allows spring to close primary valve

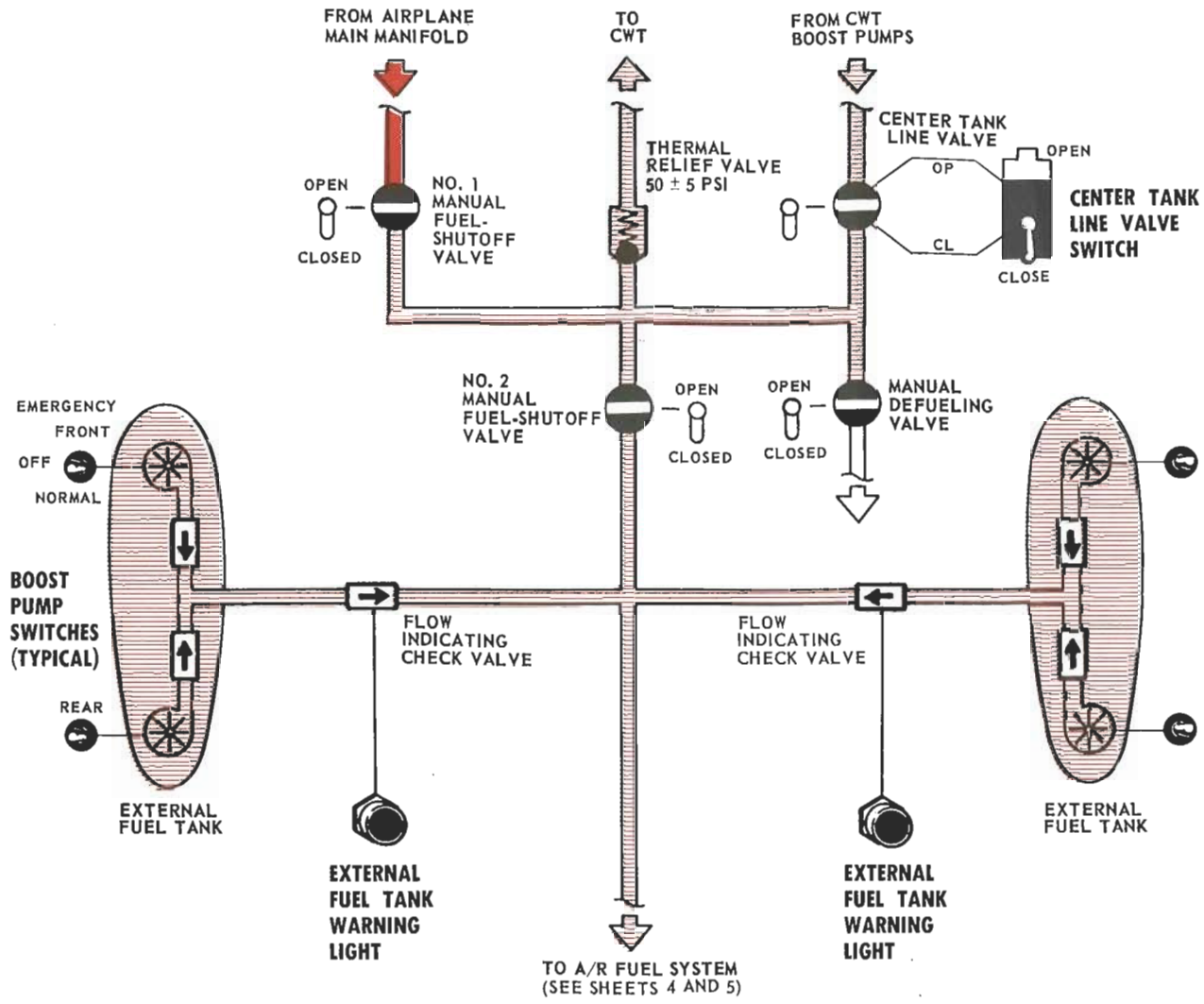
❸ If primary valve fails to shutoff fuel, flow, secondary valve float switch actuates and electrically closes secondary valve

❹ 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

❺ 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

❻ The engineer's A/R master switch does not shutoff electrical power when in the off position, but directs power to close the A/R fuel transfer valves, leveling valves, and A/R line valve by bypassing the individual valve switches

Figure 4-77 (Sheet 2 of 6)



A/R FUEL SYSTEM (CONT')

G

Figure 4-77 (Sheet 3 of 6)

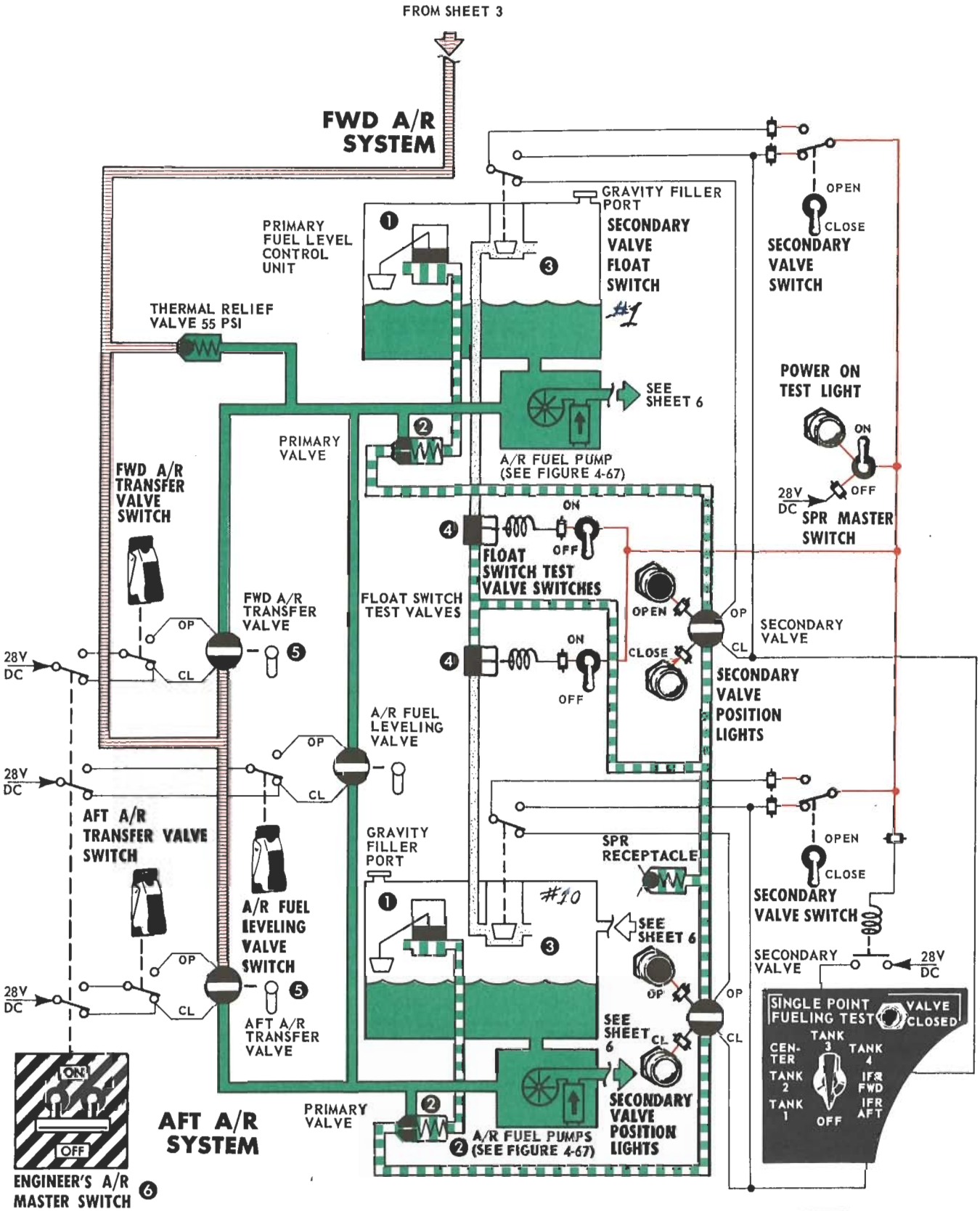
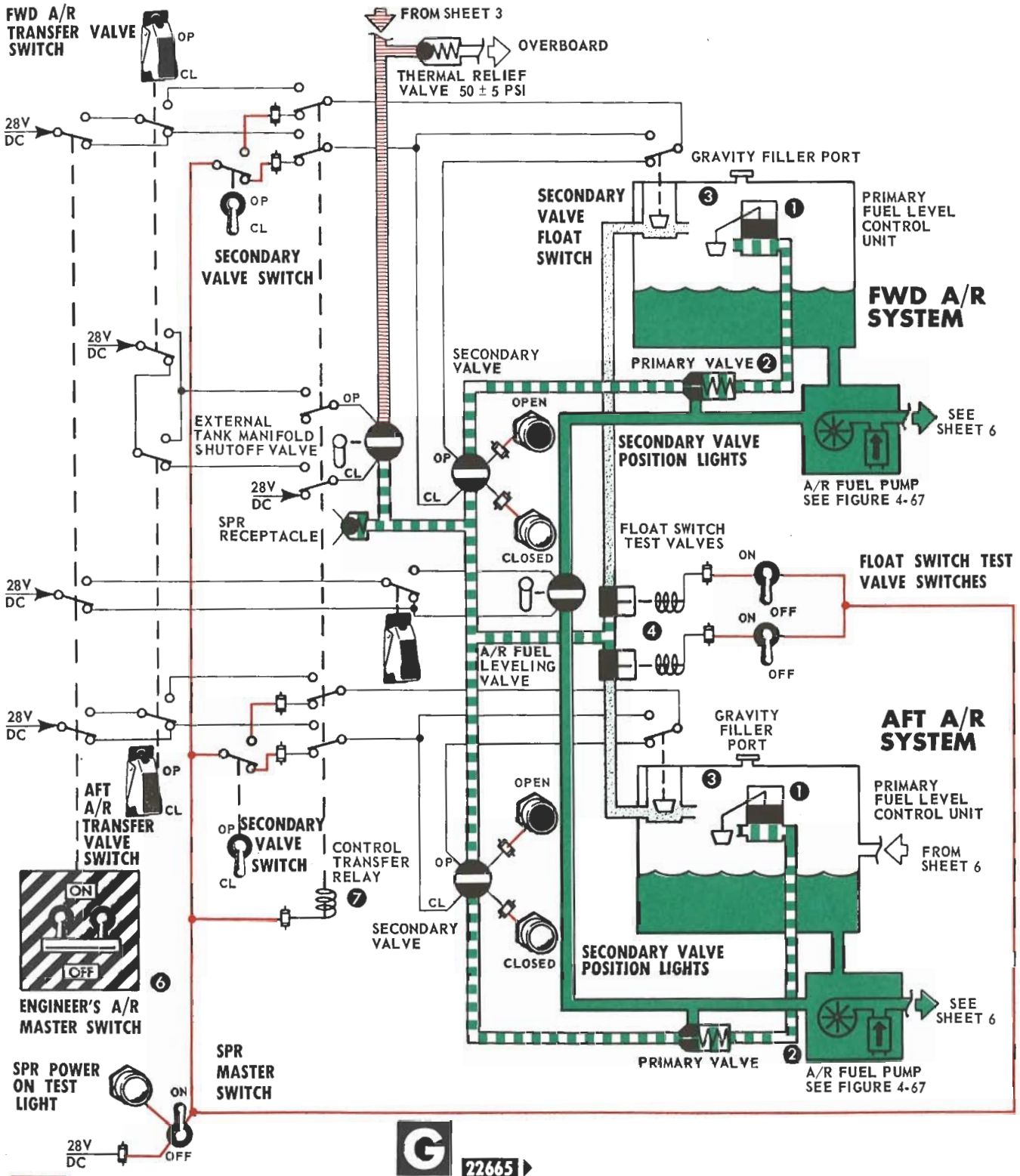


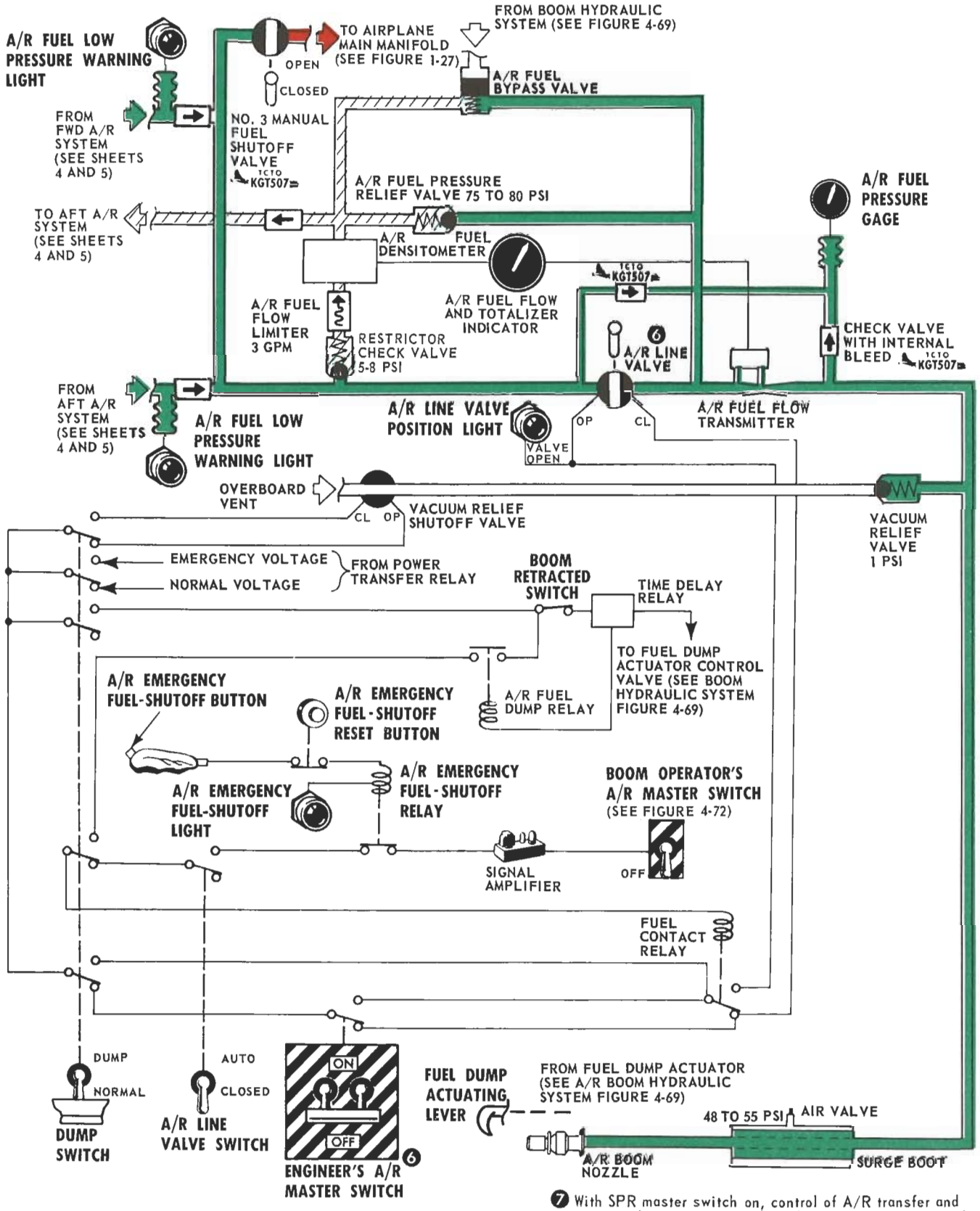
Figure 4-77 (Sheet 4 of 6)

17260 ▶ 22664



A/R FUEL SYSTEM (CONT)

Figure 4-77 (Sheet 5 of 6)



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 4-77 (Sheet 6 of 6)

G 17260

A/R Fuel Leveling Valve Light G

An amber light (22, figure 4-76) on the engineer's A/R panel will illuminate when the 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 (figure 4-62). With the fuel dump control valve in the de-energized 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 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.

Fuel Dump Switches

Three NORMAL--DUMP switches (13, figure 4-69) 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:

1. 28 volt DC power from the forward power panel or the 24 volt DC battery will supply the electrical power
2. The boom hydraulic system will become pressurized
3. Provide power to snub switch
4. Boom disconnect relay energized which:
   a. Interrupts power to No. 4 valve (open)
   b. Energizes the No. 2 valve (closed)
   c. Energizes the No. 5 valve (open)
   d. Interrupts power circuit of contact-made relay (At this time the boom will automatically retract, provided the boom hydraulic system depressurization valve is closed)
5. When the boom is retracted and the fuel dump relay No. 2 is energized, the following happens:
   a. Boom nozzle poppet valve opens (hydraulically)
   b. Fuel bypass valve closes
   c. Contact fuel relay energized which:
      (1) Energizes the A/R fuel pump pressure warning light circuits
      (2) Energizes No. 6 valves (closed)
      (3) Fuel line valve energized (open)

Fuel Dumping

For fuel dumping procedure see FUEL DUMPING, Section III.

AIR REFUELING TERMINOLOGY

AIRBORNE STANDBY TANKER - An airborne tanker stationed at a given location on or near course to refuel airplanes which may require additional fuel due to inflight emergencies or terminal weather.

AIR REFUELING (A/R) - The refueling of an airplane in flight by another airplane.

AIR REFUELING AREA - An area designated for air refueling operations and identified by a code name.

AIR REFUELING CELL - One or more airplanes scheduled to accomplish air refueling.

AIR REFUELING CONTROL POINT (ARCP) - The planned geographic location over which the receiver arrives in the observation position with the assigned tanker.

AIR REFUELING CONTROL TIME (ARCT) - The planned time that the receiver and tanker will arrive over the air refueling control point (ARCP).

AIR REFUELING ENVELOPE - That area behind the tanker in which the receiver must fly to remain in contact with the tanker.

AIR REFUELING INITIAL POINT - A point located along an extension of the planned air refueling track and upstream approximately 150 nautical miles from the air refueling control point (ARCP).

AIR REFUELING RENDEZVOUS - The procedure employed to enable the receiver to reach the observation position behind the assigned tanker by electronic, radio, and/or visual means.

a. ALTERNATE RENDEZVOUS - The procedure to be followed due to radio communications and/or electronic failure.

b. BUDDY RENDEZVOUS - That procedure normally used when tanker and receiver take off from the same base and electronic and/or visual contact is maintained.

c. HEAD-ON RENDEZVOUS - That procedure normally used when the tanker approaches the receiver on a reciprocal to the refueling track and a 180-degree course change is planned for the tanker with no orbit.

d. POINT RENDEZVOUS - That procedure normally used when the tanker arrives in the air refueling area before the receiver and a tanker orbit is planned.

AIR REFUELING SYSTEM NORMAL OPERATION - Both tanker and receiver using normal signal system.

AIR REFUELING TIME - Planned elapsed time from air refueling control point to completion point.

ALTERNATE REFUELING AREA - That area in which refueling will be conducted when the primary area cannot be used.

BASE ALTITUDE - A reference altitude at which lead airplane of formation (or single airplane for individual air refueling) will fly at initial contact.

BREAKAWAY - The command used by either tanker or receiver flight crew members to indicate need for emergency separation of airplanes.

COMPLETION POINT - The planned geographical point where air refueling should be completed and receiver sets course to continue his mission.

CONTACT - That configuration in which the air refueling equipment is connected.

CONTACT POINT - The geographical point along the refueling track where fuel transfer should commence.

CONTACT POSITION - The stabilized position of the receiver airplane within the A/R envelope where it is possible to make contact.

DESCENT AIR REFUELING - Air refueling during a descending flight path.

DESCENT RANGE - That distance between tanker and receiver at which receiver initiates descent in order to arrive in the observation position at the air refueling control point.

DISCONNECT - The command that necessitates tanker and receiver separation, but not warranting a "Breakaway."

FORMATING AIRSPEED - An airspeed or Mach number at which air refueling will be initiated.

MANDATORY DROP-OFF POINT (BINGO) - That point in space and time where the receiver must proceed to the alternate airport in the event hook-up and fuel transfer have not been effected.

MANUAL BOOM LATCHING (MBL) - Both tanker and receiver air refueling systems in manual operation.

MASS RENDEZVOUS AND AIR REFUELING - The procedure employed for rendezvous and air refueling between tanker and receiver forces using one or more air refueling control points simultaneously in the same air refueling area.

MULTIPLE AIR REFUELING CONTROL POINT PATTERN - That pattern of air refueling control points used for mass rendezvous air refueling when more than one air refueling control point is required.

OBSERVATION POSITION - Receiver's Stabilized position (approximately 100 ft) behind and slightly below assigned tanker.

OFFLOAD/ONLOAD - That amount of fuel transferred between tanker and receiver airplanes.

ORBIT DEPARTURE TIME - That time at which the tanker will depart the orbit point to effect the planned rendezvous.

RADIO SILENCE - Air refueling without the aid of verbal commands.

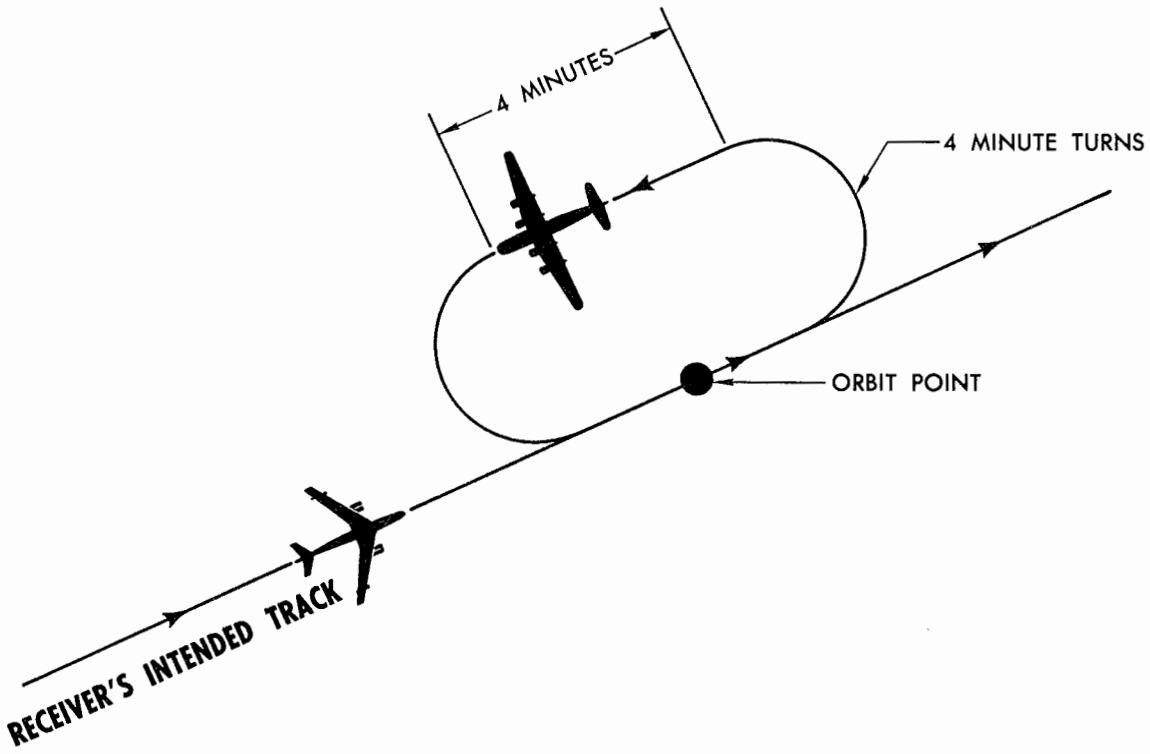
RECEIVER-TANKER DEPARTURE POINT - Two points approximately 300 NM apart on or near the planned A/R track from which the receiver and tanker depart to effect a head-on rendezvous.

SEPARATION DISTANCE - The slant range distance used in conjunction with the 180 degree head-on or point rendezvous to determine the tanker "start turn" point.

TANKER MANUAL OPERATION - Receiver air refueling system in normal; tanker air refueling system in manual operation.

TANKER ORBIT PATTERN - The pattern flown by the tanker near the orbit point when performing a point rendezvous.

TANKER ORBIT POINT - A geographical point along the planned air refueling track where the tanker will orbit.



TANKER ORBIT PATTERN

Figure 4-78

AIR REFUELING OPERATIONS

SEE SAC OP. PROCEDURE 62-2.

Orbit

Tanker airplane will orbit over the designated orbit point in a race track pattern to the left and parallel to the receiver's refueling track. (See figure 4-78.) Local altimeter setting will be utilized unless tactical operational requirements dictate otherwise. The orbit pattern will be flown utilizing four-minute legs and four-minute turns; however, the navigator may vary the length of leg or rate-of-turn if the receiver is delayed or to effect orbit departure time. Tankers will be in the orbit pattern fifteen minutes prior to planned departure for the ARCP. Flight plans will include fifteen minutes of additional fuel to accomodate late receivers.

The tanker navigator will control the orbit departure time so as to depart the orbit on refueling course and arrive at the ARCP simultaneously with the receiver. Orbit departure time will normally be based on receiver's latest ETA for the ARCP; however, the separation distance as indicated by the rendezvous equipment must be monitored to revise orbit departure time if necessary (approximately 50 NM separation). This will insure that tanker and receiver both fly the same course during the critical stages of rendezvous, which will provide planned rate of closure, accurate descent range, and best antenna positioning for rendezvous equipment. In all cases it must be clearly established between tanker and receiver what equipment is being used for the rendezvous, and the relative reliability of the indications upon which the information is being based. See RENDEZVOUS EQUIPMENT COMPATABILITY, figure 4-79.

Rendezvous Procedures

Both tanker and receiver crews will monitor the designated radio frequency at least forty minutes before planned air refueling control time. Receiver airplane rendezvous equipment will be on at least forty minutes prior to planned air refueling control time. Tanker navigator will insure that rendezvous equipment is turned on a minimum of forty minutes prior to receiver's ETA for the ARCP. The APN-69 radar beacon will be used as the primary method of electronic rendezvous, with the APN-12 Rendezvous Radar or APN-76 Rendezvous Radar being monitored for backup when installed.

The receiver pilot will communicate with the tanker pilot as far from the ARCP as possible, giving ETA to the ARCP, APN-69 beacon reception, range if in electronic contact, descent range and contact speed. To prevent erroneous electronic indications being used, it is imperative that tanker and receiver attempt to identify and confirm each other's electronic signal as soon as possible. Turning the equipment off momentarily is an effective method of insuring positive identification of rendezvous signal. In no case should this identification be completed later than the receiver's arrival at the refueling IP.

When the receiver is effecting the rendezvous utilizing signals from the tanker's APN-69 radar beacon, the tanker must be advised of the range separation. Ranges normally will be called in 10 nautical mile increments from the 50 nautical mile range to the 20 nautical mile range; then a call at the 15 nautical mile range and 12 nautical mile range. After this, calls are continued in one nautical mile increments until visual contact is established. The tanker pilot will resume control of the command radio and will communicate with the receiver pilot when the receiver range has closed to 3 NM. The receiver pilot will communicate with the tanker pilot and will relay his range and indicated airspeed at the three (3), two (2), one (1), and the one-half (1/2) Nautical Mile ranges.

When the APN-12 or APN-76 is used to accomplish the rendezvous, the tanker navigator will transmit course corrections and range to the receiver. Ranges will be transmitted every 20 nautical miles to a minimum of 100 nautical miles, and thereafter every 10 nautical miles until a point 5 nautical miles from descent range, after which range to descent point will be called in one nautical mile increments. After calling the descent range, the tanker will continue to call ranges every ten nautical miles down to ten nautical mile range, after which point the range will be called in one nautical mile increments down to the four nautical mile range. At the four nautical mile range, the tanker navigator will transmit, "Take over receiver." The receiver pilot will transmit the three (3), two (2), one (1) and one-half (1/2) nautical mile ranges and indicated airspeeds to the tanker pilot. Course corrections may be transmitted at any time regardless of range.

The AN/ARA-25 UHF/DF, if installed, will be used as a reference to receiver/tanker position during electronic rendezvous. An additional rendezvous capability is the use of a medium frequency homing identifier to be picked up by receivers equipped with radio compass.

Rendezvous Equipment Failure Procedures

When equipment malfunctions prevent an electronic rendezvous, the following action will be taken:

1. Receiver will transmit to tanker an ETA to the ARCP based on latest known information.
2. Tanker will depart the orbit point to make good the receiver's latest ETA to the ARCP. Should radio failure prevent receiver transmitting an ETA to the tanker, the flight planned ARCT will be made good by both tanker and receiver.
3. When the tanker arrives at the ARCP an attempt will be made to establish visual contact. If visual contact is established with receiver, proceed with normal A/R operations. If visual contact is not established, tanker will orbit the ARCP for 15 minutes after the scheduled ARCT or as otherwise briefed.
4. When attempting to establish visual contact over the ARCP, the receiver may ask the tanker to dump fuel when passing over the ARCP. This should be done in 1000 pound increments using 2500 ppm fuel flow. Normally not more than 3000 pounds should be dumped.

Lighting

Under night or low visibility conditions, the following lighting and visual backup provisions apply:

1. Night refueling lights will be turned on by tanker airplane when in positive radar contact with the receiver and when the range has closed to 30 nautical miles. If radar contact is not made, the refueling lights will be turned on 20 minutes before the latest ETA of the receiver.
2. All navigation lights, anti-collision lights, rendezvous lights, underwing and underbody lights will be on during rendezvous. If rendezvous lights are not installed, boom operators will be equipped with Aldis lamps complete with color slides to shine out the pod in the direction of receivers.
3. Flares may be utilized if available. The tanker commander will inform the receiver commander of the color of flare being fired. (This will be done only at the request of the receiver commander to aid in identifying the proper tanker.)
4. When receiver arrives in the observation position, light switches will be positioned as outlined in the pilot's and boom operator's check lists and figure 4-82, EXTERIOR LIGHTING DURING AIR REFUELING.

KC-97	B-47	B-52
APN–12 Range & Relative Position Only	APN–76 Rendezvous Radar (Transponder)	APN–76 Rendezvous Radar (Transponder)
APN–76 Transponder less TCTO K572		
APN–69 Radar Beacon	APS–23 Search Radar APS–64 Search Radar	ASQ–38 Search Radar APS–64 Search Radar
APS–42 Search Radar	APN–69 Radar Beacon	APN–69 Radar Beacon
ARA–25 UHF/DF TCTO 321	ARC–27 UHF Radio	ARN-27 ARC-34 UHF Radio
ARC–27 UHF Radio		ARA–25 UHF/DF
ART-13 MF XMTR	ARN–6 Radio Compass RCVR	
ARC–3 VHF Radio	ARN-14 VHF Navigation Radio (Omni)	ARN-14 VHF Navigation Radio (Omni)
Anti-Collision Lights TCTO 591 Rendezvous Beacon Lights G 3196 ▶ plus TCTO K231	Visual	Visual
Pyrotechnics	Visual	Visual

RENDEZVOUS EQUIPMENT COMPATABILITY

Figure 4-79

5. The receiver and tanker will turn off any lights on top, bottom or tail that may be considered a hazard to the refueling operation.

6. The receiver may turn on landing lights after contact position has been accomplished.

A/R Procedures

1. The tanker will establish 230 KTAS when departing the orbit point and will maintain 500 feet above air refueling altitude until the receiver has approached the 12 nautical mile range point. (See figure 4-80.) The refueling altitude may be limited either by tanker or receiver. When higher performance receiver airplanes (for example, the B-47) are refueled or, if for any other reason it is difficult to obtain the desired airspeed, a constant descent will provide higher airspeeds without impeding the contact. If this condition exists, shortly after fuel transfer has commenced the tanker pilot will gradually nose the tanker down as required to obtain the desired gradual increase in speed. It should not be necessary to exceed 150 to 300 feet per minute rate of descent. The flight crews prior to contact will have agreed upon the desired initial and final airspeeds and approximate duration of the contact. With this information, the tanker pilot can increase airspeed with ample accuracy by varying the rate of descent. If it is necessary to exceed 220 knots IAS, caution should be exercised as boom ruddevator control becomes critical above this speed. See figure 4-80 for A/R Rendezvous Profile.

2. The tanker accelerates to the formating speed of 250 KTAS by descending 500 feet to the refueling altitude when the receiver has approached within 12 nautical miles. The receiver's speed advantage enables it to close and formate with the tanker. The formating speed is a function of the receiver and tanker gross weights. Good operational planning is required to insure that both airplanes will be at compatible gross weights and air speed schedules during refueling.

3. The receiver levels out 500 feet below refueling altitude and decelerates in accordance with the following speed schedule:

   a. B-47.

      (1) Four Nautical Miles -- 310 KIAS.

      (2) Three Nautical Miles -- 275 KIAS.

      (3) Two Nautical Miles -- 250 KIAS.

      (4) One Nautical Mile -- 225 KIAS.

   b. B-52.

      (1) Four Nautical Miles -- 270 KIAS.

      (2) Three Nautical Miles -- 270 KIAS.

      (3) Two Nautical Miles -- 250 KIAS.

      (4) One Nautical Mile -- 225 KIAS.

4. Prior to receiver reaching 1/2 NM range, the air refueling boom will be lowered. The rendezvous equipment will be turned to standby when the receiver reaches the observation position.

   Receiver airplane will establish a zero rate of closure in the observation position prior to moving forward for contact.

5. The fuel transfer rate will be as follows:

   a. B-47.

      (1) 3500 pounds per minute when scheduled offload does not exceed deck A/R tank capacity.

      (2) First 70 percent scheduled offload at 3500 pounds per minute and final 30 percent at 2500 pounds per minute when total offload exceeds deck A/R tank capacity.

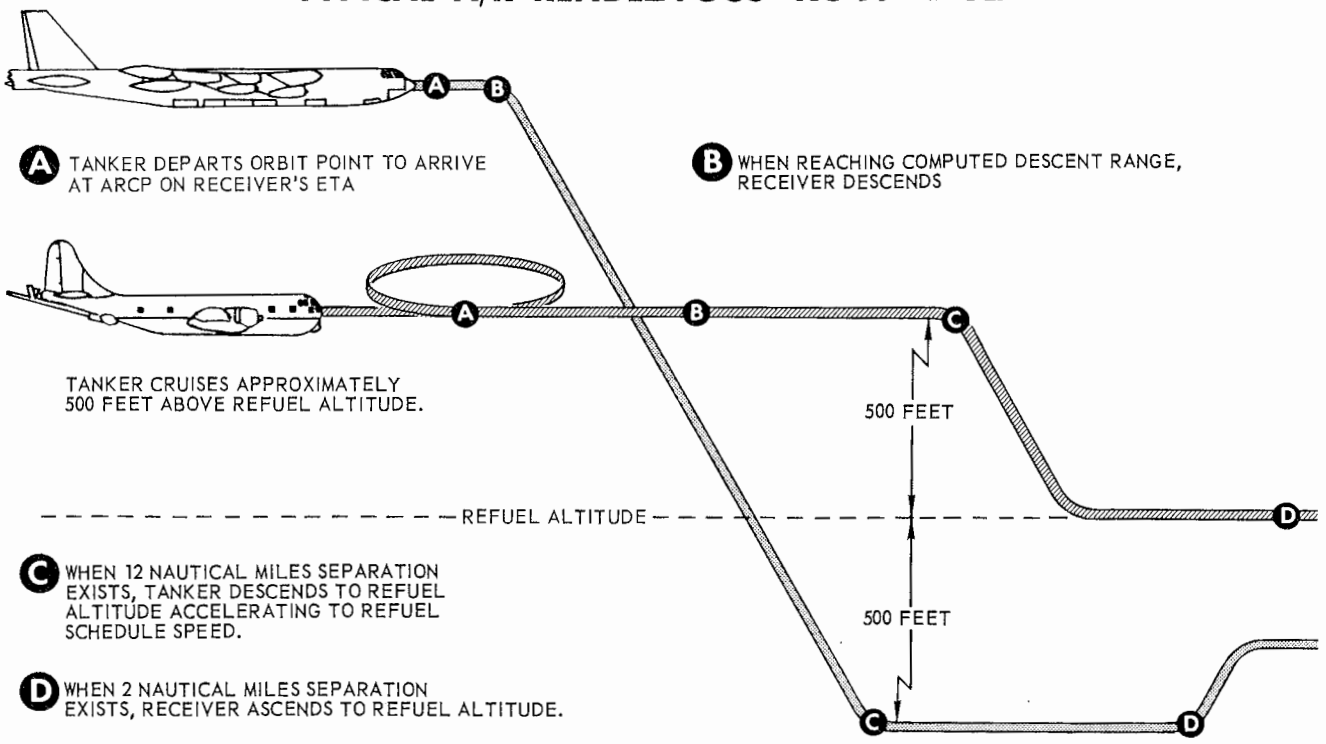
   b. B-52 -- 5000 pounds per minute.

6. Upon completion of refueling, the receiver will move back into observation position. The tanker will execute a 45° turn to the left to afford airplane separation.

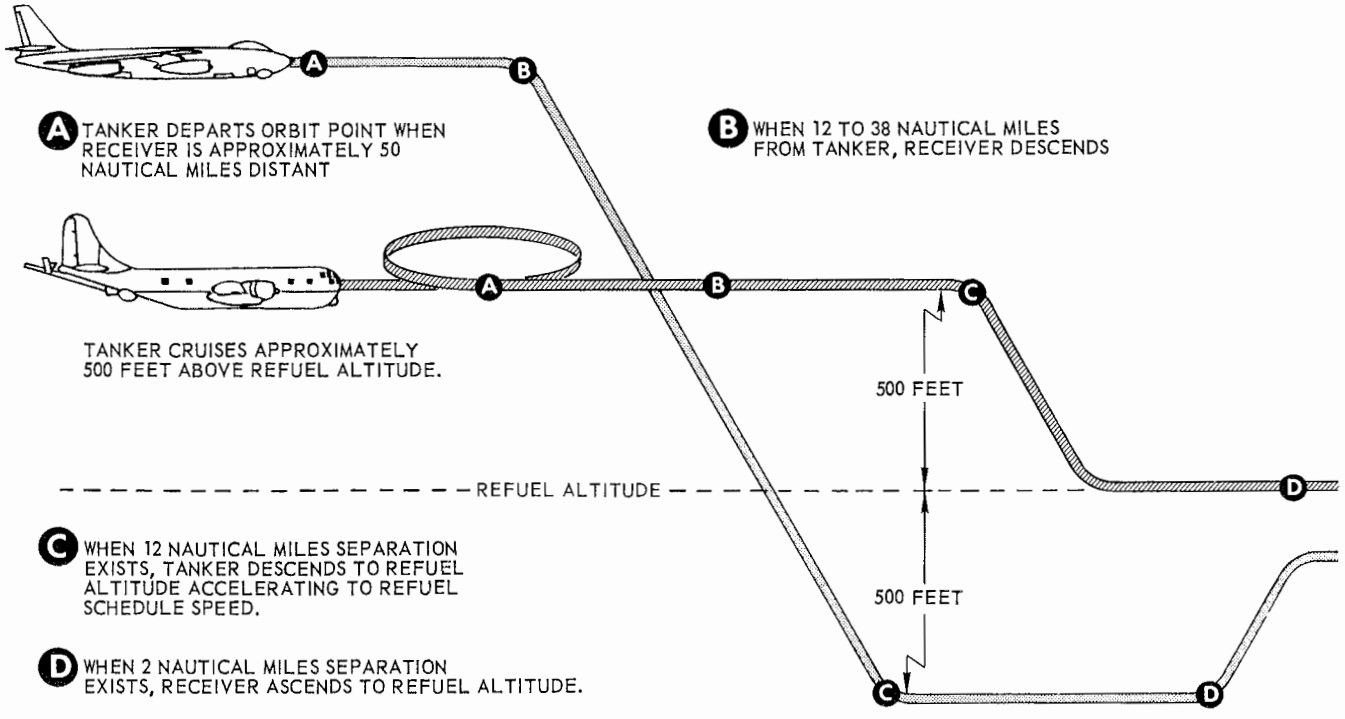
Tanker Pilot Technique

FLYING AT CONSTANT ALTITUDE. The tanker is essentially a platform for the flying boom. The tanker pilot must therefore, fly the airplane in such a manner as to provide the most stable platform possible. During the time that contact is being established, flight at constant attitude is important for two reasons: to provide a stable platform for accurate operation of boom and to make it easier for the receiver pilot to get into the contact position and remain in the envelope. After contact is established the tanker pilot should continue to maintain a stable attitude and in particular refrain from excessive rudder and elevator control. This must be kept in mind especially while the tanker is flying formation on another airplane. Establishing and maintaining contact in smooth air is relatively easy. However, smooth air rarely occurs and in the mild to moderate turbulence which will generally prevail, it is important that care be exercised in flying the tanker. As the boom is lowered in preparation for contact, the

TYPICAL A/R RENDEZVOUS—KC-97—B-52

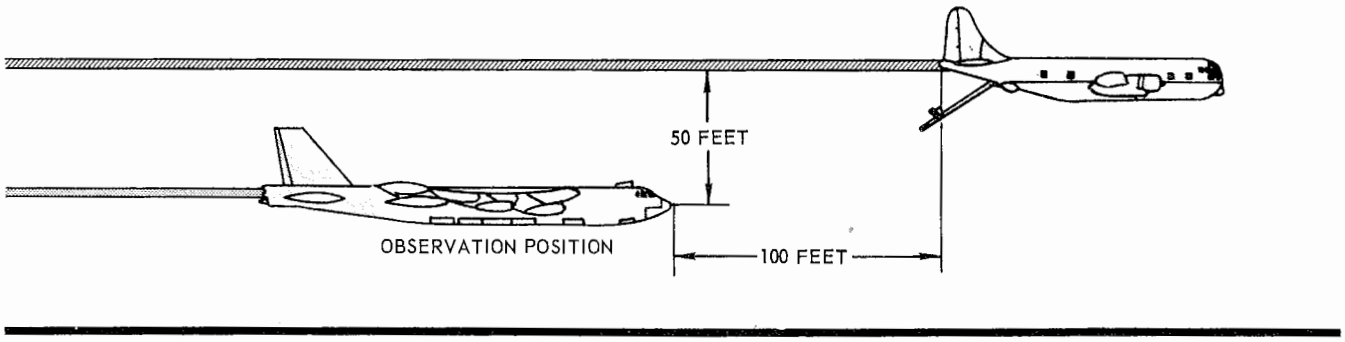


TYPICAL A/R RENDEZVOUS—KC-97—B-47



A/R RENDEZVOUS PROFILE

Figure 4-80 (Sheet 1 of 2)



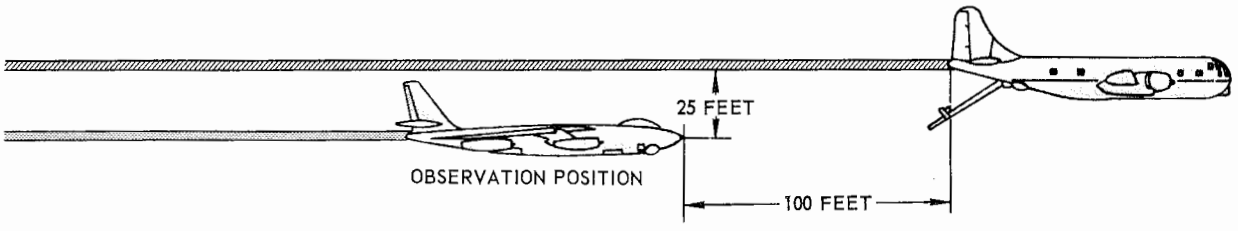


Figure 4-80 (Sheet 2 of 2)

ITEM	DURING RENDEZVOUS	DURING CONTACT
Navigation Lights	Bright Flashing (N)	Dim Steady (N)
Anti-Collision Lights TCTO 591	Both On (N) (D)	Top On (D) (N) Bottom Off (D) (N)
Wing Illumination Lights	On (N) Off (D)	On (N) Off (D)
Under Body Light	Bright (N) Off (D)	Bright (N) Off (D)
Under Wing Lights	Bright (N) Off (D)	Bright (N) Off (D)
Boom Marking Lights	Off (D) (N)	Upper Set On (B) B-47 (N) Lower Set On (B) B-52 (N)
Receiver Director Lights	Off (D) (N)	Sta. 750 Set On (B) (N) Full Intensity (D) Sta. 350 Set to Full Intensity (D) (N) TCTO K526
Boom Nozzle Lights	Off (D) (N)	Lower Set On (B) (N)
Interior Lights	Optional	No Bright Lights (N)
Rendezvous Beacon Light G 3196 plus TCTO K231	On (D) (N)	Off (D) (N)

(B) Position is the first letter in the word BRIGHT located above each rheostat on the boom operator's panel

(D) Day

(N) Night

EXTERIOR LIGHTING DURING AIR REFUELING

Figure 4-81

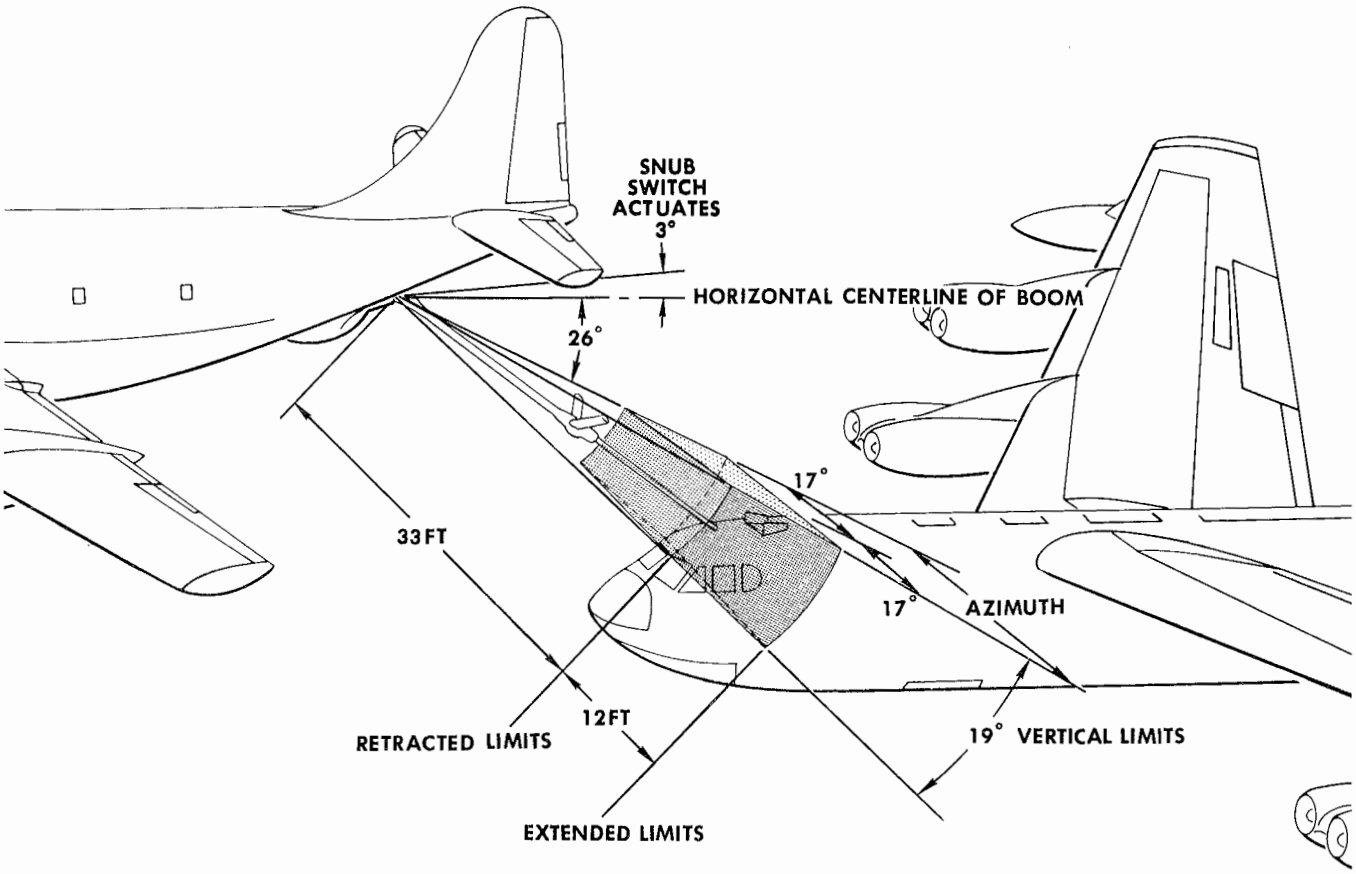
tanker pilot will observe that the airplane will slow down about 5 knots and become slightly nose heavy. The airplane should then be retrimmed and power set up for the desired refueling airspeed for the particular receiver. Additional trim may be required as the receiver gets within 15 feet of the contact position since the bow wave of large receivers makes the tanker slightly nose heavy. It is a most important requirement that the tanker pilot make no power changes after the receiver starts to move in for contact.

AIRSPEED. As fuel is off-loaded from the tanker, the tanker airspeed will slowly increase. This is advantageous for the following reasons:

1. Refueling may be initiated at lower airspeeds. This is important when the tanker is beginning a high altitude transfer at high gross weight. Also it is less difficult for the boom operator to make contact at lower airspeed
2. Tanker engine cooling is improved as the refueling progresses because during an extended transfer, it might become critical at high altitude and high gross weight
3. The receiver is assisted in maintaining a comfortable margin above stalling speed as its gross weight increases. This, of course, is particularly important when receivers having higher stalling speeds than the tanker, are used. Adjustment of power will be limited to 1/2 in. Hg per engine, across the board. If the tanker is operating below meto power, a slight increase in MP will assure safe stall margin for the receiver; however, if the tanker is operating at meto power and off-loading of fuel does not result in sufficient increase in airspeed, a slight descent must be initiated
4. If a disconnect is experienced before transfer is completed, the tanker pilot should maintain the airspeed and rate of descent scheduled for that period of off-load when the disconnect occurred until a new contact is established; then resume briefed airspeed increase when transfer starts
5. An increase in airspeed, if possible, will minimize inadvertent disconnects resulting from turbulence.

TURNS IN CONTACT. Moderate turns for navigational purposes can be made while in contact. There will usually be continuous slight tanker pitching because of nudging by the receiver airplane, even in smooth air. Therefore, it is most important that the tanker pilot remember to hold as steady an attitude as possible without large or sudden control movements. During the actual fuel transfer period, as the tanker gross weight decreases, the average attitude will slowly become more nose down when the constant altitude procedure recommended for comparable performance receivers is followed.

ROUGH AIR. In rough weather, strong gusts require immediate corrective action, but airplane pitching, yawing, or rolling due to moderate gusts should be ignored unless return to original attitude does not occur. The reason is that for two similar airplanes flying in such close formation, the gust effect on each is approximately the same. If the tanker pilot were to fight the controls, overcontrolling would usually occur resulting in inadvertent disconnect due to tanker and receiver airplane move-

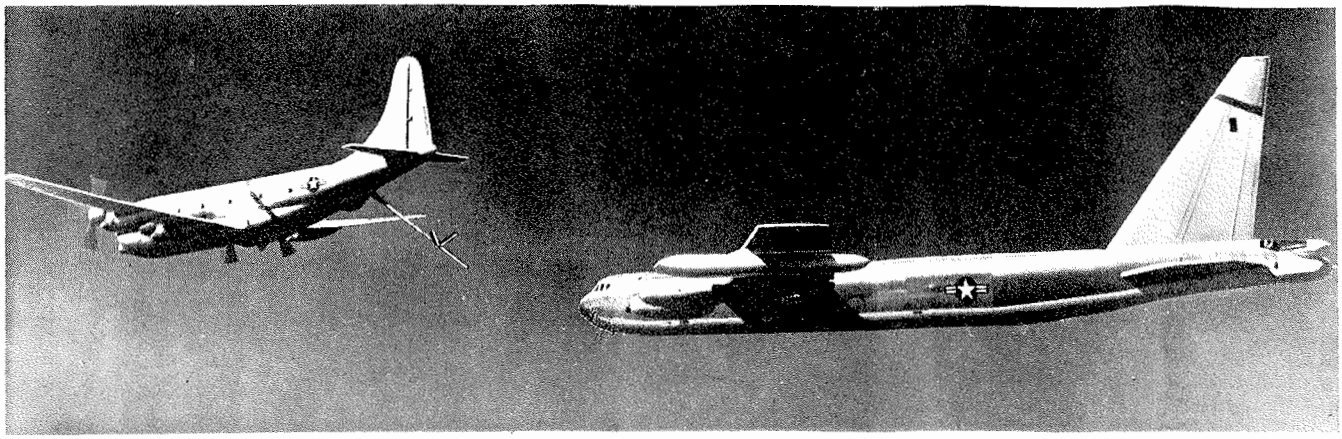


BOOM ENVELOPE LIMITS

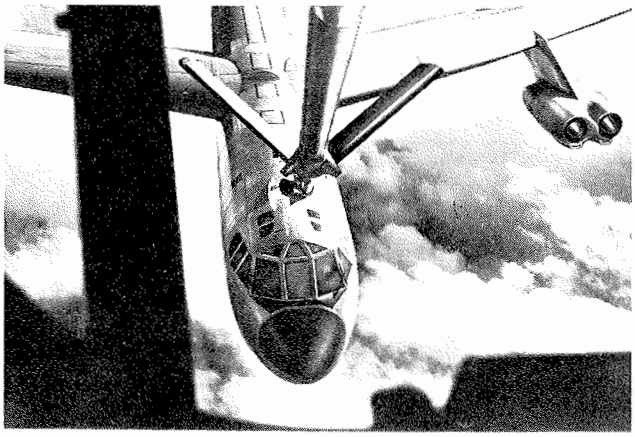
Figure 4-82

ments getting out of phase with each other. Momentary changes of airspeed due to turbulence or other causes should be disregarded. If, during a constant altitude refueling, the altitude goes beyond a tolerance of ± 200 feet, the pilot should edge back toward the nominal desired altitude by a change in power, but holding the same airspeed. To sum up rough air pilot technique; in the first of two extremes the pilot makes little or no effort to offset, with elevator movement, the pushing and pulling of the receiver. In such a case the tanker and receiver continue to pitch until they get out of phase and go to automatic disconnect. In the second extreme the tanker pilot fights the controls to hold absolutely constant altitude, thereby forcing the receiver pilot to work much harder to hold the green light position. Good tanker flying requires that the pilot operate somewhere between these two extremes. It has been found that an increase in airspeed, if possible, will minimize inadvertent disconnects resulting from turbulence.

USE OF THROTTLE. Comparable performance receivers may not have sufficient power to maintain speed for contact during the latter part of a large fuel transfer at high gross weight. In this case it may be desirable for the copilot to reduce manifold pressure not more than 1/2 inch across the board on one engine at a time, repeating the power reduction every few seconds. If more abrupt power changes are made, the receiver airplane is likely to inadvertently disconnect by overrunning the tanker. Information to date indicates that the maximum practical altitude for refueling certain jet type receivers may be below 20,000 feet and the optimum altitude for such transfers below 15,000 feet. At the higher altitudes, tanker maximum level flight refueling airspeeds have forced the jet receivers to operate on the back side of their power required curves. With power requirements for the receivers as high as 95 to 100 percent rpm the jet receivers do not have sufficient power adjustment available to hold contact during the latter stages of the transfer.

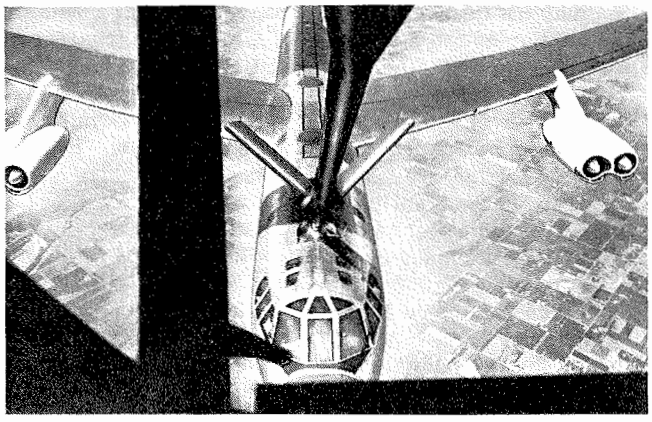


OBSERVATION POSITION



BEFORE CONTACT—
Seen From Tanker

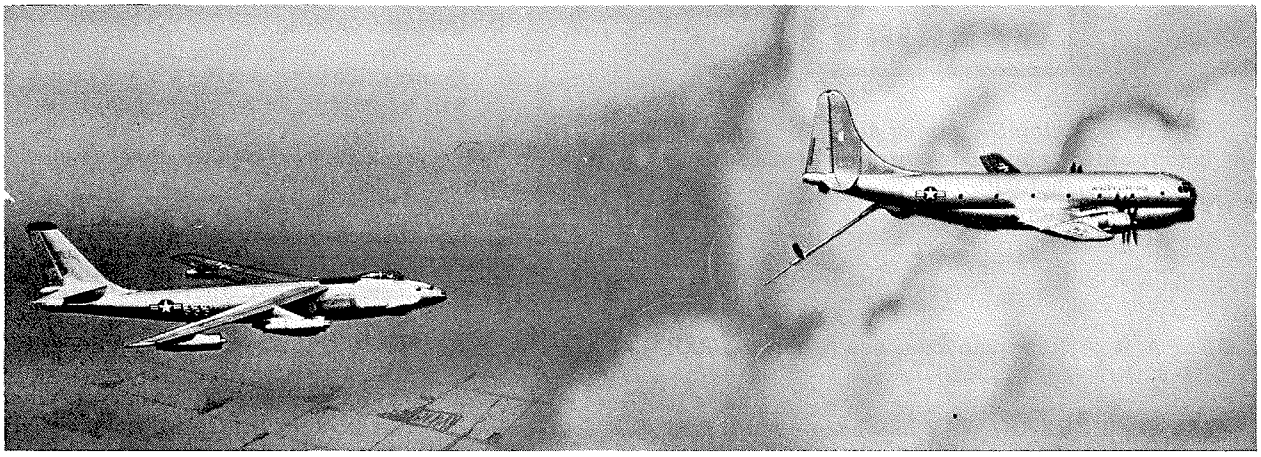
KC-97—B-52



CONTACT—
Seen From Tanker

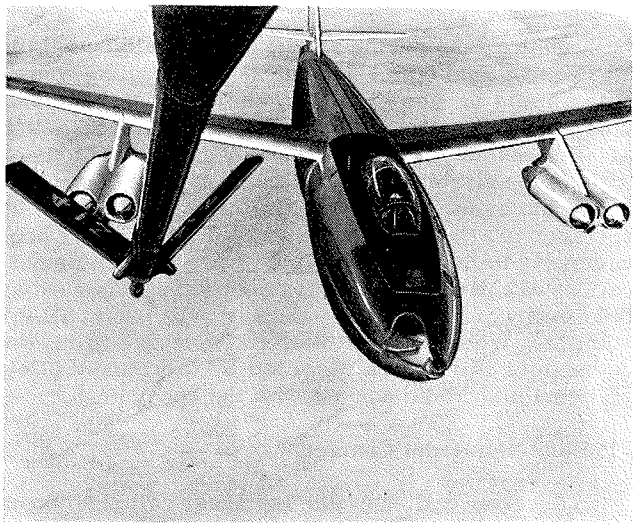
A/R FORMATING

Figure 4-83 (Sheet 1 of 2)



OBSERVATION POSITION

BEFORE CONTACT—
Seen From Tanker



KC-97—B-47

CONTACT—
Seen From Tanker

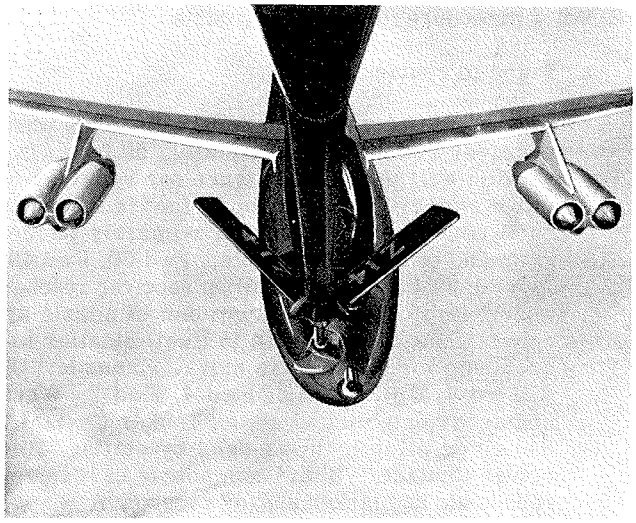


Figure 4-83 (Sheet 2 of 2)

WARNING

Do not use autopilot during an A/R operation. Inadequate or erratic autopilot functioning while in contact with the receiver airplane can result in structural damage to one or both of the airplanes.

NOTE

- For A/R performance data, see Appendix, T.O. 1C-97(K)F-1-1.
- The word BREAKAWAY has been established and reserved for use as a code word to indicate an emergency condition.

A/R Oral Communications

Communications during rendezvous should be held to an absolute minimum. The actual air refueling operation should be performed whenever possible under complete radio silence. Occasionally situations will arise, such as refueling under adverse conditions or with an inexperienced receiver pilot, when it will become necessary for the boom operator to give the receiver oral corrections. The following voice procedure is to be used as a guide when oral communications are necessary and it is not to be construed as the exact words the boom operator will use in all instances. When the receiver reaches 1/2 mile, the boom operator, when directed by the tanker pilot, will establish radio contact with the receiver.

1. Establish Radio Contact.

   "(Receiver call sign) this is (tanker call sign) boom operator, radio check." Acknowledge receipt of receiver's transmission.

2. Voice procedure for normal contacts.

   a. Prior to contact.

      Boom operator will begin communications when receiver reaches approximately 50 feet. Direction will precede distance for receiver to move and will be given in 10 foot increments until receiver reaches approximately 10 feet from end of boom. Example: Fwd 50, Fwd 40, Fwd 30, Fwd 20, Fwd 10. When receiver reaches approximately 10 feet from end of nozzle all corrections will be given in (feet) smaller increments for receiver to move. Example: Up 4, Fwd 8, Up 2, Fwd 6, Fwd 4, Fwd 2. When contact is established state "Tanker Contact." Receiver pilot acknowledges by stating "Receiver Contact." With boom nozzle in receiver receptacle and tanker and/or receiver A/R system does not advance to CONTACT MADE the boom operator or receiver pilot will call "Disconnect."

   b. During Contact.

      Communications during air refueling operation will be held to an absolute minimum.

3. Voice procedure for tanker manual operation and manual boom latching.

   a. Receiver Briefings:

      (1) Tanker Manual Operation Briefing. "(Receiver call sign), the following contacts will be made in Tanker Manual Operation. Receivers A/R system will remain in Normal. Receiver pilot must initiate all disconnects. Inform boom operator when receiver A/R system is in contact made. "Tanker ready." Receiver pilot will acknowledge transmission by stating "Receiver ready."

      (2) Manual Boom Latching Briefing. "(Receiver call sign), the following contacts will be made in Manual Boom Latching. Receiver pilot must initiate all disconnects. Inform boom operator when receiver A/R System is in contact made. Tanker ready." Receiver pilot will acknowledge transmission by stating "Receiver ready."

   b. For voice procedure prior to contact refer to 2a above.

   c. During Contact.

      Communication during air refueling operation will be held to an absolute minimum.

   d. Disconnect.

      Use the command words "Disconnect" or "Breakaway" as the case warrants, before receiver reaches normal envelope limits.

4. Breakaway.

   When a crew member aboard either the tanker or receiver determines that an emergency exists, he will transmit on air refueling frequency, (the other airplane tactical call sign), followed by "Breakaway, Breakaway, Breakaway." (During mass refuelings, the cell position call sign will be used.)

Radio Silence - Tankers and Receivers

During air refueling operations, tanker and receiver crews normally transmit necessary information by use of radio; however, radio silence air refueling can be conducted provided the following precautions and procedures are observed.

1. Both crews must be experienced in normal air refueling procedures.

2. The method, time, and place of rendezvous and amount of fuel to be transferred must be covered in the briefing of each crew.

3. When using this procedure, radio silence will not be broken except in the event of an emergency.

4. Radio equipment on both airplanes must be operative and crews on both airplanes must monitor the same frequency during the refueling procedures.

NOTE

Tanker and receiver crews, properly prebriefed and fully qualified, should be capable of making radio silence contact without two way radio communications.

5. The boom operator will position his jackbox so that he is capable of transmitting to the receiver and receiving necessary communication within his own airplane.

6. All precontact air refueling checks will be completed prior to the receiver reaching 1/2 mile.

7. The receiver pilot director lights (red only) may be actuated with the receiver pilot director light switches when in the ready condition, to aid in positioning the receiver airplane. A steady red light will indicate a large correction and a flashing red light will indicate a small correction in the direction indicated by the "Red Director Lights." When in contact-made the receiver pilot director lights are actuated by boom motion as caused by the relative displacements between the tanker and receiver airplane.

8. In the event of radio communication failure, or radio silence contacts, the following visual signals will be used:

   a. Up-and-down movement of the boom ending in trail position with the boom extended to 10 feet means that the tanker is ready for contact.

   b. Boom retracted, up-and-down movement of the boom ending in stowed position indicates that there is a malfunction in the tanker that will be fixed shortly. The receiver should remain in the observation position until the malfunction is corrected or until the receiver deems it necessary to depart.

   c. Side-to-side movement of the boom ending in trail position, with the boom extended 10 feet, indicates that the tanker is fully operative and requests that the receiver check his air refueling system.

   d. Side-to-side movement of the boom with the boom retracted and ending in trail indicates that prescribed fuel load has been transferred.

   e. Side-to-side movement of the boom ending with the boom in the stowed position indicates that the tanker air refueling system is completely inoperative.

   f. The need for a disconnect, when the situation does not warrant a BREAKAWAY, will be indicated by receiver director lights being turned off by actuating the disconnect switch. Receiver pilot observing that all receiver director lights go out will immediately initiate a disconnect and return to the observation position.

   g. The need for emergency BREAKAWAY by tanker will be indicated by receiver director lights being turned off and on rapidly by actuation of the lighting system selector switch. Receiver pilot will immediately initiate disconnect and institute breakaway procedure.

   h. Should the receiver pilot desire BREAKAWAY, he will institute breakaway procedure and close slipway door(s).

   i. To indicate termination of refueling the receiver will turn upper anti-collision light on or off as applicable.

   j. A steady light from receiver indicates an emergency fuel shortage exists and refueling operations must be conducted. Applicable lights for various model airplanes are as follows:

      B-47 - Both landing lights
      B-52 - Aldis lamp/Flashlight (day or night)

      Other Airplanes - Any available bright light

9. If necessary to use Manual Operation, in the event of communication failure, the following visual signals will be used:

CAUTION

Refueling operations will be discontinued in the event of communications failure or tanker boom position instrument failure except in case of an emergency.

   a. Boom operator will indicate use of Tanker Manual Operation by trailing fully extended boom. The receiver pilot will acknowledge by:

      B-47 - Flashing both landing lights
      B-52 - Flashing A/R overwing lights (night) or Aldis lamp/flashlight (day)

      Boom operator will then retract boom into ready position and standby for contact.

b. Should the receiver pilot desire to initiate Manual Boom Latching, he will pull into observation position and signal by:

B-47 - Flashing both landing lights
B-52 - Flashing A/R overwing lights (night) or Aldis lamp/flashlight (day)

Receiver will remain in the observation position until his signal has been acknowledged by the boom operator, which will be one up-and-down movement of the boom fully extended ending with the boom in the ready position.

CAUTION

When operating in manual boom latching or tanker manual operation, actuating the boom operator's disconnect switch only initiates a disconnect in the tanker signal system. The nozzle will remain in the receiver receptacle, secured by the Toggles, until the receiver pilot initiates a disconnect.

Practice Dry Contacts

To prevent excessive wear of the A/R fuel bypass valve during practice dry contacts, the following procedure will be followed:

1. Prior to dry contact operation, actuate the emergency fuel-shutoff button
2. Upon completion of dry contact operation, or prior to actual fuel transfer operation, press reset emergency fuel-shutoff button

This procedure will facilitate any number of dry contacts without operation of the A/R fuel bypass valve.

A/R System Manual Operation

SIGNAL SYSTEM FAILURE. In the event that normal preparation for refueling reveals a malfunctioning signal system, change the signal amplifier. Personnel experienced in refueling can complete the fuel transfer by manual operation of the A/R system. The normal system of the receiver may be used in conjunction with manual operation of the tanker, provided it is clearly understood what configurations are being used. The main point to be remembered by all refueling crews is that when either system is in manual operation, the receiver must initiate the disconnect. When the receiver is operating in emergency boom latching, the tanker must be in "manual".

CAUTION

- This procedure shall be attempted only by personnel who are experienced in normal air refueling and have been checked out on this procedure by qualified instructor personnel.
- Receiver pilot must initiate all disconnects when receiver is operating in emergency boom latching. Except in case of an emergency, emergency boom latching will not be used without radio contact between the two airplanes and/or tanker boom position instruments operative.

For Tanker Manual Operation or Manual Boom Latching, the boom operator establishes contact as follows:

1. Place Signal System Override Switch to OVERRIDE

WARNING

The signal system override switch de-energizes the signal amplifier circuit, and thus discontinues limit switch operation.

2. Position Telescope-at-Disconnect Switch to MANUAL
3. Establish radio contact with receiver. Brief receiver pilot as outlined in A/R ORAL COMMUNICATIONS this Section
4. Talk receiver pilot into correct position or utilize the manual Receiver Director Light Switches. A steady red light will indicate a large correction and a flashing red light will indicate a small correction in the direction indicated by the Red Receiver Director Lights
5. When receiver has stabilized in position, insert boom nozzle and hold nozzle in receptacle

CAUTION

The boom operator must use caution when holding boom nozzle in receiver's receptacle, as constant extend pressure will deplete the tanker A/R hydraulic system. This may cause the boom operator to lose control of the extend and retract portion of boom control.

6. Inform receiver pilot "Nozzle Contact." Nozzle contact is defined as the time that the boom nozzle is inserted and bottomed in the receiver's receptacle

7. Receiver pilot states, "Receiver Contact Made"
8. Actuate Signal System Manual Contact Switch
9. Inform receiver pilot, "Tanker Contact Made"
10. Proceed with normal A/R methods. Advise receiver pilot of corrective action to be used to remain within A/R envelope
11. When fuel transfer has been completed, call for "Disconnect" and when receiver pilot states, "Receiver Disconnect," or nozzle is free in receptacle, press Disconnect Switch.

CAUTION

When operating in manual boom latching or tanker manual operation, actuating the boom operator's disconnect switch only initiates a disconnect in the tanker signal system. The nozzle will remain in the receiver receptacle, secured by the toggles, until the receiver pilot initiates a disconnect.

12. When the nozzle is free from the receptacle, manually retract the boom
13. Initiate POST REFUELING CHECK LIST, if no additional refueling contacs are to be made

A/R System Emergency Procedures

AIR REFUELING FUEL SYSTEM FAILURE. In the event of a fuel leak in the A/R system of either the tanker or the receiver airplane, a disconnect should be initiated immediately and all A/R equipment will be turned off. The flight crew will determine the source of the leak and, if possible, make immediate repairs. If the trouble cannot be remedied, no further contacts will be made. If at any time fuel is being transferred and a steady stream of fuel is being pumped overboard from the receiver, or the receptacle of the receiver is filled with fuel, an immediate disconnect will be made.

RETRACTING A WET BOOM WHEN FUEL BYPASS VALVE IS INOPERATIVE. When the fuel bypass valve is inoperative, retract the wet boom as follows:

1. Reset signal system to READY and fully extend boom to decrease fuel pressure
2. Pull line valve circuit breaker
3. Manually open line valve
4. Retract boom a distance sufficient to build up a fuel pressure of 50 psi
5. After fuel pressure drops approximately 10 psi, retract until fuel pressure is again at 50 psi
6. Repeat step (5) until boom is fully retracted. This procedure may take 15 minutes or more to complete

NOTE

On G airplanes, opening of pet cock in fuel drain line in pod area will reduce boom retraction time to a few minutes.

7. Restore line valve and circuit breaker to original configuration

HYDRAULIC PRESSURE SYSTEM FAILURE. A ruptured hydraulic line on the pressure side of the engine-driven A/R hydraulic pump will be indicated by a lowering of fluid in the main A/R hydraulic reservoir and a drop in hydraulic pressure indicated by the hydraulic pressure gages on the engineer's A/R panel. After determining the pump with the ruptured line proceed as follows:

1. Place hydraulic oil supply valve switch to CLOSED
2. Refill A/R hydraulic oil reservoir if necessary
3. Land as soon as possible

In the case where a hydraulic system leak cannot be determined by direct observation, but is only noted by a gradual lowering of the fluid in the A/R hydraulic reservoir, the following is recommended to determine if the leak can be stopped by use of the hydraulic oil supply valves:

1. Position No. 1 engine hydraulic oil supply valve on the engineer's A/R panel to CLOSED
2. Note if there is continued lowering of the fluid in the hydraulic reservoir. If fluid loss has ceased, leave the valve switch at CLOSED

CAUTION

To prevent unnecessary damage to the pump do not leave the valve closed for more than one minute unless it stops the loss of fluid.

3. If the leakage continues, reopen the No. 1 engine valve and position No. 4 engine hydraulic oil supply valve to CLOSED. If the leak is forward of the pressure line check valves, (figure 4-67) this will stop further loss of fluid. Leave the valve closed. In order to provide sufficient lubrication and cooling for the engine-driven pumps, the valve closed time for any one operation should be limited to one minute, with a four minute period between repeat operations of the same valve. In any case, if either valve is left closed or if all hydraulic fluid is lost, land as soon as possible to minimize damage to the engine-driven pumps.

WARNING

Wing anti-icing heaters should not be operated after loss of hydraulic fluid from the A/R 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.

FUEL FUMES VENTILATION PROCEDURE. See SMOKE OR FUME ELIMINATION in Section III.

ENGINE FAILURE. An engine failure on the tanker is more serious than a receiver engine failure. A tanker engine failure will probably cause the receiver to overrun the tanker, whereas, a receiver engine failure will merely result in extension of the boom and possible separation. The tanker pilot should at all times when flying in formation be ready to increase power immediately on the good engines in case of an engine failure.

JAMMED RUDDEVATORS. If ruddevators become jammed in flight, the following procedures will be followed:

1. Retract boom
2. Adjust airspeed to conform with existing emergency
3. Remove the electrical connector to No. 3 solenoid valve or pull the oleo relay circuit breaker
4. Move the ruddevator control stick up and down, and at the same time move the hoist lever back and forth. When the ruddevator control stick is moved up, move the hoist lever to the UP position. These operations should be continued until the ruddevators are released

BOOM RETRACTION MECHANISM FAILURE. If the boom retraction mechanism malfunctions, necessitating a landing with a partially or fully extended boom, the following steps should be taken:

1. Retract the boom as far as possible; any retraction from the fully extended position will greatly relieve the stresses on the boom, latch, and latch support
2. Land with a dry boom
3. Make as smooth a landing as possible to prevent excessive whipping action on the boom
4. After any landing with boom extended, have the boom, stowing mechanism, and chock attachments to the fuselage carefully checked for structural damage

B-52 Rendezvous And A/R Operation

1. Rendezvous and A/R procedures are as outlined in RENDEZVOUS PROCEDURES AND A/R PROCEDURES. Figure 4-80 shows a typical A/R rendezvous profile for B-52 - KC-97.
2. For rendezvous equipment available, see RENDEZVOUS EQUIPMENT COMPATIBILITY, Figure 4-79. For photographs of observation position, before contact position (as seen from tanker) and contact position (as seen from tanker), see figure 4-83.
3. For maximum formating altitude and speed charts, see Appendix

REFUELING THE B-52. Air refueling the B-52 should, where possible, be accomplished in level flight. The B-52 is a large airplane, the tanker should therefore, be handled as smoothly as possible to avoid any unnecessary maneuvering of the receiver airplane. The B-52 has the receptacle located in a slipway in the center and on the top of the fuselage, three feet behind the pilot's overhead windows. It is covered by doors when not required. Care should be exercised to avoid damage to slipway doors, no difficulty should be found in extending the boom into the receptacle; however, it should be borne in mind that the receiver pilot may have restricted vision due to structural members above his windshield. For night refueling the B-52 carries lights to illuminate the upper surfaces of the wings and the slipway. Fuel transfer to the receiver airplane is straight forward although the rate of flow may be limited by fuel transfer considerations within the receiver airplane. At disconnect the receiver airplane should be directly astern of the tanker, and care should be taken to avoid striking the slipway doors and lights when the boom is released.

B-47 Rendezvous And A/R Operations

1. Rendezvous and A/R procedures are as outlined in RENDEZVOUS PROCEDURES, AND A/R PROCEDURES. Figure 4-80 shows a typical A/R rendezvous profile for B-47 - KC-97
2. For rendezvous equipment available, see RENDEZVOUS EQUIPMENT COMPATIBILITY, Figure 4-79. For photographs of observation position, before contact position (as seen from tanker) and contact position (as seen from tanker), see Figure 4-83
3. For maximum formating altitude and speed charts, see Appendix

F-84 Rendezvous And A/R Operations

1. Rendezvous: When feasible, the ARCP will be over known geographical or radio fix. The ARCP will be the orbit point planned midway along the down stream leg of the receivers intended track. Tankers will plan to be at the ARCP, 15 minutes prior to the receivers latest ETA and will remain in the orbit pattern, (4 minute turns, 4 minute legs) until visual contact is established. Fuel may be dumped in 1000 pound increments not to exceed 3000 pounds during daylight hours when passing over the ARCP to aid in visual contact. During night operation, all tanker external lights will be on 20 minutes prior to the ARCP and will remain on until the receiver is in the observation position. Where compatible equipment is installed, UHF/DF will be used as an aid for rendezvous. If visual or radio contact is not established, the tankers will remain at the ARCP in orbit for 15 minutes after the planned ARCT unless otherwise directed. When visual contact is established, tankers will proceed down the refueling track and the receivers will form behind the tankers in preparation for refueling.

2. Refueling Airspeeds. Airspeeds will be as follows:

   a. Receiver without external tanks and with 2 - 230 gallon external tanks, 200 KIAS. Receiver with 4 - 230 gallon external or 2 - 450 gallon external tanks, 210 KIAS. Receivers with 2 - 450 gallon external and 2 - 230 gallon external tanks, 220 KIAS.

3. Refueling Altitude: Base altitude will normally be 15,000 feet.

PILOTS' AIR REFUELING PROCEDURES

RENDEZVOUS AND A/R FLIGHT PLANNING

A. Coordinate with navigator for completeness of air refueling flimsy.

B. Ascertain that manuals and directives pertaining to air refueling are available to the crew.

C. Review and coordinate with the navigator on the briefed refueling area to include:

1. Air refueling frequencies
2. Air refueling control times
3. Air refueling timing
4. Orbit and air refueling control points
5. Refueling track and altitude
6. Air refueling completion point

PREPARATION FOR CONTACT

The following procedure will normally be initiated in sufficient time to meet the planned ARCT requirements for communications and rendezvous procedures.

(1.) Set Altimeter - Set (as briefed) (P, CP, N)

(2.) Establish Radio Contact - Established (or as briefed) (P, CP, or N)

a. Obtain Formating Airspeed

b. Obtain Receiver ETA to ARCP

c. Give Altimeter Setting

d. Confirm Base Refueling Altitude

(3.) Clear Navigator to UHF - Cleared (P, N)

Navigator will assume control of UHF communications up to and including the 4 mile range call when directed by the pilot.

(4.) Set Refueling Power - Set (P, E)

When the receiver is at 12 NM range, direct the engineer to set power for refueling.

NOTE

A minimum of 2550 rpm will be used for normal air refueling. During extended periods of operation, when oil consumption is critical, a lower rpm may be used. Normally, TBS will be adjusted so that maximum allowable manifold pressure is available with full open throttle, for the rpm being utilized.

WARNING

During cold weather, reduced throttle and increased TBS settings may be required to maintain desired CAT's. When operating under these circumstances, or with rpm less than 2550, caution must be exercised so as not to exceed maximum manifold pressure during breakaway.

5. Descend 500 feet - Descend (if required) (P)

Initiate a 500 foot descent, if required, when receiver is at 12 NM range.

6. Autopilot Master Switch OFF - OFF (P)

7. Rudder Boost OFF - OFF (P)

(8.) Control of Command Radio - Assumed (N, P)

Pilot will assume control of UHF communications after the 4 mile range call. The receiver pilot will relay his range and indicated airspeed (KIAS) at the 3, 2, 1 and 1/2 mile ranges.

NOTE

During cell formation, only the cell leader will make the above calls.

(9.) Clear Boom Operator to UHF - Cleared (P, BO)

The boom operator will assume control of the UHF communications at 1/2 mile separation when directed by the pilot.

(10.) Receive Engineer's Report - "Preparation for Contact Checklist Complete" (P, E)

OBSERVATION POSITION

The following procedure will normally be initiated when the receiver reports at 1/2 NM range.

1. Set Navigation Lights - Set (STEADY and DIM) (CP)

2. Lower Anti-Collision Light OFF - OFF (CP) TCTO 591

(3.) Notify Engineer of Copilot's Power - Notified (P, CP, E)

Pilot will advise engineer that it is "copilot's power." Engineer will acknowledge and advise copilot of maximum allowable manifold pressure to be used for the established rpm setting. Copilot's responsibility for power changes will be terminated when the POST REFUELING checklist is called for.

(4.) Clear Crew to UHF - Cleared (All)

Pilot directs all crew members to position interphone selector switch to COMM UHF.

CAUTION

- The receiver must stabilize at a zero rate of of closure in the observation position and execute a breakaway in case it appears that over-running will occur after leaving the observation position.
- The boom operator must be alert to insure that breakaway action is initiated should the receiver fail to stabilize in the observation position.

POST REFUELING

This checklist will be initiated after refueling has been completed.

1. Navigation, Anti-Collision Lights - Set (CP)

Reposition switches as mission requires.

(2.) Offload Report - (P, N)

Direct navigator to give offload report after refueling track has been cleared.

(3.) Crew on Interphone - On interphone (ALL)

Pilot directs crew members to return to interphone.

(4.) Set Cruise Power - Set (P, E)

Direct engineer to set cruise power after boom operator reports "Boom Stowed."

(5.) Reset Altimeter - Reset (P, CP, N)

Obtain and set current altimeter setting.

NAVIGATOR'S AIR REFUELING PROCEDURES

RENDEZVOUS AND A/R FLIGHT PLANNING

A. Air Refueling Flimsy - Checked complete

The air refueling flimsy received at briefing will be checked for the following information. Any items not included in the flimsy will be determined and recorded prior to takeoff.

1. Receiver Initial Point. The point at which all rendezvous equipment will be in full operation and the initial attempt to contact the receiver will be made.
2. Rendezvous identification code settings
3. Tanker orbit point
4. Control time at ARCP, if applicable
5. Type of rendezvous
6. Air refueling control point
7. Refueling altitude
8. Refueling course
9. True airspeed - start, end, and average during refueling
10. Estimated time to refuel
11. Refueling completion point, if applicable
12. Secondary and tertiary ARCP's, if applicable
13. Steps 1 through 11 for the secondary and tertiary ARCP's, if applicable

PREPARATION FOR CONTACT

1. Rendezvous Equipment - ON as required

   a. Radar Beacon

      (1) Code Selector Switches - Check briefed settings

      (2) Power Supply - Alternator ON, NO. 2 BUS (N, E)

      If alternator power is not available, APN-69 may be operated on the essential inverter by placing the power selector switch to EMERG position. In the EMERG position, power is cut off from radio altimeter, loran, and glide path receiver.

      (3) Off--Stdby--Operate Switch - OPERATE, Light on

      After a three-minute warmup period, the green transmitter light should illuminate, indicating radar beacon is ready for automatic operation. Returning switch to STDBY for identification purposes does not require the three-minute delay when returning to OPERATE.

   b. APN-12

      (1) Power Switch - ON

      Turn set on and place transmitter switch on HIGH

      (2) Range Switch - 200

      (3) Gain Knob - As required

2. Trailing Wire Antenna - Fully retracted (if installed)

(3.) Control of Command Radio - Assumed (P, N)

Navigator will assume responsibility for UHF communications up to and including the 4 mile range call when directed by the pilot.

4. Rendezvous (APN-69)

   a. APN-69 Signal - Receive and identify code (by receiver)

   Navigator will switch to STDBY and back to OPERATE at request of receiver to aid in identification.

   b. Initial Radar Contact - Record time and range, notify crew

   c. Descent Range - Obtain from receiver

   Have receiver notify tanker when descent range is reached.

   d. 30 Nautical Mile Range - Advise boom operator

   When positive radar contact has been established advise boom operator when receiver range has closed to 30 nautical miles. Rendezvous beacon light will be turned on at this time. If radar contact has not been established, advise boom operator 20 minutes prior to receiver's latest ETA.

   e. 12 Nautical Mile Range - Advise pilot

   NOTE

   Use of APN-69 is the primary method of effecting an air refueling rendezvous. However, the APN-12 should be used as a cross reference whenever possible.

   (f.) 4 Nautical Mile Range - Advise pilot and boom operator (N, P, BO)

   Pilot will assume control of UHF radio for 3, 2, 1 and 1/2 mile range calls. Navigator will clear boom operator to pod at the 4 nautical mile range.

   NOTE

   During cell formation, only the cell leader will make the above calls.

5. Rendezvous (APN-12)

   a. Receiver APN-76 Signal - Identify

   As soon as signal appears on APN-12 scope, request receiver to place APN-76 on STAND BY to identify signal. Signal on APN-12 should disappear and reappear when receiver turns APN-76 back on. Repeat procedure until receiver is definitely identified. Inform receiver that positive identification has been established.

   NOTE

   If APN-76 signal cannot be received and radio contact has been established, advise receiver to change channel settings and change APN-12 channel accordingly to attempt to establish electronic contact.

b. Initial Radar Contact - Record time and range, notify crew

c. Receiver Ranges - Relay to receiver and crew

See RENDEZVOUS PROCEDURES in this Section.

d. Descent Range - Obtain from receiver

e. 30 Nautical Mile Range - Advise boom operator (Night or low visibility)

When positive radar contact has been established, advise boom operator when receiver range has closed to 30 nautical miles. If radar contact has not been established, advise boom operator 20 minutes prior to receiver's latest ETA.

f. 12 Nautical Mile Range - Advise pilot

(g.) 4 Mile Range Call - Advise receiver pilot "Take over receiver." Clear boom operator to pod (N, BO)

Pilot will assume control of UHF radio for 3, 2, 1 and 1/2 mile range calls. Navigator will clear boom operator to pod at the 4 nautical mile range.

NOTE

During cell formation, only the cell leader will make the above calls.

CONTACT AND REFUELING

1. Rendezvous - Record time, position, and receiver identification
2. Rendezvous Equipment - Standby
3. Initial Contact - Record time, MH, TAS, and ALT
4. Final Disconnect - Record time, MH, TAS, and ALT

POST REFUELING

(1.) Refueling Report - Relay to receiver (N, P)

When directed by pilot transmit position and fuel offload to receiver and return to interphone.

2. Rendezvous Equipment - Off

NOTE

The navigator's air refueling procedures also appear in T.O. 1C-97(K)F(CL)1-2, which is a condensed checklist. The condensed checklist has each numbered step (and some sub-steps) of the normal, air refueling, alert and emergency procedures.

FLIGHT ENGINEER'S AIR REFUELING PROCEDURE

The following A/R pump operating duties are handled by the engineer and are in addition to his normal flight duties. The checks and procedures are presented as an aid to successful operation of the A/R pump system before and during refueling flights.

PREPARATION FOR CONTACT

1. Airplane Fuel Configuration - TE (or as required)

Establish TE fuel configuration except when inboard wing tank fuel restriction applies because of payload.

2. Marker Beacon Circuit Breaker - Pulled
3. A/R Panel - In position
   a. Master Switch - ON
   b. All Circuit Breakers - Set
   c. Indicator Lights - Test
   d. Fuel Quantity - Checked
   e. Totalizer - Zero
   f. A/R Fuel Pressure - Zero
   g. Hydraulic Oil Supply Valve Switches - OPEN
   h. Isodraulic Handle - OFF
   i. Fuel Leveling Valve Switch - CLOSED (or as required)

(4.) Transfer Valves - Visually checked CLOSED (E, BO or RO)

(5.) Manual Fuel-Shutoff Valves - Visually checked CLOSED (or as required) (E, BO or RO)

6. Mixtures - Check AUTO RICH (locked)

(7.) Refueling Power - Set (when directed by pilot) (E, P)

When pilot directs, set power for refueling.

NOTE

A minimum of 2550 rpm will be used for normal air refueling. During extended periods of operation, when oil consumption is critical, a lower rpm may be used. Normally, TBS will be adjusted so that maximum allowable manifold pressure is available, with full open throttle, for the rpm being utilized.

WARNING

During cold weather, reduced throttle and increased TBS settings may be required to maintain desired CAT's. When operating under these circumstances or with rpm less than 2550, caution must be exercised so as not to exceed maximum manifold pressure during breakaway.

8. Line Valve Switch - AUTO

NOTE

Line valve switch must be in the CLOSED position except when wet transfer is anticipated.

(9.) Report to Pilot - Report "Preparation for contact checklist complete" (E, P)

(10.) Copilot's Power - Acknowledge (E, P, CP)

Acknowledge when pilot advises "Copilot's power" and advise copilot of maximum allowable manifold pressure to be used for established rpm setting.

11. Radios - Monitor (as required)

Switch to VHF (or UHF) upon direction of pilot, monitor interphone.

CONTACT AND REFUELING

During contact and refueling, the engineer will advance the isodraulic handle when contact has been established and the contact-made light illuminates. Advance as required to obtain desired fuel pressure and/or flow.

CAUTION

To prevent damage to the A/R system, do not exceed 5400 pounds per minute MAXIMUM fuel flow during A/R operations.

NOTE

When operating with only one A/R fuel pump, do not advance the isodraulic handle beyond the No. 5 position. Advancing this handle further will result in excessive hydraulic oil pressure and temperature, with no increase in fuel flow. If disconnect occurs, reset the isodraulic handle to OFF before contact is re-established.

Maintain A/R fuel pressure as required. To hold the pressure in the tanker below the maximum recommended psi for the receiver involved, while still maintaining the highest practical rate of transfer, the following procedure will generally be necessary. Start fuel transfer by advancing the isodraulic handle toward maximum recommended refueling pressure and as the pressure approaches the limiting psi, move the isodraulic handle toward OFF.

NOTE

- The pressure disconnect settings are:

  B-47 - 55 ± 2 psi
  B-52 - 68 ± 2 psi
  F-84F - 78 ± 2 psi

- The engineer will attempt to maintain tanker fuel pressure between 25-40 psi during refueling the F-84F airplane.

WARNING

Due to the possibility of fuel contamination, every precaution will be taken to insure that aviation gasoline is not transferred to F-84F airplanes.

Depending on the receiver type, fuel pressure in the receiver manifold will be approximately 10 psi higher than the fuel pressure indicated on the boom operator's and engineer's A/R fuel pressure gage. A pressure disconnect may result if allowances are not made for this condition. Be on the alert at all times for sudden increases in pressure resulting from incorrect operation or malfunction and retard isodraulic handle immediately in such events. Disconnects may be made automatically when receiver fuel tanks are full. Disconnects may be initiated by the receiver if less than a full load is required or a malfunction is suspected. If a pre-arranged quantity of fuel is to be transferred, the boom operator may initiate a disconnect or stop

the flow of fuel with his A/R emergency fuel-shutoff button at any time. In the event the boom operator stops the fuel flow with his A/R emergency fuel-shutoff button, the flight engineer must retard the isodraulic handle to OFF until the boom operator reestablishes flow with the A/R emergency fuel-shutoff reset button, then the isodraulic handle may be advanced as required. The A/R emergency fuel-shutoff light will illuminate on the flight engineer's A/R panel when the A/R emergency fuel-shutoff button has been actuated. The flight engineer will periodically check his A/R indicators and lights.

When the amount of fuel transferred nears the predetermined amount of fuel off-load, the flight engineer will begin retarding the isodraulic handle and will retard it to OFF when proper fuel quantity has been transferred.

During practice dry contacts, the engineer will periodically monitor the aft A/R fuel quantity gage for an indication of reverse flow from the receiver to the tanker.

POST REFUELING

1. Isodraulic Handle - OFF

   When the predetermined amount of fuel has been transferred, the flight engineer will inform navigator of amount.

2. Line Valve Switch - CLOSED

3. Fuel Leveling Valve Switch - CLOSED

4. Transfer Valve Switches - CLOSED

(5.) Cruise Power - Set (when directed by pilot) (E, P)

(6.) A/R Fuel Valves - Correct position (E, BO)

7. A/R Master Switch - OFF

8. Marker Beacon Circuit Breaker - Reset

(9.) Report to Pilot - Report "Panel stowed, valves checked" (E, P)

NOTE

The flight engineer's air refueling procedures also appear in T.O. 1C-97(K)F-(CL)1-3, which is a condensed checklist. The condensed checklist has each numbered step (and some substeps) of the normal, air refueling, alert, and emergency procedures.

BOOM OPERATOR'S AIR REFUELING PROCEDURES

The following checks and procedures are presented as an aid to successful operation of the air refueling system for all flights. When an air refueling fuel transfer is anticipated, all checks and procedures must be accomplished as outlined.

PREPARATION FOR CONTACT

Navigator will notify boom operator to turn on rendezvous beacon light when receiver is at 30 NM range. The preparation for contact checklist will be completed up to establishing radio contact with the receiver and prior to receiver reaching 1/2 mile distance in trail.

NOTE

Normal operation of the air refueling equipment will include use of all automatic provisions. Manual operation shall be confined to training and special or emergency conditions.

(1.) Manual Fuel-Shutoff and Transfer Valves - As briefed (BO, E)

2. Command Radio - Monitor

3. Signal System Manual Override Switch - NORMAL

4. Boom Operator's A/R Master Switch - ON

5. Boom Hydraulic Pressure Switch - AUTO F G 1243 ▶ 22736 or ON G 22737 ▶

6. Telescope-at-Disconnect Switch - AUTO

   Telescope-at-Disconnect Switch - MANUAL - for fighter refueling.

NOTE

There is no slipway on F-84F airplanes; therefore the boom must be slowly and smoothly placed in the receptacle.

7. Limit Cutout Switches - ACTIVE

8. Signal Coil - TEST

9. Receiver Director Lights - ON

   Turn all rheostats ON. Intensity variations subject to request of receiver pilot.

10. Boom Nozzle and Marker Lights - ON (as required)

    See figure 4-81 for proper lighting during air refueling.

11. Boom - Lower, extend 10 feet.

12. Radio Contact - Established (Receiver 1/2 mile) (P, BO)

    The boom operator will establish radio contact with the receiver at 1/2 mile separation when directed by the pilot.

13. Rendezvous Beacon Light Switch - OFF G 3196 ▶ and F G with TCTO K231

14. Receiver in Observation Position - Report, "Tanker ready."

    The boom operator will report "Tanker ready" when receiver is stabilized at a zero rate of closure in the observation position.

CAUTION

- The receiver must stabilize at a zero rate of closure in the observation position and execute a breakaway in case it appears that over-running will occur after leaving the observation position.
- The boom operator must be alert to insure that the breakaway action is initiated should the receiver fail to stabilize in the observation position.

CONTACT AND A/R PROCEDURES

When the pilot clears the boom operator to use the command radio, the boom operator will establish radio contact with the receiver. Communications during contact and refueling operations should be held to an absolute minimum except when it is deemed necessary to use voice procedures to establish contact. A/R ORAL COMMUNICATIONS, A/R VISUAL SIGNALS, PRACTICE DRY CONTACTS, A/R SYSTEM MANUAL OPERATION, and A/R SYSTEM EMERGENCY PROCEDURES are outlined in this section.

NOTE

- It is the boom operator's responsibility to insure that the boom is clear of the receiver during precontact and disconnect.
- During night contacts, maintain the boom in a position that will prevent the boom nozzle lights from blinding the receiver pilot.

If necessary, talk receiver pilot into correct position, or utilize receiver director light manual switches. If the receiver director light manual switches are used, the boom operator will actuate the switches after the receiver is within the observation position. A steady red light will indicate a large correction and a flashing red light will indicate a small correction in the direction indicated by the red director lights.

The boom operator should follow the receiver movements with the ruddevator control stick. A slight stick pressure should be maintained in the direction of receiver movement. The greater the displacement from normal, the more pressure is required - except for up elevation when only slight up pressure is required.

WARNING

When refueling with the B-52, the Boom Operator will call for and initiate disconnect procedure as the receiver passes through 40 degrees lower elevation. If the boom binds in the receptacle or fails to retract, BREAKAWAY procedure will be immediately initiated.

CAUTION

- Do not apply too much up pressure on ruddevator control stick as a disconnect could cause damage to boom and fuselage.
- When refueling the F-84, the boom operator will call for and initiate a disconnect as the receiver reaches the following boom positions: 6 degrees left, 12 degrees right azimuth, and 30 degrees upper elevation. If these positions are exceeded there is a possibility of striking the receiver on disconnect and/or binding of the nozzle in the receptacle.
- Nozzle binding can occur while in contact with a receiver. This condition will depend on the relative position of the tanker and receiver and the receiver's stability while in the air refueling envelope. Nozzle binding occurs at many positions depending on degree of azimuth and/or elevation and rate-of-closure. The boom operator must be constantly aware of the receiver's position and be prepared to initiate a disconnect or breakaway before the receiver gets into a position where nozzle binding could occur.

If oral communications are requested by the receiver, inform the receiver pilot of the corrective action to stay within the refueling envelope. It is important to preface instructions to receiver by first giving direction for receiver to move, then estimated distance to move to reach normal envelope position. This will prevent misunderstanding and minimize communications. It is necessary for the boom operator to have a clear understanding of the actual boom envelope. The boom position indicators and receiver position should be monitored closely.

NOTE

If a tow is requested by a receiver (fighter airplanes only) move the extension limit cutout switch to inactive and request the receiver to move slowly aft until the boom is fully extended.

POST REFUELING

1. Boom - Stow

   Check boom stowed and latched by placing hoist lever to the DOWN position momentarily.

   CAUTION

   Due to airflow around the tail of the airplane, ruddevator control forces become much lighter as the boom approaches the horizontal position. This leads to a tendency to over-control. Care must be exercised when raising the boom to the stowed position to prevent damage to the boom and the empennage of the airplane.

2. Inform Pilot - "Boom stowed" (BO, P)

3. Ruddevator Control Stick - LOCK

4. Switches - Off (as required)

5. A/R Hydraulic System - Depressurized

6. Fuel Valve and Walk-around Inspection - Report "Fuel Valves_____ and walk-around inspection complete" (BO, E)

7. Form 781 - Enter A/R information

   Enter amount of fuel off-loaded in Form 781.

NOTE

The boom operator's air refueling procedures also appear in T.O. 1C-97(K)F(CL)1-4, which is a condensed checklist. The condensed checklist has each numbered step (and some substeps) of the normal, air refueling, alert and emergency procedures.

RADIO OPERATOR'S AIR REFUELING PROCEDURES

PREPARATION FOR CONTACT

1. Communications Duties - As required

   Utilize HF as required to maintain ATC or Tactical reporting if applicable and monitor HF backup during rendezvous. If required, use HF backup procedures for rendezvous (MF Homing) and/or communications with the receiver.

2. Observation Position

   a. HF Transmitter - OFF

      Check HF transmitter OFF at radio position, unless transmitter is required for communications during air refueling.

   b. Off Watch - Logged

      Make appropriate entry in log, when leaving position. Pilots should assume HF radio watch during air refueling.

   c. Scanning Position - On interphone

      Scan engines and receiver. Report any abnormal conditions.

   d. Valves and Hydraulic Panel - Check as directed (RO, E, BO)

      Check or position fuel valves as directed by engineer. Check hydraulic panel as directed by boom operator.

POST REFUELING

1. Receiver Position - Scan

   Advise pilot of receiver's position after disconnect.

2. Radio Equipment - On as required

   Restore power to radio operator's equipment as required.

3. On Watch - Logged

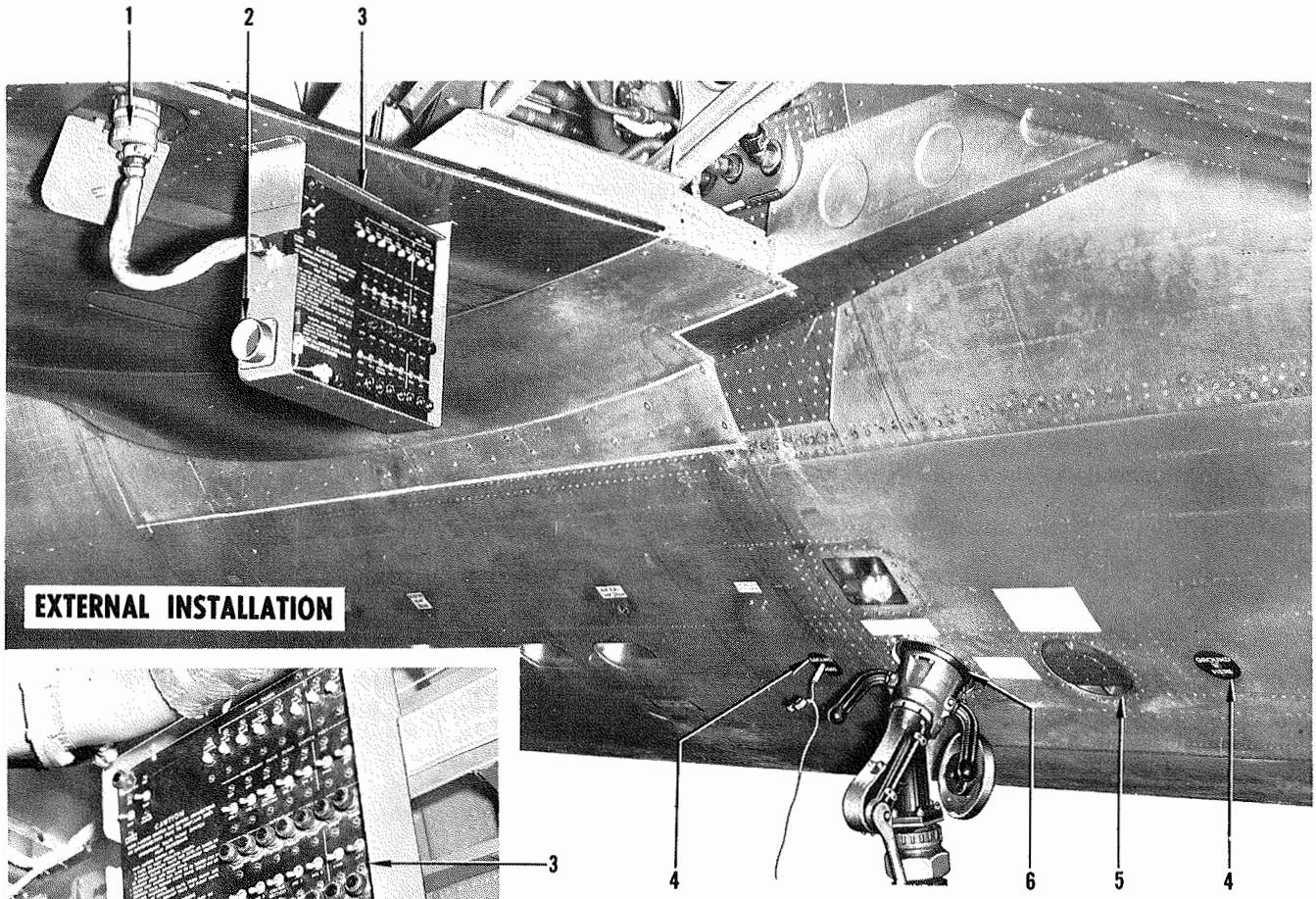
   Make appropriate entries in log as required.

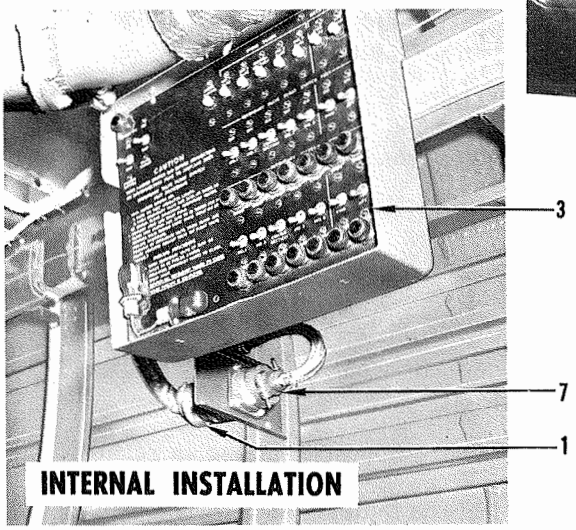
4. Communications Duties - As required

   Transmit required reports as directed by the pilot or as briefed.

NOTE

The radio operator's air refueling procedures also appear in T.O. 1C-97(K)F(CL)1-5, which is a condensed checklist. The condensed checklist has each numbered step (and some substeps) of the normal, air refueling, alert and emergency procedures.





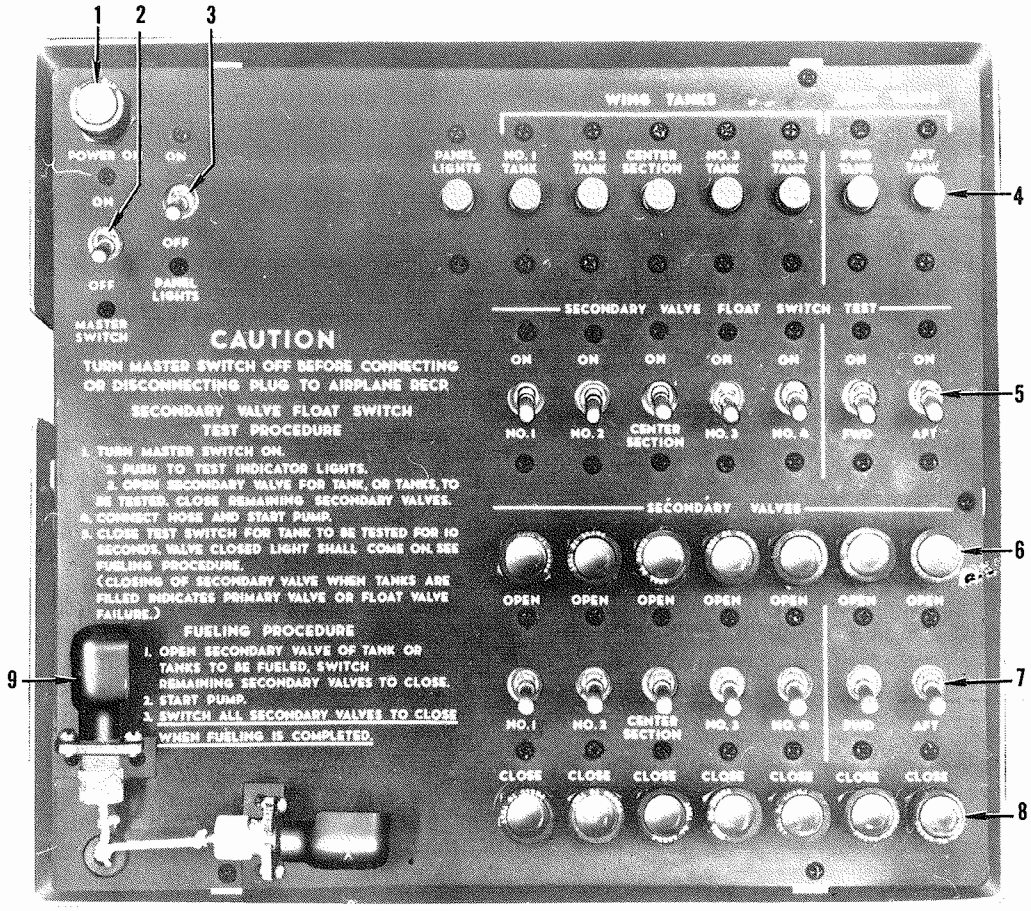
1 PANEL ELECTRICAL CONNECTION (2 PLACES)
2 ELECTRICAL CONNECTOR STOWAGE
3 SINGLE POINT REFUELING PANEL (2 PLACES)
4 GROUND CONNECTION (2 PLACES)
▼T 5 A/R SINGLE POINT RECEPTACLE
6 SINGLE POINT REFUELING NOZZLE IN AIRPLANE SINGLE POINT RECEPTACLE
7 RANGE EXTENSION RECEPTACLE G TCTO KGT507

SINGLE POINT REFUELING F G 1255▶

Figure 4-84

SINGLE POINT REFUELING (SPR) F G 1255▶

Airplanes F G 1255▶ are equipped with a single point pressure refueling system in addition to individual filler necks on each tank. The single point refueling system (figure 4-77 and 4-86) provides a means for refueling all the fuel tanks in the airplane except the external fuel tanks on G airplanes, from two filler ports (receptacles) located on the lower left hand side of the fuselage aft of the left wing rear spar. The forward receptacle (6, figure 4-84) is for the main fuel system (No. 1 Main, No. 2 Main, No. 3 Main, No. 4



1 SPR POWER ON TEST 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 FIG 1255

Figure 4-85

Main, and Center Wing Tanks). These fuel tanks may be filled simultaneously or selectively. The aft receptacle (5, figure 4-84) is for the A/R tank system when the airplane is in the tanker configuration. 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 4-85) with which the operator can control the entire refueling operation, and the necessary fuel lines and electrical wiring.

SINGLE POINT REFUELING EQUIPMENT

F G 1255

CAUTION

If fuel other than grades 115/145 or 100/130 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. An electrical receptacle for the single point refueling panel is located on the underside of the left wing inboard of the No. 2 nacelle (figure 4-85). On airplanes G 22665, 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 and close the external tank manifold transfer valve (figure 4-77). On G airplanes with TCTO KGT507 incorporated, a cannon plug receptacle is installed in lower aft compartment. The receptacle provides electrical connection to the single point refueling panel so the switches on the panel may be monitored inside the airplane.

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 115/145 or 100/130 fuel in the center wing tank, the manual fuel-shutoff valve on F airplanes or the No. 1 manual fuel-shutoff valve on G airplanes must be safety wired in the closed position. On G airplanes when carrying fuel other than uncontaminated grade 115/145 or 100/130 in the external fuel tanks but not in the center wing tank, the No. 2 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 these fuel tanks for the airplane system, all contaminated fuel must be drained and flushed out before refilling with grade 115/145 or 100/130 fuel.

Single Point (SPR) Master Switch

The SPR master switch (2, figure 4-85) 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

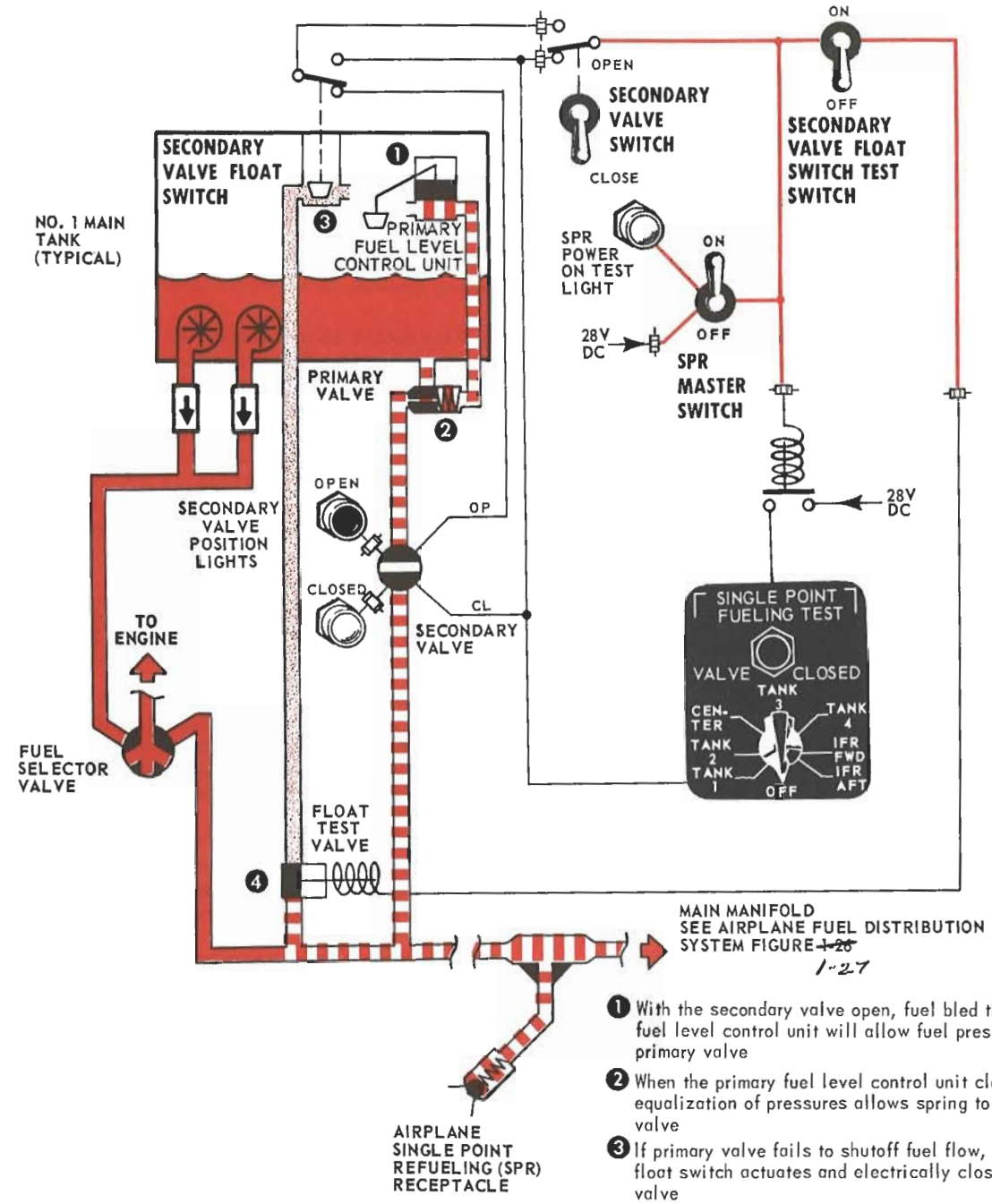
Each secondary valve switch (7, figure 4-85) on the SPR panel has OPEN--CLOSE positions. With the SPR master switch ON, the secondary valve can be; opened or closed by the secondary valve switch, closed by the single point secondary valve test switch on engineer's instrument panel and closed by the secondary valve float switch during single point refueling. On airplanes G 22665 opening and closing of the secondary valves is controlled either by the A/R transfer valve switches on 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 4-77.) 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 valve float switch test switch (5, figure 4-85) 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, thus simulating a full tank condition.

Single Point Refueling Secondary Valve Closed Light

A single point refueling secondary valve closed light (10, figure 1-22) 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 SYSTEM (AIRPLANE)

FG 1255

Figure 4-86

Single Point Secondary Valve Test Switch

The single point secondary valve test switch (11, figure 1-22) 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 airplanes G 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 thru the transfer valve switches (15, figure 4-76) only.

SPR Power On Test Light

A push-to-test light (1, figure 4-85), above the master switch on the single point refueling panel, illuminates when pressed if 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 4-85) is illuminated when the secondary valve is open and the lower light (8, figure 4-85) is illuminated when the secondary valve is closed.

SINGLE POINT REFUELING SYSTEM NORMAL OPERATION

CAUTION

- To prevent damage to the fuel distribution system when refueling with a hydrant system, the fuel tanks should be filled to only 85% of the tank capacity. Make final shutoff with the hydrant system, not by means of any airplane valve. Complete the refueling by use of the standard gravity method on airplanes G 22737 ▶ and those having decals which permit use of the hydrant system by use of an F-6 truck.

- 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:

1. Remove the 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. On G airplanes with 1C1O KGT507 incorporated, a connon plug 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 and should be off the bus during refueling. Use battery power only for single point refueling.

- Check SPR master switch on single point refueling panel in OFF position before inserting electrical plug in receptacle.

2. Insert the electrical plug in the plug receptacle.
3. Position SPR master switch on the single point refueling panel to ON
4. Press the SPR power on indicator light. The light should illuminate, indicating that power is supplied to the panel
5. Connect refueling hose grounding lead to grounding jack

6. 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 OFF. This will isolate the engines from the manifold line, thus relieving the carburetors from undue pressure.

- Before filling the A/R system, check leveling valve closed, vent valve open (if applicable). Fuel load in aft tank system must not exceed that in forward tank system.

7. Press all circuit breakers on the single point refueling panel
8. Position secondary valve switch to OPEN for tank or tanks to be filled; remaining secondary valve switches to CLOSE
9. Start fuel flow. The fuel will flow into the tanks selected
10. Hold secondary valve float switch test switch ON for tanks to be tested for 10 seconds. The secondary valve close light should illuminate

CAUTION

The secondary valve of at least one tank must remain open to prevent fuel pressure surge.

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 plug receptacle. With SPR master switch ON, possible arcing at receptacle may cause an explosion if fuel fumes are present.

- Drain approximately one quart of fuel from the aft single point refueling receptacle drain line to provide thermal relief.

MISCELLANEOUS EQUIPMENT

SEATS

The navigator's seat is adjustable for vertical movement and on airplanes without TCTO 562 incorporated will rotate 45 degrees to the right toward the nose of the airplane. On airplanes with TCTO 562 incorporated, the stop bolt restricting rotational movement of the seat is removed, thus allowing the navigator to face aft during crash landing or ditching. A safety belt is provided. A left auxiliary troop seat, including a safety belt, near the left escape hatch is for the boom operator when he is not engaged in air refueling.

The navigator's seat is adjustable for vertical and rotational movement. On airplanes G 3178 ▶, the seat is also adjustable fore and aft along a set of tracks. The seat is equipped with a safety belt and shoulder harness. The shoulder harness has an inertia reel and lock mechanism. 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.

NAVIGATOR'S SIGHTING STOOL

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

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; another hatch in the aft end of the main compartment provides access to the tail compartment.

WINDSHIELD WIPERS

Hydraulically operated windshield wipers clear the windows directly in front of the pilot and copilot. The wipers are operated by the airplane hydraulic system (figure 1-36). A control knob (11, figure 1-11) is provided to turn the windshield wipers on by rotating the knob counterclockwise, and to regulate the speed of the wipers.

CAUTION

To prevent damage to windshields and difficulty in parking the windshield wipers on dry glass, they 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.

HEATED SUIT PROVISIONS GF 1243 ▶ 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 1-33 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

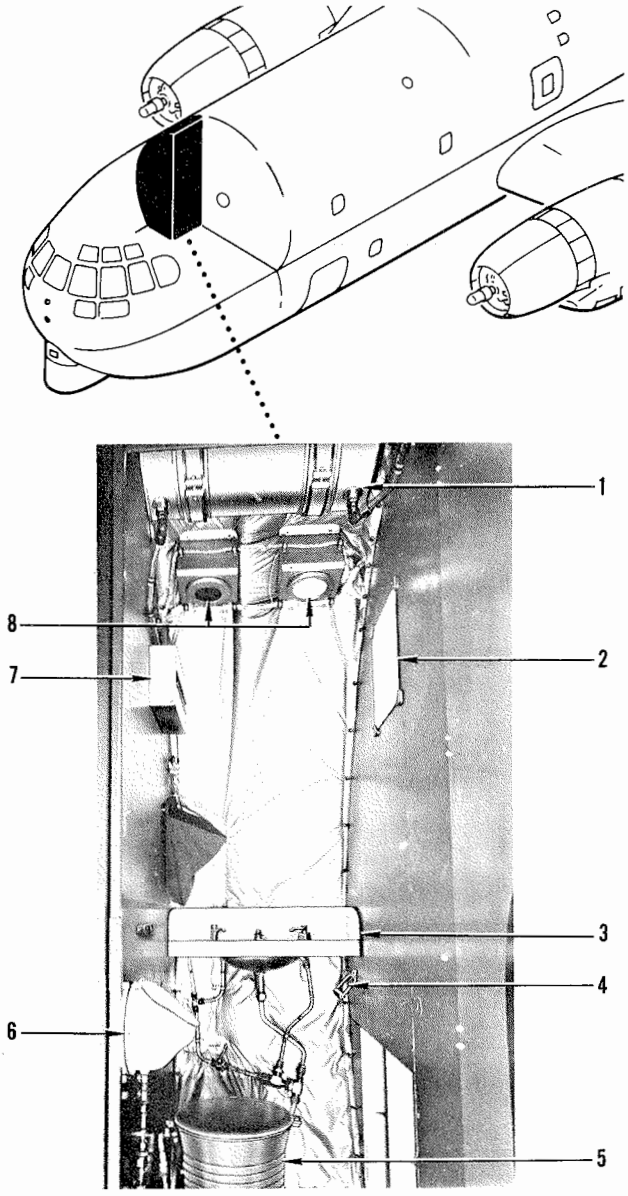
The load adjuster, used for computing the center of gravity under various loading conditions, is located in the control cabin.

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 for protection against sun light. The curtains are attached by snapping them to clips on the window frame. The pilots' sliding windows are equipped with curtains that can be manually rolled up. These curtains, when rolled up are held in place with straps; when unrolled, they are snapped in place. Snap-on type curtains are also provided at the navigator's window and the window behind the engineer's station. A special curtain is provided for celestial shots. This curtain is rolled up and held in place by straps when not in use. Two night flying curtains, one on each side of the fuselage, isolate the pilot, copilot, and engineer from the lighted navigation station when the curtain is properly installed. The night flying curtains are folded against the cabin wall and held in place by straps. On airplanes G 2826 ▶ in the tanker configuration, 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; the third connects the main compartment with the lower aft compartment. When the airplane is in the tanker configuration, 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.



1 WATER TANK
2 MIRROR
3 WASH BASIN
4 TOILET TISSUE DISPENSER
5 TOILET
6 URINAL
7 TOWEL DISPENSER
8 DOME LIGHTS

TOILET COMPARTMENT

Figure 4-87

RELIEF EQUIPMENT

There is a toilet compartment (figure 4-87) 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

The engineer and navigator are provided with tables for their convenience.

MAP STOWAGE DRAWER

A drawer is provided in the navigator's table to permit stowage of maps and charts.

ASH TRAYS

Ash trays are conveniently located at each crew station.

BOOM STOWING MIRROR

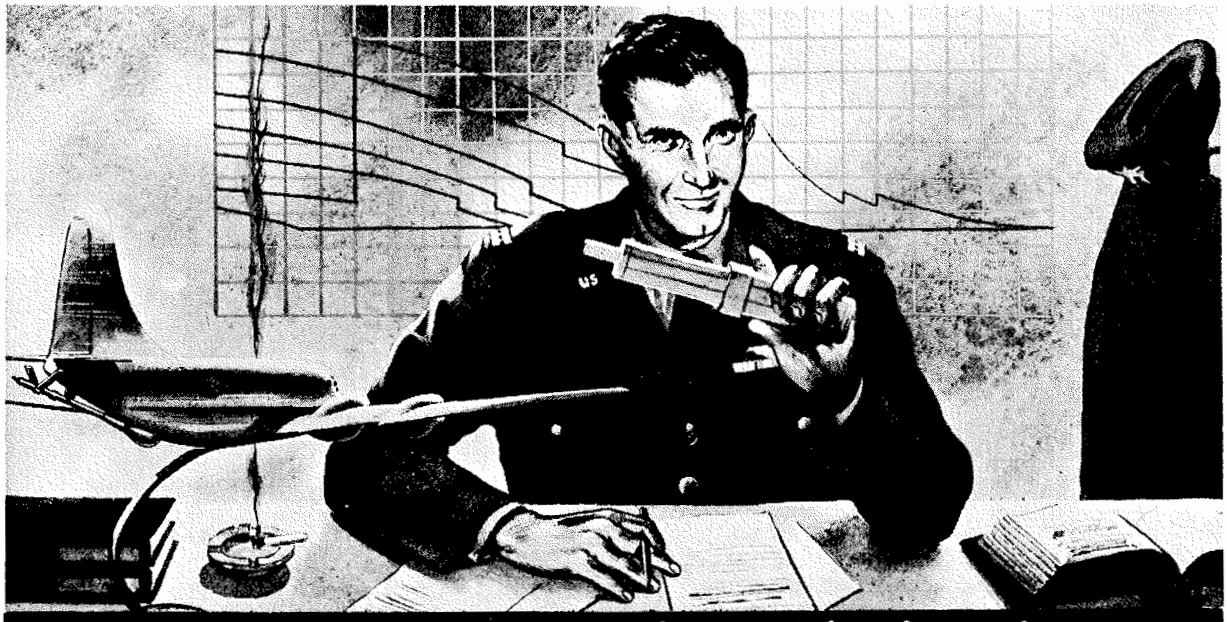
A rear view mirror is provided in the boom operator's compartment aft of the instrument panel to assist him in stowing the A/R boom.

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.

NAVIGATOR'S STOWAGE CABINET

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



Section V Operating Limitations

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SCOPE

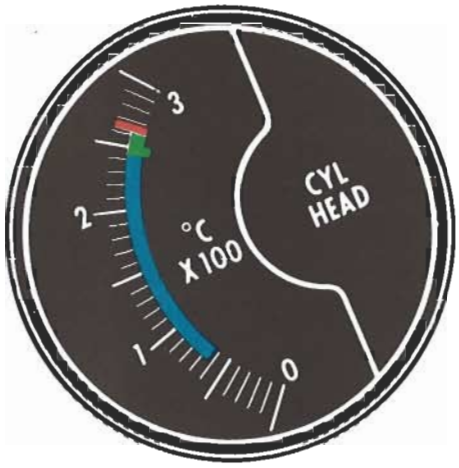
This Section covers the operating limitations of the airplane which must be observed during normal operation. Special attention should be given to the instrument markings (figure 5-1) since these limits are not necessarily repeated under their respective sections. The instrument markings are used to 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 equipment and to the airplane.

MINIMUM CREW REQUIREMENTS

The minimum crew requirements for this airplane are a pilot, copilot, engineer and boom operator. Additional crew members as required will be added at the discretion of the Commander.

MANIFOLD PRESSURE

- 14 IN. HG . . . . . MINIMUM IN FLIGHT
- 14 IN. HG TO 50.5 IN. HG . . . AUTO LEAN PERMITTED
- 50.5 IN. HG TO 60 IN. HG . . . AUTO RICH REQUIRED
- 60 IN. HG . . . . . TAKEOFF (WET OR DRY)



CYLINDER HEAD TEMPERATURE

- 65°C TO 243°C . . . . . AUTO LEAN PERMITTED
- 243°C TO 265°C . . . . AUTO RICH REQUIRED
- 265°C . . . . . MAXIMUM

NOTE: A CHT of 220°C is the maximum for start of takeoff. Maximum CHT for level flight is 255°C. Maximum at 70% METO power or less is 243°C.

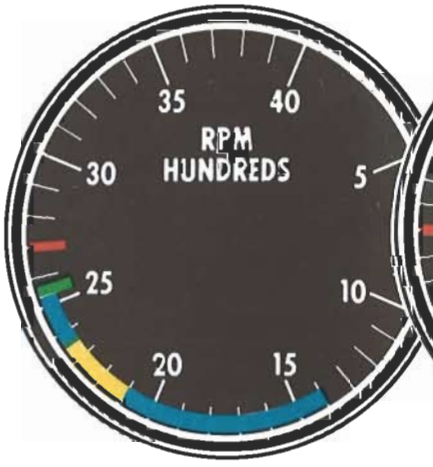
FUEL GRADE 115/145

TORQUEMETER

- 50 PSI . . . . . MINIMUM FOR FLIGHT
- 50 PSI 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

- 1300 TO 1400 RPM. . . . . ALLOWABLE FOR CRUISING

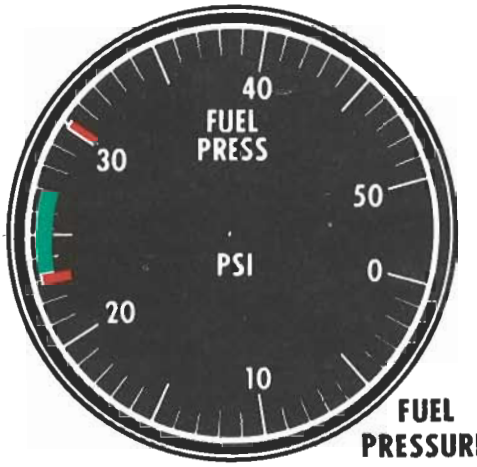
  NOTE: Operation below 1400 rpm not recommended because of propeller inefficiency
- 1401 RPM TO 2550 RPM. . AUTO LEAN PERMITTED (MARKED ON PILOTS' TACHOMETERS ONLY)
- 2100 TO 2350 RPM . INFLIGHT OPERATION PROHIBITED EXCEPT WHILE PASSING THROUGH THIS RANGE. SEE TEXT FOR GROUND RESTRICTIONS.
- 2550 RPM (METO) . . . . . MAXIMUM CONTINUOUS AUTO LEAN OR AUTO RICH

  NOTE: Operation above this rpm limited to 30 minutes in AUTO RICH
- 2700 RPM. . . . . MAXIMUM

ENGINEER'S TACHOMETER

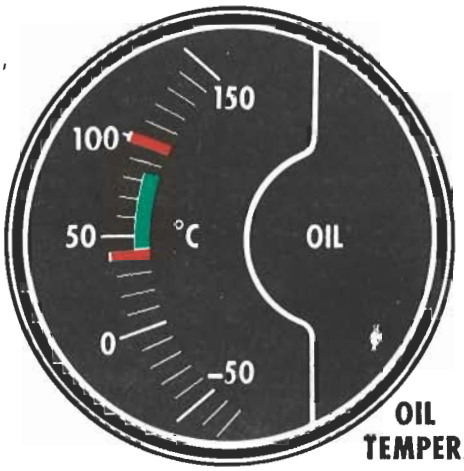
INSTRUMENT MARKINGS

Figure 5-1 (Sheet 1 of 7)



FUEL PRESSURE

- 23 PSI. . . . . MINIMUM FOR FLIGHT
- 23 PSI TO 27 PSI . . . . . CONTINUOUS OPERATION
- 30 PSI. . . . . MAXIMUM ALLOWABLE (engine operating)



OIL TEMPERATURE

- 40°C . . . . . MINIMUM FOR FLIGHT
- 40°C TO 85°C. . . . . CONTINUOUS OPERATION
- 100°C . . . . . MAXIMUM

NOTE: See also Section IX COLD WEATHER for other limitations.

CAUTION

150°C to 160°C during flight is limited to 2 minutes. 160°C is maximum for continuous ground operation. 160°C to 190°C during ground operation is limited to 5 minutes. 190°C to 227°C during ground operation is limited to 1 minute and over 227°C requires turbo shutdown.

TURBO BEARING TEMPERATURE

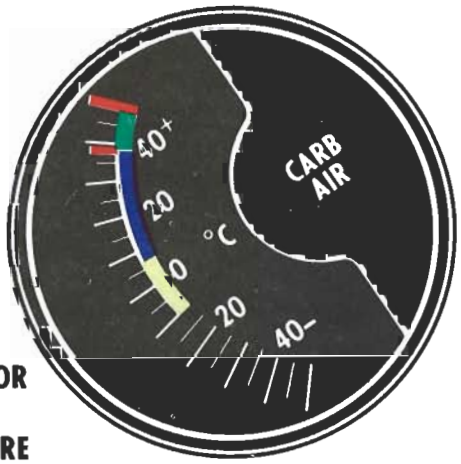
TCTO 611

- 160°C. . . . . MAXIMUM DURING FLIGHT
- 40°C 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 PSI TO 110 PSI . . . . . CONTINUOUS OPERATION
- 110 PSI . . . . . MAXIMUM

NOTE: An indication of 25 psi is the minimum oil pressure during idle engine rpm.
75 psi is required during takeoff to minimize bearing wear.

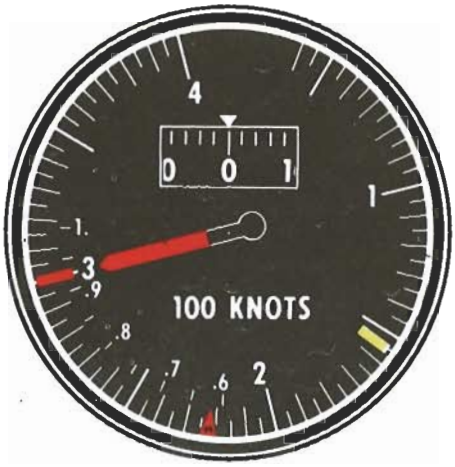


CARBURETOR AIR TEMPERATURE

- -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°C 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 increaded 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 7)



MAXIMUM ALLOWABLE AIR SPEED

155 KNOTS.. FULL FLAPS (LANDING GEAR 200 KNOTS)
300 KNOTS..... MAXIMUM AIRSPEED

This instrument setting is such that the red pointer will move to indicate a limiting structural airspeed of 300 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 7-5 FOR OTHER COWL FLAP LIMITS)

PROPELLER DE-ICING LOADMETER

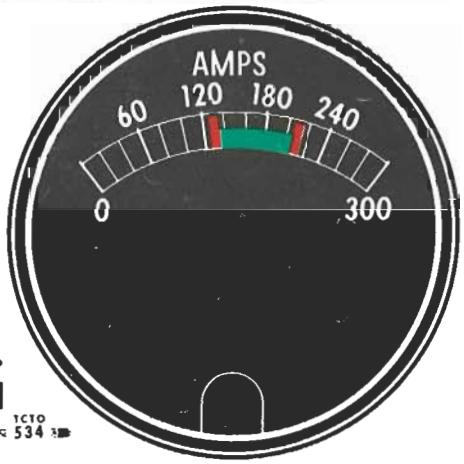
G 22629 ▶

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

F G
1243 ▶
22628
WITH TCTO 534



PROPELLER DE-ICING AMMETER

130 AMPS PER CYCLE..... MINIMUM
130 TO 215 AMPS PER CYCLE ..... NORMAL
215 AMPS PER CYCLE..... MAXIMUM

INSTRUMENT MARKINGS (CONT)

Figure 5-1 (Sheet 3 of 7)

▽A/R FUEL PRESS

50 PSI . . . . . MAXIMUM A/R FUEL PRESSURE

CABIN AIR FLOW

1 IN. HG 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

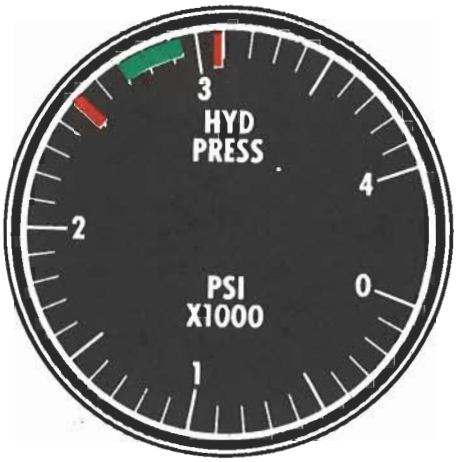
–20°C TO 182°C. . . . . NORMAL
182°C . . . . . MAXIMUM

Figure 5-1 (Sheet 4 of 7)

F

DIRECT READING GAGE

G



ELECTRICAL GAGE

▽ BOOM HYDRAULIC SYSTEM PRESSURE

2500 PSI	MINIMUM
2700 TO 2950 PSI	NORMAL
3080 PSI	MAXIMUM

F G
1243 ▶ 2893 ▶

DIRECT READING GAGE

G
2894 ▶

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

INSTRUMENT MARKINGS (CONT)

Figure 5-1 (Sheet 5 of 7)

EMERGENCY BRAKE HYDRAULIC PRESSURE

520 PSI . . . . ONE BRAKE APPLICATION REMAINING
1825 PSI . . . . . MAXIMUM

SERVICE BRAKE HYDRAULIC PRESSURE

520 PSI . . . . ONE BRAKE APPLICATION REMAINING
1500 PSI TO 1650 PSI . . . . . NORMAL
1825 PSI . . . . . MAXIMUM

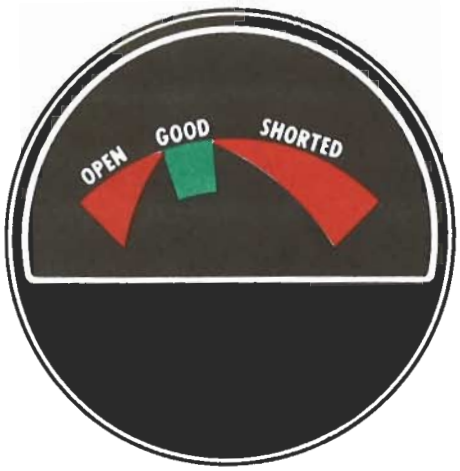
MAIN HYDRAULIC PRESSURE

1500 PSI TO 1650 PSI . . . . . NORMAL
1825 PSI . . . . . MAXIMUM

▽AIR REFUELING HYDRAULIC OIL TEMPERATURE

100°C . . . . . MAXIMUM
NOTE: Reduce refueling flow or shut-down as necessary to stay below this limit.

Figure 5-1 (Sheet 6 of 7)



BOOM SIGNAL COIL TEST VOLTMETER

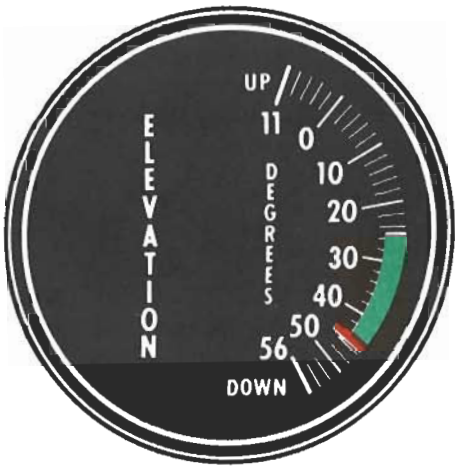
OPEN . . . . . BOOM SIGNAL COIL CIRCUIT OPEN
GOOD . . . . . BOOM SIGNAL COIL CIRCUIT GOOD
SHORTED . . . BOOM SIGNAL COIL CIRCUIT SHORTED

BOOM AZIMUTH

17°L – 17°R . . NORMAL ENVELOPE (Automatic Operation)
17°L AND 17°R . . . . . MAXIMUM

BOOM TELESCOPE

6 FT . . . . . MINIMUM
6 FT – 18 FT . . . . . NORMAL ENVELOPE (Automatic Operation)
18 FT . . . . . MAXIMUM



BOOM ELEVATION

25°30' – 45° DOWN . . . . . NORMAL ENVELOPE (Automatic Operation)
45° DOWN . . . . . MAXIMUM

Figure 5-1 (Sheet 7 of 7)

ENGINE LIMITATIONS

OVERSPEED

Whenever engine overspeeding occurs, the following information must be noted in the appropriate section of Form 781; the maximum rpm which was obtained during flight, duration in minutes of the overspeed condition and reason for overspeed if known. If engine rpm was between 3100 rpm and 3300 rpm, an inspection of the engine is required before further flight. If the engine exceeded 3300 rpm the engine must be removed for overhaul.

OVERBOOST

The ratings commonly used consist of several different power levels, the highest of which is usually for takeoff and the lowest of which (of interest to overboosting) is the maximum allowed for continuous use. Other lower recommended ratings, such as climb and cruise, are not involved in overboosting. The specific values of rpm and manifold pressure approved for engine rating are the acceptable power levels for normal operation. If manifold pressures in excess of 60 in. Hg are used, overboosting has occurred.

a. For any operating condition using manifold pressures above 60 in. Hg, overboost of from 1 to 5 in. Hg for periods up to 5 seconds requires no action.

b. From 1 to 10 in. Hg, overboost for periods of 5 to 15 seconds requires engine inspection.

c. For overboost of 10 in. Hg or more the engine must be removed for overhaul.

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 220°C during start of takeoff run to prevent other cylinders from exceeding 265°C. Once the airplane is moving, cylinders A-1 and B-1 give more accurate indications of maximum CHT, and when airborne cylinders A-1 and B-1 give the most accurate indications of maximum CHT.

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

TURBO LIMITATIONS

Figure 5-2

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 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 emergency the engine can 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 a fuel grade of 115/145 to develop maximum power ratings without exceeding detonation margins. The alternate fuel for R-4360-59B engines is 100/130 grade. If this lower grade fuel is used for continuous operation the power ratings must be reduced by mechanically limiting manifold pressure to achieve the same safety margin as shown in figure 5-3. Under emergency conditions when using 100/130 grade fuel the above limitations do not apply and the engines can be operated using the same limitations as for the 115/145 grade fuel.

PROP LIMITATIONS

Ground operation between 1250 to 1650 rpm and 2100 to 2650 rpm is prohibited except for passing through these ranges. Do not use reverse thrust for ground maneuvering. Flight operation between 2100 rpm and 2350 rpm is prohibited except while passing through this range.

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 thru 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% MAC, wing flaps are limited to 80% on final approach and touchdown. Reduce airspeed to cross threshold at 30 knots above full flap power off stall 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.

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 (Climb)	2550	2500	187	48.1	265°C	240° – 265°C	38°C	7°–38°C	AR
METO POWER (Level Flight)	2550	2500	187	48.1	255°C	240° – 255°C	38°C	7°–38°C	AR
MAX AUTO LEAN	2300	1900	158	39.0	243°C	225° – 243°C	38°C	7°–38°C	AL

FOR MIL-F-5572, GRADE 100/130 FUEL

CONTINUOUS OPERATION WITH ALTERNATE FUEL

Figure 5-3

BRAKE LIMITATIONS

1C10 K555

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 use of figure 5-4. This figure is for brakes only, and does not include the effects of prop reversing. However, at lower speeds, less than 50 knots, the effect of prop reversing is small and the chart will give realistic values even if the props are still in reverse pitch while the brakes are being applied. (See 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 Chart, figure 5-4. 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 wheel-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 5-4. 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 one 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 two minutes for each one million foot-pounds in excess of 7 million foot-pounds.

WARNING

- Landing gear extension will decrease available rate of climb approximately 350 feet per minute and may result in a negative rate of climb at METO power.

- 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; 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 seven minutes for each one 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.

NOTE

Peak temperatures are reached in the brake housing approximately 15 to 20 minutes after braking.

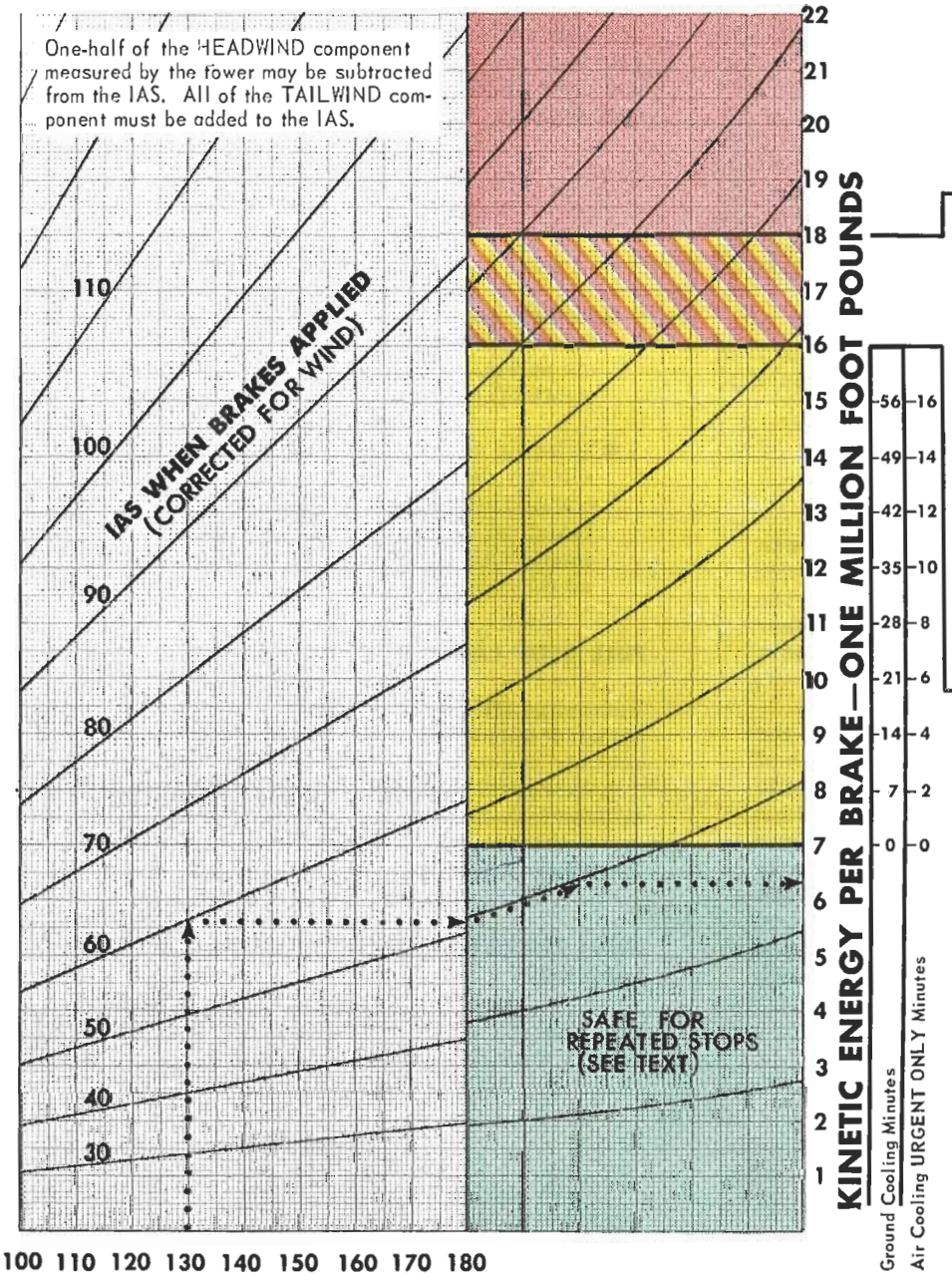
WARNING

If a second braking attempt is made before heat is dissipated from the first attempt, the brake energy limits may be exceeded causing tire explosions and fire that could endanger the crew and airplane.

GIVEN:
Full stop landing
Gross weight = 130,000 LB
Airspeed when brakes applied = 55 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 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. See text for example calculation.

Figure 5-4

Do not approach the overheated brakes for at least one half 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 one and one half 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.

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 slip stream, 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 to 30 knots.

c. For at 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 2.9 million foot-pounds at 40 knots and 1.6 million foot-pounds at 30 knots. The difference between these values, 1.3 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 + 1.3 = 4.3 million foot-pounds. Total cumulative energy would be 6.3 + 4.3 = 10.6 million foot-pounds. It can be seen from figure 5-4 that approximately 25 minutes ground cooling or 7 minutes gear down air cooling would be required.

NOTE

Under extreme conditions a normal traffic pattern would not be sufficient timewise for gear down air cooling.

AIRSPEED LIMITS

NOTE

The following limits supplement those shown in figure 5-1. See also Part 8 of the Appendix, T.O. 1C-97(K)F-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% flaps. Do not exceed 155 knots IAS with flaps 55% to 100%. 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.

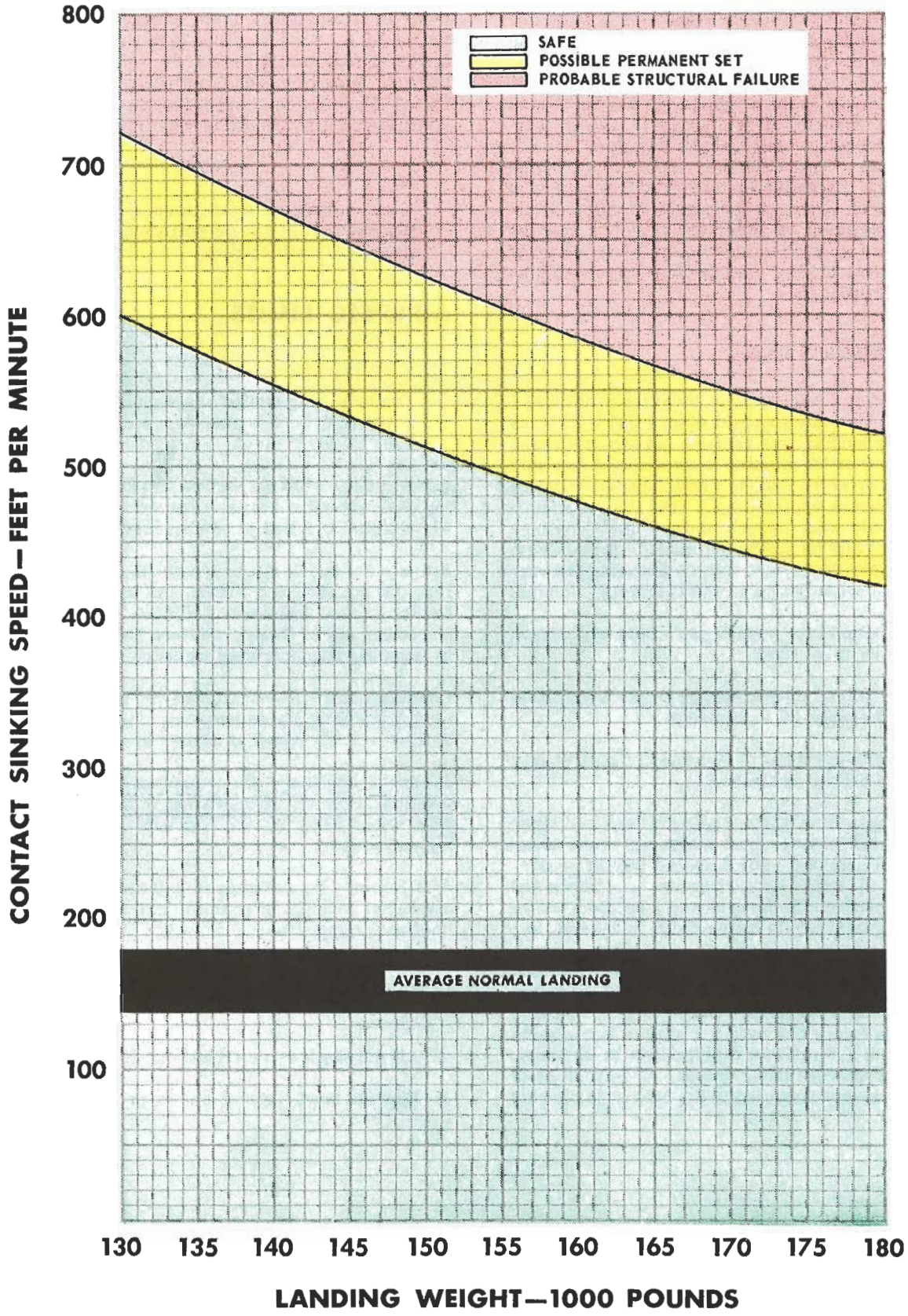
Sheltered Air Door - Do not exceed 210 knots IAS when opening, closing, or operating in the sheltered position. Operating mechanism will be overstressed at higher speeds.

A/R Boom - Do not exceed 260 knots IAS with boom unlatched because of possible damage to the boom or the boom supports.

FLIGHT RESTRICTIONS

a. All acrobatics are strictly prohibited.

b. Operate cowl flaps as shown in figure 7-5.



HIGH GROSS WEIGHT LANDING CHART

Figure 5-5

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)F-1-1.

HIGH GROSS WEIGHT LANDING SINKING SPEEDS

The airplane structure is designed for normal landing with a payload up to 45,500 pounds in the cargo configuration and 39,700 pounds in the tanker configuration up to normal gross landing weight. At these weights the airplane is designed for a 10 fps limit contact sinking speed with 0.67g wing air lift (a condition which occurs frequently).

CAUTION

Taxi or takeoff gross weights which exceed 175,000 pounds, or the 2.0g line, whichever is least, are not recommended because of possible structural damage to the landing gear.

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 CHART

The weight limitations charts shown in figures 5-7 and 5-8 graphically illustrate the weight carrying capabilities of the airplane in the cargo and tanker configurations with equal and unequal fuel distribution. The charts are generally used to determine whether the airplane is in recommended or restricted gross weight range with respect to the amount of fuel carried in the fuel tanks versus the payload. Various components of the charts are explained in the following paragraphs.

Gross Weight

Gross weight is indicated by diagonal lines on the weight limitations charts. These diagonal lines not explained in the chart notes are reference lines only.

Operating Weight

The operating weight of 87,500 pounds F or 90,000 pounds G shown near the top of the chart is an approximate value for the tanker configuration. It includes the basic weight of the airplane as shown in Chart C of the Manual of Weight and Balance Data, T.O. 1-1B-40 plus the standard crew and oil capacity. Since individual airplanes vary in operating weight, it will be necessary to adjust the charts for a specific airplane. This correction is especially significant for the cargo configuration where the operating weight is approximately 81,500 pounds F or 83,000 pounds G.

Payload

The payload capacity is shown on the vertical axes of the charts. This includes the weight of center wing tank fuel, air refueling fuselage fuel, cargo and airplane operating weight in excess of 87,500 pounds F or 90,000 pounds G. If the operating weight is less than 87,500 pounds F or 90,000 pounds G, the allowable payload is increased by the difference between 87,500 pounds F or 90,000 pounds G and the true operating weight. (See the Example Problem.)

Wing Fuel Capacity

F

The wing fuel capacity is shown on the horizontal axes of the charts. This includes the weight of fuel in the four main tanks only.

	Air Refueling Fuel Load (Pounds) ❷	Airplane Gross Weight (Pounds) ❶	Fuel Loading Sequence	Fuel Usage Sequence ❶
RECOMMENDED LOADING ALLOWABLE LIMIT LOAD FACTOR IS 2.5 OR GREATER	Up To 25,700 (T) 32,000 (C)	Up To 153,000	1. FILL MAIN TANKS Fuel in tanks 1 and 4 must be equal to or greater than fuel in tanks 2 and 3 2. FILL CENTER WING TANK	1. USE CENTER WING TANK ❹ 2. USE MAIN TANKS Fuel in tanks 1 and 4 must always be equal to or greater than fuel in tanks 2 and 3
	Up To 39,000 (T) 45,000 (C)	Up To 133,000		
	32,000 (C) 25,700 (T) To 45,000 (C) 39,700 (T)	133,000 To 153,000	1. FILL MAIN TANKS Not over 1200 pounds each (200 gal) in tanks 2 and 3 unless tanks 1 and 4 are full 2. FILL CENTER WING TANK	1. USE CENTER WING TANK ❹ 2. USE OF MAIN TANKS For weight limitations with optimum flight load factors (figure 5-7, Sheets 1, 2, 3 & 4), use fuel in tanks 2 and 3 until 1200 pounds (200 gallons) remain in each; then use fuel in tanks 1 and 4. For alternate weight limitations (figure 5-7, Sheets 5, 6, 7 & 8), fuel in tanks 1 and 4 may be equal or greater than fuel in tanks 2 and 3
ALLOWABLE LIMIT LOAD FACTOR IS LESS THAN 2.5	Over 39,700 (T) 45,500 (C)			
		Over 153,000		

F

NOTES: (Use notes as indicated by above chart)

❶ For landing gross weights refer to figure 5-5.

❷ Fuselage load includes weight of center wing tank fuel and refueling tank fuel or cargo. Fuselage loading must be corrected for operating weight empty.

❸ See Manual of Weight and Balance Data, T.O. 1-1B-40, for additional weights, restrictions and limitations.

❹ Use fuel in center wing tank as soon as possible except when loaded with air refueling fuel.

❺ 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.

❻ With fuel in external fuel tanks increase gross weight to include weight of fuel and weight of tanks.

FUEL LOADING AND USAGE RESTRICTIONS

Figure 5-6 (Sheet 1 of 2)

Fuselage Loading for 90,000 Pounds OPERATING WEIGHT EMPTY (2) (3)		Airplane Gross Weight	Fuel Loading Sequence	Fuel Usage Sequence (1)
RECOMMENDED LOADING ALLOWABLE LIMIT LOAD FACTOR IS 2.5 OR GREATER (5)	Up To 23,600 Pounds	Up To 153,000 Pounds	1. FILL MAIN TANKS Fuel in tanks 1 and 4 must be equal to or greater than fuel in tanks 2 and 3 2. FILL EXTERNAL WING TANKS 3. FILL CENTER WING TANKS	1. USE CENTER WING TANK (4) 2. USE EXTERNAL WING TANK 3. 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 Pounds	Up To 133,000 Pounds (6)		
	23,600 Pounds To 38,100 Pounds	133,000 Pounds To 153,000 Pounds (6)	1. FILL MAIN TANKS Not over 1200 pounds (200 gallons) each in tanks 2 and 3 unless tanks 1 and 4 are full 2. FILL EXTERNAL WING TANKS 3. FILL CENTER WING TANK	1. USE CENTER WING TANK (4) 2. USE EXTERNAL WING TANK 3. USE OF MAIN TANKS (4) For weight limitations with optimum flight limit load factors (figure 5-8, Sheets 1, 2, 3 & 4), use fuel in tanks 2 and 3 until 1200 pounds (200 gallons) remain in each; then use fuel in tanks 1 and 4. For alternate weight limitations (figure 5-8, Sheets 5, 6, 7 & 8), fuel in tanks 1 and 4 may be equal or greater than fuel in tanks 2 and 3
ALLOWABLE LIMIT LOAD FACTOR IS LESS THAN 2.5	Over 38,100 Pounds	ALL GROSS WEIGHTS		

Quantity of air refueling fuel to be loaded	Distribution and Loading Sequence
Up To 38,100 Pounds	Fill fuselage air refueling tanks.
Over 38,100 Pounds	External wing tanks must be filled if fuselage tanks are to exceed 38,100 pounds. Fill center wing tank.

WARNING

If external tanks are not serviced with fuel, the Maximum Equivalent Performance Weight allowable will be based on F airplane limitations

G

Figure 5-6 (Sheet 2 of 2)

G

The wing fuel capacity is shown on the horizontal axes of the charts. This includes the weight of fuel in the four main wing tanks and also the weight of the external fuel tanks regardless of whether the latter is used to operate the airplane or for air refueling.

Load Factor

The airplane structure is limited in the amount of weight it can carry without danger of permanent set at reasonable load factors. Load factor is the ratio of the force acting on the airplane to the weight of the airplane and may be expressed by the term g. All airplanes at rest on the ground or in straight and level flight are sustaining a one g load which is equivalent to one load factor. The force to resist this load is supplied on the ground by the landing gear and in flight by the wing and tail lift. Increased load factors are produced from acceleration and occur during turns, pull-ups, gusts, landings and taxi. The allowable limit load factor is the load factor above which permanent set can possibly occur. The load factor lines in figures 5-7 and 5-8 are allowable limit load factors. The allowable ultimate load factor is one and one-half times the limit load factor and is the load factor at which the structure may fail. These allowable load factors vary with gross weight and distribution of payload and fuel.

Airplane Flight Load Factor

Three of the lines on the weight limitations charts indicate airplane allowable limit load factors for various combinations of fuel and payload. With a 2.5 load factor, the airplane will support 153,000 pounds gross weight without danger of permanent set. Combinations of fuel and payloads which increase gross weights above 153,000 pounds should be flown with caution. especially when making turns or pullouts, or flying through turbulent air.

CAUTION

It is recommended that the airplane not be flown at any gross weight exceeding 175,000 pounds, or in excess of the 2.0g line whichever is least, because of possible structural failure in the event that 2.0g is exceeded or the airplane is subjected to severe maneuver, turbulence, taxi, or landing loads.

Performance Limitations

Performance limitations are shown and explained on the weight limitations charts (figures 5-7 and 5-8).

EXAMPLE I USING THE CHARTS

TANKER CONFIGURATION

F

To demonstrate a problem where the operating weight of the airplane is greater than that shown on the charts, assume an operating weight of 91,000 pounds, 46,000 pounds of air refueling fuel, and 26,000 pounds of airplane fuel. According to the fuel loading and usage table, the flight fuel should be distributed in the following manner: Tanks 1 and 4 contain 10,620 pounds each, and the remaining 4760 pounds equally distributed between tanks 2 and 3. The air refueling fuel should be distributed as follows: 39,700 pounds in the fuselage tanks and 6300 pounds in the center wing tank. Reference is now made to figure 5-7, sheets 3, 4, 7 and 8. The payload correction for the operating weight is 91,000 - 87,500 or 3500 pounds. The effective payload is the sum of the payload correction for operating weight, i.e., the deck tank fuel and the center wing tank fuel (3500 + 39,700 + 6300) or 49,500 pounds. Proceed along the vertical axis of the chart to 49,500 pounds. On the horizontal axis of the chart, locate the wing fuel load 26,000 pounds and project the line vertically to intersect the horizontal projection of the 49,500 pound line. A gross weight of 163,200 pounds is interpolated from the diagonal lines. It is noted that the weight condition is better than the 2.0g allowable flight and landing limit load factor line and falls within a cautionary loading range. Therefore, the airplane should be flown with caution especially when making turns or pullouts or flying through turbulent air. During the flight prior to fuel transfer the allowable limit flight load factor will increase slightly as fuel is used from the inboard tanks, but will remain in the cautionary range. After air refueling fuel is transferred, the allowable limit load factor will be greater than 2.5g.

TANKER CONFIGURATION WITH FULL EXTERNAL TANKS

G

To demonstrate a problem where the operating weight of the airplane is greater than that shown on the charts, assume an operating weight of 94,000 pounds, 53,000 pounds of air refueling fuel, and 26,000 pounds of airplane fuel. According to the fuel loading and usage table, the flight fuel should be distributed in the following manner: Tanks 1 and 4 contain 10,620 pounds each; and the remaining 4760 pounds equally distributed between tanks 2 and 3. The air refueling fuel should be distributed as follows: 39,150 pounds in the fuselage tanks, 8775 pounds in the external tanks and the remaining 5075 pounds in the center wing tank. Reference is now made to figure 5-8, sheets 1 and 2. The payload correction for the operating weight is 94,000 - 90,000 or 4000 pounds. The effective payload is the

sum of the payload correction for operating weight, i.e., the deck tank fuel and the center wing tank fuel (4000 + 39,150 + 5075) or 48,225 pounds. Proceed along the vertical axis of the chart to 48,225 pounds. On the horizontal axis of the chart, locate the wing fuel load of 8775 pounds plus 26,000 pounds or 34,775 and project the line vertically to intersect the horizontal projection of the 48,225 pound line. A gross weight of 173,000 pounds is interpolated from the diagonal lines. It is noted that the weight condition is better than the 2.0g allowable flight and landing limit load factor line and falls within a cautionary loading range. Therefore, the airplane should be flown with caution especially when making turns or pullouts or flying through turbulent air. During the flight prior to fuel transfer the allowable limit flight load factor will increase slightly as fuel is used from the inboard tanks, but will remain in the cautionary range. After air refueling fuel is transferred, the allowable limit load factor will be greater than 2.5g.

EXAMPLE II USING THE CHARTS

CARGO CONFIGURATION F

To demonstrate a problem where the operating weight of the airplane is less than that shown on the charts consider an operating weight of 77,000 pounds, 45,000 pounds cargo and 24,000 pounds fuel. Refer to figure 5-7, sheets 1, 2, 5 and 6. The payload correction for the operating weight empty is 81,500 - 77,000 or 4500 pounds. Locate the effective payload ordinate of 40,500 pounds on the vertical axis and project horizontally to intersect the vertical projection of the 24,000 pound fuel ordinate where a gross weight of 146,350 pounds is interpolated. This places the mission in a recommended loading range.

CARGO VERSION WITHOUT EXTERNAL TANKS G

To demonstrate a problem where the operating weight of the airplane is less than that shown on the charts consider an operating weight of 83,000 pounds, 45,000 pounds cargo and 24,000 fuel. Refer to figure 5-8, sheets 3 and 4. The payload correction for the operating weight empty is 90,000 - 83,000 or 7000 pounds. Locate the effective payload ordinate of 38,000 pounds on the vertical axis and project horizontally to intersect the vertical projection of the 24,000 pound fuel ordinate where a gross weight of 151,000 pounds is interpolated. This places the mission in a recommended loading range.

EXAMPLE III USING THE CHARTS

CARGO VERSION WITH EXTERNAL TANKS G

To demonstrate a problem where the operating weight is less than that shown on the weight limitations charts assume an operating weight of 84,000 pounds for the airplane, 47,500 pounds of fuel and 40,000 pounds of cargo. When external tanks are full figure 5-8, sheets 1 and 2 is applicable. The payload correction for the lower operating weight is 6000 pounds (90,000 - 84,000 pounds). Locate the effective payload of 34,000 pounds (40,000 - 6000 pounds) on the vertical axis and the wing fuel load of 47,500 pounds on the horizontal axis. Project the payload and wing fuel ordinates along their horizontal and vertical paths respectively to their intersection and interpolate a gross weight of 171,500 pounds. Note that if the correction for the operating weight had been neglected the apparent gross weight would have been 177,500 pounds and the load condition would appear to be in the red or not recommended portion of figure 5-8, sheets 1 and 2. The fuel usage chart recommends that the fuel in the external tanks be used first. To determine the load condition after the external tanks have been emptied proceed to figure 5-8, sheets 3 and 4. The correction for operating weight is 6000 pounds. Proceed along the 34,000 pound payload line to intersect the 39,400 wing fuel line and find a gross weight of 157,400 pounds. Note that the airplane load factor at this stage is about 2.3 and that as soon as the inboard main wing tanks have been half emptied the airplane will be in a recommended loading range. Thus, except for the first portion of the flight the mission will be in a recommended loading range.

OPTIMUM FLIGHT LIMIT LOAD FACTORS UNEQUAL FUEL DISTRIBUTION (CARGO CONFIGURATION)

Envelope ABC represents design payload and fuel limit.

GROSS WEIGHT CONDITIONS

Structural Limits

179,000 LB Allowable flight limit load factor is 2.0 g (with payload equal to or less than 64,500 LB).

175,000 LB Allowable landing gear limit load factor is 2.0 g.

167,000 LB Allowable flight limit load factor is 2.25 g (with payload equal to or less than 51,800 LB).

153,000 LB Allowable flight limit load factor is 2.50 g (with payload equal to or less than 45,500 LB).

130,000 LB Allowable limit landing sinking speed is 10 fps.

Takeoff Performance

178,000 LB 8000 feet takeoff ground run, sea level, standard day, (3500 bhp per engine).

167,100 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 engine inoperative, propeller feathered, gear up, flaps set for takeoff; sea level, hot day, 3380 bhp per engine.

Flight Performance

190,000 LB 100 fpm rate of climb, sea level, standard day, one 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 engines operating, gear up, flaps up, METO power.

154,000 LB Long range cruise capability at pressure altitude of 500 feet, 70 per cent of METO power, hot day.

PAYLOAD CONDITIONS

45,500 LB Design fuselage payload (includes wing center tank fuel).

51,800 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.25 g.

64,500 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.0 g.

WEIGHT LIMITATIONS F

Figure 5-7 (Sheet 1 of 8)

OPERATING WEIGHT EMPTY = 81,500 POUNDS

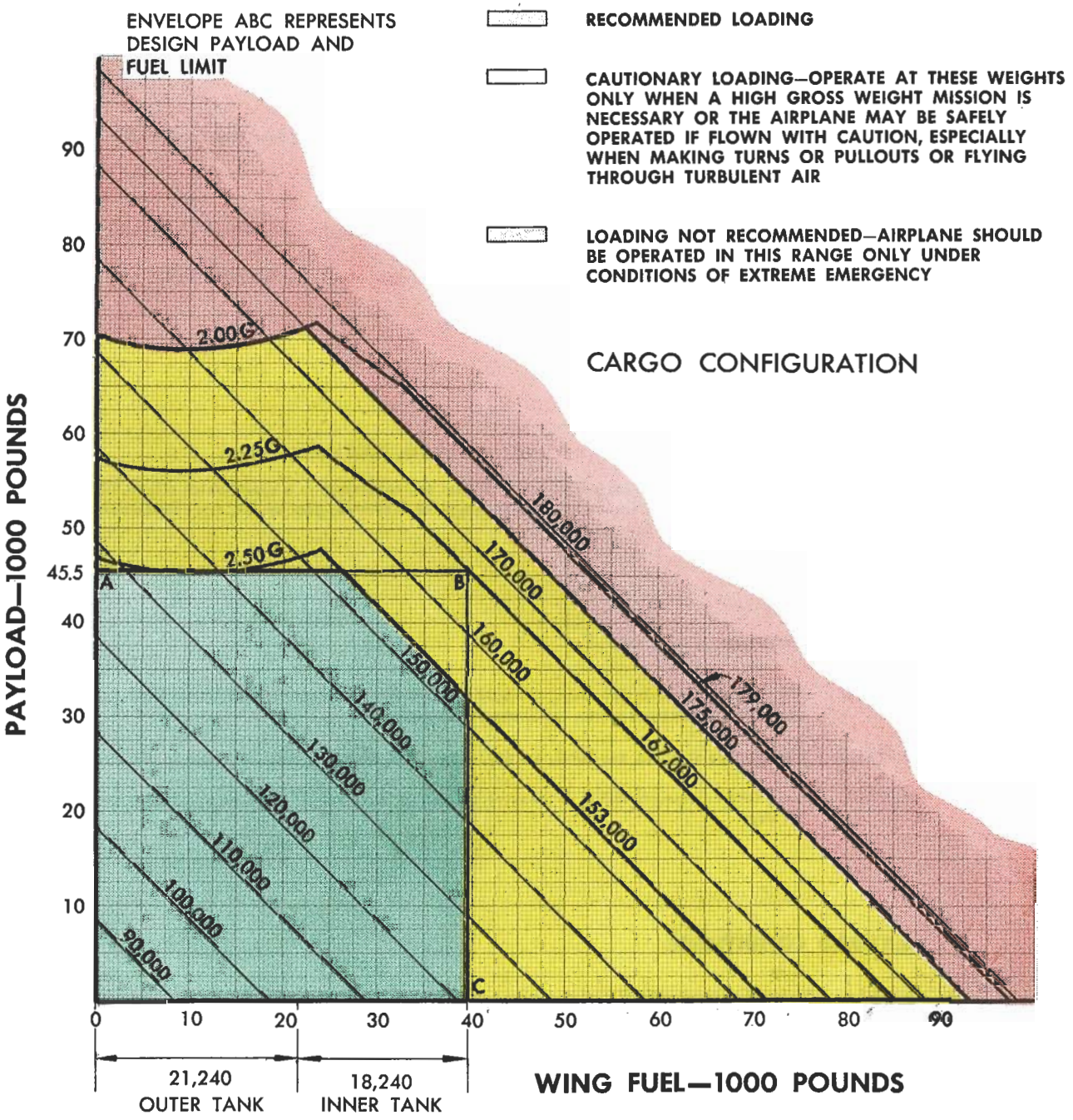


Figure 5-7 (Sheet 2 of 8)

OPTIMUM FLIGHT LIMIT LOAD FACTORS UNEQUAL FUEL DISTRIBUTION (TANKER CONFIGURATION)

Envelope ABC represents design payload and fuel limit.

GROSS WEIGHT CONDITIONS

Structural Limits

179,000 LB Allowable flight limit load factor is 2.0 g (with payload equal to or less than 58,000 LB).

175,000 LB Allowable landing gear limit load factor is 2.0 g.

167,000 LB Allowable flight limit load factor is 2.25 g (with payload equal to or less than 45,800 LB).

153,000 LB Allowable flight limit load factor is 2.50 g (with payload equal to or less than 39,700 LB).

130,000 LB Allowable limit landing sinking speed is 10 fps.

Takeoff Performance

178,000 LB 8000 feet takeoff ground run, sea level, standard day, (3500 bhp per engine).

167,100 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 engine inoperative, propeller feathered, gear up, flaps set for takeoff; sea level, hot day, 3380 bhp per engine.

Flight Performance

190,000 LB 100 fpm rate of climb, sea level, standard day, one 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 engines operating, gear up, flaps up, METO power.

154,000 LB Long range cruise capability at pressure altitude of 5000 feet, 70 per cent of METO power, hot day.

PAYLOAD CONDITIONS

39,700 LB Design fuselage payload (includes center wing tank fuel).

49,000 LB Fuselage payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.25 g.

62,000 LB Fuselage payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.0 g.

WEIGHT LIMITATIONS (CONT) F

Figure 5-7 (Sheet 3 of 8)

OPERATING WEIGHT EMPTY = 87,500 POUNDS

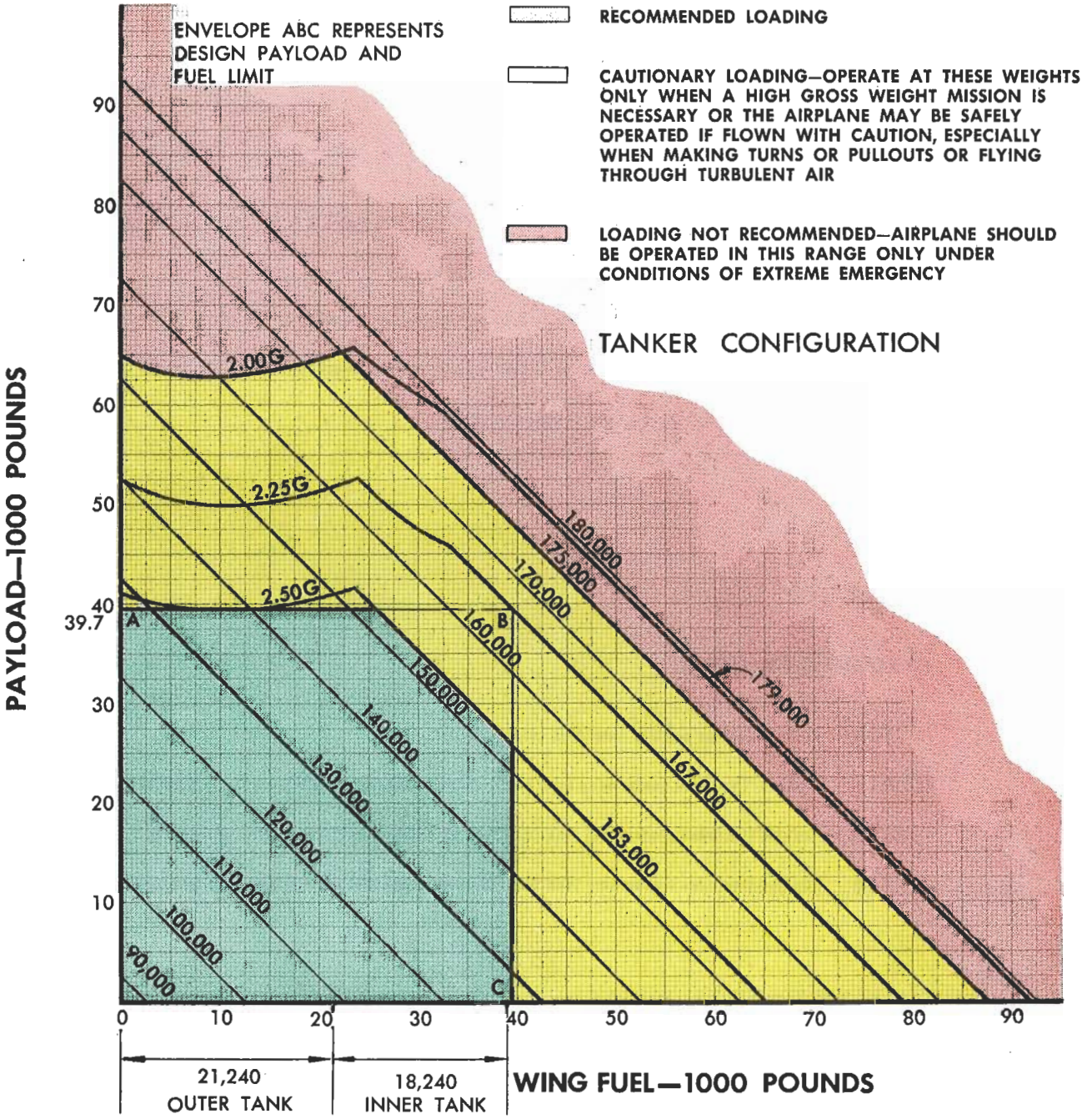


Figure 5-7 (Sheet 4 of 8)

ALTERNATE FLIGHT LIMIT LOAD FACTORS EQUAL FUEL DISTRIBUTION (CARGO CONFIGURATION)

Envelope DEF represents design payload and fuel limit.

GROSS WEIGHT CONDITIONS

Structural Limits

177,000 LB Allowable flight limit load factor is 2.0 g (with payload equal to or less than 59,000 LB).

175,000 LB Allowable landing gear limit load factor is 2.0 g.

160,400 LB Allowable flight limit load factor is 2.25 g (with payload equal to or less than 42,500 LB).

153,000 LB Allowable flight limit load factor is 2.25 g (with payload equal to or less than 45,500 LB).

130,000 LB Allowable limit landing sinking speed is 10 fps.

PAYLOAD CONDITIONS

45,500 LB Design fuselage payload (includes center wing tank fuel).

22,700 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.5 g.

42,500 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.25 g.

59,000 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.0 g.

OPERATING WEIGHT EMPTY=81,500 POUNDS

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 PULLOUTS OR FLYING THROUGH TURBULENT AIR

LOADING NOT RECOMMENDED—AIRPLANE SHOULD BE OPERATED IN THIS RANGE ONLY UNDER CONDITIONS OF EXTREME EMERGENCY

ENVELOPE DEF REPRESENTS DESIGN PAYLOAD AND FUEL LIMITS

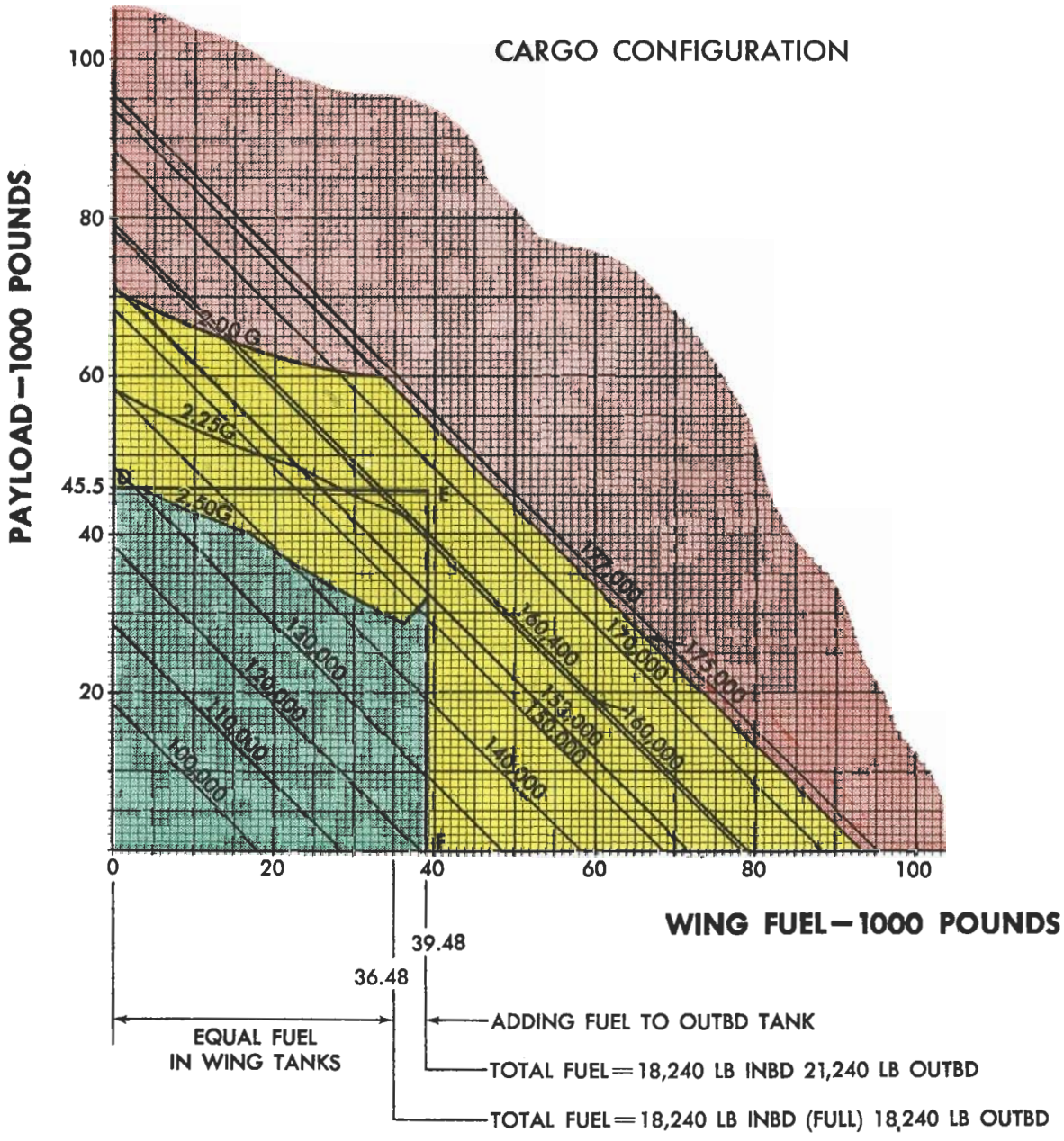


Figure 5-7 (Sheet 6 of 8)

ALTERNATE FLIGHT LIMIT LOAD FACTORS EQUAL FUEL DISTRIBUTION (TANKER CONFIGURATION)

Envelope DEF represents design payload and fuel limit.

GROSS WEIGHT CONDITIONS

Structural Limits

177,000 LB Allowable flight limit load factor is 2.0 g (with payload equal to or less than 53,000 LB).

175,000 LB Allowable landing gear limit load factor is 2.0 g.

160,400 LB Allowable flight limit load factor is 2.25 g (with payload equal to or less than 36,500 LB).

153,000 LB Allowable flight limit load factor is 2.25 g (with payload equal to or less than 39,700 LB).

130,000 LB Allowable limit landing sinking speed is 10 fps.

PAYLOAD CONDITIONS

39,700 LB Design fuselage payload (includes center wing tank fuel).

22,700 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.5 g.

36,500 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.25 g.

53,000 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.0 g.

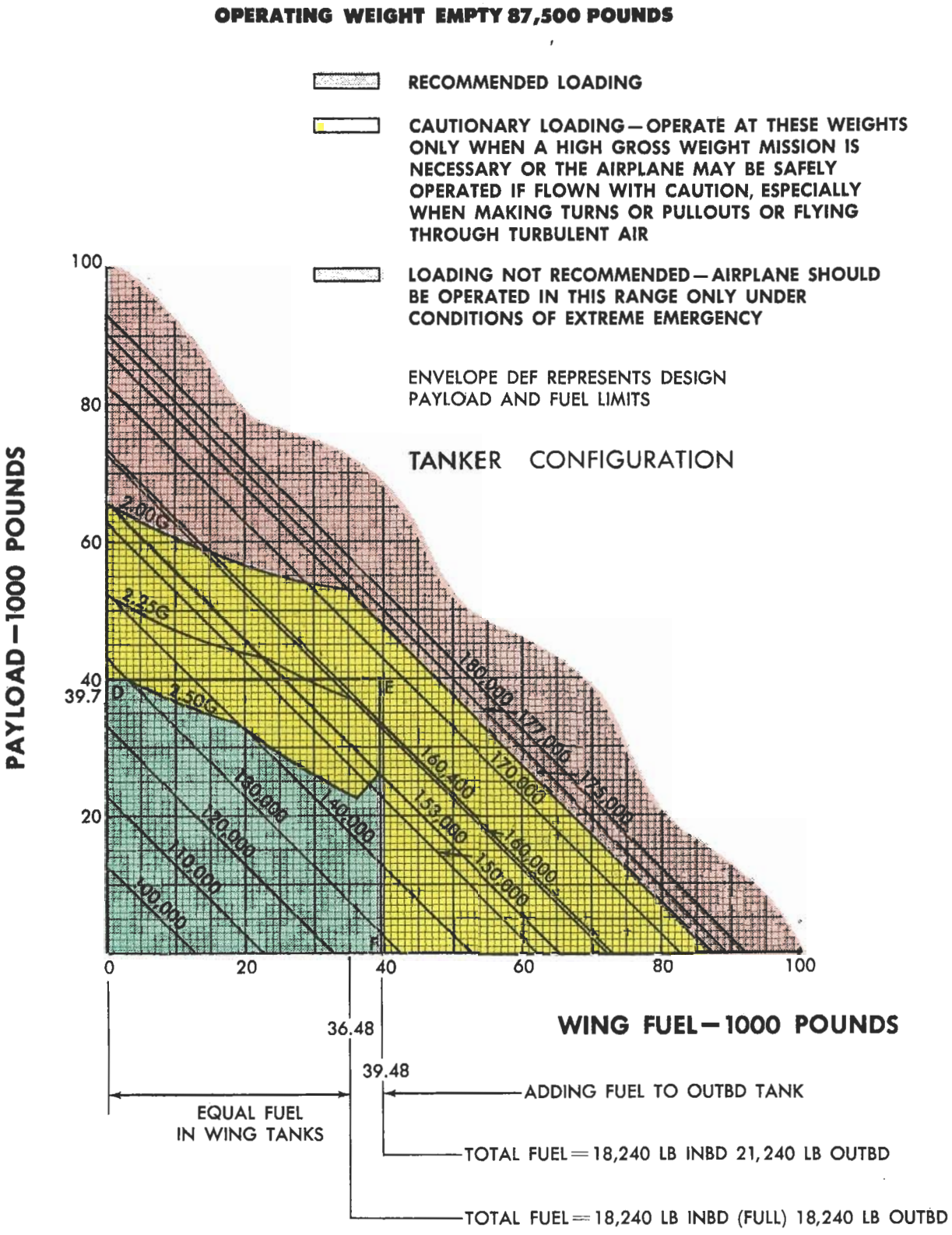


Figure 5-7 (Sheet 8 of 8)

OPTIMUM FLIGHT LIMIT LOAD FACTORS EXTERNAL FUEL TANKS FULL

Envelope ABC represents design payload and fuel limit with external fuel tanks full.

GROSS WEIGHT CONDITIONS

Structural Limits

189,000 LB Allowable flight limit load factor is 2.0 g (with payload equal to or less than 67,600 LB).

175,000 LB Allowable landing gear limit load factor is 2.0 g.

169,000 LB Allowable flight limit load factor is 2.25 g (with payload equal to or less than 53,400 LB).

153,000 LB Allowable flight limit load factor is 2.50 g (with payload equal to or less than 42,300 LB).

130,000 LB Allowable limit landing sinking speed is 10 fps.

Takeoff Performance

178,000 LB 8000 feet takeoff ground run, sea level, standard day, (3500 bhp per engine).

167,100 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 engine inoperative, propeller feathered, gear up, flaps set for takeoff; sea level, hot day, 3380 bhp per engine.

Flight Performance

190,000 LB 100 fpm rate of climb, sea level, standard day, one 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 engines operating, gear up, flaps up, METO power.

154,000 LB Long range cruise capability at pressure altitude of 5000 feet, 70 per cent of METO power, hot day.

PAYLOAD CONDITIONS

38,100 LB Design fuselage payload (includes wing center tank fuel).

46,900 LB Design payload (includes wing center and external tank fuel).

51,800 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.25 g.

60,600 LB Payload (includes center wing and external tank fuel) minimum allowable flight limit load factor is 2.25 g.

65,000 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.0 g.

73,800 LB Payload (includes center wing and external tank fuel) minimum allowable flight limit load factor is 2.0 g.

WEIGHT LIMITATIONS (CONT)

G

Figure 5-8 (Sheet 1 of 8)

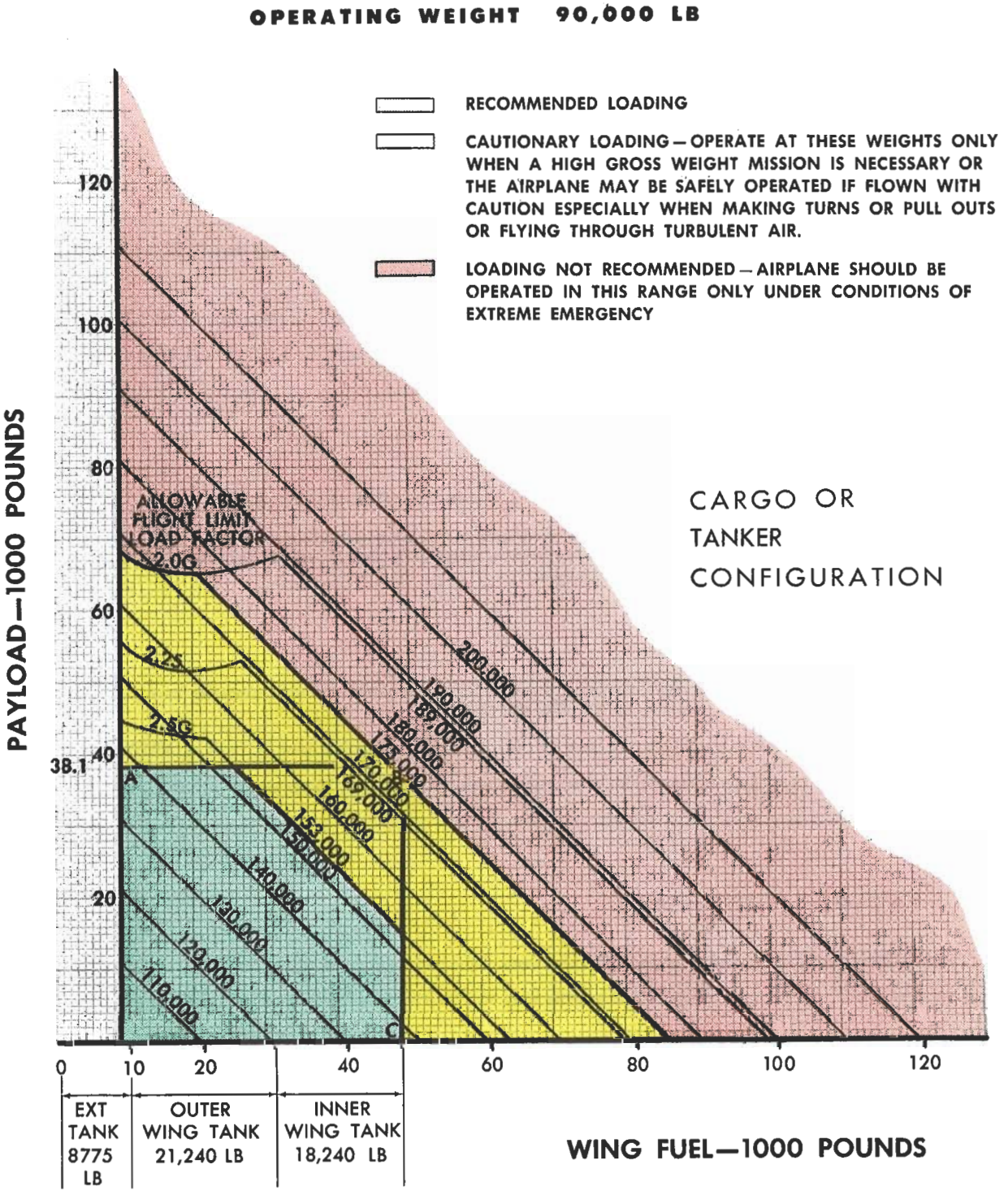


Figure 5-8 (Sheet 2 of 8)

OPTIMUM FLIGHT LIMIT LOAD FACTORS EXTERNAL FUEL TANKS EMPTY OR NOT INSTALLED

Envelope NOP represents design payload and fuel limit with external fuel tanks empty.

GROSS WEIGHT CONDITIONS

Structural Limits

182,000 LB Allowable flight limit load factor is 2.0 g (with payload equal to or less than 52,500 LB).

175,000 LB Allowable landing gear limit load factor is 2.0 g.

169,000 LB Allowable flight limit load factor is 2.25 g (with payload equal to or less than 43,000 LB).

153,000 LB Allowable flight limit load factor is 2.50 g (with payload equal to or less than 39,600 LB).

130,000 LB Allowable limit landing sinking speed is 10 fps.

Takeoff Performance

178,000 LB 8000 feet takeoff ground run, sea level, standard day, (3500 bhp per engine).

167,100 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 engine inoperative, propeller feathered, gear up, flaps set for takeoff; sea level, hot day, 3380 bhp per engine.

Flight Performance

190,000 LB 100 fpm rate of climb, sea level, standard day, one 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 engines operating, gear up, flaps up, METO power.

154,000 LB Long range cruise capability at pressure altitude of 500 feet, 70 per cent 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) minimum allowable flight limit load factor is 2.25 g.

60,500 LB Fuselage payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.0 g.

OPERATING WEIGHT EMPTY 90,000 LB

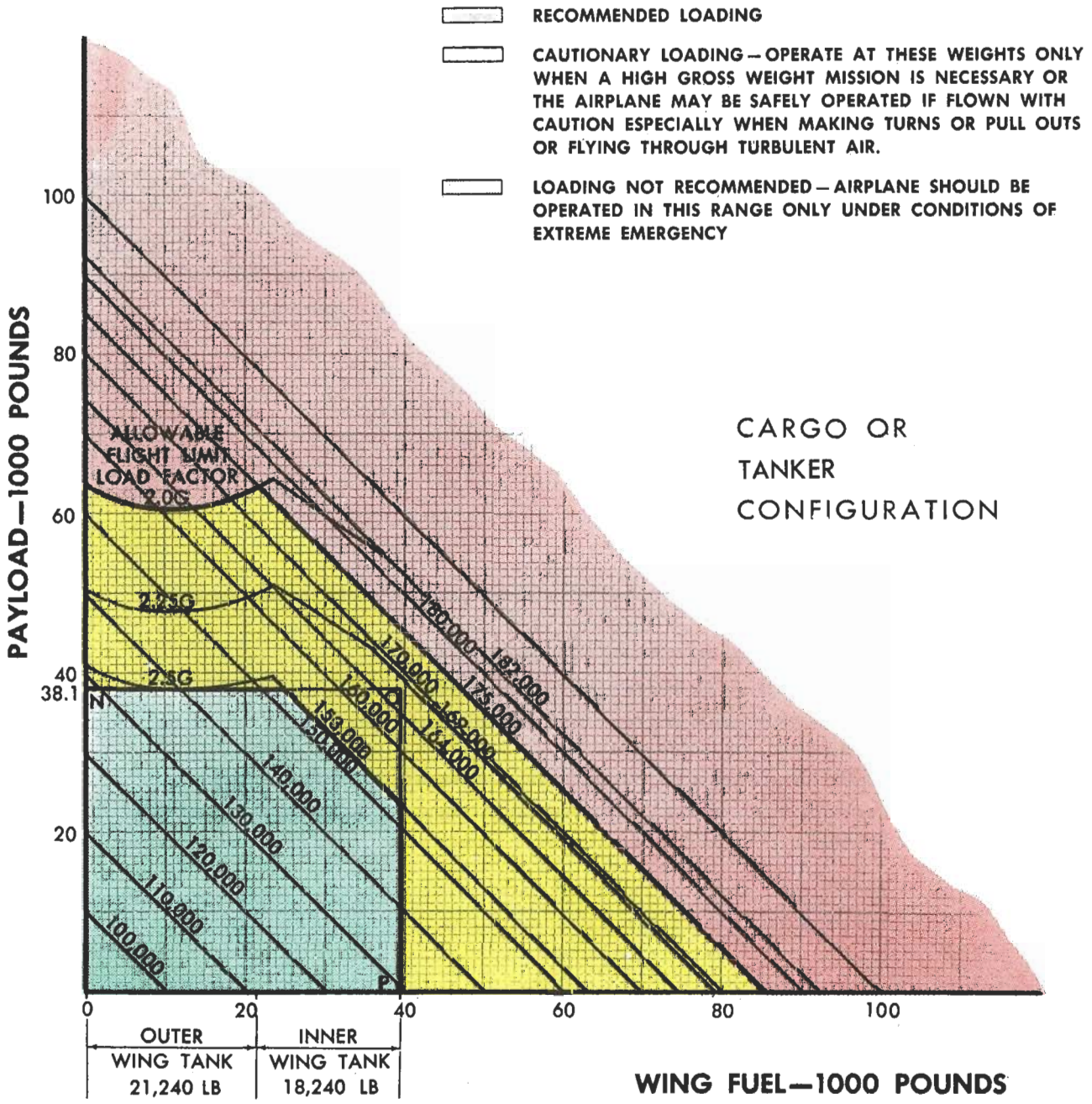


Figure 5-8 (Sheet 4 of 8)

EXTERNAL FUEL TANKS FULL AND EQUAL FUEL IN WING TANKS

Envelope ABC represents design payload and fuel limit with external tanks full.

GROSS WEIGHT CONDITIONS

Structural Limits

189,000 LB Allowable flight limit load factor is 2.0 g (with payload equal to or less than 50,750 LB).

175,000 LB Allowable landing gear limit load factor is 2.0 g.

169,000 LB Allowable flight limit load factor is 2.25 g (with payload equal to or less than 40,500 LB).

153,000 LB Allowable flight limit load factor is 2.50 g (with payload equal to or less than 37,000 LB).

130,000 LB Allowable limit landing sinking speed is 10 fps.

PAYLOAD CONDITIONS

35,100 LB Design fuselage payload when operating weight empty equals 93,000 LB (includes center wing tank fuel).

46,900 LB Design payload (includes outer wing and external tank fuel).

40,500 LB Payload (includes center wing tank fuel) minimum allowable limit load factor is 2.25 g.

49,300 LB Payload (includes center wing and external tank fuel) minimum allowable flight limit load factor is 2.25 g.

50,750 LB Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.0 g.

59,500 LB Payload (includes center wing and external tank fuel) minimum allowable flight limit load factor is 2.0 g.

WEIGHT LIMITATIONS (CONT)

G

Figure 5-8 (Sheet 5 of 8)

OPERATING WEIGHT EMPTY 93,000 LB

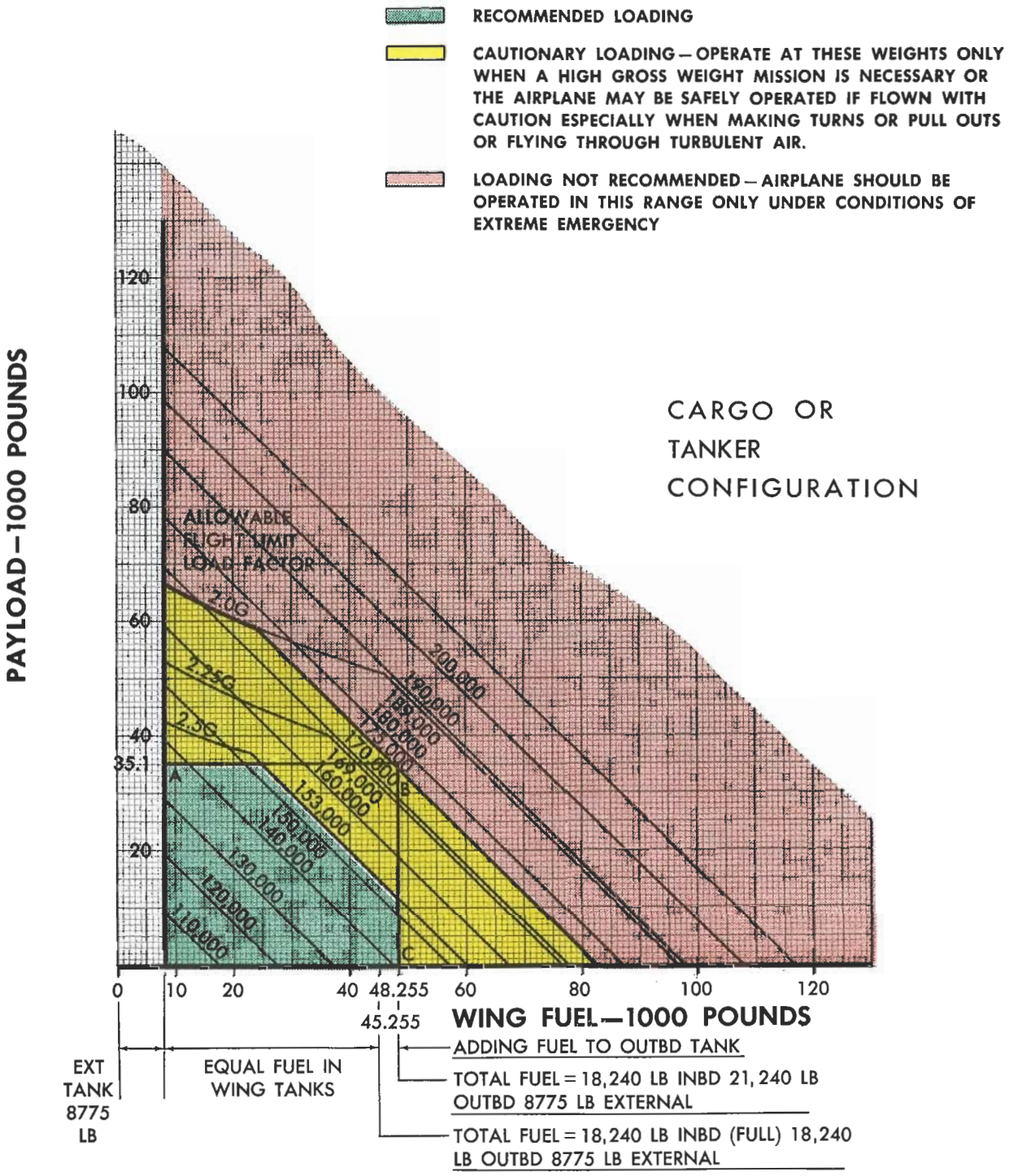


Figure 5-8 (Sheet 6 of 8)

ALTERNATE FLIGHT LIMIT LOAD FACTORS EXTERNAL FUEL TANKS EMPTY OR NOT INSTALLED AND EQUAL FUEL IN WING TANKS

Envelope DEF represents design payload and fuel limit with external tanks empty.

GROSS WEIGHT CONDITIONS

Structural Limits

177,000 LB	Allowable flight limit load factor is 2.0 g (with payload equal to or less than 47,500 LB).
175,000 LB	Allowable landing gear load limit factor is 2.0 g.
160,400 LB	Allowable flight limit load factor is 2.25 g (with payload equal to or less than 31,000 LB).
147,000 LB	Allowable flight limit load factor is 2.25 g (with payload equal to or less than 17,200 LB).

PAYLOAD CONDITIONS

35,100 LB	Design fuselage payload when operating weight empty equals 93,000 LB (includes center wing tank fuel).
17,200 LB	Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.5 g.
31,000 LB	Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.25 g.
47,500 LB	Payload (includes center wing tank fuel) minimum allowable flight limit load factor is 2.0 g.

OPERATING WEIGHT EMPTY 93,000 LB

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

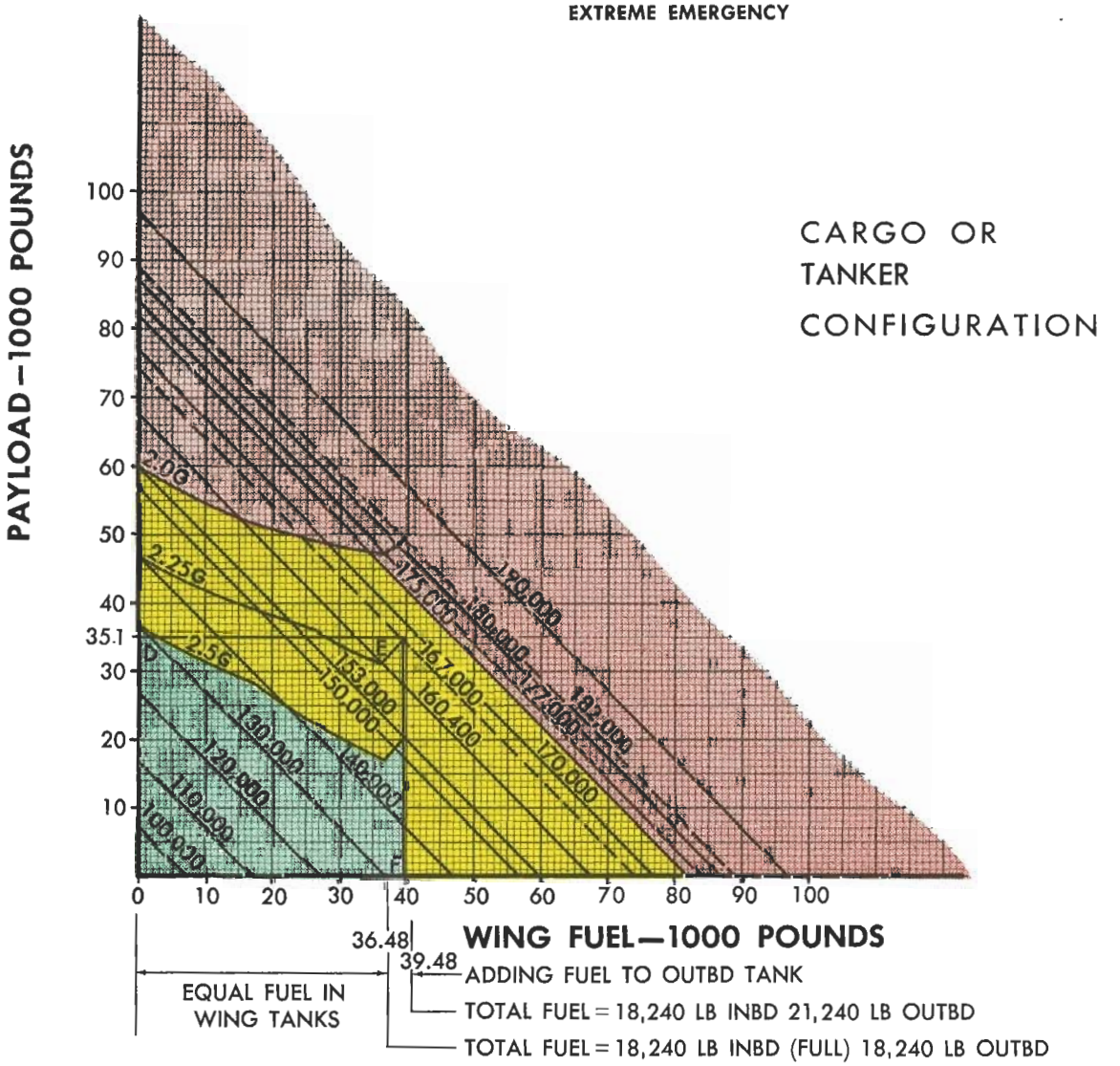
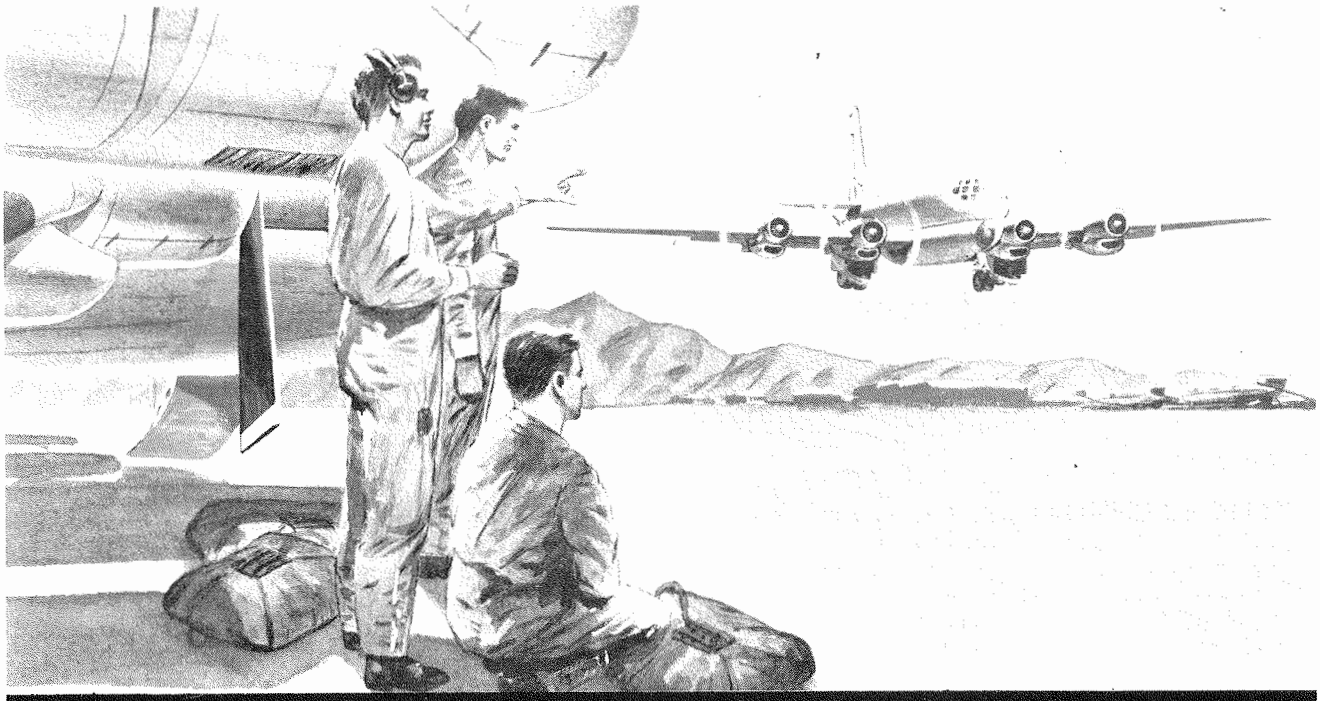


Figure 5-8 (Sheet 8 of 8)



Section VI Flight Characteristics

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LEVEL FLIGHT CHARACTERISTICS 6-3
DIVING 6-4
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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 climb-out. 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 cautions 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. The extended landing gear has no appreciable effect on the stalling speeds.

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 20

knots above the stall. With flaps down buffeting begins approximately 10 knots above stall speed. The buffeting range is reduced as 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.

NOTE

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 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 even with one engine out, since the minimum directional control speed is below the stall speeds except at weights below approximately 100,000 pounds. 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 pullouts 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 props 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

CONDITION		WING FLAPS UP			WING FLAPS 33%			WING FLAPS 55%			WING FLAPS 100%		
BANK ANGLE DEGREES		0	30	45	0	30	45	0	30	45	0	30	45
ACTUAL GROSS WEIGHT — POUNDS	180,000	134	144	160	123	133	148	115	123	136	105	113	125
	160,000	126	136	150	117	125	139	108	116	128	99	106	117
	140,000	118	127	141	109	117	130	101	108	120	93	99	110
	120,000	110	117	130	101	109	121	93	101	111	86	92	102
	100,000	100	108	119	92	101	110	85	92	102	78	84	93
	80,000	89	96	106	83	89	98	76	82	91	69	75	83

Stalling speed not affected by landing gear position

Power on stalling speeds are approx. 10 knots lower

POWER-OFF STALLING SPEEDS (INDICATED AIRSPEED-KNOTS)

Figure 6-1

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, it 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 let-downs 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% down positions. Oil cooler flap, intercooler flap and cowl flap position 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 three 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.

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 prop
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 setting should be checked immediately, since leaving the cowl flaps open more than three 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 to 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% 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, as 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

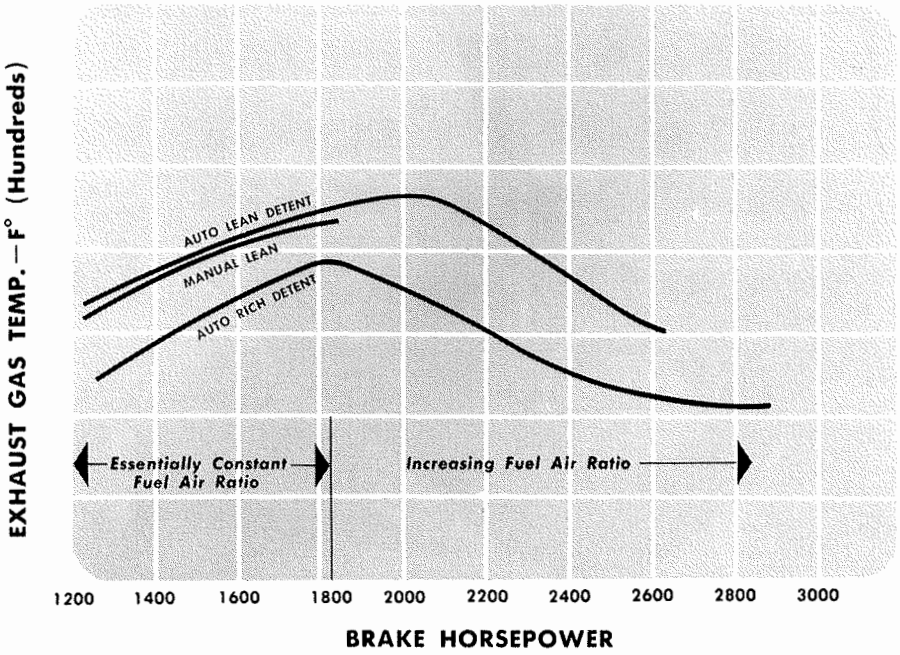
OPERATING CONSIDERATIONS

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 power plant 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.



EXHAUST GAS TEMPERATURE VS BRAKE HORSEPOWER

Figure 7-1

Engine Cooling

In figure 7-1 the drop off in temperature at low powers is due to the lower energy (heat) being developed per unit of time than at higher powers. The high power drop off 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° C 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 bhp 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 the scavenge pumps to remove all the oil satisfactorily. When the engine is not running, this oil may collect in the lower cylinders. Similarly, over-priming 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 incompressible 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 2 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 start 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. Provision is made for engine start during cold weather by preheating the primer fuel. The starting procedure totals about 8 minutes to start all four engines. Prior to use of hot fuel prime, accomplish all steps up to Start Engines in accordance with Normal Procedure or Alert Procedure as applicable. Hot fuel prime may then be utilized as follows:

CAUTION

Reference to figure 7-2, sheet 2 will show that the constant loads (interphone, lights, oleo relays, flight instruments, and engine instruments) essential inverter and hot fuel prime will result in a 600 ampere load. The APU has an overload limit of 620 amperes not to exceed 5 minutes in duration.

a. No. 3 Hot Fuel Prime Switch - HIGH

b. No. 4 Hot Fuel Prime Switch - LOW

c. No. 3 Hot Fuel Prime Switch - OFF (when indicator light is extinguished)

CAUTION

If the hot fuel prime indicator light does not extinguish, do not exceed 3 minutes operation on HIGH only or 6 minutes operation on LOW only. See figure 7-2, sheet 1, for maximum operation time on high after initial operation on low (less than 6 minutes on low). Either system malfunction or extremely low fuel temperature may cause the hot fuel prime indicator light to remain illuminated.

d. Essential Inverter Switch - OFF

e. No. 2 Hot Fuel Prime Switch - LOW

NOTE

When using hot fuel prime for starting, after the start the fuel pressure will drop approximately 20 PSI and fuel flow will increase momentarily. This is normal and due to refilling of the hot fuel prime tank.

f. No. 3 Engine-Started (Refer to Normal Procedure)

g. Essential Inverter Switch - ESS INV (after No. 3 engine is running)

h. No. 4 and No. 2 Hot Fuel Prime Switches - HIGH

i. No. 1 Hot Fuel Prime Switch - LOW

j. No. 4 Hot Fuel Prime Switch - OFF (when indicator light is extinguished)

k. No. 4 Engine-Started (Refer to Normal Procedure)

m. No. 1 Hot Fuel Prime Switch - HIGH

n. No. 2 Hot Fuel Prime Switch - OFF (when indicator light is extinguished)

p. No. 2 Engine - Started (Refer to Normal Procedure)

q. No. 1 Hot Fuel Prime Switch - OFF (when indicator light is extinguished)

r. No. 1 Engine - Started (Refer to Normal Procedure)

An eight minute procedure may be used to start all engines with a minimum of delay (figure 7-2, sheet 2). The temperature is maintained automatically until the switch is placed in the OFF position.

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 catches, use prime as required to bring engine rpm up to 1000 rpm. 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 after-burning 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 richen 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.

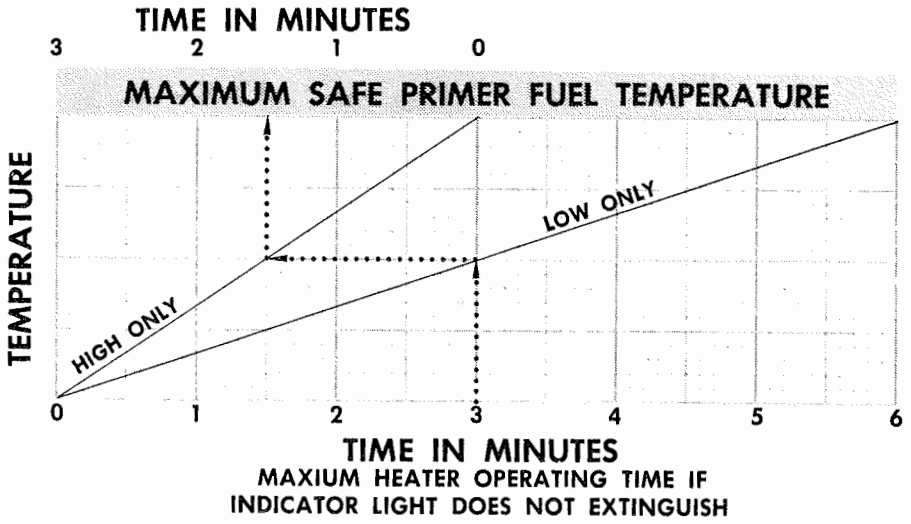
Throttle Position after Starting

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.

WARM UP AND GROUND TEST

Warm Up

The engines should be operated on the ground only as necessary for warm-up, preflight check, and taxiing. Operating time should be held to a minimum. Use of auto lean will not accelerate the warm-up. At warm-up 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 warm-up, regardless of OAT or the cylinder head temperature indication because heat from the exhaust system can cause damage to the ignition leads. Provisions are made for reducing engine warm-up time by the addition of an oil diverter segregator below the engine oil tank. The diverter segregator valve directs oil circulation through the oil tank hopper until the temperature reaches 55° C (130° F). 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 whenever possible to aid in filtering



EXAMPLE

GIVEN:
Heater has been operated on LOW for 3 minutes

FIND:
Time heater can be operated on HIGH

SOLUTION:
Enter bottom of chart at 3 minutes proceeding vertically to LOW ONLY line. Proceed horizontally to HIGH ONLY line and then vertically to read time from "0" point = 1 1/2 minutes

HOT FUEL PRIME - STARTING TIME AND LOAD REQUIREMENTS

Figure 7-2 (Sheet 1 of 2)

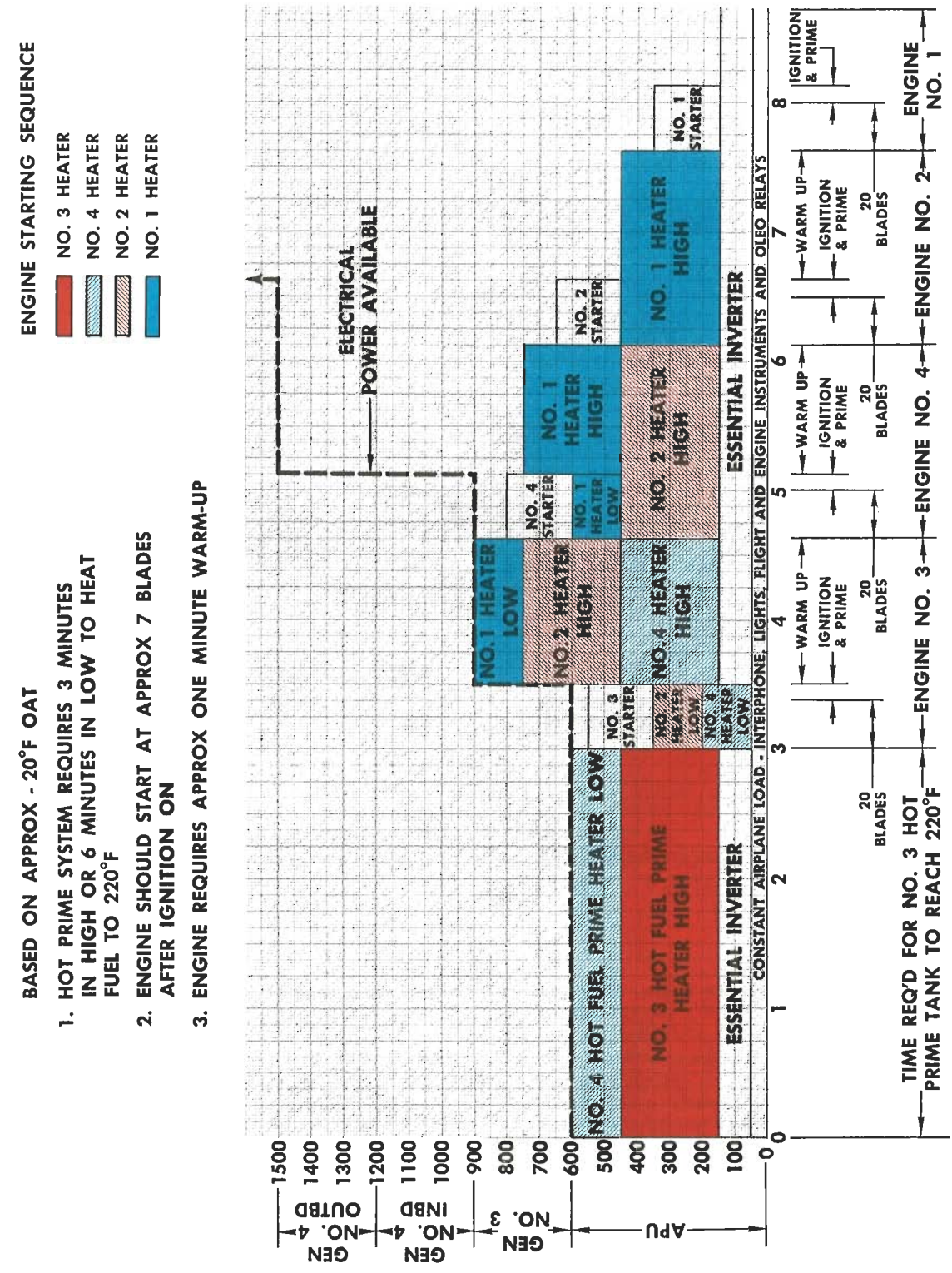


Figure 7-2 (Sheet 2 of 2)

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 PROCEDURE ON THE GROUND in 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

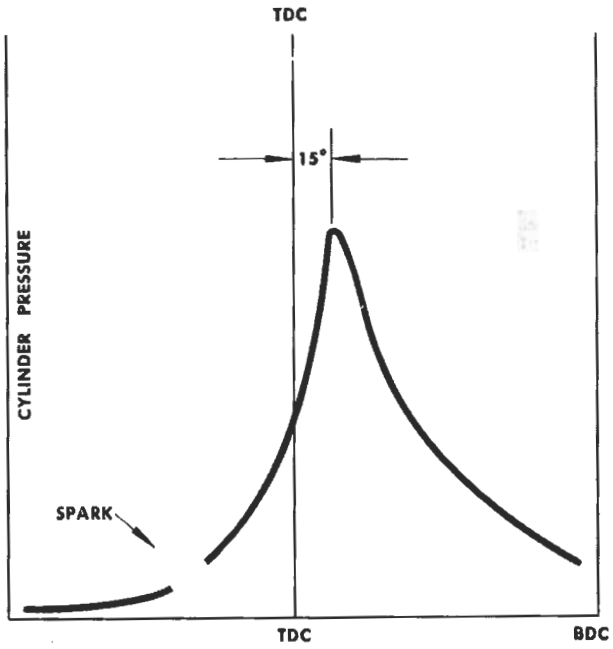
Due to the high energy output of the engine at maximum power, cooling is critical and engine wear is at a maximum. Every effort must be made to observe engine temperature limits at the start of takeoff. Full power should be used to insure a safe takeoff with ample climb airspeed and height above obstacles before the first power reduction. However, maximum power should not be extended unnecessarily because of the above mentioned effects.

CLIMB

Climb performance for METO power is shown in the Appendix.

CRUISING FLIGHT

During normal flight operations, the engine should be operated at power settings obtained from the data in the Appendix. The Appendix charts give optimum performance data which takes 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, in 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 flight 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 thru the engine. Engine performance is limited by three main considerations: engine temperature limits, propeller efficiency and fixed position ignition.



CYLINDER PRESSURE VARIATION

Figure 7-3

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 - 2350 rpm; to prescribe mixture control settings for various cruise powers and cylinder head temperatures; to correlate cruise and climb cylinder head temperature limits with cowl flap settings. Therefore, the inflight engine rpm restriction between 2100 and 2350 rpm makes it necessary to operate at higher than the normal 150 BMEP for powers between 1735 BHP 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 denotation 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 223°C.

In order to accomplish the intent of the foregoing, it is recommended that the following be adhered to:

A. RPM AND MIXTURE SETTINGS.

1. For power settings from 1735 to 1900 BHP use 2100 rpm. For power settings above 1900 to 2050 BHP, use 2350 rpm.

2. 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.

3. 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.

4. When operating between 1850 and 2050 BHP, auto rich is required.

5. When operating with alternate grade fuel, auto rich is required for all power settings above 1735 BHP.

B. CYLINDER HEAD TEMPERATURE LIMITS AND COWL FLAP SETTINGS. (See figure 7-6.)

1. A concentrated effort should be made to maintain CHT at or near 223°C in level flight at all power and mixture settings if cowl flap opening does not exceed 1.5 inches.

2. Maximum CHT in level flight at all power and mixture settings is 243°C for cowl flap openings of 2 inches or less.

3. Maximum CHT in level flight at powers up to and including 1850 BHP (70% METO) is 243°C for cowl flap openings of 2 to 3 inches.

4. 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.

5. Maximum CHT in climb is 243°C for cowl flap openings of 2 inches or less and 170 knots IAS. Auto rich is required.

6. 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.

7. 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 KIAS to maintain 255°C. Auto rich is required. Never allow CHT's to exceed 265°C.

8. Maximum CHT for three-engine climb is 265°C. Refer to figures 1A4-3 and 1A4-4 for climb speed schedule and related NOTE.

C. MISSION PLANNING.

1. Whenever 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.

2. Whenever practicable, select cruise altitudes so that required power settings will be in the lean mixture range (1850 BHP or less).

3. 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 (figures 1A5-12 through 1A5-24).

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° past top dead center (figure 7-3). If this pressure is reached before the 15° 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 thru 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. Mechanical tolerances may cause up to plus or minus four 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.

R.P.M. The rpm can be controlled by either the automatic propeller synchronizing system or the propeller governor selector switches. (See figure 1-24.) 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 available 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 .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 thru 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.

STEP PROCEDURE	EXPLANATORY NOTES
❶ Set all engines at the desired cruise power with the mixture control lever at AUTO RICH.	❶ 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 c. Adjust intercooler flaps to set approximately 20 ° C CAT	(b)(c) Although limits of 243° C CHT and 38° C CAT are allowed for cruise, 230° CHT and 20° CAT will give a safer margin between critical points of the procedure and the engine detonation limit
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 ❹ or ❻

❷ Set 109% base torque with the throttle and note cooling is within limits	❷ Base torque was established in Step 1 and will be 158 TPSI or less depending upon mp limits. (109% of 158 is 172)
❸ Establish best power mixture by slowly moving the mixture control lever from AUTO RICH one inch of lever movement (one knob width) while carefully observing TPSI	❸ 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 re-establish 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 the primer switch in to apply prime b. Immediately adjust mixture control lever to point of highest TPSI c. Retard throttle to re-establish 109% of base torque d. Return the mixture control lever to AUTO RICH e. Release the primer switch and proceed with Step 4 below
❹ 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 abandoned. Return to AUTO RICH or AUTO LEAN setting until warmer air has restored torquemeter sensitivity.

MANUAL LEAN FUEL CONTROL

Figure 7-4 (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

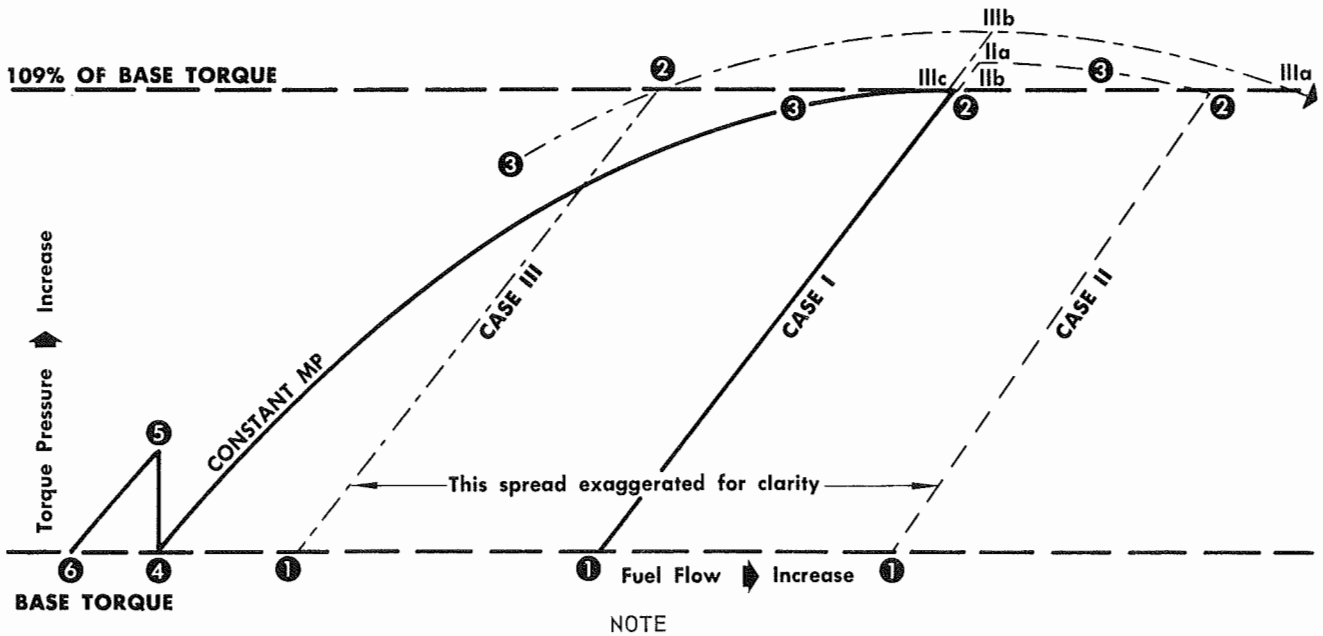
c. Adjust TBS lever for cabin air flow as desired and set throttles to avoid excessive part throttle operation

d. Check the 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) Occasionally poor engine maintenance or leaning in excess of the above procedure may precipitate minor roughness or backfire due to too lean a mixture. The flight 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.



NOTE

Circled numbers (❻) refer to step procedure, numerals, (**IIa**) refer to carburetor metering check.

Figure 7-4 (Sheet 2 of 2)

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 7-4.

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 changeing 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 rpm and 2350 rpm between 1850 BHP 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.

Engine Cooling

PRIMARY MEANS. The primary source of engine cooling is the flow of ram air around the cylinders. This airflow 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 7-5.

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 one inch manifold pressure. (See Section III.) For example, 23 in. Hg at 2300 rpm. 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 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 mag 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 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

Mag 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 factor to be considered in providing protection against carbonaceous spark plug fouling.

Anti-Fouling 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 one 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. 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 - 1000 rpm. Operate engine at this rpm for two 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° C 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 two 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 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 on all airplanes.
TAKEOFF		1.5 inch gap for OAT up to 15° C 2.0 inch gap for OAT 15° C to 25° C 2.5 inch gap for OAT 25° C to 35° C 3.0 inch gap for OAT above 35° C Do not exceed 3.0 inch gap at takeoff
DURING FLIGHT		.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.
	AUTO RICH	Above 1850 BHP, maximum CHT for level flight is 255°C, maximum CHT for climb is 265°C Below 1850 BHP do not exceed 243° C CHT
	AUTO LEAN	Cruise. Do not exceed 243° C CHT
	ENGINE SHUTDOWN	Maximum CHT for engine shutdown 180° C

NOTE

- To avoid exceeding CHT of 265°C during takeoff, reduce CHT to as low a value as possible prior to takeoff. See section IX for additional cold weather CHT limits.
- A CHT of 180°C or less is desired at start of takeoff, and a CHT of 220°C is the maximum for start of takeoff. 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 7-5

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 one inch manifold pressure). Hold 1800 BHP for two minutes. Return to cruise setting. Prior to final landing, engines will be operated at 1800 BHP for five minutes. Move mixture to AUTO RICH and set rpm and manifold pressure for 1800 BHP according to applicable power schedule in the Appendix and hold for five 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.

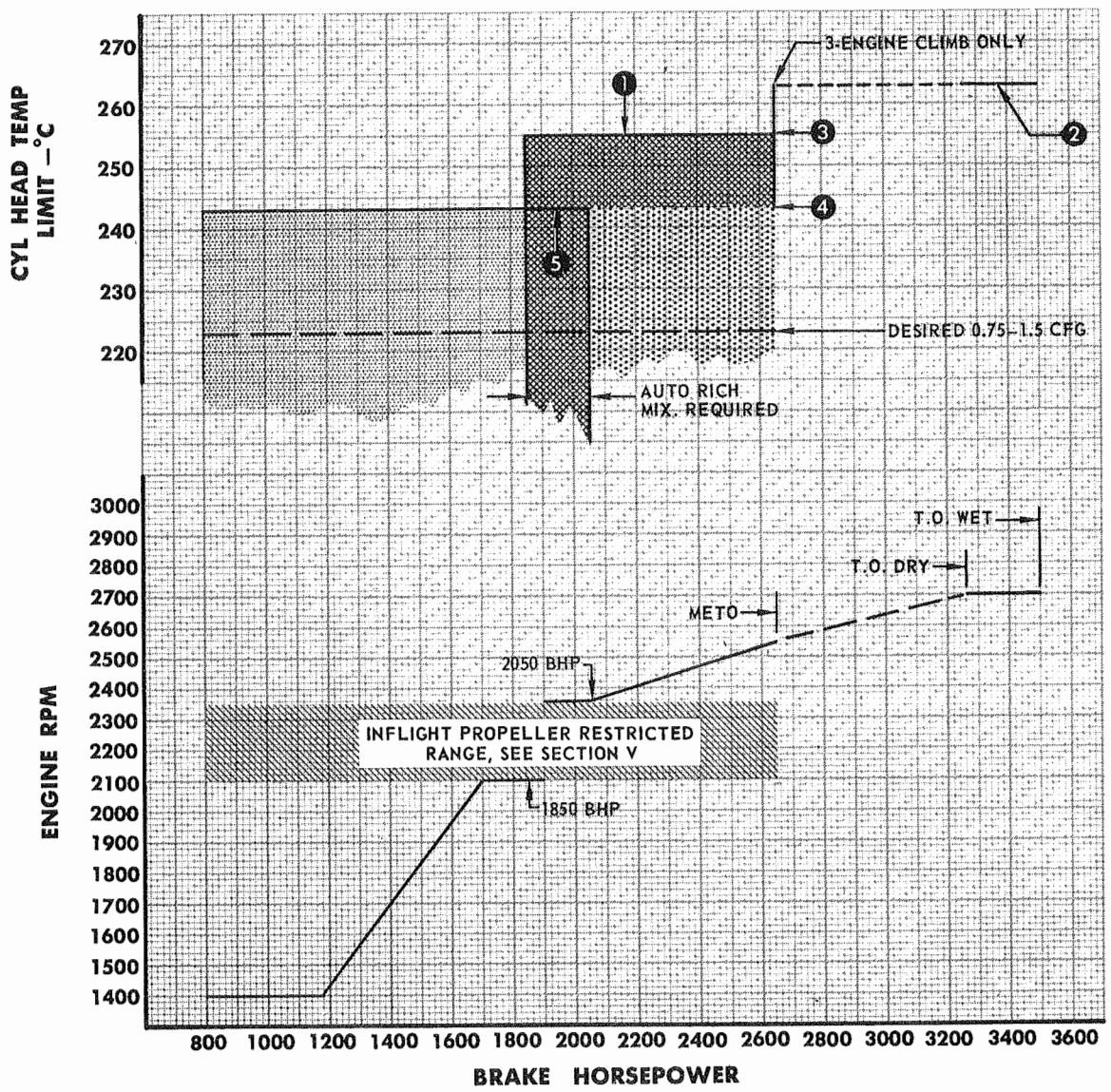
CARBURETOR ICING

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. Apply external ground heat directly to the carburetor for at least 20 minutes and then drain the carburetor chambers of water.

CAUTION

Do not takeoff until the carburetor is metering properly and the chambers have been drained.



CYLINDER HEAD TEMPERATURE INFLIGHT LIMITS

Figure 7-6

Carburetor Icing in Flight

INDICATIONS OF CARBURETOR ICING. Under conditions of high atmospheric humidity, carburetor icing can occur with carburetor air temperature between -10°C 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:

a. 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.

b. Intercoolers - Close

c. If Necessary:

(1) TBS setting - Increase

(2) Throttle - Retard (to maintain manifold pressure within limits)

d. As Ice Is Removed:

(1) Engine Instruments - Monitor (carefully)

(2) 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°C and 38°C. The amount of heat available in the following steps is directly proportional to the amount of turbo applied:

a. Intercooler Flap - Close

b. TBS setting - Increase (as desired)

c. Carburetor Air Switches - SHELT

d. Power - Re-establish

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.

TURBOSUPERCHARGER SYSTEM

NORMAL OPERATING PROCEDURES

Preflight Check

Refer to Section II.

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 one minute at 1000 rpm, every ten minutes. This one 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:

a. TBS Lever - 0

b. Turbo Override Switches - OPEN (guards down)

c. Turbo Switches - AUTO (one at a time)

Monitor manifold pressure and cabin air flow closely to guard against inadvertent overboost

d. Intercoolers - Open 2 Inches

Open intercoolers before advancing the TBS lever to anticipate carburetor air temperature rise when turbo is added

e. 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 TURBO-SUPERCHARGER EMERGENCY OPERATION in Section III.

f. 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:

a. Turbo Calibrating Knob - Full CCW

b. Turbo Override Switch - OPEN (guard down)

c. Throttle (affected engine) - Retard

d. Turbo Switch - AUTO

e. Throttle (affected engine) - Increase slowly to align with others

f. Turbo Calibrating Knob - Turn CW to desired MP

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, in 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 in 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:

a. TBS Lever - Retard to 0

b. Turbo Override Switches - Check OPEN (guards down)

c. Turbo Switches - MAN (one at a time)

Monitor the manifold pressure to guard against inadvertent overboost

d. 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:

a. To Increase Turbo Boost:

(1) Manifold Pressure (on the desired engine) - Reduce (by means of the throttle)

(2) Turbo Override Switch (corresponding) - Nudge to the CLOSE position and release

(3) Throttle - Advance (slowly to desired position)

Be alert for possible overboost

(4) Above Steps - Repeat (until within about 2 inches Hg of the desired manifold pressure)

(5) Final Manifold Pressure Adjustment - Use Throttle

b. To Decrease Turbo Boost:

(1) Decrease Turbo Override Switch - Nudge to the OPEN position and release

Repeat until within about 2 inches Hg of the desired manifold pressure

(2) 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 full 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

See Section III.

Turbo Bearing Temperature Gage Indications

TCTO 611

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 - 15° C between turbos; however, this variation should remain constant. A variation of plus or minus 20° C on any one gage from the next highest or lowest indication, respectively, 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 shutdown to prevent further damage. See 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 shutdown immediately. A minus 20° C variation is indicative of a lubrication failure and that turbo should be shutdown to prevent further damage. See 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 shutdown immediately. If a turbo is shutdown 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 synchronizing lever. (See figure 1-24.)

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 1-24.)

Synchronizer

The synchronizer is used to automatically correct for governor setting tolerances which may cause engine speeds to vary slightly. For synchronization either one of 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 over or under speed. 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 follow up arm. This connection starts a dc motor turning in the direction the master lever has been moved. The follow up 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 calibrate 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% 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% 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% 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% 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% rpm springback towards 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 downwards 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 had been reduced from its high rpm position at takeoff, its rpm would be reduced by a proportional amount (less 3 per cent spring-back) so that it will be set for a lower rpm than the rest of the system.

PROPELLER OPERATION

For ground operation and checks see 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. For power settings at 2100 rpm, the selected master engine will be used to determine the 2100 rpm setting. For brake horsepower settings of 1775 through 1900 the alternate power schedule (figure 1A2-4 T.O. 1C-97(K)F-1-1) will be utilized. Maximum cowl flap opening up to three inches will be used to attain the desired cylinder head temperature.

TAKEOFF. Move the 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.

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 air speed 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 synchronizer lever to obtain the correct rpm for the power selected. Maintain at least one inch manifold pressure per 100 rpm.

POWER-OFF DESCENT. Used for emergency descents only, see section III.

APPROACH AND LANDING. Set the 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 six 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.

STOPPING ENGINES. Move the synchronizer lever to full INCREASE RPM, follow the procedure outlined in Section II to shut-down the engines.

FEATHERING. For feathering procedure see 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. (See 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 (or 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 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 2535-2665 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 synchronizer lever is moved to set rpm below 2535-2665 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

See Section III.

PROPELLER OPERATION DURING FLIGHT

PILOTS

a. Prop Integral Control Unit - Visually check for leaks

b. If Prop Oil Quantity Light On (after three minutes) - Feather propeller

Feather the prop 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 prop must be feathered immediately to prevent runaway.

ENGINEER

a. Prop Oil Refill Switches - Check OFF

b. Prop Oil Quantity Warning Lights - Check not illuminated

c. If Prop Oil Quantity Warning Light Illuminates - Notify pilot

d. Prop Oil Refill Switch - ON

e. Prop Oil Refill Switch - OFF

When the prop oil quantity warning light goes out turn prop oil refill switch off. If the prop oil quantity light does not go out after three minutes of replenishing, notify pilot since insufficient prop oil quantity with impending difficulties, is indicated. Prop oil replenishment may be repeated as often as necessary provided that the prop oil quantity low warning light is extinguished within three minutes.

f If Prop 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 contacts 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 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 breaker points are open and the spark discharge is taking place across the 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 7-8 shows various patterns for normal and malfunctioning ignition systems.

ANALYZER OPERATION PROCEDURE

The following procedure is used to operate the ignition analyzer system.

1. With the engines running at operating temperature, the d-c bus energized, and the secondary inverter operating to supply a-c power, place the system power switch on the ignition analyzer switch panel to the ON position
2. Place the analyzer power switch on the ignition analyzer to ON. The power indicator light should illuminate
3. Allow approximately one 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
4. 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 two 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.

5. 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.

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

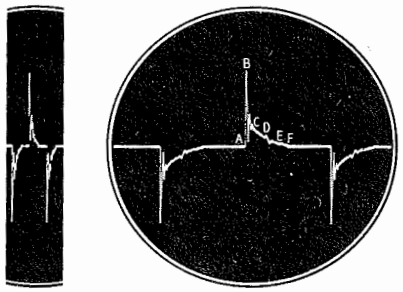
L magnetos fire the left side spark plugs of cylinders **R** magnetos fire the right side spark plugs of cylinders

Pattern sequence chart for use with P & W R-4360-59B engines equipped with a low tension ignition system

ANALYZER PATTERN SEQUENCE

Figure 7-7

NORMAL



DETAIL I

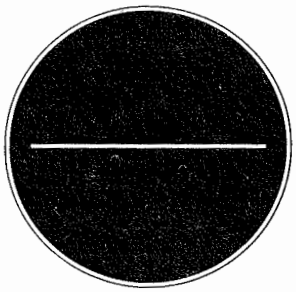
The shape of this normal wave form is the result of each component of the ignition system functioning normally, thereby causing ignition and resultant combustion within the cylinder.

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.

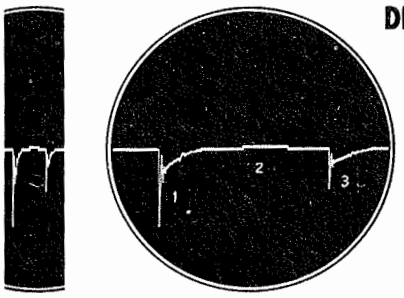
1. This condition produces a straight horizontal line on the analyzer screen

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 effect 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***

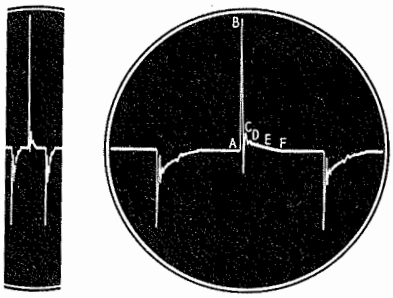
PROBABLE CAUSE.

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



The 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)

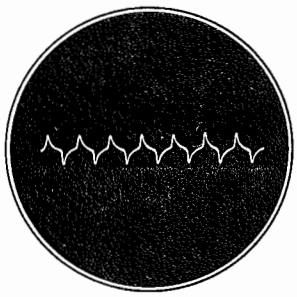
PROBABLE CAUSE.

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 7-8 (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

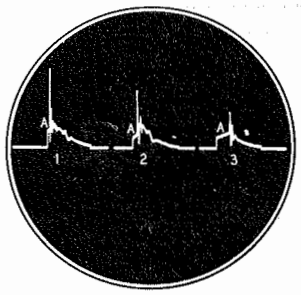
PROBABLE CAUSE.

1. Breaker points not closing

DETAIL V

DETAIL VI

BREAKER POINT ARCING
(3 Stages)



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

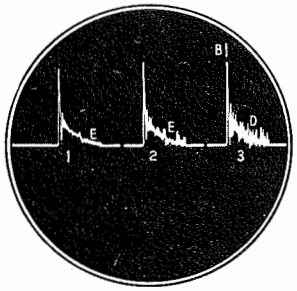
PROBABLE CAUSE.

1. Defective primary condenser
2. Primary condenser disconnected
3. Oil or foreign particles between breaker contacts

NOTE: Stage 1 is a tolerable condition.
Stage 2 and 3 require IMMEDIATE CORRECTION.

DETAIL VII

DISTRIBUTER 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 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

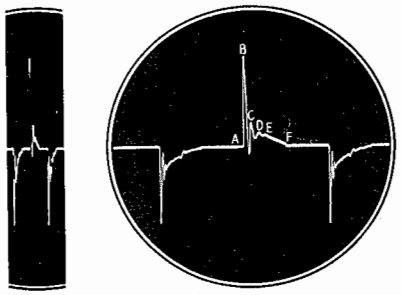
PROBABLE CAUSE.

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 7-8 (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.

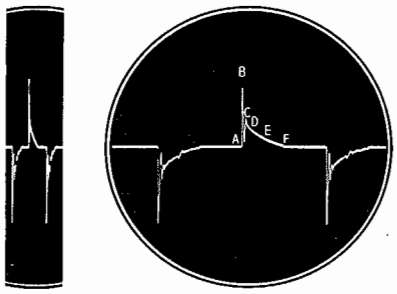
1. High amplitude of voltage at B
2. Low frequency oscillation between B and C
3. Absence of pulse at D

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



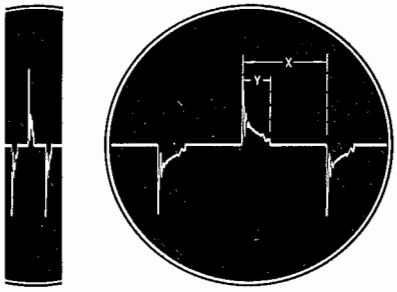
A shorted secondary wave form is produced when the resistance of the high tension circuit is abnormally low. This allows a high value of secondary current to flow at a relatively smooth rate.

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



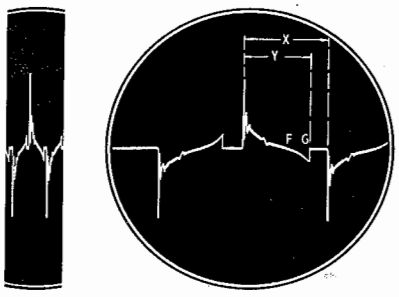
Insufficient breaker opening is the result of improper adjustment of the ignition breaker (insufficient lift of the cam follower).

1. Abnormally short breaker 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

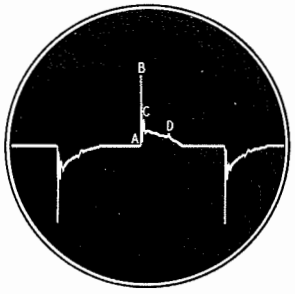
PROBABLE CAUSE.

1. Internal timing of magneto incorrect
2. Extreme breaker contact erosion

IGNITION ANALYZER PATTERN (CONT)

Figure 7-8 (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

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.

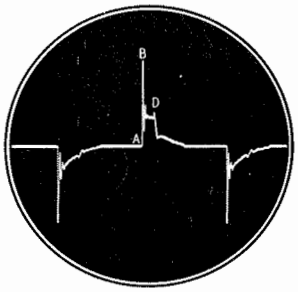
1. High amplitude of wave form at B and D
2. Shorter time of plug firing indicated by pattern width A to D

PROBABLE CAUSE.

1. Wide spark plug gap
2. Spark plug lead disconnected from plug but firing to ground across large gap
3. Contact spring missing from spark plug lead

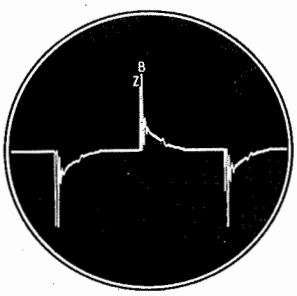
DETAIL XIII

HIGH VOLTAGE FIRING



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

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

1. Intermittent voltage pulses J at high rpm may be considered normal. Does not affect engine operation
2. Continuous voltage pulses K usually indicate a need for replacing breaker assembly

CAUTION: Do not confuse pick-up from other magnetos with this trouble.

DETAIL XV

BREAKER POINT BOUNCE

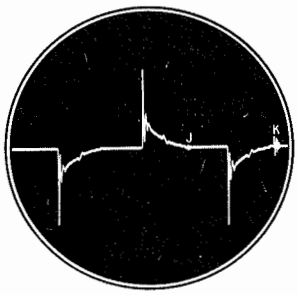


Figure 7-8 (Sheet 4 of 4)

6. Rotate the engine and magneto selector switch to the engine and magneto position desired

7. Check for abnormalities in the fourteen patterns on the 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

8. Use the horizontal position, vertical position, 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 screen for comparison

9. 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 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:

1. Place the relay-resistor switch on the 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.

2. 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 plug firing should occur

NOTE

The voltage control switch will return to the inoperative position when released.

3. The value of the dial readings where misfiring and complete stoppage of firing occur, should be noted. 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 7-7. Single detailed patterns of normal firing and common ignition troubles are shown in figure 7-8, as a guide to pattern interpretation. The detailed patterns have been coded with numbers I through XV together with explanatory test following each detail. The exact size and shape of the patterns may vary from those viewed on the analyzer screen, due to engine and ignition system characteristics, and 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 plugs and differ slightly from those for massive electrode plugs which have less vertical activity and more horizontal activity at the hash (point where firing occurs).

CAUTION

If both 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 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.

FUEL SYSTEM MANAGEMENT

USE OF FUEL BOOST PUMPS

For fuel loading and usage sequence and restrictions see 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 one boost pump switch to EMERGENCY and one boost pump switch to NORMAL with the fuel selector switches in the TME position. Note engine fuel pressure increase with other main tank boost pumps 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.

NOTE

Takeoffs and climbs are made usually with the fuel selector valve switches positioned TE.

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 whenever making a boost pump or selector switch change. At cruising altitude, set at least one boost pump on low 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 inflight 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 flight engineer when positioning the manual fuel-shutoff valve(s) and will report the position of these valve(s) after manual actuation.

FUEL BALANCING PROCEDURES

1. No. 1 and No. 4 Fuel Selector Valve Switches - TME
2. No. 1 or No. 4 Fuel Boost Pump Switch - EMERGENCY (for five minutes)
3. Other Desired Fuel Selector Valve Switches - TME
4. Fuel Boost Pump Switches - As required

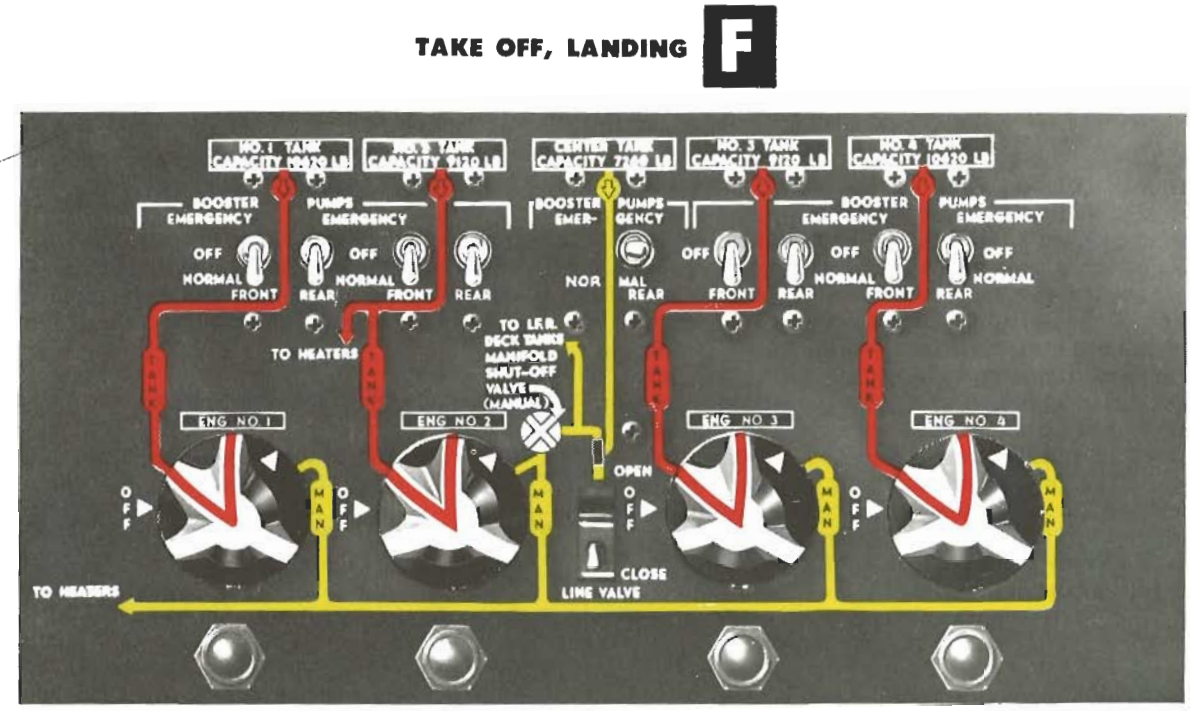
INFLIGHT USE OF AUXILIARY TANK FUEL FOR AIRPLANE

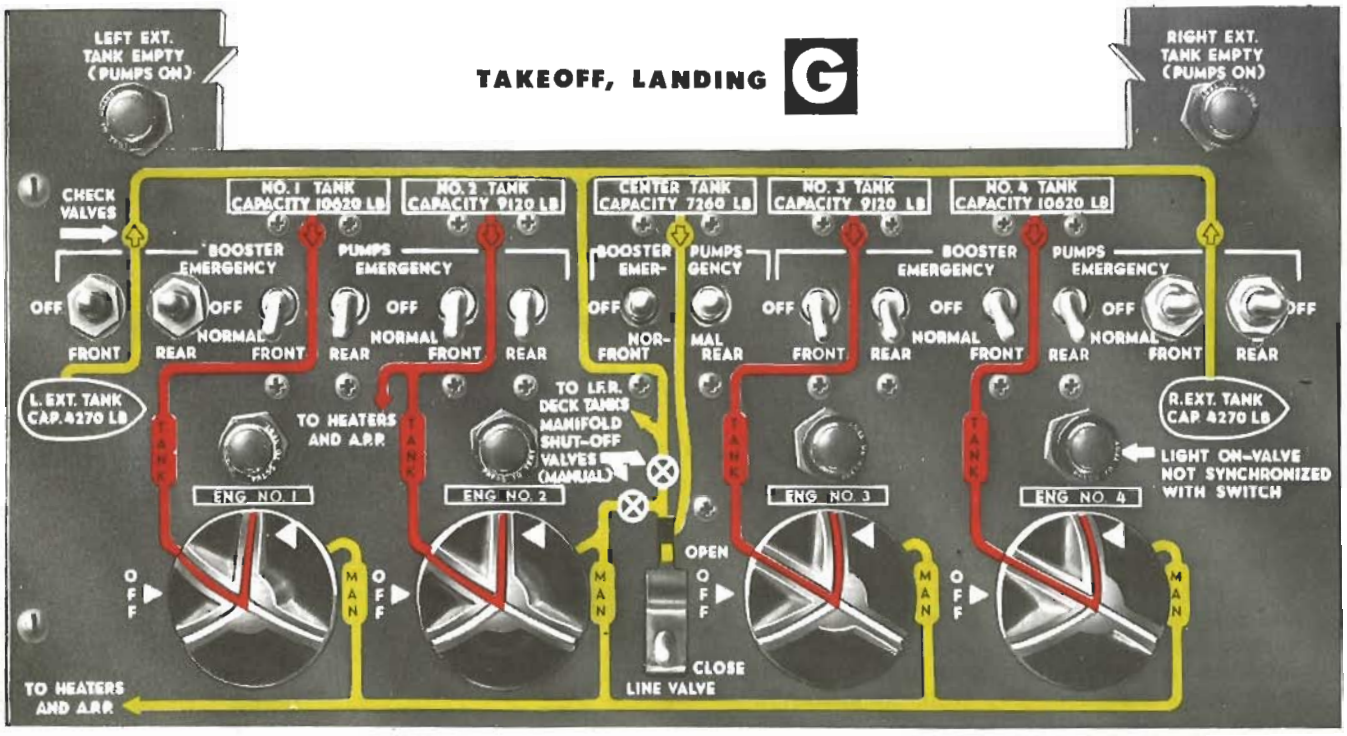
Center Wing Tank (CWT)

1. Fuel Selector Switches - TE
2. Fuel Boost Pump Switches - One per tank on NORMAL
3. A/R Transfer Valve Switches - CLOSED
4. No. 3 Manual Fuel-Shutoff Valve - Have visually checked closed G ICTO KGT507
5. A/R Transfer Valves - Have visually checked closed F G 1243▶ 22664 or

   Secondary Valves and External Tank Manifold Shutoff Valves - Have visually checked closed G 22665▶
6. No. 2 Manual Fuel-Shutoff Valve - Have visually checked closed G
7. CWT Fuel Boost Pump Switches - NORMAL
8. CWT Line Valve Switch - OPEN
9. Manual Fuel-Shutoff Valve - Have opened F or

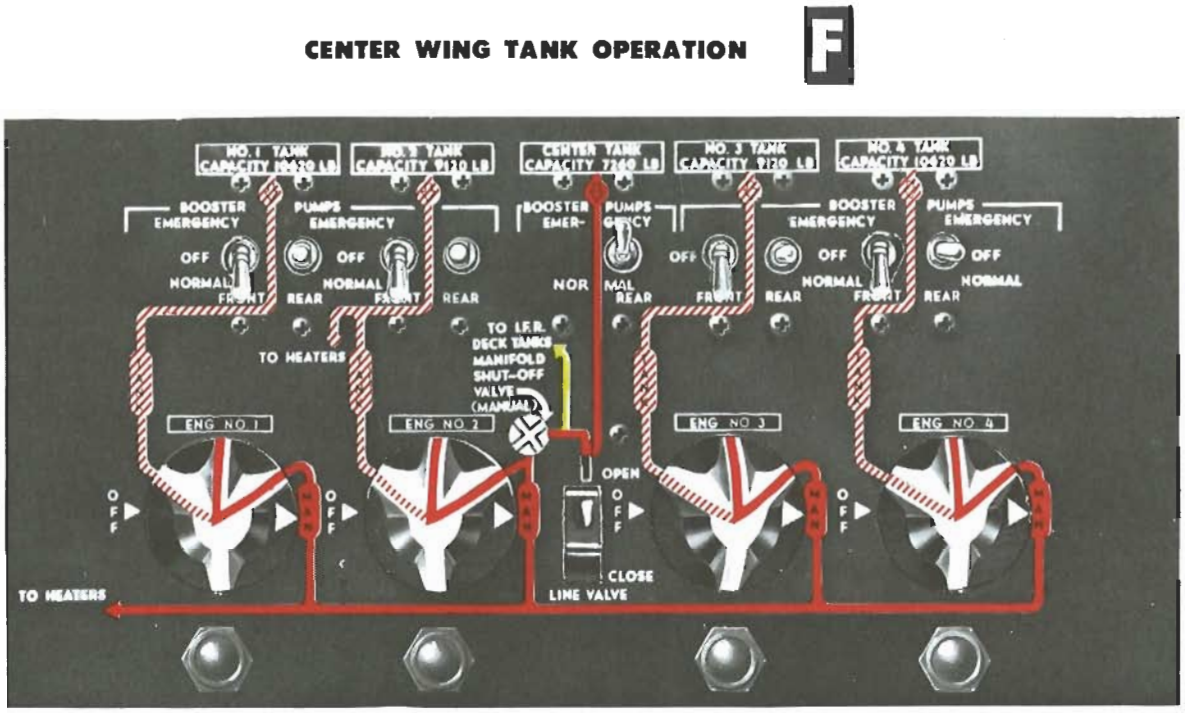
   No. 1 Manual Fuel-Shutoff Valve - Have opened G
10. Fuel Selector Switch on One Engine - TME





FUEL SYSTEM MANAGEMENT

Figure 7-9 (Sheet 1 of 4)



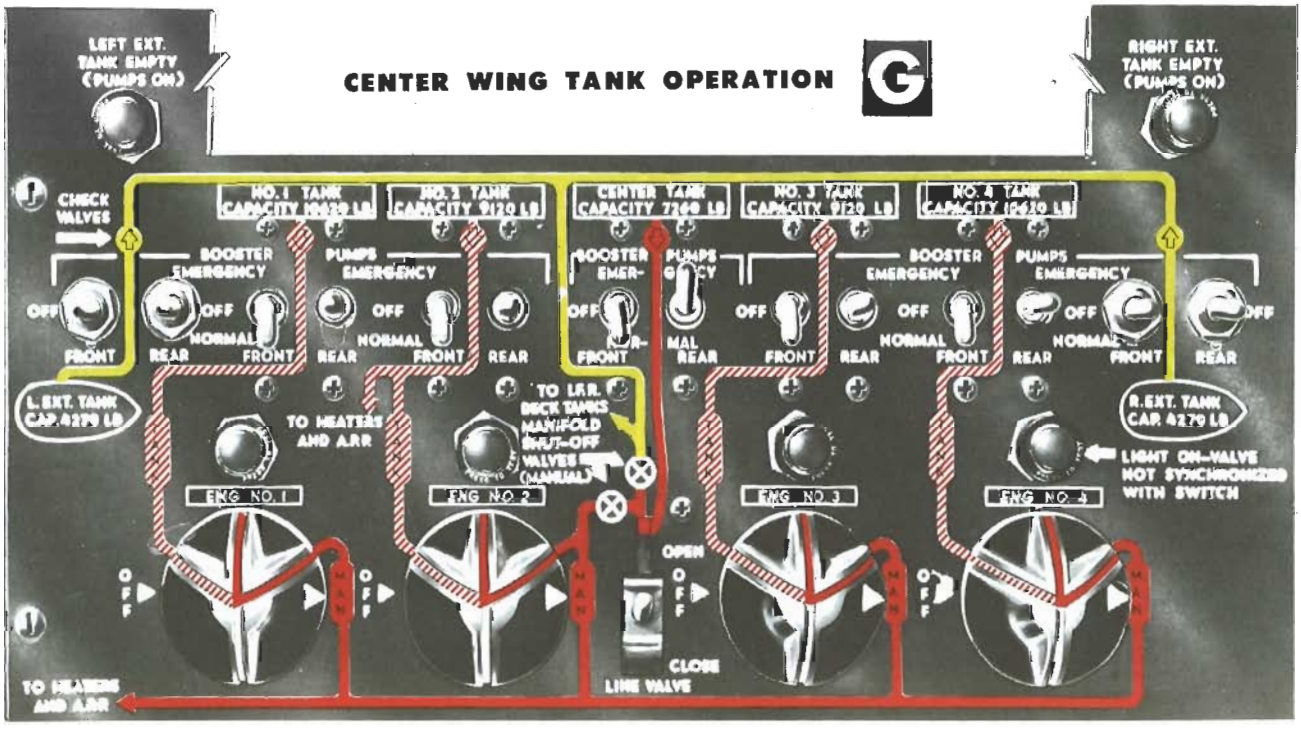
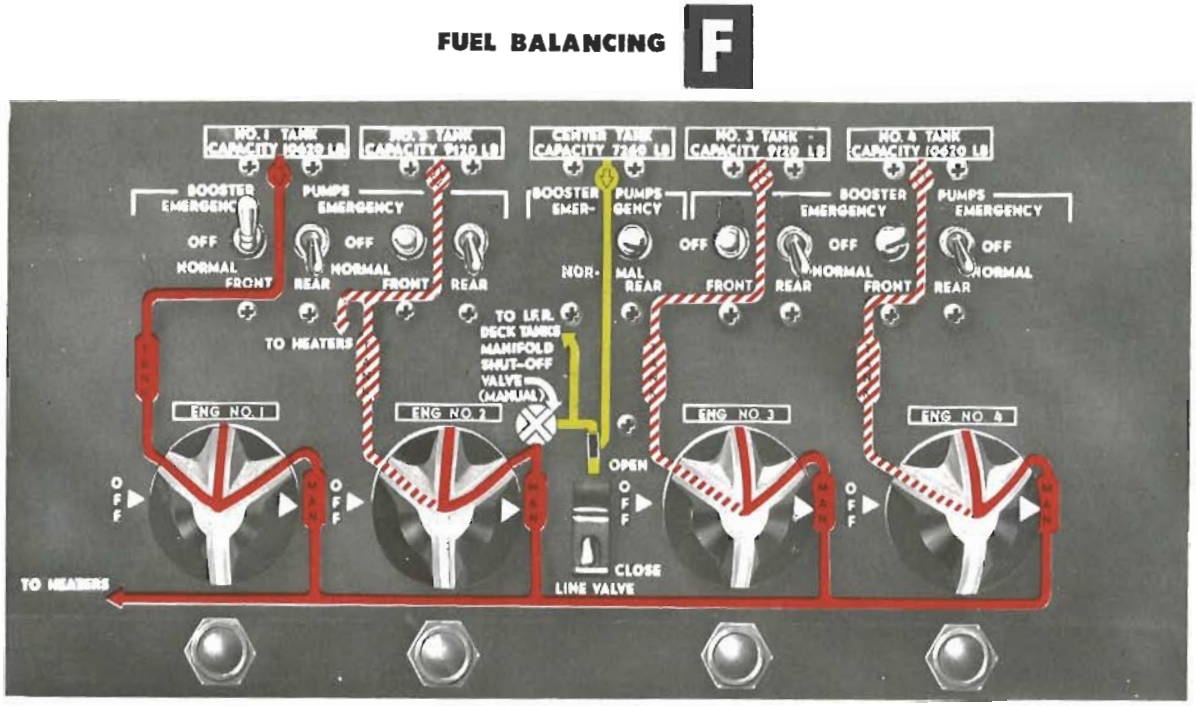
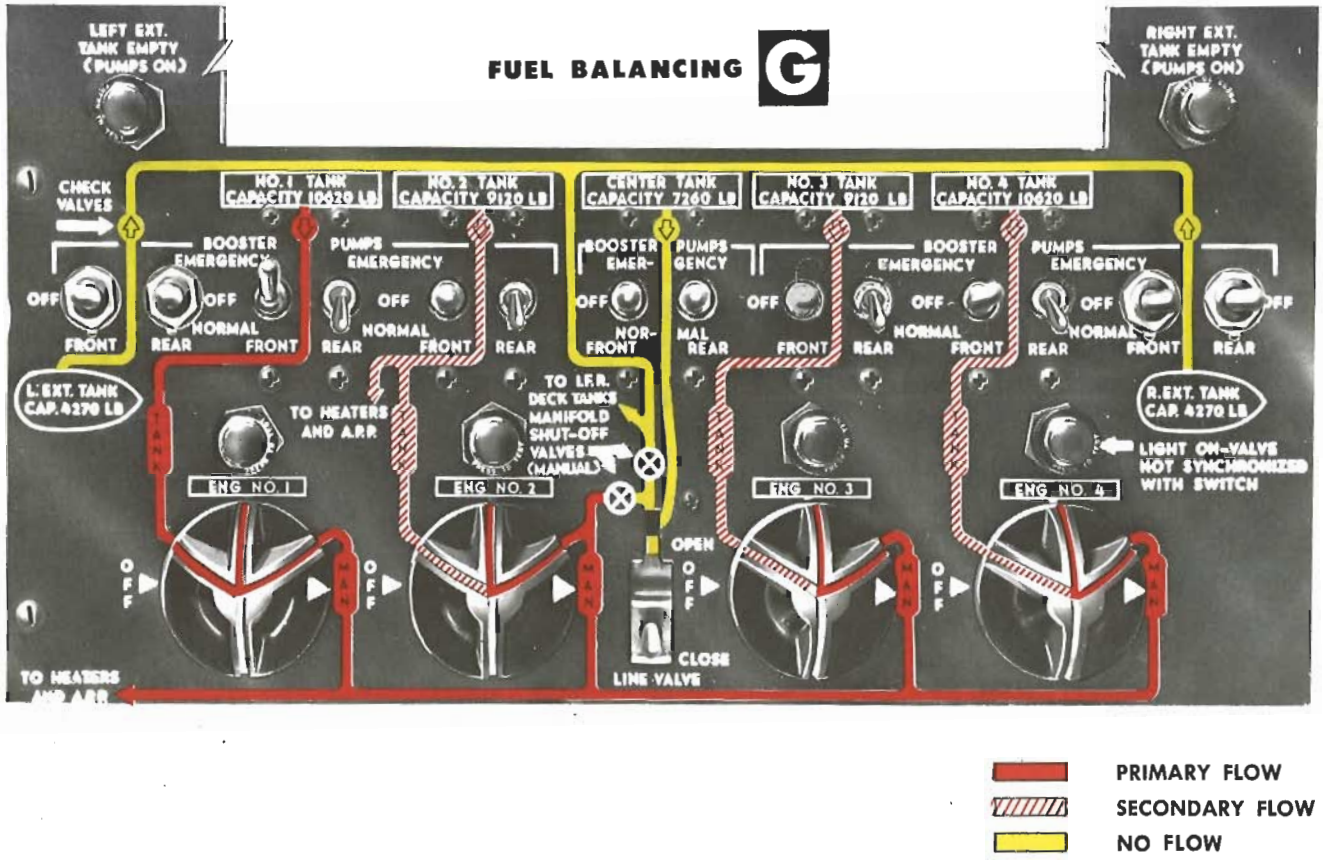


Figure 7-9 (Sheet 2 of 4)





FUEL SYSTEM MANAGEMENT (CONT)

Figure 7-9 (Sheet 3 of 4)

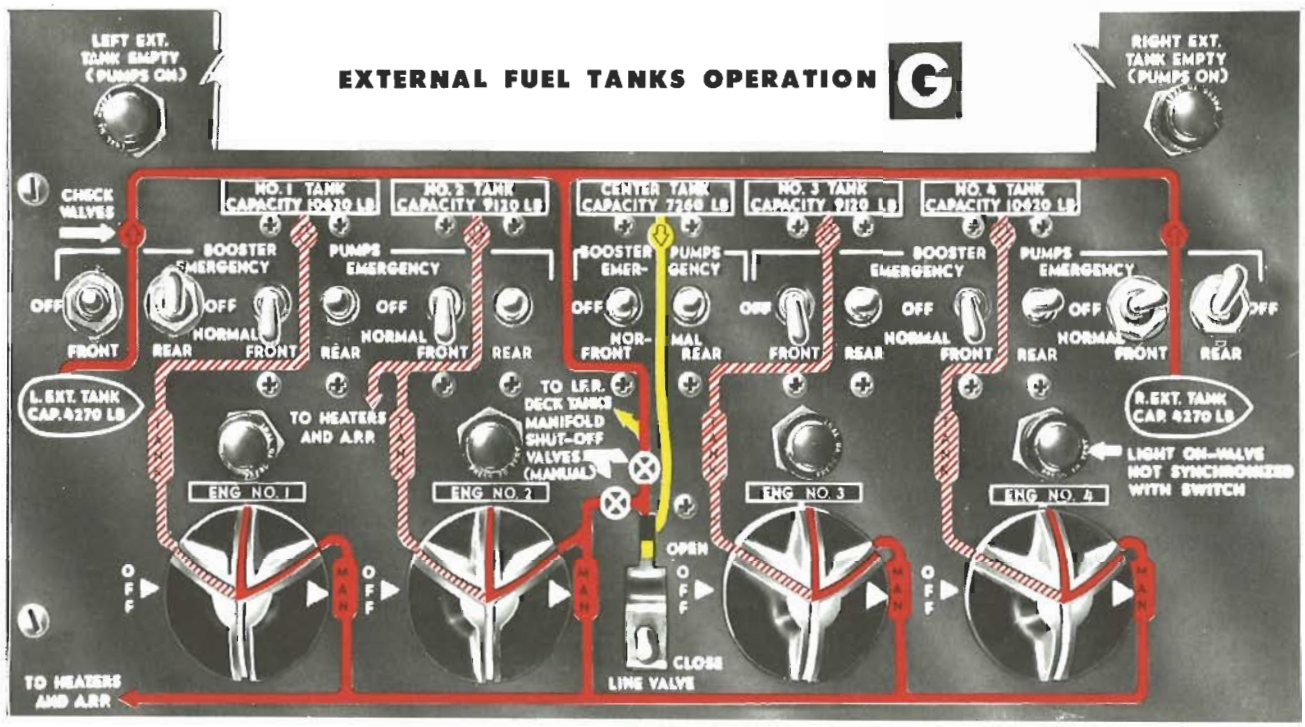


Figure 7-9 (Sheet 4 of 4)

11. CWT Fuel Boost Pump Switch - EMERGENCY (for 5 minutes to check for contaminated fuel)

12. If after 5 minutes all engine instruments indicate normal, move desired fuel selector switches - TME

13. To Discontinue Use From CWT:

    a. CWT Fuel Boost Pump Switches - NORMAL

    b. Manual Fuel-Shutoff Valve-Have closed F or

    No. 1 Manual Fuel-Shutoff Valve - Have closed G

    c. CWT Line Valve Switch - CLOSED

    d. CWT Fuel Boost Pump Switches - OFF

14. Fuel Management - As required

External Fuel Tanks G

1. Fuel Selector Switches - TE

2. Fuel Boost Pump Switches - One per tank on NORMAL

3. A/R Transfer Valve Switches - CLOSED

4. No. 3 Manual Fuel-Shutoff Valve - Have visually checked closed G TCTO KGT507

5. A/R Transfer Valves - Have visually checked closed G 17260 ▶ 22664 or

   Secondary Valves and External Tank Manifold Shutoff Valve - Have visually checked closed G 22665 ▶

6. External Fuel Tank Fuel Boost Pump Switches - One per tank on NORMAL

NOTE

The external fuel tank low fuel flow warning lights are connected to fuel flow indicating check valves and will indicate an empty tank if the fuel flow drops below 6 gallons per minute. An indication of fuel flow may be obtained by turning the boost pumps on EMERGENCY for a moment, one tank at a time, and watching the fuel pressure gages closely for a momentary rise.

7. No. 1 and No. 2 Manual Fuel-Shutoff Valves - Have manually opened

8. Fuel Selector Switch On One Engine - TME

9. External Fuel Tank Fuel Boost Pump Switches - One per external fuel tank on EMERGENCY (Operate from one tank at a time for 5 minutes to check for contaminated fuel.)

10. If after 10 minutes all engine instruments indicate normal, move desired fuel selector switches - TME

11. External Fuel Tank Fuel Boost Pump Switches - One per external tank on EMERGENCY

12. Discontinue Use From External Fuel Tanks

    a. External Fuel Tank Fuel Boost Pump Switches - NORMAL

    b. No. 1 and No. 2 Manual Fuel-Shutoff Valves - Have manually closed

    c. External Fuel Tank Fuel Boost Pump Switches - OFF

13. Fuel Management - As required

EXTERNAL FUEL TANK FUEL VALVE CHECK

G 17260 ▶ 22664

a. If JP fuel is carried in the external fuel tanks and the center wing tank, the No. 1 manual fuel-shutoff valve will be CLOSED and safetied and the No. 2 manual fuel-shutoff valve will be CLOSED until required to be opened for fuel transfer.

b. If 115/145 fuel is carried in the external fuel tanks and the center wing tank, check transfer valves CLOSED and No. 1 and No. 2 manual fuel-shutoff valves CLOSED until required to be opened for fuel transfer.

c. If JP fuel is carried in external fuel tanks and 115/145 fuel is carried in center wing tank, No. 1 manual fuel-shutoff valve will be CLOSED until required to be opened for fuel transfer and No. 2 manual fuel-shutoff valve will be CLOSED and safetied

CAUTION

If JP fuel is carried in center wing tank, then 115/145 will not be used out of external fuel tanks for engine operation.

G 22664 ▶

1. If JP fuel is carried in the external fuel tanks and the center wing tank, the No. 1 manual fuel-shutoff valve will be CLOSED and safetied and No. 2 manual fuel-shutoff valve will be CLOSED until required to be opened for fuel transfer and external fuel tank manifold shutoff valve will be CLOSED.

2. If 115/145 fuel is carried in the external fuel tanks and the center wing tank, visually check transfer/secondary valves closed, both No. 1 and No. 2 manual fuel-shutoff valves will be CLOSED until required to be opened for fuel transfer and external fuel tank manifold shutoff valve will be CLOSED.

3. If JP fuel is carried in external fuel tanks and 115/145 is carried in center wing tank, No. 1 manual fuel-shutoff valve will be CLOSED until required to be opened for fuel transfer, No. 2 manual fuel-shutoff valve will be CLOSED and safetied, and external fuel tank manifold shutoff valve will be CLOSED.

FUEL TRANSFER (RANGE EXTENSION) V G TCTO KGT507

NOTE

This procedure is for use with fuel system modification incorporating a range extension No. 3 manual fuel-shutoff valve and transfer line from the A/R manifold to the airplane manifold.

WARNING

This procedure will only be used if the air refueling tanks and boom have been flushed and air refueling tanks serviced with 115/145 or 100/130 grade fuel.

Contamination Check

This procedure will not transfer any fuel to the wing tanks but is only a test for contamination. Accomplish during ground operation and in flight. When fuel is to be used from both forward and aft A/R system tanks, each tank will be checked separately for contamination.

CAUTION

Follow steps carefully in order given.

1. Fuel Selector Valve Switches - TE

2. Main Fuel Tank Fuel Boost Pump Switches - One per tank on NORMAL

3. SPR Secondary Valve Test Switch - Valves closed, switch OFF

4. No. 3 Manual Fuel-Shutoff Valve - Have manually opened

5. No. 6 A/R Hydraulic Valves - Have manually closed

6. No. 1 and No. 2 Manual Fuel-Shutoff Valves - Have visually checked closed

7. A/R Fuel Pump Selector Valve Handle - As required

8. One Inboard Fuel Selector Valve Switch - TME

9. Selected Tank Fuel Boost Pump Switch - NORMAL

10. Isodraulic Handle - Advance

    Advance isodraulic handle until a definite rise in fuel pressure is noted on selected engine.

CAUTION

Limit A/R fuel pressure gage reading to 30 psi.

11. Monitor All Panel Instruments (especially selected engine) - 10 minutes

WARNING

If, on the selected inboard engine, the CHT begins to rise (and the other CHT's do not), the exhaust smoke becomes black or the engine begins to run rough, immediately return the engine 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 10 minutes of operation all instruments are normal:

12. Isodraulic Handle - OFF

13. Selected Fuel Selector Valve Switch - TE

14. No. 6 A/R Hydraulic Valves - Have manually opened

15. No. 3 Manual Fuel-Shutoff Valve - Have manually closed

Transfer From A/R Tanks to Airplane Tanks

NOTE

An interphone extension cord will be necessary to enable the boom operator or scanner to monitor interphone and operate the single point refueling panel and valves in the lower aft compartment.

1. SPR Panel:

    a. Master Switch - OFF to prevent arcing when connecting plug

    b. Electrical Plug - Connect

    c. Master Switch - ON

    Press power on light, check illuminated

    d. Circuit Breakers - Set

    e. Secondary Valve Switches for Tanks Selected for Transfer - Have opened

    Check valve open light illuminated

2. Fuel Selector Valve Switches - TE

3. Main Fuel Tank Boost Pump Switches - One per tank on NORMAL

4. No. 3 Manual Fuel-Shutoff Valve - Have manually opened

5. No. 6 A/R Hydraulic Valves - Have manually closed

6. No. 1 and No. 2 Manual Fuel-Shutoff Valves - Have manually closed

7. A/R Fuel Pump Selector Valve Handle - As required

WARNING

Airplane cg will be affected by selection of air refueling pump.

8. 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

Transfer termination:

9. Isodraulic Handle - Retard

10. Secondary Valve Switches - Have closed when above noted quantity or less is reached in each tank. Valve closed light illuminated.

    The engineer will monitor the fuel quantity gages and instruct the 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 air refueling pump control handle to OFF to avoid possible pressure surge.

11. No. 6 A/R Hydraulic Valves - Have manually opened

12. No. 3 Manual Fuel-Shutoff Valve - Have manually closed

13. SPR Panel:

    a. Secondary Valve Switches - All CLOSE

    b. Master Switch - OFF

    c. Electrical Plug - Disconnect and stow

14. Fuel Management - As required

External Tanks to Internal Tanks G

1. Fuel Selector Switches - TE

2. Main Fuel Tank Boost Pump Switches - One per Tank on NORMAL

3. A/R Transfer Valve Switches - CLOSED

4. No. 3 Manual Fuel-Shutoff Valve - Have visually checked closed G 7C1O KGT507

5. A/R Transfer Valves - Have visually checked closed G 17260 ▶ 22664 or

   Secondary Valves and External Fuel Tank Manifold Shutoff Valve - Have visually checked closed G 22665 ▶

6. External Fuel Tank Boost Pump Switches - One per tank on NORMAL

NOTE

The external fuel tank low fuel flow warning lights are connected to fuel flow indicating check valves and will indicate an empty tank if the fuel flow drops below 6 gallons per minute. An indication of fuel flow may be obtained by turning the boost pumps on EMERGENCY for a moment, one tank at a time, and watching the fuel pressure gages closely for a momentary rise.

7. No. 1 and No. 2 Manual Fuel-Shutoff Valves - Have manually opened

8. Fuel Selector Switch on One Engine - TME

9. External Fuel Tank Boost Pump Switches - One per external tank on EMERGENCY

   Operate from one tank at a time for 5 minutes to check for contaminated fuel

10. External Fuel Tank Boost Pump Switches - NORMAL

11. Fuel Selector Switches - TE

NOTE

An interphone extension cord will be necessary to enable the boom operator or scanner to monitor interphone and operate the single point refueling panel and valves in the lower aft compartment.

12. SPR Panel:

    a. Master Switch - OFF to prevent arcing when connecting plug

    b. Electrical Plug - Connect

    c. Master Switch - ON

       Press power on light, check illuminated.

    d. Circuit Breakers - Set

    e. Secondary Valve Switches - Opened (desired tanks)

13. External Fuel Tank Boost Pump Switches - EMERGENCY

CAUTION

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

14. External Fuel Tank Boost Pump Switches - NORMAL, at completion of transfer

NOTE

When low fuel flow warning light comes on, or when the desired quantity is reached in each tank, the engineer will direct the boom operator to close the required secondary valves.

15. No. 1 and No. 2 Manual Fuel-Shutoff Valves - Have manually closed

16. External Fuel Tank Boost Pump Switches - OFF

17. SPR Panel

    a. Secondary Valve Switches - All CLOSED

    b. Master Switch - OFF

    c. Electrical Plug - Disconnect and stow

18. Fuel Management - As required

GRAVITY TRANSFER FROM A/R DECK TANKS TO AIRPLANE MANIFOLD ▽ F

WARNING

- Use of this procedure is an exception and should be used only with extreme caution.
- This procedure will only be used if the A/R tanks and boom have been flushed and the A/R tanks serviced with 115/145 or 100/130 fuel.

1. Fuel Boost Pump Switch for Each Main Fuel Tank (at least one) - NORMAL
2. All Fuel Selector Switches - TE
3. If Fuel From the CWT is Being Used:
   a. CWT Boost Pump Switch - OFF
   b. CWT Line Valve Switch - CLOSED
4. Fuel Selector Switch for One Inboard Engine - TME
5. Manual Fuel-Shutoff Valve - Have manually opened
6. Engineer's A/R Master Switch - ON
7. A/R Transfer Valve Switches - OPEN
8. A/R Transfer Valves - Have visually checked open
9. CWT Secondary Valve - Have visually checked closed F 1255 ▶
10. Fuel Boost Pump Switches for the Selected Inboard Tank - OFF
11. Fuel Selector Switch for the Selected Inboard Engine - ME
12. Monitor all engine instruments carefully for 10 minutes, especially those for the selected inboard engine

WARNING

If, on the selected inboard engine, the CHT begins to rise (and the other CHT's do not), the exhaust smoke becomes black or the engine begins to run rough, immediately return the engine 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.

13. If, After 10 Minutes Operation, All Engine Instruments Indicate Normally:
    a. Desired Fuel Selector Switches - ME
    b. Affected Main Fuel Tank Fuel Boost Pump Switches - OFF
14. All Engine and A/R Panel Instruments - Monitor carefully during operation

NOTE

- Fuel low pressure warning light flicker and engine torque fluctuations can be expected particularly on the outboard engines and especially above 10,000 feet altitude. To minimize fuel low pressure warning light flicker and engine torque fluctuations, maintain level flight throughout this procedure and limit any climbs, glides and banks to shallow attitudes.
- In the event of excessive fuel low pressure warning light flicker and/or engine torque fluctuations, terminate this procedure.
- Monitor the A/R fuel quantity gages and control fuel distribution to prevent undesirable cg conditions.

15. Termination of Procedure:
    a. Fuel Selector Switches - TME (or as required)
    b. Main Tank Fuel Boost Pump Switches - On NORMAL (or as required)
    c. A/R Transfer Valve Switches - CLOSED
    d. Manual Fuel-Shutoff Valve - Have manually closed
    e. A/R Transfer Valves - Have visually checked closed
16. Fuel Management - As required

GRAVITY TRANSFER FROM A/R TANKS TO AIRPLANE MANIFOLD ▽ G

WARNING

- Use of this procedure is an exception and should be used only with extreme caution.
- This procedure should never be attempted when the forward and aft A/R tank systems contain less than 1000 gallons in each of the two systems, or when this fuel is contaminated with fuel other than grades 115/145 or 100/130. The forward and aft A/R tank systems must each contain 1000 gallons of fuel or the engines will not be adequately supplied with fuel.

1. Fuel Boost Pump Switch in Each Main Fuel Tank (at least one) - NORMAL
2. All Fuel Selector Switches - TE
3. If Fuel From the CWT is Being Used:
   a. CWT Boost Pump Switches - OFF
   b. CWT Line Valve Switch - CLOSED
4. External Fuel Tank Fuel Boost Pump Switches - Check OFF
5. Fuel Selector Switch for One Inboard Engine - TME
6. No. 3 Manual Fuel-Shutoff Valve - Have visually checked closed TCTO KGT507
7. No. 1 Manual Fuel-Shutoff Valve - Have manually opened
8. No. 2 Manual Fuel-Shutoff Valve - Have manually opened
9. Engineer's A/R Master Switch - ON
10. A/R Transfer Valve Switches - OPEN
11. FWD and AFT Transfer Valve Circuit Breakers (on the engineer's A/R panel) - Pull
12. A/R Transfer Valves - Have visually checked open G 17260 ▶ 22664 or

    Secondary Valves and External Tank Manifold Shutoff Valve - Have visually checked open G 22665 ▶
13. CWT Secondary Valve - Have visually checked closed
14. Fuel Boost Pump Switches for the Selected Inboard Tank - OFF
15. Fuel Selector Switch for the Selected Inboard Engine - ME
16. Monitor all engine instruments carefully for 10 minutes, especially those for the selected inboard engine

WARNING

If, on the selected inboard engine, the CHT begins to rise (and the other CHT's do not), the exhaust smoke becomes black or the engine begins to run rough, immediately return the engine 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.

17. If, After 10 Minutes Operation, All Engine Instruments Indicate Normally:
    a. Desired Fuel Selector Switches - ME
    b. Affected Main Fuel Tank Fuel Boost Pump Switches - OFF
18. All Engine and A/R Panel Instruments - Monitor carefully during operation

NOTE

- Fuel low pressure warning light flicker and engine torque fluctuations can be expected particularly on the outboard engines and especially above 10,000 feet altitude. To minimize fuel low pressure warning light flicker and engine torque fluctuations, maintain level flight throughout this procedure and limit any climbs, glides and banks to shallow attitudes.
- In the event of excessive fuel low pressure warning light flicker and/or engine torque fluctuations, terminate this procedure.
- Monitor the A/R fuel quantity gages and control fuel distribution to prevent undesirable cg conditions.

19. Termination of Procedure:

    Selector valves will be turned TE one at a time
    a. Main Tank Fuel Boost Pump Switches - One on NORMAL
    b. Fuel Selector Switches - TE (or as required)
    c. Follow "a" and "b" for each following engine
    d. A/R Transfer Valve Circuit Breakers (on engineer's A/R Panel) - IN
    e. A/R Transfer Valve Switches - CLOSED
    f. No. 1 Manual Fuel-Shutoff Valve - Have manually closed
    g. No. 2 Manual Fuel-Shutoff Valve - Have manually closed
    h. A/R Transfer Valves - Have visually checked closed G 17260 ▶ 22664 or

       Secondary Valves and External Fuel Tank Manifold Shutoff Valve - Have visually checked closed G 22665 ▶
20. Fuel Management - As required

FUEL TRANSFER TO A/R TANKS ▼

NOTE

Engineer will coordinate with the pilot on all fuel transfer operations.

WARNING

- On F airplanes when carrying fuel other than uncontaminated grade 115/145 or 100/130 in the CWT, the 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 CWT for the airplane system, all contaminated fuel must be drained and flushed out before refilling with grade 115/145 or 100/130 fuel.

- On G airplanes when carrying fuel other than uncontaminated grade 115/145 or 100/130 in the CWT, the No. 1 manual fuel-shutoff valve must be safety wired in the closed position. When carrying fuel other than uncontaminated grade 115/145 or 100/130 in the external fuel tanks but not in the CWT, the No. 2 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 these fuel tanks for the airplane system, all contaminated fuel must be drained and flushed out before refilling with grade 115/145 or 100/130 fuel. Simultaneous transfer from external fuel tanks which contain JP-4 fuel and main airplane fuel tanks to the A/R tanks will cause fuel contamination if any engine fuel valve selector is on TME as the external fuel tank booster pump is set at a higher pressure than the main tank booster pump. (3)

CWT to A/R Tanks

1. A/R Transfer Valve Switches - Have visually checked closed
2. No. 3 Manual Fuel-Shutoff Valve - Have visually checked closed G 1C1O KGT507
3. A/R Transfer Valves - Have visually checked closed F G 1243 ▶ 22664 or

   Secondary Valves and External Fuel Tank Manifold Shutoff Valve - Have visually checked closed G 22665 ▶
4. Manual Fuel-Shutoff Valve - Have visually checked closed F or

   No. 1 Manual Fuel-Shutoff Valve - Have visually checked closed G
5. No. 2 Manual Fuel-Shutoff Valve - Have manually opened G
6. Engineer's A/R Master Switch - ON
7. CWT Fuel Boost Pump Switches - EMERGENCY (or as desired)
8. CWT Line Valve Switch - OPEN
9. A/R Transfer Valve Switches - OPEN (as desired)
10. Termination of Procedure:
    a. A/R Transfer Valve Switches - CLOSED
    b. CWT Fuel Boost Pump Switches - OFF
    c. CWT Line Valve Switch - CLOSED
    d. No. 2 Manual Fuel-Shutoff Valve - Have manually closed G
    e. A/R Transfer Valves - Have visually checked closed F G 1243 ▶ 22664 or

       Secondary Valves and External Fuel Tank Manifold Shutoff Valve - Have visually checked closed G 22665 ▶
    f. Engineer's A/R Master Switch - OFF (if desired)

External Fuel Tanks to A/R Tanks G

1. A/R Transfer Valve Switches - CLOSED
2. No. 3 Manual Fuel-Shutoff Valve - Have **visually** checked closed G 1C1O KGT507
3. A/R Transfer Valves - Have visually checked closed and not safety wired G 17260 ▶ 22664 or

   Secondary Valves and External Fuel Tank Manifold Shutoff Valve - Have visually checked closed and not safety wired G 22665 ▶
4. No. 1 Manual Fuel-Shutoff Valve - Have visually checked closed
5. No. 2 Manual Fuel-Shutoff Valve - Have visually checked closed
6. Engineer's A/R Master Switch - ON
7. External Fuel Tank Fuel Boost Pump Switches - EMERGENCY (or as desired)
8. A/R Transfer Valve Switches - OPEN (as desired)

9. Termination of Procedure:

   a. External Fuel Tank Fuel Boost Pump Switches - NORMAL

   b. A/R Transfer Valve Switches - CLOSED

   c. External Fuel Tank Fuel Boost Pump Switches - OFF

   d. A/R Transfer Valves - Have visually checked closed G 17260 ▶ 22664 or

      Secondary Valves and External Fuel Tank Manifold Shutoff Valve - Have visually checked closed G 22665 ▶

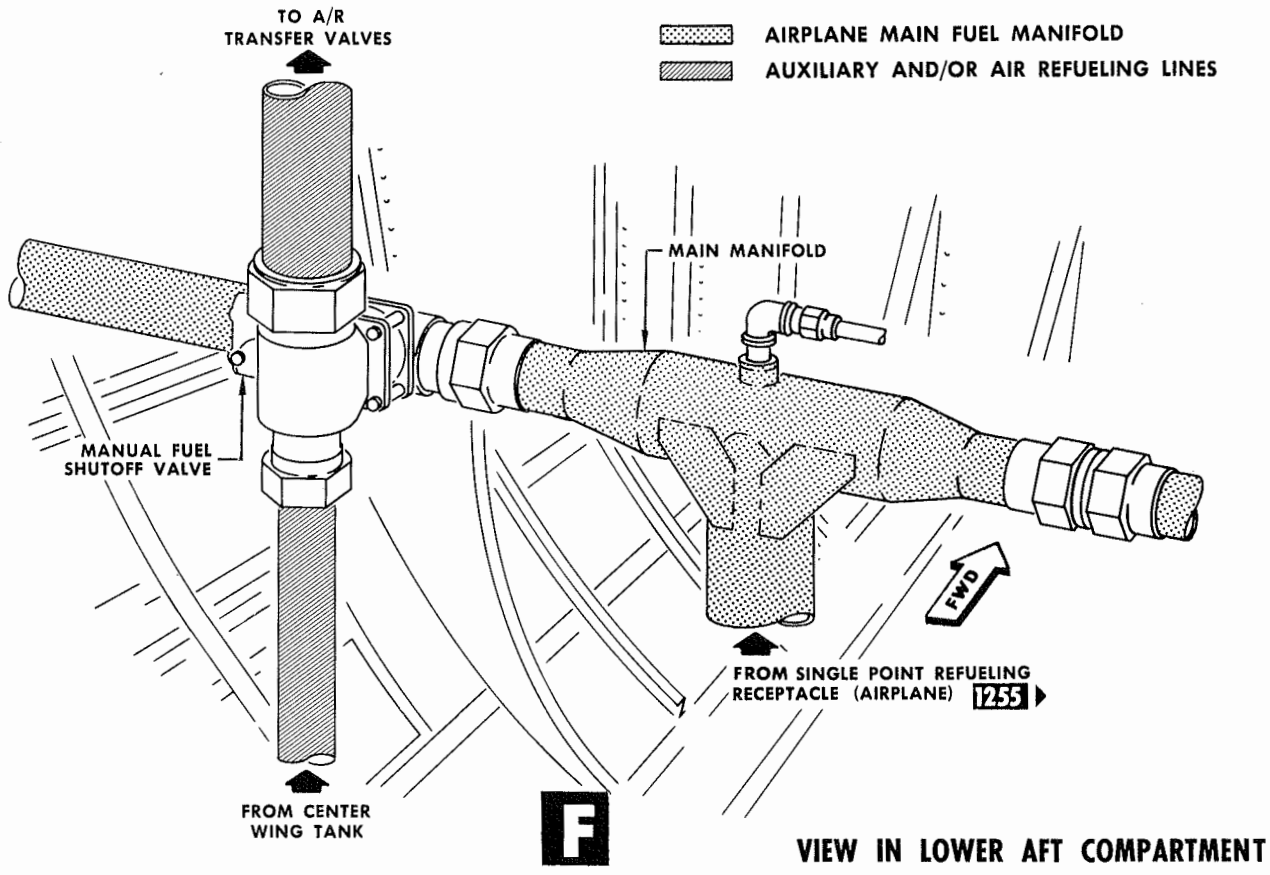
   e. Engineer's A/R Master Switch - OFF (if desired)

Main Fuel Tanks to A/R Tanks ▼

WARNING

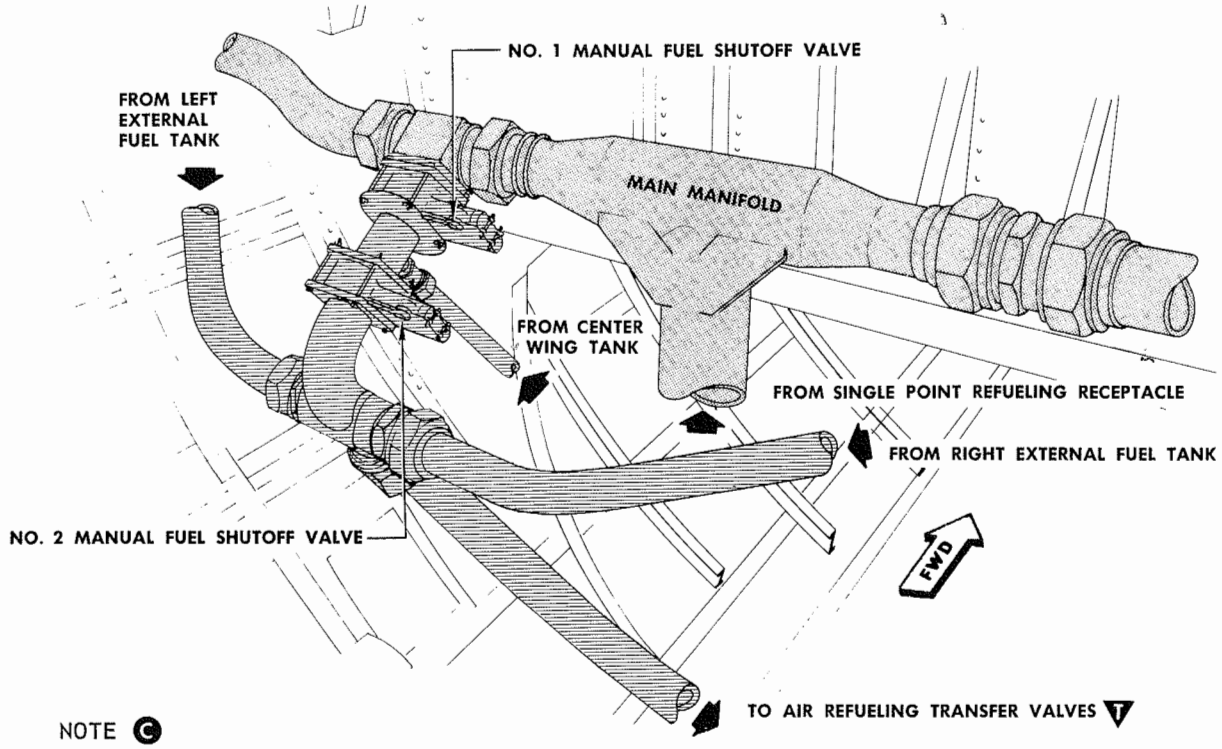
If the CWT and/or the external fuel tanks contain fuel other than grades 115/145 or 100/130 the following sequence of operation should be rigidly adhered to:

1. A/R Transfer Valve Switches - CLOSED



FUEL SYSTEMS INTERCONNECTION

Figure 7-10 (Sheet 1 of 4)

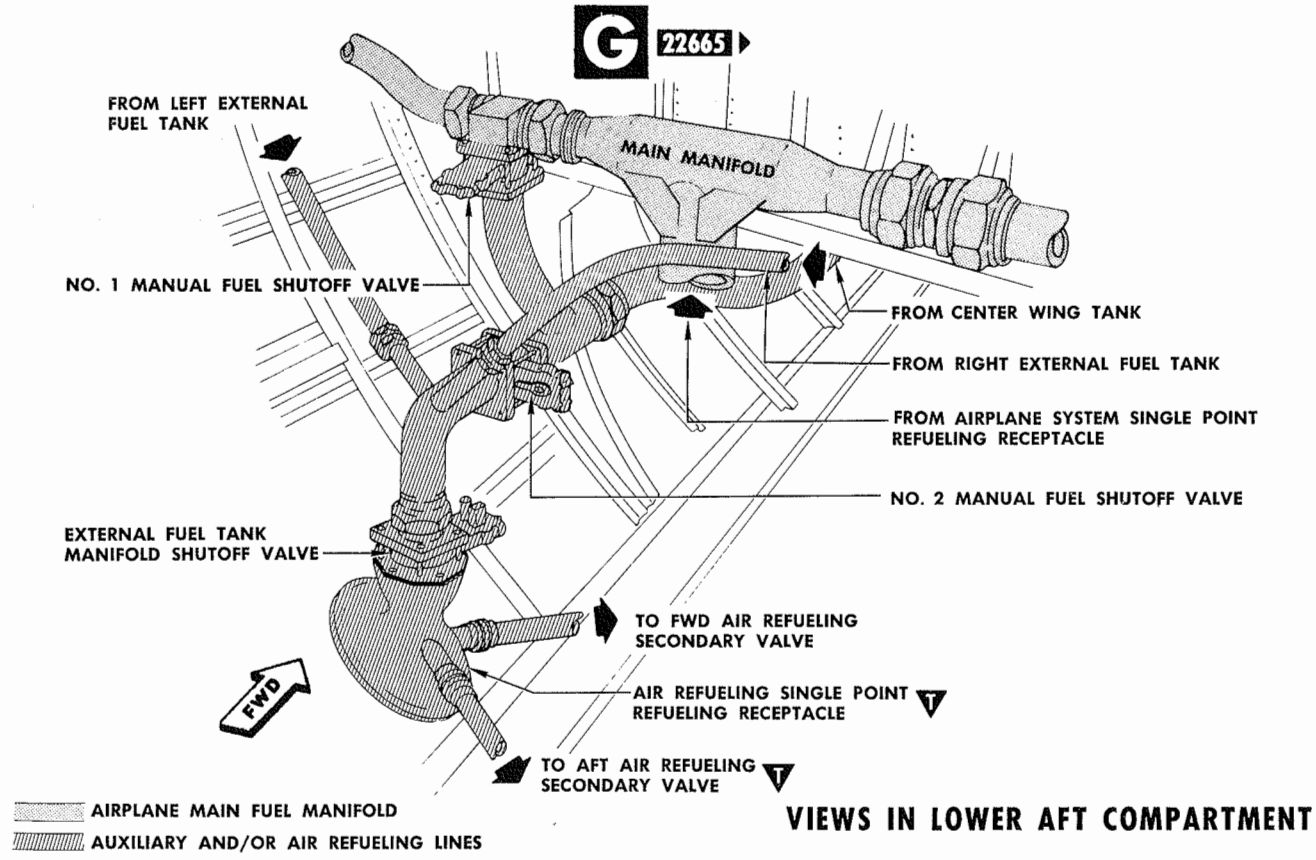


NOTE C

Manual fuel-shutoff valves should be open at all times

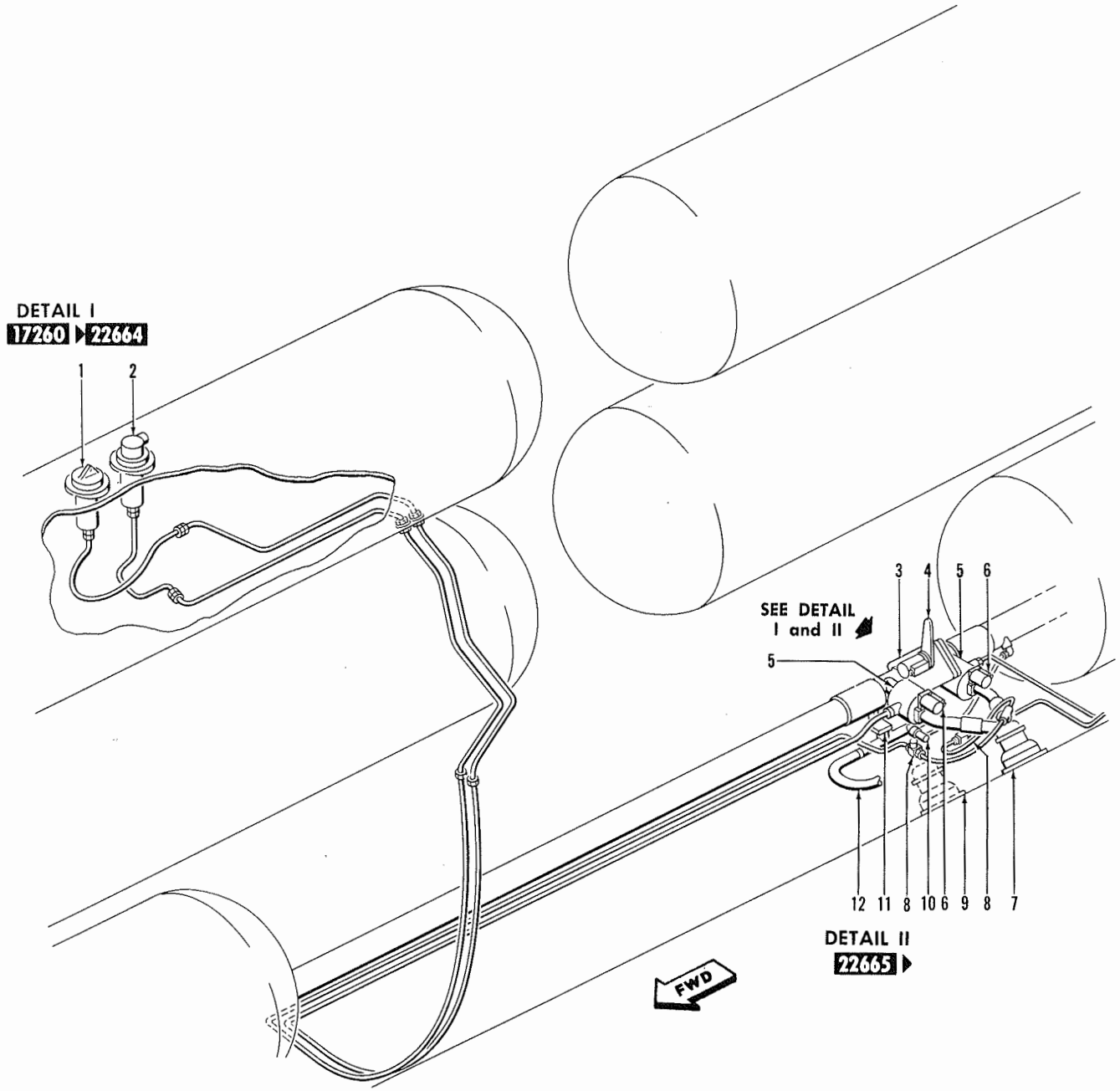
G 17260 ▶ 22664

G 22665 ▶



VIEWS IN LOWER AFT COMPARTMENT

Figure 7-10 (Sheet 2 of 4)

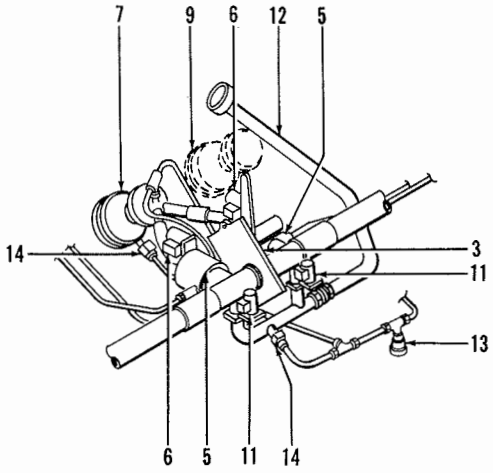


1 PRIMARY FUEL LEVEL FLOAT VALVE
2 SECONDARY FUEL LEVEL FLOAT SWITCH
3 FUEL LEVELING VALVE
4 LEVELING VALVE MANUAL CONTROL ARM
5 PRIMARY SHUTOFF VALVE (2 PLACES)
6 SECONDARY SHUTOFF VALVE (2 PLACES)
7 AIR REFUELING SINGLE POINT REFUELING PORT
8 SECONDARY FLOAT SWITCH TEST VALVE
9 MAIN FUEL SYSTEM SINGLE POINT REFUELING PORT
10 THERMAL RELIEF VALVE
11 TRANSFER VALVE 17260 ▶22664
12 LINE TO MAIN FUEL SYSTEM MANIFOLD AND TO EXTERNAL WING TANKS 17260 ▶22664
13 FILLER PORTS AND TRANSFER LINE OVERBOARD DRAIN
14 DRAIN LINE SHUTOFF VALVE
15 EXTERNAL TANK SHUTOFF VALVE 22665 ▶
16 TRANSFER LINE
17 EXTERNAL WING TANK LINE
18 THERMAL RELIEF VALVE 22665 ▶
19 LINE TO AIRPLANE FUEL SYSTEM MANIFOLD 22665 ▶
20 SECONDARY TRANSFER VALVE 22665 ▶
21 THERMAL RELIEF LINE

G

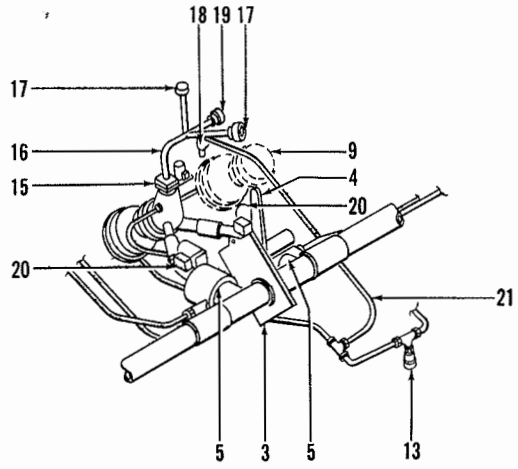
FUEL SYSTEMS INTERCONNECTION (CONT)

Figure 7-10 (Sheet 3 of 4)



DETAIL I

17260 ▶ 22664



DETAIL II

22665 ▶

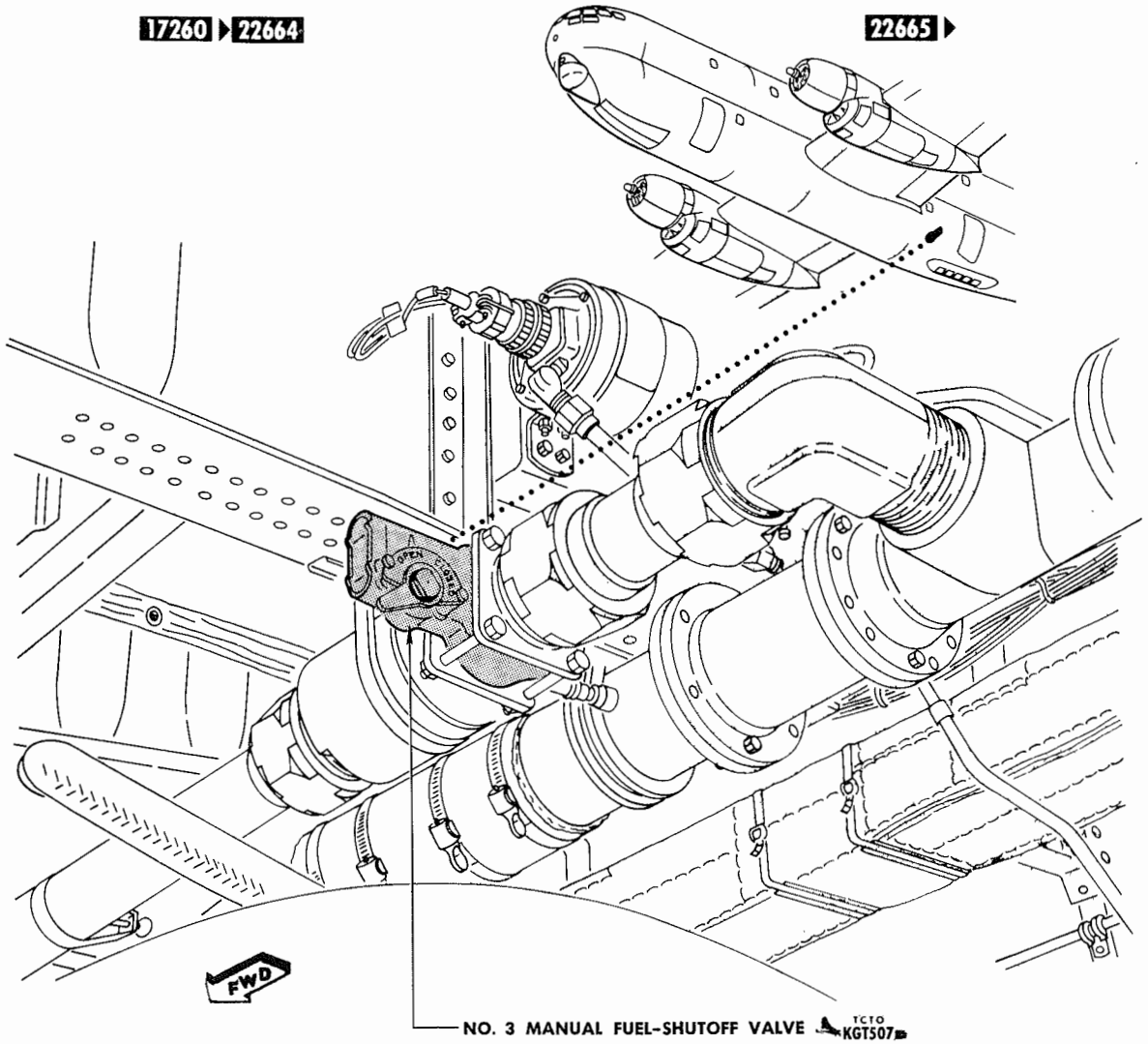


Figure 7-10 (Sheet 4 of 4)

2. No. 3 Manual Fuel-Shutoff Valve - Have visually checked closed G ICTO KGT507

3. A/R Transfer Valves - Have visually checked closed and not safety wired F G 1243 ▶ 22664 or

   Secondary Valves and External Fuel Tank Manifold Shutoff Valve - Have visually checked closed and not safety wired G 22665 ▶

4. Manual Fuel-Shutoff Valve - Have visually checked closed F or

   No. 1 Manual Fuel-Shutoff Valve - Have visually checked closed G

5. No. 2 Manual Fuel-Shutoff Valve - Have manually opened G

6. Engineer's A/R Master Switch - ON

7. External Fuel Tank Fuel Boost Pump Switches - Check OFF G

8. CWT Fuel Boost Pump Switches - Check OFF

9. CWT Line Valve Switch - Check CLOSED

10. CWT Line Valve - Have visually checked closed

11. CWT Single Point Refueling Secondary Valve - Have visually checked closed F G 1255 ▶ (always mandatory for this procedure)

12. Desired Main Fuel Tank Fuel Selector Switches - TME

13. Fuel Boost Pump Switches (in each desired main fuel tank):

    a. One - NORMAL

    b. One - EMERGENCY

CAUTION

If a fuel boost pump circuit breaker trips, move the corresponding fuel boost pump switch to NORMAL before resetting circuit breaker. Do not hold the circuit breaker in. Do not return this boost pump switch to the EMERGENCY position during this operation. This will prevent overheating the fuel boost pump.

14. Manual Fuel-Shutoff Valve - Have manually opened F or

    No. 1 Manual Fuel-Shutoff Valve - Have manually opened G

15. 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, have the manual fuel-shutoff valve, F or No. 1 manual fuel-shutoff valve G moved toward the closed position until the fuel low pressure warning lights go out and engine torque fluctuation ceases. Partially closing the manual fuel-shutoff valve F or No. 1 manual fuel-shutoff valve G will reduce the rate of fuel transfer from the main fuel tanks and 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.

16. Termination of Procedure:

    a. A/R Transfer Valve Switches - CLOSED

    b. Manual Fuel-Shutoff Valve - Have manually closed (always mandatory for this procedure) F or

       No. 1 Manual Fuel-Shutoff Valve - Have manually closed (always mandatory for this procedure) G

    c. No. 2 Manual Fuel-Shutoff Valve - Have manually closed G

    d. A/R Transfer Valve - Have visually checked closed F G 1243 ▶ 22664 or

       Secondary Valves and External Fuel Tank Manifold Shutoff Valve - Have visually checked closed G 22665 ▶

    e. Main Tank Fuel Boost Pump Switches - NORMAL (or as required)

    f. Engineer's A/R Master Switch - OFF (if desired)

17. Fuel Management - As required

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 airplanes G 22737 ▶ the inboard engines also supply hydraulic pressure to the motor-pump combination for pressurizing the boom hydraulic system.

a. Position tanker 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 fuel 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 to 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 whenever 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.

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.

CAUTION

Care must be taken with dummy receptacle and spare nozzle to prevent scratches and nicks that will result in fuel leakage.

f. Advance signal system to MADE condition, and commence fuel flow by slowly moving the fuel pump control 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, when using a nozzle to transfer fuel into airplane filler ports or a fuel truck, it is necessary to use a much lower rate of flow 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 fuel pump control 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, switch main inverter switch to the OFF position, secondary inverter switch to 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 with TCTO K521 are capable of supplying dc power to a receiver airplane. The feature is intended primarily for use with B-47 airplanes 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 engines.
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. Return the tank selector switch to OFF when the oil transfer operation is completed.

NOTE

- The oil transfer pump transfers oil at a rate of 6 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 anytime during engine operation, one gallon of oil will be transferred into the engine oil tank immediately. This will aid in improving oil scavenging and decrease 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.

When oil dilution is to be performed for more than 7 minutes, make certain that the engine oil tanks are not filled to more than 24 US gallons. See Section IX for oil dilution procedures.

NOTE

- During level flight, replenish the tank when the engine oil quantity gage indicates 20 gallons.

- a. During flight do not fill the engine oil tanks above 24 gallons.

  b. When the central oil tank supply has been depleted to 10 gallons, maintain engine oil tank quantity between 15 gallons and 20 gallons until the central tank supply is depleted.

  c. With central oil tank supply depleted, and any engine oil tank quantity less than 15 gallons, land at the nearest suitable base.

  d. The restrictions imposed in a. and b. above, are 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 d-c electrical loads are listed in figure 7-11. Average DC electrical loads and the number of generators required to meet these loads for various operating conditions are shown in figure 7-12. This table can be used as a guide to determine how many units can be operated in case of partial failure of the d-c power generation system.

Direct Current Power System Battery

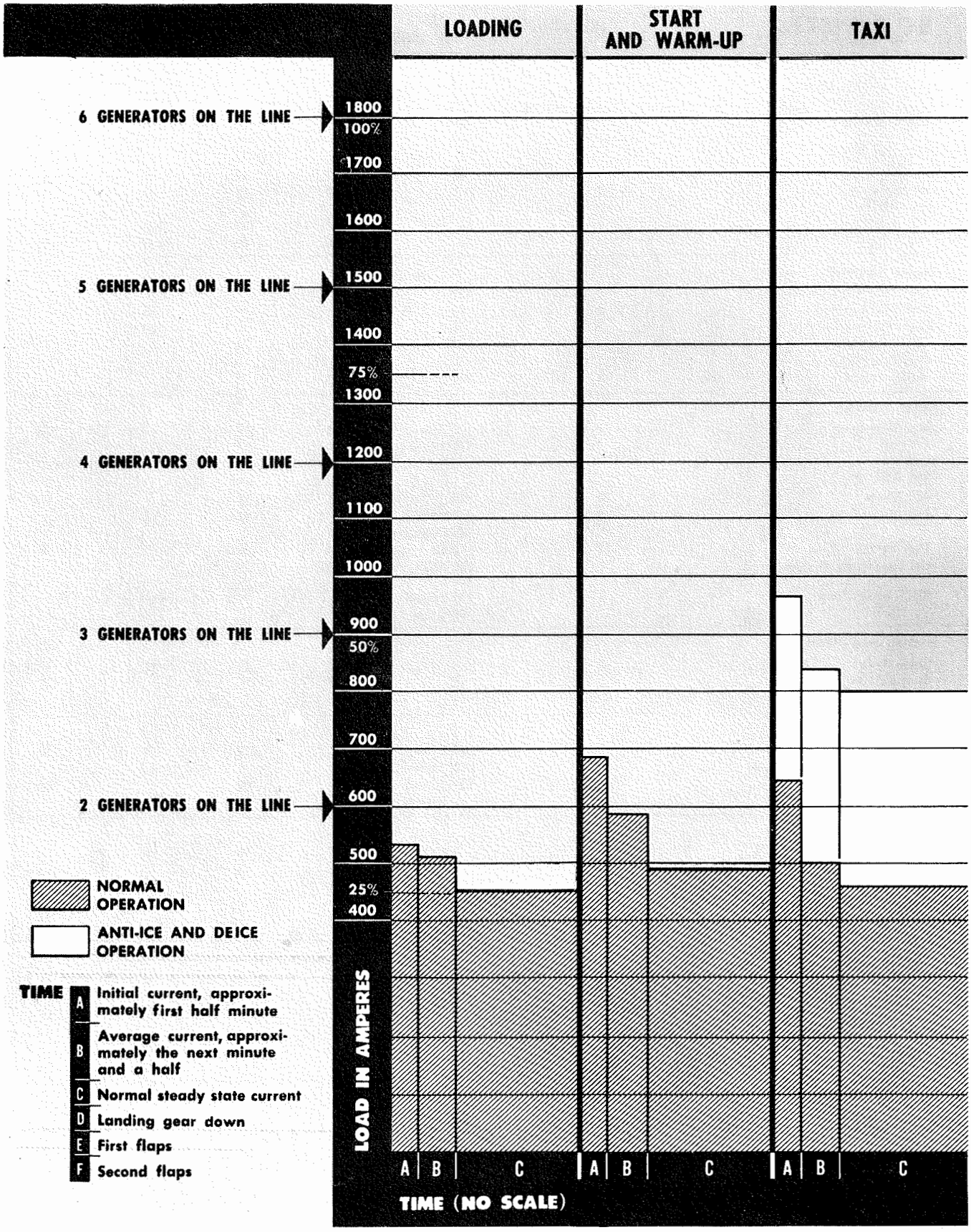
The battery can be charged at any time, whether on the ground or in flight, by placing the battery switch in the BAT CHG. position. The switch should be left on BAT CHG. during flight to assure a fully charged battery in an emergency. The life and capacity of a fully charged battery is greater than that 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 whenever the battery switch is in the BAT CHG. position the reading will show bus voltage. For further information, see ELECTRICAL SYSTEM, Section I.

EQUIPMENT	NO. UNITS	AMPS PER UNIT	START TAXI	TAKE OFF CLIMB	CRUISE	LANDING
Anti-Icing						
Empennage Ground Blowers	1 Combustion	7				
	1 Ventilating	20	27			27
Propeller Deice	4	279	279	279	279	279
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						
Prop Feathering and Reversing	4	137				
Carb. Air Actuator	4	17			68	
Carb. Preheat Actuator	4	2.5			10	
Cowl Flap Motors	4	17	69	69	69	69
Prop Throttle Lock	1	24				24
Starter Motors	4	200	205			
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 Valves	12	0.55	11	11	11	11
Hot Fuel Prime Heaters	4	300 HIGH, 150 LOW	300			
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 F G 1243 ▶ 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						
Control Lamps	79	0.2 to 0.8	20	10	10	10
Dome Lights	16	0.8	13	13	13	13
Landing Lights	2	22	48			48
Taxi Lights	2	5	11			11
Wheel Well Lights	3	2	10			10
Radio						
Interphone F 1243 ▶ 1371	1	5	5	5	5	
Interphone F G 1372 ▶	1	15	15	15	15	15
Liaison	1	41	20	20	41	20
MF Command	1	41	20	20	41	20
Search Radar	1	22			22	
UHF	1	25	25	25	25	25
VHF	1	14	14	14	14	
VHF Navigation (VOR)	1	5			5	5
T Air Refueling						
Ruddevator Anti-ice F G 1243 ▶ 3249	2	236			472	
Without TCTO K509						
F Fuel Boost Pump (Center Wing Tank)	1	32.5			32.5	
G Fuel Boost Pumps (Center Wing and Ext Fuel Tanks)	6	32.5			199	

(Loads less than 1% of three generator capacity are not included in this chart)

ELECTRICAL LOADS

Figure 7-11



DC ELECTRICAL LOADS

Figure 7-12 (Sheet 1 of 2)

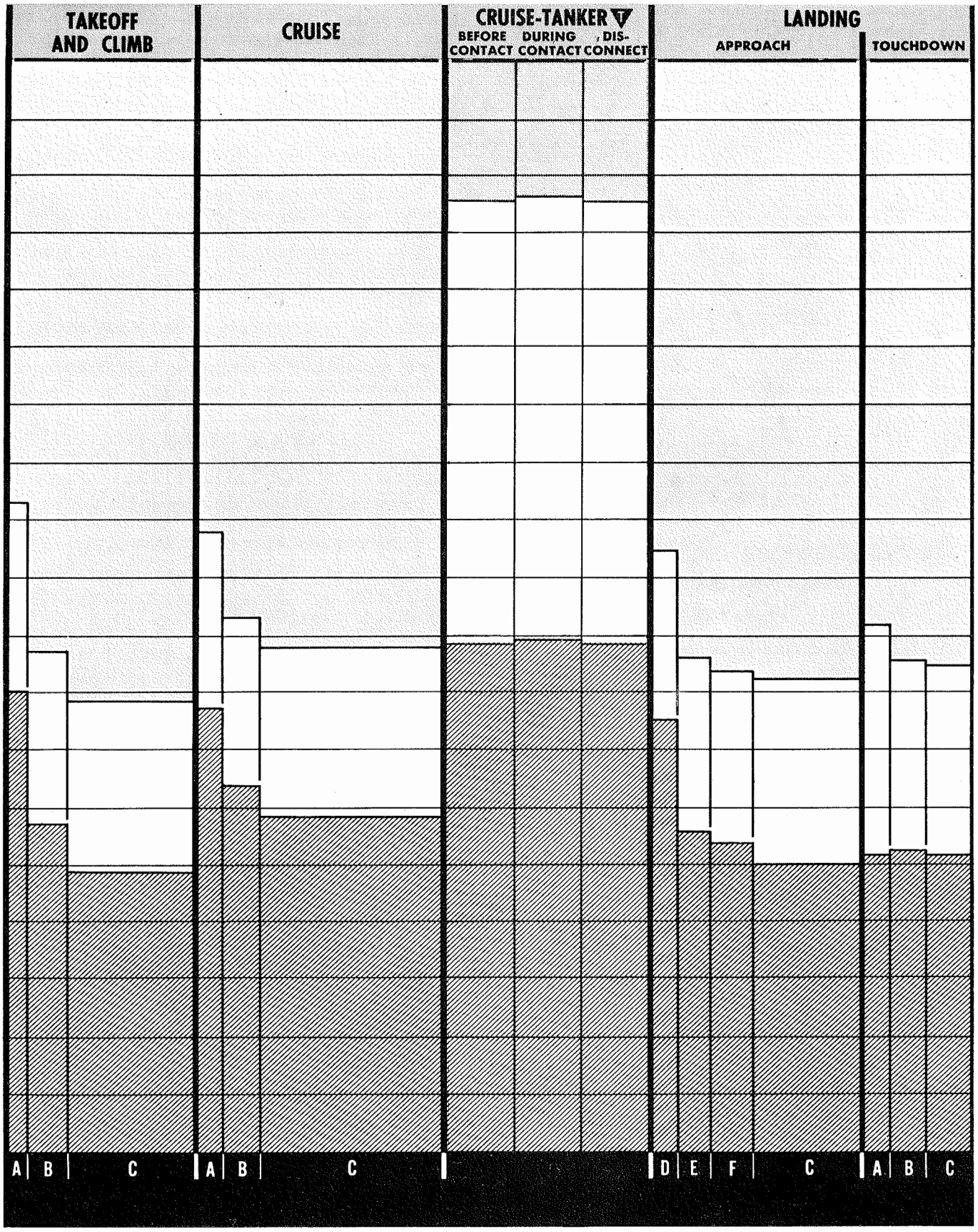
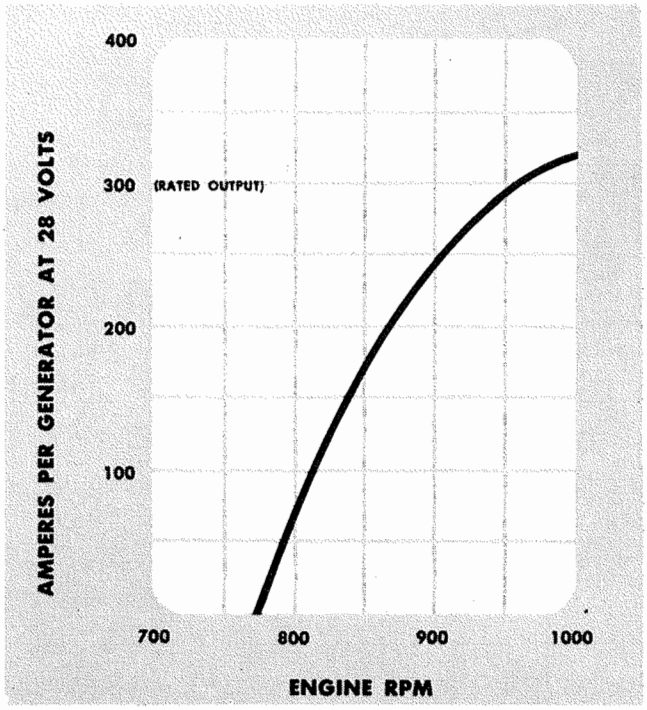


Figure 7-12 (Sheet 2 of 2)



GENERATOR OUTPUT VS ENGINE SPEED

Figure 7-13

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, the wires to the voltage regulator are to be disconnected. Extreme caution should be exercised while disconnecting the wires, as these wires are "hot." Failure to pull the wires to 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 one 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, prop reversal and braking action. (See Landing, Section II for prop 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.

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 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 1-42.) 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 on airplanes with ICIO K555 incorporated. A rapid series of applications 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 80% 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.

Section VIII Crew Duties

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INSTRUCTIONS

The KC-97 is a team work airplane, 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 pilot's, copilot's, and flight engineer's preflight duties are covered in NORMAL PROCEDURES, Section II. Additional duties and responsibilities of these crew members and duties for other crew members are assigned in the following text.

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, when signing for personal equipment to insure that each crew member and extra crew member has the necessary personal equipment as prescribed by current directives to safely accomplish the mission. At the mission briefing that is attended by all crew members, either the operations officer or the pilot will specify the equipment needed on the specified flight for which the crew has been briefed.

TIME SCHEDULE

It is very important that all crew members know crew inspection time, when to complete their preflights, Before Starting Engines Time, etc. The pilot, assisted by the copilot, should require all crew members to meet these schedules; nothing makes a crew more slovenly than stragglers. Insist on promptness.

PILOT

MISSION PREPARATION

A. Attend general briefing. Attend specialized briefing in communications, air refueling, and weather.

MISSION PREPARATION (Cont)

B. Coordinate with other crew members on routes, charts, and completion of various forms.

1. Coordinate with navigator on routes and necessary map preparation. Pilot's maps will have applicable route drawn in, ADIZ's, danger areas, highest terrain, etc.

2. Coordinate with navigator and extract necessary reporting points and entries to and from control areas.

3. Obtain the following data from navigator for entry in Form 175: total distance, average true airspeed, and time enroute.

4. Determine predicted fuel reserve from engineer's completed flight plan.

5. Review and sign Form 365F.

FINAL WEATHER BRIEFING

A. Prior to submitting Form 175 and attachments, coordinate with navigator on:

1. Forecast enroute and destination weather conditions

2. Terrain and adverse local area weather which may affect departure procedures

3. Select suitable alternate and determine time enroute (if required)

4. Revise time enroute as necessary, utilizing current forecast winds

5. Review applicable NOTAMS

AIR REFUELING

Refer to AIR REFUELING, Section IV

COPILOT

The copilot will aid the pilot in any way as directed to accomplish the assigned mission. He must be thoroughly familiar with emergency procedures as they pertain to the airplane and to his duties as copilot.

MISSION PLANNING

The following will be accomplished by the copilot when the radio operator is not aboard.

1. Communications Requirements - Complete

   Complete requirements for briefed routes to be flown. Coordinate with crew members, as required for reporting points, crystal and frequency requirements, alternate and emergency airfields, etc.

2. Applicable Pilots' Manuals, Charts - Current and complete

   Check applicable pilots' manuals (Enroute charts, enroute supplements, terminal charts), for current and complete contents. Correct publications as required.

3. Communications Kit - Complete

   Communications flimsies, forms, radio logs, frequency cards, crystals and tool kit (where applicable). ACP's (125 USAF-1, 131 and 135).

NAVIGATOR

The navigator will aid the pilot and engineer in all matters pertaining to flight planning and other assigned duties. He will be responsible for the navigation of 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 and to his duties as navigator. The navigator's procedures are included in this Section in the form of amplified checklists.

MISSION PLANNING

General Planning

The general mission planning should be accomplished with the cooperation of the other crew members. The complete mission flight planning will include:

A. Weather - Obtained

   Obtain necessary metro data for route and refueling area to include:

   1. Cloud coverage and haze

   2. Climb winds and winds aloft

3. Temperatures

4. Location of jet streams and unusual weather phenomena

5. Pressure pattern information

6. Terminal forecast

B. Maps for Mission - Selected

Select maps and charts of suitable scale and projection as indicated by the requirements of the mission. Additional maps will be procured to provide coverage for emergency changes in flight plan. All pertinent air space restrictions and ADIZ boundaries within 50 NM of the flight planned route will be shown, including altitude and time of restriction. The current Flight Information Publication will be consulted for information on danger, warning, and ADIZ's.

C. Routes - Plotted

Complete route plotted on the charts. When using Lambert Conformal Charts, the route will be divided into segments with the length of each leg short enough to prevent large departure of the rhumb line from the straight line on the chart.

1. Dog legs will be included to aid in accomplishing control times when required.

2. Alternate and emergency airfields along the flight planned route will be clearly marked on the chart by enclosing the airfield in a circle.

3. Reporting Points and Control Areas. The navigator will coordinate with the pilots on necessary reporting points and entries to and from control areas.

Radar Navigation Planning

A. Charts - Prepared

Prepare navigation data and chart for the route. Select current charts of suitable scale. Consider the availability of radar targets along the route for selection of proper scale chart.

1. Points for precision fixing and wind determination will be selected.

2. Areas for control time solution and performance, if required, will be selected.

Celestial Navigation Planning

A. Charts - Selected and plotted

The JN-series chart is recommended, when available.

B. Celestial Precomputations - Accomplished

NOTE

Command directives will be followed as pertains to celestial precomputations.

Grid Navigation Planning

A. Charts - Selected or prepared

Select a chart of the appropriate area which incorporates a printed grid overlay or construct a grid on an appropriate chart.

Airborne Radar Approach Planning

A. Planning - Accomplished

Complete general planning for a radar approach will be accomplished by members of the crew using all available aids (such as: published instrument patterns, instrument let-down books, Flight Information Publications, and scope photos) for base of intended landing and at least one alternate. Obtain detailed map of base and surrounding area.

Airborne Radar Approach Planning (Cont)

B. Data - Secured

The following information will be recorded and/or secured for inflight use:

1. Detailed map of base and surrounding area, with approach pattern plotted
2. Clearly marked scope photographs of approach, if available
3. Field Elevation
4. Type of lighting and obstructions
5. Availability and location of navigational aids
6. Altitudes for each phase of approach
7. Terminal weather

C. Patterns - Studied

The following will be studied:

1. Instrument let-down and GCA patterns
2. Terrain and prominent radar returns on or near the base

Metro Flight Plan

A. Metro Flight Plan - Completed

1. A complete metro flight plan will be completed utilizing airspeeds provided by the flight engineer prior to flight.
2. A complete line entry will be made for the alternate landing base. This alternate landing base will be as noted on the Form 175.

BEFORE INTERIOR INSPECTION

Check navigation kit and mission folder prior to reporting to airplane. Ascertain that all necessary plotting equipment, computers, watches, etc., are available. Check for necessary forms, flimsies, and logs. Upon arrival at the airplane stow personal equipment and check oxygen equipment as outlined in Section IV. When the pilot directs, the crew will assemble and the Form 781 will be read and discrepancies pertaining to each crew position will be discussed with the crew member concerned. Prior to dismissing the crew, the pilot will announce a Starting Engines Time. The navigator will be in the lower forward compartment to receive the three ground locks and boom pin from the GC, close and lock the forward entry door, and start the APU if requested by the engineer. This must be accomplished immediately prior to starting engines and must be completed in sufficient time to have all four engines started 20 minutes prior to takeoff.

INTERIOR INSPECTION — POWER ON

1. APU - Started (P, N, E)

   If external power is not to be used, navigator will start the APU when pilot rings alarm bell. See Section IV for STARTING PROCEDURE.

2. Almanac and Volumes I, II, III H.O. 249 - Check availability and currency

3. AC Power Clearance - Received from engineer (N, E)

4. Table, Dome, and Panel Lights - ON and set as required

5. Interphone - Check

6. N-1 Compass - Synchronize

7. Driftmeter

   a. Driftmeter Switch - ON

   b. Gyro Switch - ON

   c. Starting Button - Depress and hold momentarily (if applicable)

8. Periscopic Sextant and Mount

NOTE

If sextant is stowed in personal equipment section, steps a, b, and c, may be performed at personal equipment.

a. Desiccant - Check

b. Halftime Dial - Check for accuracy

See Section IV for detailed instructions.

c. Altitude Averager - Check for accuracy

See Section IV for detailed instructions.

d. Navigator's Sighting Stool - Lock in position

e. Sextant - Insert

Insert sextant with arrows on tube and mount aligned, then turn clockwise until plunger locks sextant in retracted position. Open port and push sextant up until it locks in operating position.

f. Electrical Cable - Connect to sextant and mount

g. Illumination - Check

Check for illumination of bubble and size, azimuth ring scale, altitude counters, averager indices, and watch clip. Illumination of the bubble and azimuth ring scale is further controlled by a rheostat on the side of the sextant. Check rheostat for proper operation. Other lights are not adjustable. If lights do not operate, check circuit breaker and bulbs.

h. Sextant Alignment - Check

See Section IV for detailed instructions.

i. Bearing for Driftmeter Alignment - Obtain and record

See Section IV for detailed instructions.

j. Illumination Switch - OFF

k. Averager Actuator - Depress and release

m. Sextant Port - Retract sextant and close

n. Mount, Sextant and Cable - Drain, remove and stow

Remove plug from sextant mount and allow excess moisture to drain out. Replace plug. Place sextant in case and strap down securely prior to takeoff to prevent damage to the sextant.

p. Navigator's Sighting Stool - Stow

Tie down securely in main compartment.

9. Driftmeter

a. Azimuth Drive Knob - Check _____ degrees alignment

Perform alignment check on predetermined point selected with periscopic sextant check. Reposition driftmeter azimuth pointer or record correction to be applied during flight. See Section IV for detailed instructions.

b. Azimuth Drive Knob - Turn azimuth scale to 180 degrees

c. Gyro Caging Knob - UNCAGE, check, CAGE

Check for precession of gyro.

d. Gyro Switch - OFF

e. Driftmeter Switch - OFF

10. Time Hack - Obtain (if required)

If a time hack is required, the BC-348 receiver will have been tuned to the time hack frequency and left on by the radio operator (if aboard) or the ARC-21 or ARC-65 by the copilot. (Radio Operator not aboard.) After checking time hack, turn the appropriate radio off.

11. Boom Operator's Oxygen Supply Valve - Open

(12) Power-On Preflight Complete - Advise engineer (N, E)

BEFORE STARTING ENGINES

NOTE

If the airplane is on ALERT status, do not accomplish the BEFORE STARTING ENGINES checklist.

(1.) APU - Started (N, E)

Navigator will start APU if external power is not used and APU is not already running upon completion of the INTERIOR INSPECTION - POWER ON.

(2.) Ground Locks and Boom Lock Pin - Stow (N, GC)

Ground crew will remove the three landing gear ground locks and the boom pin and hand them to navigator through the forward entry door. Navigator will stow ground locks and boom lock pin in lower forward compartment.

3. Forward Entry Door - Close and lock

(4.) Time Hack - (If required) (All)

A time hack is not required if the navigator has ascertained all crew members have an accurate hack prior to this time.

STARTING ENGINES

NOTE

- Normally personal equipment will be donned prior to initiating this checklist; however, during ALERT PROCEDURES, if time does not permit, the takeoff may be made without wearing the applicable emergency equipment.

- On airplanes not on alert, items one through seven will be omitted and the checklist is started with item eight.

(1.) Ground Heating Equipment and Covers - Remove (as briefed) (All)

(2.) Right Landing Gear Down Lock - Remove and give to pilot or copilot (P, CP, N)

3. No. 3 and No. 4 Engine Dust Plugs - Remove and stow

Remove and stow in lower aft compartment (if applicable).

4. No. 3 and No. 4 Engine - Stand fire guard

5. Fire Bottle - Move to right wing tip

6. Right Forward and Aft Chocks - Move to right wing tip

7. Enter Airplane - Aft entry door

8. Headset - On

9. IFF - STANDBY

a. SIF - Set proper code (If applicable)

b. Mode Switches - Set as briefed (If applicable)

(10.) Power Clearance - Received from engineer (N, E)

11. N-1 Compass - Synchronize

(12.) APU - Started (N, E)

Start APU if external power was used for engine start.

13. VHF COMM and UHF COMM Interphone Mixer Switches - ON (up)

Position the interphone mixer switches to permit the navigator to monitor the flight clearance.

14. Radio Altimeter Gain Knob - ON

15. Radar Pressurizing Switch - NORMAL ON

16. Search Radar Function Switch - STANDBY

17. Driftmeter - ON

Turn both driftmeter power and gyro switches on.

(18.) Set Altimeters - Set (N, P, CP)

Check all three pointers on the altimeter to assure proper settings. Pilot will announce station pressure over interphone, after which crew members will set station pressure and verbally compare readings over interphone.

(19.) Taxi Report - Complete (All)

Copilot sounds alarm bell and announces, "Taxi Report." Crew reports in the following order; BO, N, E, CP, P. Navigator responds, "Ground locks and boom pin stowed, front entry door closed, navigator ready to taxi." (If aircraft is on alert report, "Navigator ready to taxi.")

If the boom operator is not on interphone, he may give a visual signal to the navigator to signify that the aft entry door is locked, alarm bell checked, and aft compartment personnel are ready to taxi. Upon receipt of this signal the navigator will also report, "Boom operator ready to taxi."

20. APS-42 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 - Received (N, P)

3. IFF Master Switch - NORM (if applicable)

4. Safety Belt - Fasten F, or
Safety Belt and Shoulder Harness - Fasten and Lock G

(5.) Takeoff Report - Report "Navigator ready for takeoff" (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 aircraft accelerates, the copilot will alert the navigator over interphone by calling "60 knots" as the speed approaches 55 knots IAS. At exactly 60 knots IAS the copilot will announce over interphone "Now." At this exact instant, the navigator will start his stop watch. The master or hack watch will be used as a back-up. Approximately four seconds before the time has expired, the navigator will alert the pilots by announcing over interphone "Time." At the exact 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.

AFTER TAKEOFF, CLIMB AND CRUISE

Monitor departure instructions to determine the route of departure to be flown. Maintain airplane position making maximum utilization of search radar. If flying in cell formation, locate and identify reference airplane using beacon function as necessary. Adjust heading and airspeed as required to maintain briefed position. Upon completion of the climb phase, determine airplane position. Check deviation after level off and on each succeeding leg as required.

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 or between two search radars makes the scope presentations unreliable.

AIR REFUELING

Refer to AIR REFUELING, Section IV

GRID NAVIGATION

Grid — Entry

(1.) Disengage Autopilot - Disengaged (N, P)

(2.) Follow Direction Indicator - Followed (N, P)

Use the pilot's direction indicator to maintain heading while setting the N-1.

3. N-1 Compass

a. Latitude Correction Knob - CW and set

Set latitude correction pointer on geographic latitude.

b. Synchronizer Knob - Engage and set

Convert true heading of airplane to grid heading and set on master direction indicator.

c. Heading Check - Complete

Determine the heading of the airplane by celestial means.

d. Master Direction Indicator - Correct

(4.) Engage Autopilot - Engaged (N, P)

(5.) Steer Desired Grid Heading - Steered (N, P)

Turn the airplane until the desired grid heading is read on the N-1 compass. Unless there is a predetermined precession rate, the desired and initial headings are the same.

(6.) Set Direction Indicator - Set (N, P)

After airplane is established on desired heading, the pilot will set the desired heading on the pilot's direction indicator. This will be rated as the secondary gyro. Pilots should be cautioned against resetting the directional indicator unless so instructed by the navigator.

Grid — Enroute

1. Heading Check - Accomplish

Celestial heading checks should be accomplished periodically so that directional indicators can be monitored and rated as required. If directional indicators are in error in excess of two degrees, heading check information must be recorded on the

Grid—Enroute (Cont)

grid graph or gyro log. When recording heading information for the primary and secondary gyro, record grid heading minus gyro reading.

NOTE

It is not necessary to reset the secondary gyro to the grid heading. The N-1 should be reset any time the precession exceeds 4 degrees. If the navigator resets the gyro(s) steps 2, 3 and 4 will be accomplished.

(2.) Disengage Autopilot - Disengaged (N, P)

3. Heading Pointer - Reset

Reset the N-1 heading pointer and/or secondary gyro to the celestial grid heading.

(4.) Engage Autopilot - Engaged (N, P)

5. Latitude Correction Pointer - Reset (if applicable)

Reset the latitude correction pointer to the mid-latitude in two degree increments as the airplane changes latitude.

6. Heading Check - Complete (if applicable)

Heading check should be taken as soon as possible after any turn in excess of 20 degrees to determine any N-1 compass precession during the turn. Should the N-1 compass become inoperative, the pilot's directional indicator will be used as the primary steering reference.

Grid—Exit

(1.) Disengage Autopilot - Disengaged (N, P)

2. N-1 Compass

a. Latitude Correction Pointer - OFF

b. Synchronizer Knob - Engage and synchronize

Set the heading pointer to indicate the approximate magnetic heading of the airplane. The annunciator pointer should be approximately centered.

(c.) Cross Check B-16 Compass - Cross checked (N, CP)

Cross check the B-16 compass reading with the N-1 compass reading.

(3.) Engage Autopilot - Engaged (N, P)

DESCENT

1. UHF COMM, VHF COMM, and INTER Interphone Mixer Switches - ON (up)

2. Trailing Wire Antenna - Fully retracted (if installed)

3. Descent - Monitor instructions and airplane position

Monitor descent instructions to determine the route of descent to be flown, maintain airplane position, and make maximum utilization of search radar.

(4.) Altimeter - Set (N, P)

Acknowledge altimeter setting over interphone.

5. Radio Altimeter Gain Knob - ON

See Section IV for detailed operating instructions

6. Periscopic Sextant and Sighting Stool - Stow

Stow and tie down sextant in designated stowage area forward of engineer's panel. Securely tie down sighting stool in main compartment.

7. Headset - On

8. Electrical Equipment - OFF (if not required)

9. Search Radar - Tune

Vary range switch to keep target in outer one-half of scope.

10. Initial Points - Make good

The navigator will direct or monitor the airplane to the VOR station, LF range, or other published reference points to be used for initiating the instrument let-down, arriving over the point on the desired heading for initial descent.

11. Let-down - Initiate or monitor

Upon reaching the selected reference point, a standard instrument let-down will be initiated.

12. Published Let-down Pattern - Direct or monitor airplane

The navigator will direct or monitor the airplane through the published instrument let-down pattern for that particular base, advising the pilot of the proper times for adjusting heading, altitude, or airspeed. The bearing of the cursor and the fixed range markers will be used to determine when to start turns and/or descents.

BEFORE LANDING

(1.) Nose Gear - Visually checked down (N, E)

Report to engineer when nose gear is visually checked down.

2. Safety Belt - Fasten **F**, or
Safety Belt and Shoulder Harness - Fasten **G**

3. Traffic Pattern - Direct airplane or monitor as required

   Upon reaching the level-off altitude specified for the instrument let-down, the navigator will direct or monitor the airplane around the normal radar approach pattern for the active runway, advising the pilot of the proper times for adjusting altitudes and/or airspeeds. The airplane should be 1200 feet above the terrain at 130 knots IAS upon reaching the glide path. The bearing of the azimuth marker and the fixed range markers will be used to determine when to start turns and/or descents.

4. Airplane Position - Align or monitor alignment with runway on final approach

   Upon completing the turn on final, the navigator will position or monitor the airplane to approach the runway on the runway heading plus or minus drift.

5. Heading - Correct or monitor as required

   During remainder of approach, correct or monitor airplane heading as required to keep airplane aligned with runway, while maintaining runway heading plus or minus drift.

6. Final Descent - Initiate or monitor at 4 nautical miles

   When airplane reaches four miles from end of runway, instruct or monitor the pilot to initiate a 600 foot-per-minute descent while maintaining desired heading.

7. Rate-of-Descent - Check at 2 nautical miles

   The rate-of-descent will be checked when the airplane reaches two miles. The airplane should be 600 feet above the terrain. If not, adjust rate-of-descent accordingly.

8. Go-Around - Direct airplane or monitor position as required

   If a practice approach is being made, it will be discontinued at published radar approach minimum altitude for PPI approaches and a go-around initiated, maintaining the last heading, if feasible to evaluate approach. Navigator will direct airplane during go-around or monitor position as required. If a landing is to be made from the approach, navigator will continue corrections as required and be prepared to direct airplane if a go-around becomes necessary.

AFTER LANDING

1. IFF Master Switch - STDBY (if applicable)
2. Search Radar
   a. Range Switch - 10 NM
   b. Gain Knob - Full UP
   c. Scan Switch - OFF, trace at 180 degrees
   d. Tilt switch - Full UP
   e. Antenna Stab Switch - OUT
   (f.) Scope Intensity Knobs - Full CCW (N, CP)
   g. Delay Knob - Full CW
   h. A--J Switch - OUT
   i. Tune Switch - AFC
   j. Function Switch - OFF
3. Radar Pressurizing Switch - OFF
4. Radar Pressurizing Bleed Valve Knob - Depress and bleed to 30 in. Hg.
5. All Electrical Equipment - OFF

   Insure that the following equipment is turned off: loran, APN-12 rendezvous radar, APN-76 rendezvous radar, radar beacon, radio compass, radio altimeter, and driftmeter.

(6.) Report to Engineer - Report "Electrical equipment OFF" (N, E)

7. Form 781 - Complete

NOTE

- All items on the navigators AFTER LANDING checklist, with the exception of IFF master switch, should be performed only for the final landing.
- The navigator's normal procedures also appear in T.O. 1C-97(K)F-(CL)1-2, which is a condensed checklist. The condensed checklist has each numbered step (and some sub-steps) of the normal, air refueling, alert, and emergency procedures.

NAVIGATOR'S EMERGENCY PROCEDURES

Refer to NAVIGATOR'S EMERGENCY PROCEDURES in Section III and T.O. 1C-97(K)F-(CL)1-2.

NAVIGATOR'S ALERT PROCEDURES

Due to the alert concept, there is a need for a plan to enable the crew to safely launch the airplane in the most expeditious method. For overall alert concept, refer to ALERT PROCEDURES in Section II.

AIRPLANE ACCEPTANCE

Accomplish INTERIOR INSPECTION - POWER ON as set forth in the normal procedures, prior to airplane being placed on alert status.

COCKING

After the airplane has been run-up prior to being placed on alert status, complete the AFTER LANDING checklist. When the airplane has been parked, start the APU if required. This will cock the airplane and complete the navigator's cocking duties. (If equipment preflight uncovered no discrepancies.)

SCRAMBLE

Complete the normal STARTING ENGINES and BEFORE TAKEOFF checklists.

DAILY PREFLIGHT

(1.) APU - Started (N, E)

2. Almanac - Check current

3. Sextant Mount - Drain

4. Personal and Professional Equipment - Check for availability and stowage

   Check for presence of all navigation equipment, sextant and personal equipment.

UNCOCKING

No items are required for the navigator.

TAXI BACK

Accomplish normal AFTER LANDING checklist.

NAVIGATOR'S DEFCON ONE AND MINIMUM REACTION POSTURE CHECKLIST

COCKING (DEFCON ONE)

If engines have not been started, start APU or external power. If launch progression occurs, crew initiates STARTING ENGINES checklist and continues normal "scramble" procedures. If one or more engines have been started, accomplish the following checklist to assume DEFCON ONE posture.

(1.) APU - Started (if applicable) (N, E)

2. Search Radar

   a. Gain Knob - Full CCW

   b. Scan Switch - OFF, trace at 180 degrees

   c. Tilt Switch - Full UP

   d. Antenna Stab Switch - OUT

   e. Scope Intensity Knob - Full CCW

   f. Function Switch - OFF

3. Radio Altimeter Gain Knob - OFF

4. Driftmeter Switches - OFF

5. IFF Master Switch - STANDBY (if applicable)

(6.) Report to Pilot - "Cocking checklist complete." (N, P)

COCKING (MINIMUM REACTION POSTURE)

All checklists through the BEFORE TAKEOFF checklist must have been completed prior to starting the MINIMUM REACTION POSTURE checklists.

For COCKING (MINIMUM REACTION POSTURE), complete the COCKING (DEFCON ONE) checklist.

SCRAMBLE (MINIMUM REACTION POSTURE)

This checklist will be used only when launch is required and subsequent to accomplishment of the COCKING (MINIMUM REACTION POSTURE) checklist.

(1.) Power Clearance - Received from engineer (N, E)

2. N-1 Compass - Synchronize

3. Radio Altimeter Gain Knob - ON

4. Search Radar Function Switch - STANDBY

5. Driftmeter Switches - ON

6. IFF Master Switch - NORM (mode switches set) (if applicable)

(7.) Report to Pilot - "Ready for takeoff" (N, P)

8. APS-42 Search Radar - Tune

NOTE

The navigator's alert procedures also appear in T.O. 1C-97(K)F-(CL)1-2, which is a condensed checklist. The condensed checklist has each numbered step (and some sub-steps) of the normal, air refueling, alert, and emergency procedures.

FLIGHT ENGINEER

The flight 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 must be thoroughly familiar with emergency procedures as they pertain to the airplane and his duties as flight engineer.

WARNING

To prevent accidental opening of the fuel transfer valves and/or fuel leveling 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.

FLIGHT ENGINEER'S FUEL MANAGEMENT PROCEDURE

Refer to FUEL SYSTEM, Section VII.

NOTE

The boom operator will coordinate with the flight engineer when positioning the manual fuel-shutoff valve(s) and will report the position of these valve(s) after manual actuation.

AIR REFUELING

Refer to AIR REFUELING, Section IV.

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.

CHECKLISTS

The following action will be required in complying with the response portion of the checklists:

Condition - A visual check only is required

Security - A physical check is required

Check - An operational check is required

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 (2) 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 "Charts "E"." There are two versions of the 365F: TRANSPORT and TACTICAL. They are designed for the respective loading arrangement. A sample form for each with applicable instructions and explanations for the completion of the form are presented in this Section. See figures 8-1 and 8-2.

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.

Mission Planning Check

1. Form 365F - Accomplish

   The sample WEIGHT AND BALANCE FORM 365F (figures 8-1 and 8-2) are to be used only as a guide.

2. Briefings - Attend

(3.) Rendezvous Beacon Light - Color Code (BO, GC)

   Notify ground crew of proper color discs to be installed.

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, SACM 55-7A, SACR 60-13 and the PLANNING FACTORS, this Section. The E-1035 computer plate was used to complete figures 8-1 and 8-2.

NOTE

For **F** airplanes the entries will remain the same except for the use of an E-999 computer plate number and deletion of the external tank entry. The REMARKS column contains some abbreviations, which are defined as follows:

(I) Inboard Fuel Tanks
(O) Outboard Fuel Tanks
(C) Center Wing Tank
(E) External Fuel Tanks
(Tot) Total Fuel
(RT) Runup and Taxi
(Tot) Total Fuel for Takeoff

Loading Data Form 365F (Tactical)

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. CREW: (Ref. 3) The crew for this sample consists of a pilot, copilot, navigator, flight engineer, boom operator and a radio operator. These crew members are assumed to weigh 245 pounds each with professional equipment, and are listed by compartment.

5. ADDITIONAL LOAD: (Ref. 3) Enter by compartment all additional items. To include emergency equipment, passengers and cargo. This sample has 500 pounds of emergency equipment and 500 pounds of extra equipment.

6. OPERATING WEIGHT: (Ref. 4) The operating weight entry will be the sum of the weights entered above in reference 1 through reference 3.

7. 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.

External: Enter fuel, as applicable, in tanks.

A/R Tanks: Enter fuel, as applicable, in tanks.

8. WATER INJ. FLUID: (Ref. 8) This item is included in the basic weight of the airplane.

9. TAKEOFF CONDITION: (Uncorrected) (Ref. 10) This entry will be the total of all weights entered in references 4 and 7.

10. CORRECTIONS: (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.

11. 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 takeoff condition corrected line, (Ref. 12).

12. TAKEOFF CG % MAC: (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, line through the figure previously listed and enter the corrected % MAC.

13. LESS EXPENDABLES: (Ref. 14) Indicate fuel and A/R fuel expended, by weight and index.

14. 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).

15. ESTIMATED LANDING CG IN % MAC: (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.

16. LIMITATIONS: Enter the permissable gross weight for takeoff and landing. Enter the permissable cg for takeoff and landing.

NOTE

The forward cg limit for takeoff and landing of the airplane has been established at fifteen (15) % MAC at airplane gross weights below 105,000 pounds.

17. REMARKS: For mission planning purposes, enter the planned fuel loading. 875 pounds is normally used for runup and taxi fuel.

Loading Data Form 365F (Transport)

The following information refers to figure 8-2.

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. CREW: (Ref. 3) The crew for this sample consists of a pilot, copilot, navigator, flight engineer, boom operator and a radio operator. These crew members are assumed to weigh 245 pounds each with professional equipment.

5. EMERGENCY EQUIPMENT: (Ref. 6) Enter all emergency equipment not listed in the Chart C. This sample lists 500 pounds of equipment.

6. EXTRA EQUIPMENT: (Ref. 7) Enter all extra equipment. This sample lists 500 pounds.

7. OPERATING WEIGHT: (Ref. 8) The operating weight entry will be the sum of all weights entered above in references one (1) through seven (7).

8. TAKEOFF FUEL: (Ref. 9) Enter the fuel weight as determined in the REMARKS section.

9. WATER INJ. FLUID: (Ref. 10) This item is included in the basic weight of the airplane.

10. TOTAL AIRPLANE WEIGHT: (Ref. 11) The total airplane weight will be the sum of all weights entered in references one (1) through ten (10).

11. DISTRIBUTION OF ALLOWABLE LOAD: (Ref. 12) Enter by compartment all additional items. (To include passengers and cargo.)

12. TAKEOFF CONDITION: (Uncorrected) (Ref. 13) This entry will be the total of all weights entered in references one (1) through twelve (12).

13. CORRECTIONS: (Ref. 14) 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, in the corrections line with the applicable index.

14. TAKEOFF CONDITION: (Corrected) (Ref. 15) The weight correction, (Ref. 14), subtracted from or added to the takeoff weight uncorrected, (Ref. 13), will then give takeoff weight corrected. The index correction, (Ref. 14), will also be entered on the takeoff condition corrected line, (Ref. 15).

15. TAKEOFF CG IN % MAC: (Ref. 16) Takeoff gross weight and index will be used to compute cg in % MAC from the load adjuster. If a correction is necessary, line through the figure previously listed and enter the corrected % MAC.

16. LESS FUEL: (Ref. 17) Indicate weight of fuel expended by weight and index.

17. ESTIMATED LANDING CONDITION: (Ref. 20)

NOTE

- For corrections made prior to the original Form 365F being filed, subtract the total of reference 17 from the final takeoff condition corrected, (Ref. 15).

- Corrections made after the original Form 365F has been filed need not be reflected on precomputed estimated landing condition, (Ref. 20).

18. ESTIMATED LANDING CG IN % MAC: (Ref. 21) The landing gross weight and index shown in reference 20 will be used to compute the cg in % MAC from the load adjuster.

19. LIMITATIONS: Fill in appropriate blocks for takeoff and landing limitations. Enter the permissable cg for takeoff and landing. Fill in the landing fuel weight.

NOTE

The forward cg limit for takeoff and landing of the airplane has been established at fifteen (15) % MAC at airplane gross weights below 105,000 pounds.

20. 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 weight 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.

3. CREW. Example to use:

Man	180 pounds
Parachute	25 pounds
Prof Equipment	40 pounds
	245 pounds per man
	x 5
	1225 (5 man crew)

4. CREW'S BAGGAGE. (If applicable) 40 pounds per man.

5. STEWARD'S EQUIPMENT (Not applicable)

6. EMERGENCY EQUIPMENT.

a. 20 Man life raft	155 pounds each
b. Gibson Girl Radio	40 pounds each
c. 1 Man life raft	20 pounds each
d. Life vest or RI suit	5 pounds each
e. Individual survival kit	40 pounds each
f. Crew survival kit	360 pounds each
g. Spare parachute	25 pounds each
h. URC-4 radio	6 pounds each

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
12 Oct. 61	KC-97G	Barksdale AFB, La.	Barksdale AFB, La
MISSION/TRIP/FLIGHT/NO.	**SERIAL NO.**	**TO**	**PILOT**
A/R Nav.	52-2645	Barksdale AFB, La.	Capt. Doe

REMARKS

Built In

Fuel	Wt.
I	18240
O	21240
C	1725
Tot	41205
RT	875
Tot	40330

REF	ITEM	WEIGHT	[1] INDEX ~~OR MOM/~~
1	BASIC AIRPLANE (*From Chart C*)	93073	770
2	OIL (164 *Gal.*)	12300	732
3	DISTRIBUTION OF LOAD		

COMPT.	CREW NO.	CREW WEIGHT	BAGGAGE	CARGO AND MISC.		
A	4	980			980	656
N	2	490			490	691
D				500	500	678
G				500	500	679

COMPUTER PLATE NO. (*If used*) E-1035

Pertinent instructions to the pilot for shifting load and crew during takeoff and landing should be noted above.

4	OPERATING WEIGHT	96773	679
5	AMMUNITION — COMPT. / ROUNDS / CALIBER		
6	BOMBS, ROCKETS, ETC. — FORWARD		
	AFT		
	EXTERNAL		
	ROCKETS		
7	FUEL — BUILT IN (*Gal.*)	40330	701
	BOMB BAY (*Gal.*)		
	EXTERNAL (*Gal.*)	7897	685
	A/R Tanks	30000	651
8	WATER INJ. FLUID (*Gal.*)		
9	JATO OR RATO		
10	TAKEOFF CONDITION (*Uncorrected*)	175000	651
11	CORRECTIONS (*If required*)	-9000	658
12	TAKEOFF CONDITION (*Corrected*)	174100	658
13	TAKEOFF C. G. IN % M. A. C. ~~GEAR~~	~~24.0~~ 24.2	
14	LESS EXPENDABLES — JATO OR RATO		
	BOMBS		
	AMMUNITION		
	FUEL	42427	649
	A/R Tanks	30000	681
15	ESTIMATED LANDING CONDITION	102573	681
16	ESTIMATED LANDING C. G. IN % M. A. C. ~~GEAR~~	20.7	

CORRECTIONS (*Ref. 11*)

COMPT.	ITEM	CHANGES (+ or −) WEIGHT	[1] INDEX ~~OR MOM/~~
	In'bd Fuel	-1200	65.2
H	Extra Equip	+ 300	65.8
	TOTAL WEIGHT REMOVED	- 1200	-
	TOTAL WEIGHT ADDED	+ 300	+
	NET DIFFERENCE (*Ref. 11*)	- 900	65.8

LIMITATIONS

[2] GROSS WT. TAKEOFF (*lb.*)	[2] GROSS WT. LANDING (*lb.*)
175000	175000

	FROM	TO (% *M. A. C.* ~~OF MAC.~~)
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/William S. Hart CMsgt, USAF

WEIGHT AND BALANCE AUTHORITY (*Signature*)

PILOT (*Signature*) /s/ Allen T. Doe, Captain, USAF

SAMPLE

DD FORM SEPT 54 365F

Figure 8-1

WEIGHT AND BALANCE CLEARANCE FORM F
TRANSPORT
(USE REVERSE FOR TACTICAL MISSIONS)

Cross Reference RAF Form 2870 RCAF Form F. 115 C 50M 5-51 (6797)

FOR USE IN T. O. 1-1B-40 & AN 01-1B-40

DATE	AIRPLANE TYPE	FROM	HOME STATION
12 Oct. 61	KC-97G	Barksdale AFB, La.	Barksdale AFB, La
MISSION/TRIP/FLIGHT/NO.	**SERIAL NO.**	**TO**	**PILOT**
X-C	52-2645	Fairchild AFB, Wash.	Capt. Doe

LIMITATIONS			
CONDITION	TAKEOFF	LANDING	LIMITING WING FUEL
[3] ALLOWABLE GROSS WEIGHT	175000	175000	
TOTAL AIRPLANE WEIGHT (*Ref. 11*)	143578		
OPERATING WEIGHT PLUS ESTIMATED LANDING FUEL WEIGHT		111578	
OPERATING WEIGHT (*Ref. 8*)			
ALLOWABLE LOAD (*Ref. 12*) (*use SMALLEST figure*)	31422	63422	
[3] PERMISSIBLE C. G. TAKEOFF	FROM 18.5	TO (% *M.A.C.*) 30.5	
[4] PERMISSIBLE C. G. LANDING	FROM 18.5	TO (% *M.A.C.*) 30.5	
[3] LANDING FUEL WEIGHT	14805		

REF	ITEM	WEIGHT	[1] INDEX
1	BASIC AIRPLANE (*From Chart C*)	93073	770
2	OIL (164 *Gal.*)	12300	732
3	CREW (*No.* 6)	1470	691
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT G	5000	692
7	EXTRA EQUIPMENT L	5000	718
8	OPERATING WEIGHT	96773	718
9	TAKEOFF FUEL (*Gal.*)	46805	734
10	WATER INJ. FLUID (*Gal.*)		
11	TOTAL AIRPLANE WEIGHT	143578	734

REMARKS

Tanks Wt. Crew Wt.
I 18240 4A 980
O 21240 2N 490
C 8200
E 0
Tot47680
RT 875
Tot46805

12 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

COMPT	UPPER COMPARTMENTS PASSENGERS NO.	UPPER COMPARTMENTS PASSENGERS WEIGHT	UPPER COMPARTMENTS CARGO	LOWER COMPARTMENTS PASSENGERS NO.	LOWER COMPARTMENTS PASSENGERS WEIGHT	LOWER COMPARTMENTS CARGO	WEIGHT	INDEX
A								
B								
C			800				8000	700
D			2600				26000	623
E			2200				22000	587
F			1800				18000	576
G	2	490	1600				20900	585
H	3	735	1300				20350	618
I			1200				12000	650
J			1400				14000	700
K			1200				12000	753
L			1500				15000	835
M								
N								
O								
P								
FWD	BELLY							
AFT	BELLY							

TOTAL FREIGHT

TOTAL MAIL

COMPUTER PLATE NUMBER (*If used*) E-1035

[1] *Enter constant used.*
[2] *Enter values from current applicable T. O.*
[3] *Applicable to gross weight (Ref. 15).*
[4] *Applicable to gross weight (Ref. 18).*
[5] *Ref. 9 minus Ref. 17.*

SAMPLE

CORRECTIONS (*Ref. 14*)			
COMPT	ITEM	CHANGES (+ or −) WEIGHT	[1] INDEX
	In'bd Fuel	- 1100	83.9
A	Crewmember	+ 245	81.9
L	Extra Equip	- 200	80.8
	TOTAL WEIGHT REMOVED	-1300	-
	TOTAL WEIGHT ADDED	+ 245	+
	NET DIFFERENCE (*Ref. 14*)	-1055	80.8

13	TAKEOFF CONDITION (*Uncorrected*)	160403	835
14	CORRECTIONS (*If required*)	- 1055	808
15	TAKEOFF CONDITION (*Corrected*)	159348	808
16	TAKEOFF C. G. IN % M. A. C.	~~27.2~~ 26.7	
17	LESS FUEL	32000	826
18	LESS AIR SUPPLY LOAD DROPPED		
19	MISC. VARIABLES		
20	ESTIMATED LANDING CONDITION	128403	826
21	ESTIMATED LANDING C. G. IN % M. A. C.	26.1	

COMPUTED BY
/s/ John C. Roe, CMsgt, USAF
SIGNATURE

WEIGHT AND BALANCE AUTHORITY
SIGNATURE

PILOT
/s/ Allen T. Doe, Captain, USAF
SIGNATURE

NOTE.—THIS TRANSPORT CLEARANCE FORM HAS RESULTED FROM TRIPARTITE AGREEMENT AND NO FURTHER CHANGES MAY BE MADE TO IT WITHOUT PRIOR CONSIDERATION BY TRIPARTITE AUTHORITIES.

DD FORM 1 SEPT 54 365F

Figure 8-2

7. 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

8. FUEL LOADING. The following fuel weights of 115/145 aviation gasoline and JP-4 jet fuel will be used when actual fuel densities are not known or available.

a. 115/145 AV/Gas at 5.85 pounds per gallon (average)

b. JP-4 at 6.4 pounds per gallon (average)

c. Example:

External Tanks (AV/Gas) 7897
External Tanks (JP-4) 8640

d. Fuel for run-up and taxi 50#/min for 15 min
25#/min thereafter
(Time dependent on local conditions)

BEFORE INTERIOR INSPECTION

1. Equipment - Stow

Stow individual equipment near position. Stow spare parachute(s) near primary bailout exit.

2. Oxygen Equipment - Check

Detailed oxygen equipment check is outlined in OXYGEN EQUIPMENT CHECK, Section IV. Check oxygen outlet at boom operator's station.

3. Crew Assembly - Complete

When the pilot directs, the crew will assemble and the Form 781 will be read and discrepancies pertaining to each crew position will be discussed with the crew member concerned. Prior to dismissing the crew, the pilot will announce a STARTING ENGINES TIME. When dismissed from crew assembly, the preflight will be started.

INTERIOR INSPECTION

(1) Cargo and Loose Equipment - Security (BO, GC)

Check cargo and loose equipment as INTERIOR INSPECTION progresses.

2. Manual Fuel-Shutoff Valve - CLOSED F

3. No. 1 and No. 2 Manual Fuel-Shutoff Valves - CLOSED G

4. Center Wing Secondary Valve - CLOSED F G 1255 ▶

5. Transfer Valves - CLOSED F G 1243 ▶ 22664

6. A/R Secondary Valves - CLOSED F G 1255 ▶

7. Leveling Valve - CLOSED

8. External Tank Manifold Transfer Valve - CLOSED G 22665 ▶

9. No. 3 Manual Fuel-Shutoff Valve - CLOSED and safetied G

10. A/R Fuel Pump Selector Valve - NORMAL

11. Boom Operator's Panel - Condition

12. Boom Hydraulic System Depressurization Valve - CLOSED

13. Boom Operator's A/R Master Switch - ON

14. Boom Hydraulic Pressure Switch - AUTO F G 1243 ▶ 22736 or ON G 22737 ▶

15. Ruddevator Control Stick - Check stowed

16. Hatches and Doors - Check

a. Tail Compartment Access Door - Check closed

b. Emergency Exit Hatches - Condition

Insure that the improved emergency exit hatch assemblies are available for the left aft and right overwing emergency exits.

c. Forward Cargo Door - Check closed and locked

Check the selector handle in the CLOSE position and the door hydraulic system pressurized.

(17) Main Fuel Manifold Lines - Condition (lower aft compartment) (BO, E)

Check with engineer to insure that the main fuel manifold is pressurized.

18. Manual Fuel Shutoff Valves - CLOSED

(19) Form 365F - Correct as necessary (BO, E)

Cross check planned Form 365F against actual airplane loading and make changes as necessary. Inform flight engineer of any weight change in planned against actual airplane loading.

PASSENGER BRIEFING

Passengers - Brief (if applicable)

If passengers or extra crew members are carried, conduct passenger briefing inside the airplane in sufficient time to complete briefing prior to engine start. The passenger briefing as indicated below will be tailored to be commensurate with the extra crew members experience.

a. Introduce yourself

State your name and crew position.

b. Parachute and spares (if applicable)

Proper fit and location of spare parachutes.

c. Safety Belts

d. Emergency exits, main compartment, escape rope, and egress technique

Show personnel location of escape rope, hatches, and egress technique for bailout, crash landing, and/or ditching.

e. Emergency alarm bell

Explain signals as applicable

f. Smoking restrictions

g. Relief facilities

h. Airplane cleanliness

STARTING ENGINES

If the airplane is NOT on ALERT status, boom operator will begin with item number eight.

(1) Ground Heating Equipment and Covers - Remove (as briefed) (All)

Each crewmember (and ground crew) will remove ground heating equipment, ducting, wing and empennage covers as briefed by pilot or as per local directives.

(2) Tail Jack Assembly - Remove and stow (BO, RO or P)

(3) Left Landing Gear Down Lock - Remove and give to pilot or copilot (P, CP, BO)

4. No. 1 and No. 2 Engine Dust Plugs - Remove and stow

5. Left Forward and Aft Chocks - Move to left wing tip after No. 3 engine has been started.

6. No. 1 and No. 2 Engines - Stand fire guard

7. Fire Bottle - Move to left wing tip

8. Aft Entry Door - Close and lock

9. A/R Master and Boom Hydraulic Pressure Switches - OFF

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.

(10) Taxi Report - Alarm bell checked, rear entry door locked, ready to taxi (BO, P)

Report after pilot sounds the alarm bell and announces over interphone, "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, rear entry door locked, and aft compartment personnel are ready to taxi. Upon receipt of this signal the navigator will also report, "Boom operator ready to taxi."

TAXI AND ENGINE RUNUP

If the airplane is on ALERT status, omit item number 2.

1. Scan - As required

Report unusual conditions observed.

(2) Run-up Report - Report "Airplane clear for run-up" (BO, P)

Report after pilot announces over interphone, "Run-up report."

3. Hatches - Installed (if applicable)

BEFORE TAKEOFF

1. Wing Flap Position - Report

2. Takeoff Report - Report "Cowl flaps set, ready for takeoff" (BO, P)

3. Safety Belt - Fastened

TAKEOFF, CLIMB, AND CRUISE

1. Scan - As required

   Report unusual conditions observed.

2. Wing Flaps - Report

   Report when flaps start up and when fully retracted.

3. Walk-around Inspection Report - Report "Walk-around inspection complete" (BO, E)

   Check main compartment, and lower compartments for fuel fumes and hydraulic leaks and close APU exhaust port as soon as practical after takeoff. Check A/R hydraulic reservoir fluid level. Inform flight engineer, "Walk-around inspection complete."

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.

4. A/R Lights - ON (if applicable)

   To insure that the A/R lights are ON, as required for air refueling, the navigator will notify the boom operator when to accomplish the following checklist. This does not restrict the use of A/R lights during night missions.

   a. Rendezvous Beacon Light Switch - ON G 3196 ▶ and F G with TCTO K231 ▶

   b. A/R Underwing Lights - ON

   c. A/R Underbody Lights - ON

AIR REFUELING

Refer to AIR REFUELING, Section IV.

DESCENT

1. 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.

2. Rendezvous Beacon Light Switch - OFF (if applicable)

3. Passengers and Cargo - Condition

BEFORE LANDING

1. Main Landing Gear - Report down

2. Wing Flaps - Report

3. Safety Belt - Fastened

AFTER LANDING AND POSTFLIGHT

If the airplane is on alert status, accomplish this checklist for TAXI BACK.

1. Urinal Tank Drain - OPEN (if applicable)

   When this checklist is used for TAXI BACK, do not open urinal tank drain.

2. Scan - As required

   Report unusual conditions observed.

3. A/R Hydraulic System - Depressurized (if applicable)

4. Ground Locks - Check installed

   If the airplane is placed in ALERT STATUS, the ground locks will be installed.

BOOM OPERATOR'S EMERGENCY PROCEDURES

Refer to BOOM OPERATOR'S EMERGENCY PROCEDURES in Section III and T.O. 1C-97(K)F-(CL)1-4.

BOOM OPERATOR'S ALERT PROCEDURES

Refer to Section II for the scope of the Alert Procedures.

AIRPLANE ACCEPTANCE

After maintenance has declared airplane ready for alert, the boom operator performs his preflight up to and including TAXI AND ENGINE RUN-UP checklist. After ENGINE RUN-UP is complete, accomplish the normal AFTER LANDING AND POST FLIGHT checklist. When an alert signal is sounded, the crew begins with the STARTING ENGINES checklist.

COCKING

Upon completion of the boom operator's INTERIOR INSPECTION checklist, the boom operator's cocking duties have been accomplished.

SCRAMBLE

When an alert signal is sounded, the boom operator begins with the STARTING ENGINES checklist and accomplishes checklists in normal sequence, except omit item number 2 of TAXI AND ENGINE RUN-UP checklist.

UNCOCKING

No items are required for the boom operator.

DAILY PREFLIGHT

While the airplane is in the alert status, accomplish the INTERIOR INSPECTION checklist. When a new alert crew takes over an airplane already in the alert status, the boom operator will accomplish the INTERIOR INSPECTION checklist before accepting the airplane.

TAXI BACK

Accomplish normal AFTER LANDING AND POST-FLIGHT checklist.

NOTE

The boom operator's alert procedures also appear in T.O. 1C-97(K)F-(CL)1-4, which is a condensed checklist. The condensed checklist has each numbered step (and some sub-steps) of the normal, air refueling, alert, and emergency procedures.

BOOM OPERATOR'S DEFCON ONE AND MINIMUM REACTION POSTURE CHECKLIST

COCKING (DEFCON ONE)

If one or more engines have been started, accomplish the following checklist to assume DEFCON ONE Posture.

1. Boom Operator's A/R Master Switch - ON
2. Boom Hydraulic Pressure Switch - AUTO

   F G 1243 ▶ or ON G 22737 ▶

3. Report to Pilot - Report "Cocking checklist complete" (BO, P)

COCKING (MINIMUM REACTION POSTURE)

For COCKING (MINIMUM REACTION POSTURE) complete the COCKING (DEFCON ONE) checklist.

SCRAMBLE (MINIMUM REACTION POSTURE)

1. Hatches - Installed (if applicable)
2. A/R Master Switch and Boom Hydraulic Pressure Switches - OFF
3. Wing Flap Position - Report
4. Takeoff Report - Report "Cowl flaps set, ready for takeoff" (BO, P)
5. Safety Belt - Fastened

JUMPMASTER

The pilot will assign one crew member to act as the jumpmaster. Normally this will be the boom operator. The jumpmaster will be responsible for the proper execution of the bailout procedure and will be on interphone during the bailout alert. Prior to bailing out, the jumpmaster will notify the pilot that all other occupants have departed and that he is leaving the airplane.

RADIO OPERATOR

The radio operator must be proficient in the utilization of all radio equipment installed in the airplane and, in addition, be current in the use of CW and voice procedures. He must be thoroughly familiar with emergency procedures as they pertain to his duties as radio operator.

MISSION PLANNING

1. Communications Requirements - Complete

   Coordinate with pilot for desired frequencies to be set during preflight. Complete requirements for briefed routes to be flown. Coordinate with crew members, as required, for reporting points, crystal and frequency requirements, alternate and emergency airfields, etc.

2. Applicable Pilot's Manuals - Current and complete

   Check applicable pilot's manuals (Enroute Charts, Enroute Supplements, Terminal Charts) for current and complete contents. Correct publications as required.

3. Communications Kit - Complete

   Communication flimsy, forms, radio logs, frequency cards, crystals and tool kit (where applicable). ACP's (125 USAF-1, 131, 135).

BEFORE INTERIOR INSPECTION

1. Publications and Equipment - Stow

   Prior to crew assembly, stow pilot's manuals and communications publications in the control cabin. Stow personal and professional equipment at the radio or scanning position as applicable.

2. Oxygen Equipment - Check and stow

   See Section IV for oxygen equipment check procedures. On airplanes G 3178 ▶ the copilot's oxygen

bottle will be primary oxygen supply for the radio operator. The portable bottle may be stowed at the scanning position for emergency use.

3. Crew Assembly - Complete

Crew will assemble when pilot directs. Pilot reads Form 781 and discusses discrepancies with crew members concerned. Pilot announces a STARTING ENGINES TIME. When dismissed from crew assembly, the preflight will be started.

INTERIOR INSPECTION

1. VHF Channelization - Set as required

Check for proper crystals and thumb wheel settings

2. UHF Channelization - Set as required F G less TCTO 600

3. Radio Operator's Interphone - Check

4. UHF LOCAL/REMOTE Switch - REMOTE F G less TCTO 600

5. Liaison Receiver (BC-348) F and G 17260▶3278 less TCTO KG206, TCTO K572

a. Function Switches - Check

Turn on equipment (power switch to MVC). Check volume control, CW OSC switch, beat frequency knob, crystal filter switch, dial lights, and antenna alignment knob.

b. Reception - Check all bands

c. Time Signal - Tune

If accurate time hack was not available at crew inspection, tune time signal and leave on for navigator's time hack.

6. Radio Compass

a. Alignment - Check

Check alignment against a known and identified stations signal.

b. Function Switch - LOOP, check nulls

Check operation of loop left-right switch, and check nulls with VOICE-CW switch in CW position.

c. Function Switch - COMP, check ADF

Check the No. 1 bearing indicator for proper homing. Leave tuned to desired station.

7. VOR

a. Instrument Select Switch - VOR-ILS TCTO 572

b. Local Station - Tune

c. No. 2 Bearing Indicator - Check for homing

d. TO/FROM Flags - Check

Set the reading indicated by the pointer of the No. 2 bearing indicator into the course set window. Check the course deviation indicator on the pilot's course indicator for centering and the TO/FROM window for a TO indication. Set the reciprocal reading indicated by the No. 2 bearing indicator into the course set window. Check the course deviation indicator on the pilot's course indicator for centering and the TO/FROM window for FROM indication. Leave tuned to desired station.

8. TACAN TCTO 572

a. Instrument Select Switch - TACAN

b. Desired Station - Tune

c. No. 1 Bearing Indicator - Check for homing

d. Range Indicator - Check

e. Pilot's Course Indicator - Check

f. Instrument Select Switch - VOR-ILS

Place the instrument select switch to TACAN. Tune in station by selecting the proper channel on TACAN control panel. Check the No. 1 bearing indicator on the pilot's TACAN/VOR RMI for proper homing. Place the function selector switch to T/R and check the range indicator. Check course deviation indicator and TO/FROM flags on pilot's course indicator. Return the instrument select switch to VOR-ILS. Leave tuned to desired station.

9. VHF Radio - Check

Check operation of transmitter, receiver, and D/F tone. Leave tuned to desired frequency.

10. UHF Radio - Check

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

NOTE

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

11. Liaison Radio (ARC-21) G less 1-1-666, (ARC-65) G plus 1-1-666

a. Channelization Card - Check (as required)

Channelization cards should be checked against required frequencies as outlined by current directives. Any rechannelization required for the mission should be made as time permits after takeoff.

b. Operation - Check (as required)

Operational checks will only be made when the equipment is required for the mission or as required by current directives.

c. Liaison Radio - OFF

12. MF Command Transmitter (ART-13) F, G less TCTO K572

a. Channelization Card - Check (as required)

Channelization cards should be checked against required frequencies as outlined by current directives. Any rechannelization required for the mission should be made as time permits after takeoff.

b. Operation - Check (as required)

Operational checks will only be made when the equipment is required for the mission or as required by current directives.

STARTING ENGINES

NOTE

- Normally personal equipment will be donned prior to initiating this checklist; however; during ALERT PROCEDURES, if time does not permit, the takeoff may be made without wearing the applicable emergency equipment.
- For airplanes NOT on alert, the radio operator will start with item five.

(1.) Ground Heating Equipment and Covers - Remove (as briefed) (All)

(2.) Tail Jack - Remove and stow (RO, BO)

Assist boom operator in removing and stowing tail jack.

(3.) External Power Unit - Remove (if applicable) (RO, GC)

Assist ground crew in removing external power unit.

4. Enter Airplane - Aft entry door

5. Radio - Monitor as briefed

Monitor as briefed, initiate radio log, and have classified material ready for use.

6. Engine Start - Scan (if applicable)

Report unusual conditions observed.

TAXI AND ENGINE RUN-UP

1. Scan - As required

Report unusual conditions observed.

BEFORE TAKEOFF

1. Wing Flap Position - Report

(2.) Cowl Flaps - Scan and report (RO, BO)

Scan cowl flaps and report to BO "Cowl flaps set."

3. Safety Belt - Fasten

(4.) Takeoff Report - Report "Radio operator ready for takeoff" (RO, P)

TAKEOFF, CLIMB, AND CRUISE

1. Scan - As required

Report unusual conditions observed.

2. Wing Flaps - Report (RO or BO)

Report when flaps start up and when fully retracted.

INFLIGHT PROCEDURES

During flight, perform all duties as briefed to complete the mission. Perform inflight maintenance, if possible, to maintain communications. Utilize the inflight checklists as a guide, depending on the mission briefing requirements and operating limitations.

1. Radio Log - Initiate and maintain (if directed)

Log will contain pertinent information concerning the flight.

2. Radios - Monitor as briefed

Monitor assigned frequencies at required times.

3. HF Reports - As briefed

When HF reporting is directed at briefing, procedures to be used will be as outlined in current directives and publications. Strict radio communications security will be adhered to when HF communications procedures are not covered at briefing, or radio silence is directed.

4. Time Hacks - As required

5. Emergency Communications - Transmit as pilot directs

When circumstances require emergency transmis-

sion, the pilot will authorize the type message required. Format and procedures will be as outlined in current publications and directives.

AIR REFUELING

Refer to AIR REFUELING, Section IV.

DESCENT

1. Radio Equipment - Off

   Turn equipment off at radio position when not required for approach or landing communications.

2. Off Watch - Logged

   Sign off watch if not required to operate radio for approach or landing, complete log and forms.

BEFORE LANDING

1. Landing Gear - Report (RO or BO)
2. Wing Flaps - Report (RO or BO)
3. Safety Belt - Fasten

AFTER LANDING AND POSTFLIGHT

1. Scan - As required

   Report unusual conditions observed

2. Portable Oxygen Bottle - Stow

   If portable oxygen bottle has been placed at scanner's position for convenience, stow in proper position.

3. Classified Material - Account for

   Insure classified material is accounted for and given to crew member that signed for material.

4. Form 781 - Complete

   Insure all communication discrepancies noted during preflight and the mission are correctly entered in Form 781.

NOTE

The radio operator's normal procedures also appear in T.O. 1C-97(K)F-(CL)1-5, which is a condensed checklist. The condensed checklist has each numbered step (and some substeps) of the normal, air refueling, alert, and emergency procedures.

RADIO OPERATOR'S EMERGENCY PROCEDURES

Refer to RADIO OPERATOR'S EMERGENCY PROCEDURES in Section III and T.O. 1C-97(K)F-(CL)1-5.

RADIO OPERATOR'S ALERT PROCEDURES

For overall alert concept, refer to ALERT PROCEDURES in Section II.

AIRPLANE ACCEPTANCE

Accomplish INTERIOR INSPECTION as set forth in the normal procedures.

COCKING

No items are required for the radio operator.

SCRAMBLE

Accomplish normal procedures in sequence beginning with the STARTING ENGINES checklist.

DAILY PREFLIGHT

While the airplane is in alert status, accomplish a daily preflight using this checklist. When checking the radios, only a check on the operational frequency is required.

1. Power Clearance - Receive from engineer (RO, E)
2. Radio Compass:
   a. Desired Station - Tune
   b. Function Switch - LOOP, check nulls
   c. Function Switch - COMP, check ADF
3. VOR:
   a. Desired Station - Tune
   b. No. 2 Bearing Indicator - Check for homing
   c. TO/FROM Flag - Check
4. TACAN:
   a. Instrument Select Switch - TACAN
   b. Desired Station - Tune
   c. No. 1 Bearing Indicator - Check for homing

d. Range Indicator - Check

e. Pilot's Course Indicator - Check

f. Instrument Select Switch - VOR-ILS

5. VHF Radio - Check

6. UHF Radio - Check

NOTE

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

7. AN/ARC-8 Radio - Check (as required)

Check ART-13 transmitter and BC-348 receiver if required by current directives or for the mission.

UNCOCKING

No items are required for the radio operator.

TAXI BACK

Accomplish normal AFTER LANDING AND POST-FLIGHT checklist.

NOTE

The radio operator's alert procedures also appear in T.O. 1C-97(K)F-(CL)1-5, which is a condensed checklist. The condensed checklist has each numbered step (and some substeps) of the normal, air refueling, alert, and emergency procedures.

RADIO OPERATOR'S DEFCON ONE MINIMUM REACTION POSTURE

Use normal checklist.

RULES TO BE ENFORCED

SMOKING

A. No smoking during ground operation, takeoffs, or landings.

B. No smoking during air refueling.

C. No smoking at any time when fuel fumes are detected.

D. Smoking in main compartments.

1. No smoking will be permitted in the main compartment during unpressurized flight or when fuel is carried in the air refueling tanks.

2. Smoking may be permitted in the main compartment during pressurized flight, and when no fuel is carried in the air refueling tanks.

CAUTION

Never attempt to throw lighted materials from the airplane.

PARACHUTES

A. All personnel aboard will wear a parachute or parachute harness at all times from takeoff to landing, except when removal for the accomplishment of certain duties is required.

B. One additional parachute or 10 percent of the required number of parachutes (whichever is greater) 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 personally ordered to do so by the pilot, and then only by the aft entry door.

USE OF OXYGEN AND PRESSURIZATION

A. Oxygen masks will be carried by crew members on all flights, regardless of altitude or duration of mission.

B. The copilot will initiate complete crew checks at appropriate time intervals when cabin altitudes are as shown in the table below:

Below 10,000 ft.	- every hour
10,000 to 20,000 ft.	- every 15 minutes
20,000 to 25,000 ft.	- every 10 minutes
25,000 ft and above	- every 5 minutes

NOTE

Above 25,000 feet, crew members will make continuous visual checks of personnel in their compartment to augment the above checks by the copilot.

C. The general rules on use of oxygen masks as prescribed by current directives will apply.

INTERPHONE

A. All crew members will wear headsets during the following conditions:

1. All ground operations (including engine starts) except when removal is required to accomplish certain duties
2. During rendezvous and air refueling
3. During flight under weather conditions
4. Formation flying
5. During all takeoffs and landings

B. Interphone calls will be made by identifying the crew position being called and the crew position from which the call is originated. All crew members 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 listed under paragraph A above. Crew members will monitor interphone at all times except as follows:

1. When crew duties necessitate leaving interphone
2. At least one pilot will monitor interphone during climb, cruise, and descent

SAFETY BELTS

All crew members and/or 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 crew member is performing duties in a lower compartment.

CONTROLS AND SWITCHES

All crew members will visually check switches and controls before actuation.

NOTE: Page 8-25 may be cut out and removed from this manual.

EXTERIOR LIGHTING DURING A/R

ITEM	DURING RENDEZVOUS	DURING CONTACT
Navigation Lights	Bright Flashing (N)	Dim Steady (N)
Anti-Collision Lights TCTO 591	Both On (N) (D)	Top On (D) (N) Bottom Off (D) (N)
Wing Illumination Lights	On (N) Off (D)	On (N) Off (D)
Under Body Light	Bright (N) Off (D)	Bright (N) Off (D)
Under Wing Lights	Bright (N) Off (D)	Bright (N) Off (D)
Boom Marking Lights	Off (D) (N)	Upper Set On (B) B-47 (N) Lower Set On (B) B-52 (N)
Receiver Director Lights	Off (D) (N)	Sta. 750 Set On (B) (N) Full Intensity (D) Sta. 350 Set to Full Intensity (D) (N) TCTO K526
Boom Nozzle Lights	Off (D) (N)	Lower Set On (B) (N)
Interior Lights	Optional	No Bright Lights (N)
Rendezvous Beacon Light G 3196 plus TCTO K231	On (D) (N)	Off (D) (N)

(B) Position is the first letter in the word BRIGHT located above each rheostat on the boom operator's panel

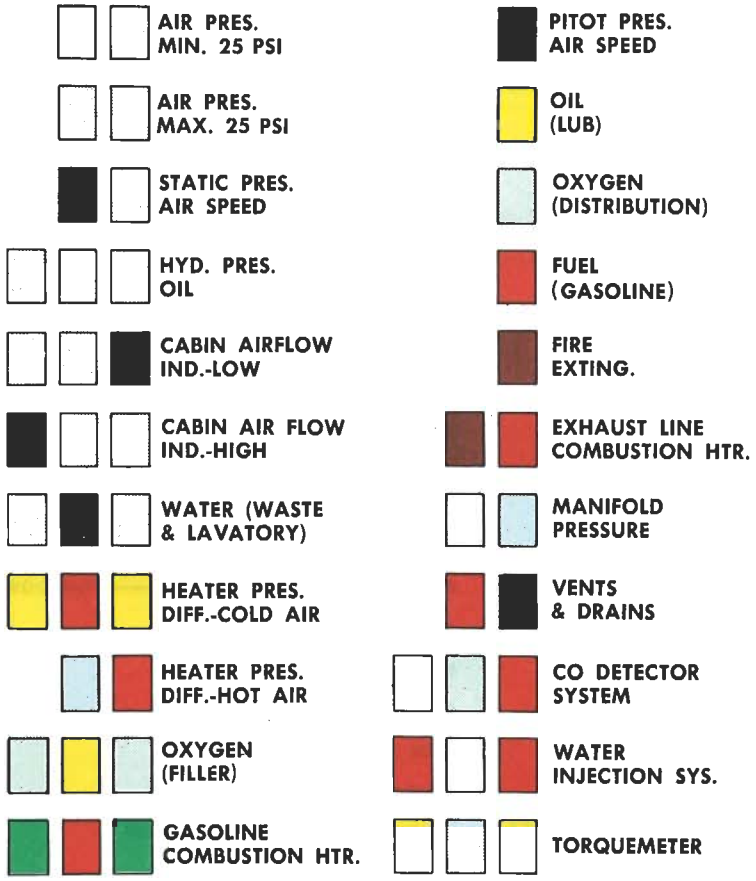
(D) Day (N) Night

T.O. 1C-97(K)F-1
15 October 1961

CUT ON DOTTED LINE

COLOR CODING

TUBING CODE KC-97F AND KC-97G SERIES AIRPLANES



CUT ON DOTTED LINE

CONTROL CABLE CODE

APPLICABLE TO ALL C/KC-97 SERIES AIRPLANES

COLOR CODE	LETTER CODE	CONTROL & FUNCTION
	AA	AILERON — { R. AILERON UP / L. AILERON DOWN
	AB AS	AILERON AIL. SERVO — { L. AILERON UP / R. AILERON DOWN
	ATA	AILERON TRIM TAB — { R. TAB DOWN / L. TAB UP
	ATB	AILERON TRIM TAB — { R. TAP UP / L. TAB DOWN
	RA RSA	RUDDER RUDDER SERVO } — RUDDER LEFT
	RB RSB	RUDDER RUDDER SERVO } — RUDDER RIGHT
	RTA	RUDDER TRIM — TRIM LEFT
	RTB	RUDDER TRIM — TRIM RIGHT
	EA ESA	ELEVATOR ELEV. SERVO } — ELEV. DOWN
	EB ESB	ELEVATOR ELEV. SERVO } — ELEV. UP
	ETA	ELEVATOR TRIM TAB — TAB UP
	ETB	ELEVATOR TRIM TAB — TAB DOWN
	ETFA	ELEVATOR TAB-FLAP OPERATED — TAB UP
	ETFB	ELEVATOR TAB-FLAP OPERATED — TAB DOWN
	SLA	SURFACE LOCK — LOCK
	SLB	SURFACE LOCK — UNLOCK
	SED	SERVO EMERGENCY DISCONNECT
	NWSA	NOSE WHEEL
	NWSB	NOSE WHEEL
	M1A M2A M3A M4A	MIXTURE — FUEL CUT OFF
	M1B M2B M3B M4B	MIXTURE — RICH
	T1A T2A T3A T4A	THROTTLE — CLOSE
	T1B T2B T3B T4B	THROTTLE — OPEN

CUT FROM OTHER SIDE

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 lift nose until the miniature airplane on attitude indicator is approximately two bar widths above horizon. Allow airplane to leave runway and establish and maintain initial climb in this attitude. Retract gear as soon as airplane is definitely airborne as indicated by an increase in altitude on altimeter and vertical velocity indicator.

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 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 whenever possible, to relieve pilot fatigue.

DESCENT

Descents can be made straight ahead up to the limiting airspeed; limit maximum banks to 30 degrees.

NOTE

At IAS over 220 knots, it is recommended that banks be limited to 15 degrees to provide a safe margin above buffeting range.

Normally descents should be made with the airplane clean, however, the airplane is completely controllable in a maximum rate descent with gear and flaps extended.

CAUTION

Descents with gear or wing flaps extended under icing conditions should not be made when avoidable.

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

Instrument approaches are easily performed and the flight characteristics during range letdown, ILS, and radar approaches are satisfactory.

NOTE

In cases where a circling approach is required by the instrument approach chart being used, maintain pattern airspeed (148 knots normal) until final approach to the runway is initiated.

INSTRUMENT APPROACH — 4 ENGINES

1. Complete the DESCENT checklist prior to reaching initial station.
2. Start the BEFORE LANDING checklist after initial station passage. Maintain 148 knots IAS.
3. After completing procedure turn inbound to low station, slow airplane to 130 knots IAS.
4. Make final flap setting when visual contact with runway is established.

INSTRUMENT APPROACH — LESS THAN 4 ENGINES

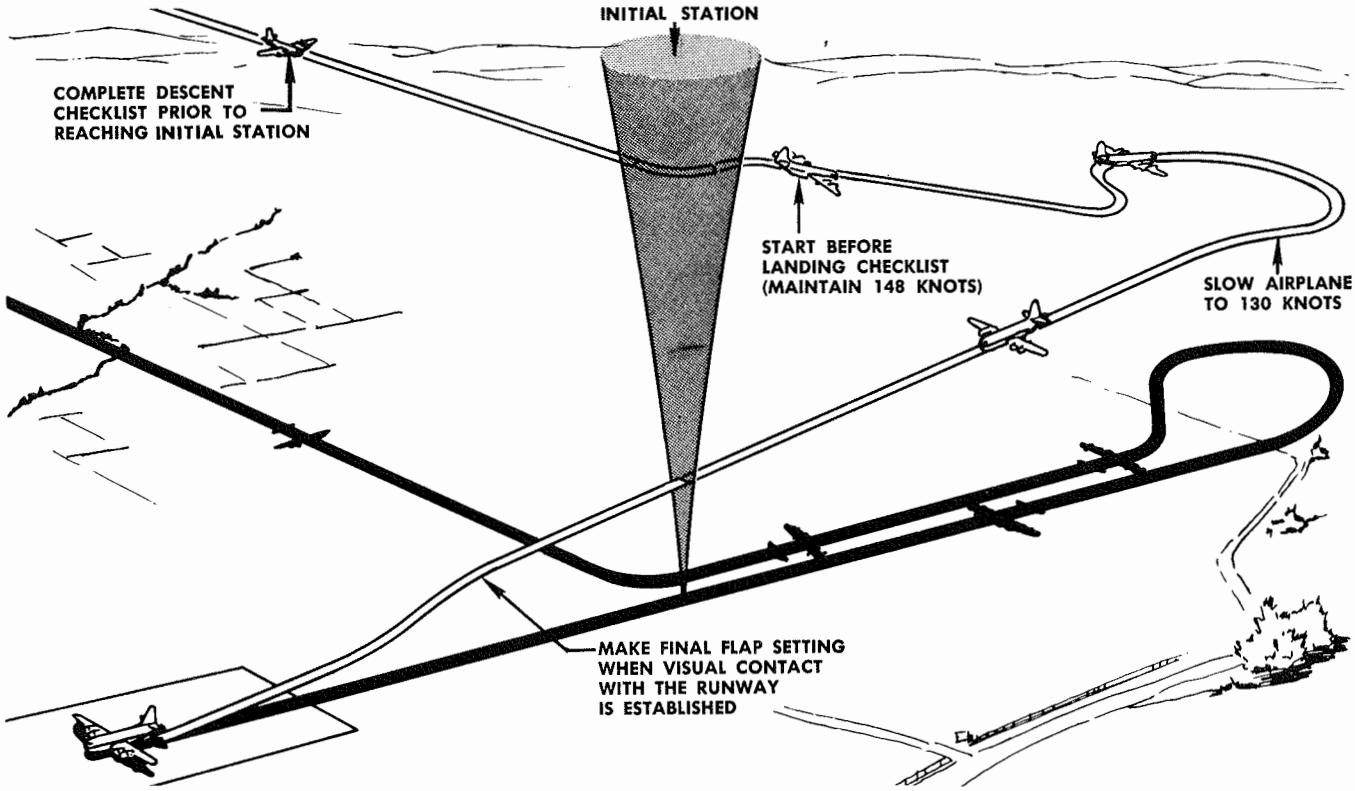
1. Complete the DESCENT checklist prior to reaching initial station.
2. Start the BEFORE LANDING checklist (except for landing gear) after initial station passage. Use 2550 or 2700 rpm if required. Flaps as required to maintain 148 knots IAS.
3. After completing procedure turn inbound to low station, slow airplane to 130 knots IAS. If operating conditions are critical, gear may be held up at pilot's discretion.
4. Make final flap setting when visual contact with the runway is established.

RADAR APPROACH — 4 ENGINES

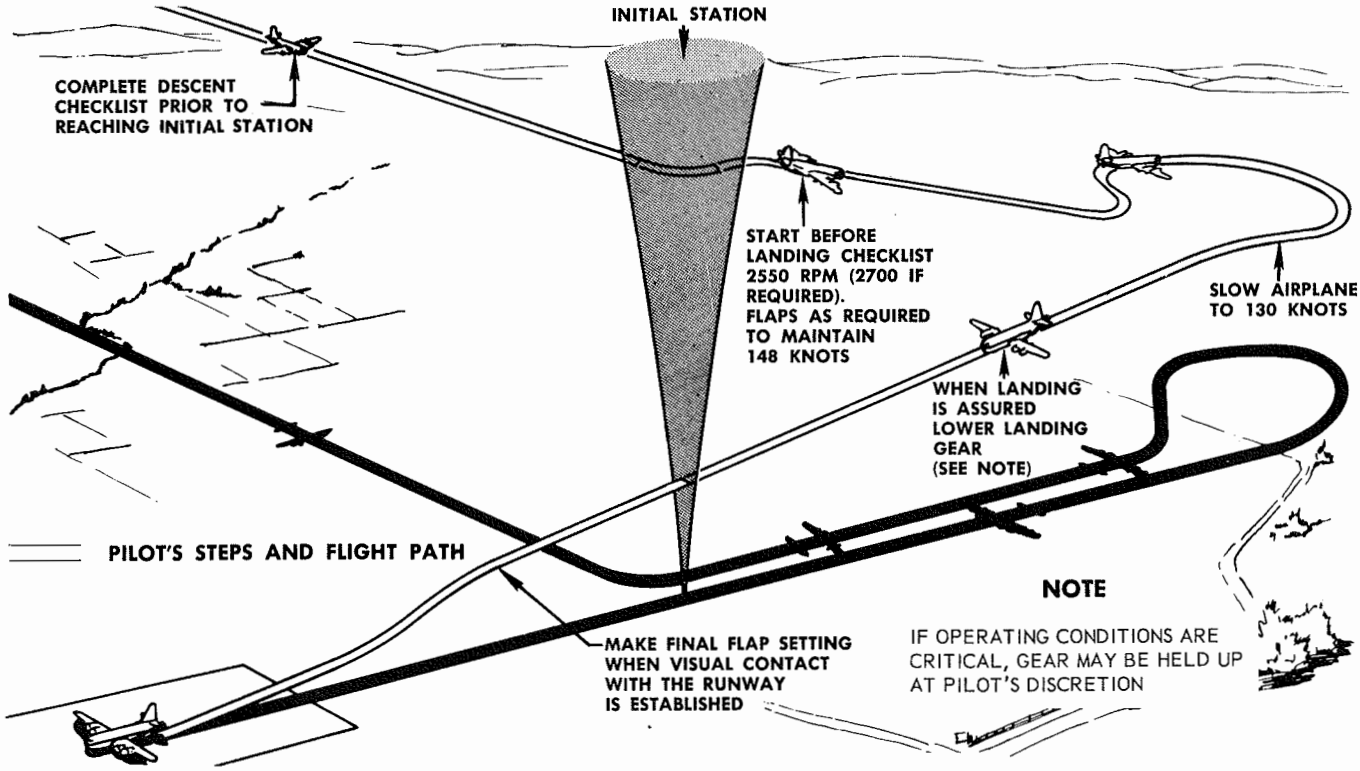
1. Complete the DESCENT checklist prior to reaching designated radio fix.
2. Start the BEFORE LANDING checklist after passing radio fix.
3. After turning final approach, slow airplane to 130 knots IAS. Maintain rate of descent as required by radar controller.
4. Make final flap setting when visual contact with the runway is established.

RADAR APPROACH — LESS THAN 4 ENGINES

1. Complete the DESCENT checklist prior to reaching the designated radio fix.
2. Start the BEFORE LANDING checklist (except for gear) after passing the radio fix. Use 2550 or 2700 rpm if required. Flaps as required to maintain 148 knots IAS.

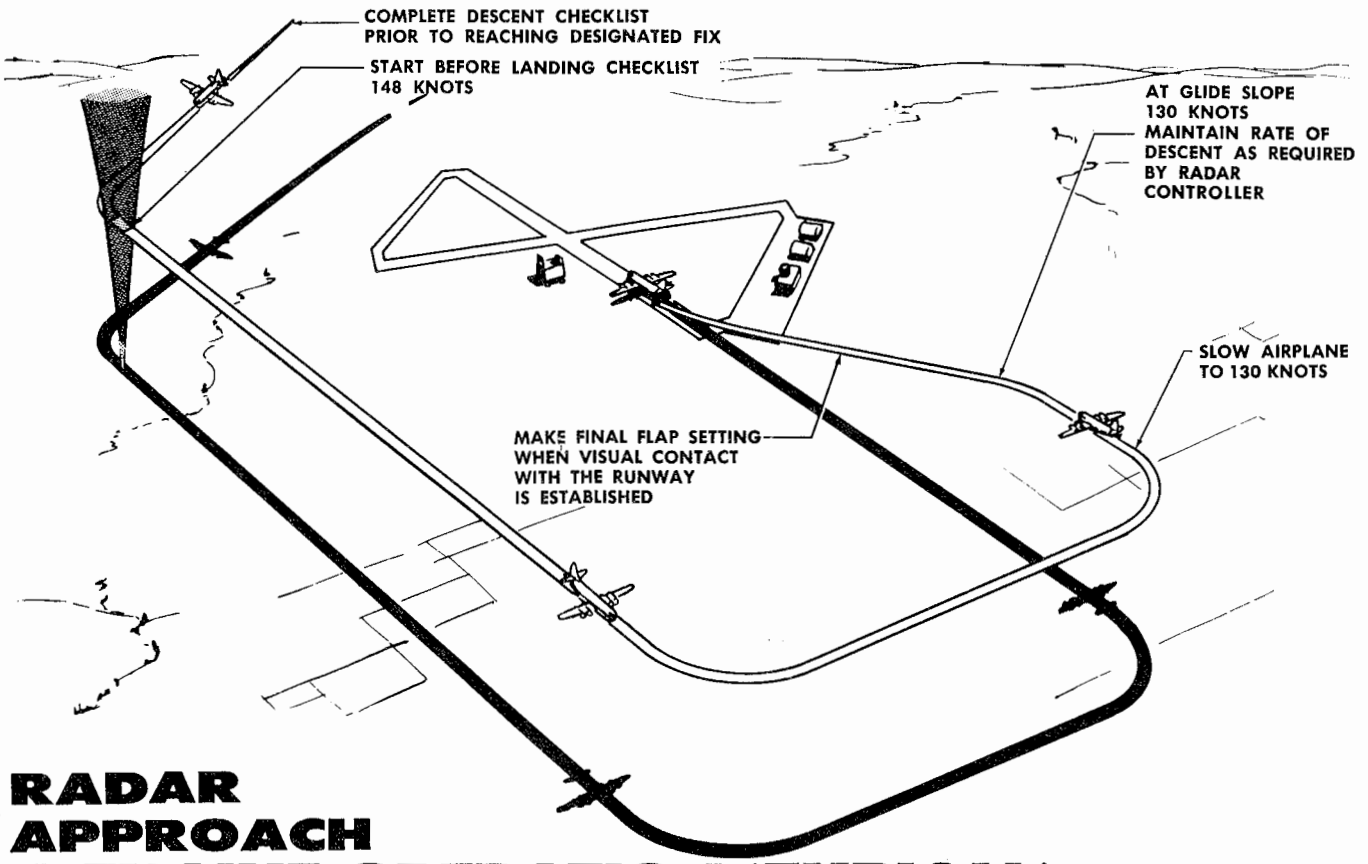


INSTRUMENT ADF AND VOR APPROACH— 4-ENGINE OPERATION (TYPICAL)

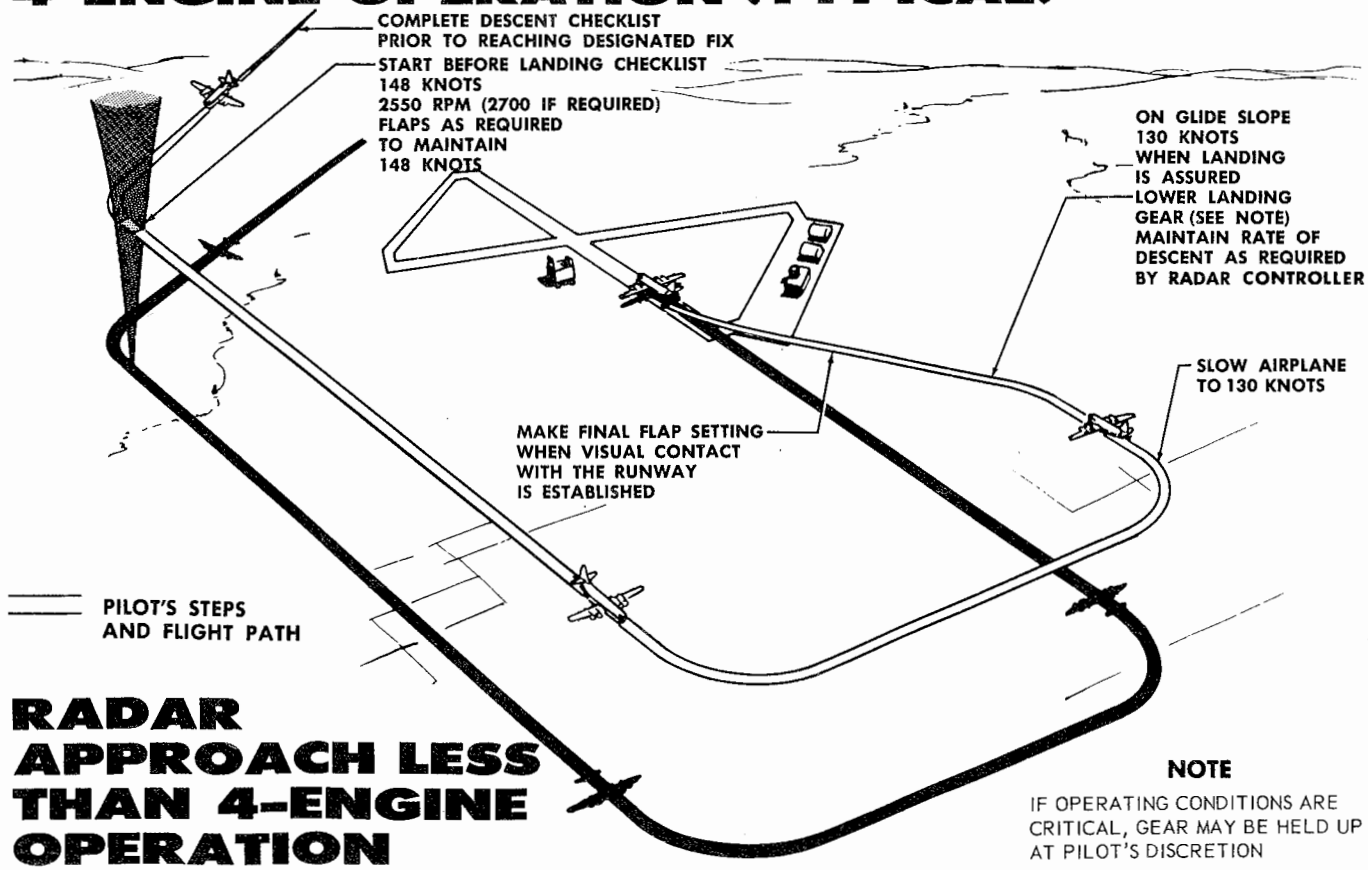


INSTRUMENT ADF AND VOR APPROACH— LESS THAN 4-ENGINE OPERATION (TYPICAL)

Figure 9-1



RADAR APPROACH 4-ENGINE OPERATION (TYPICAL)

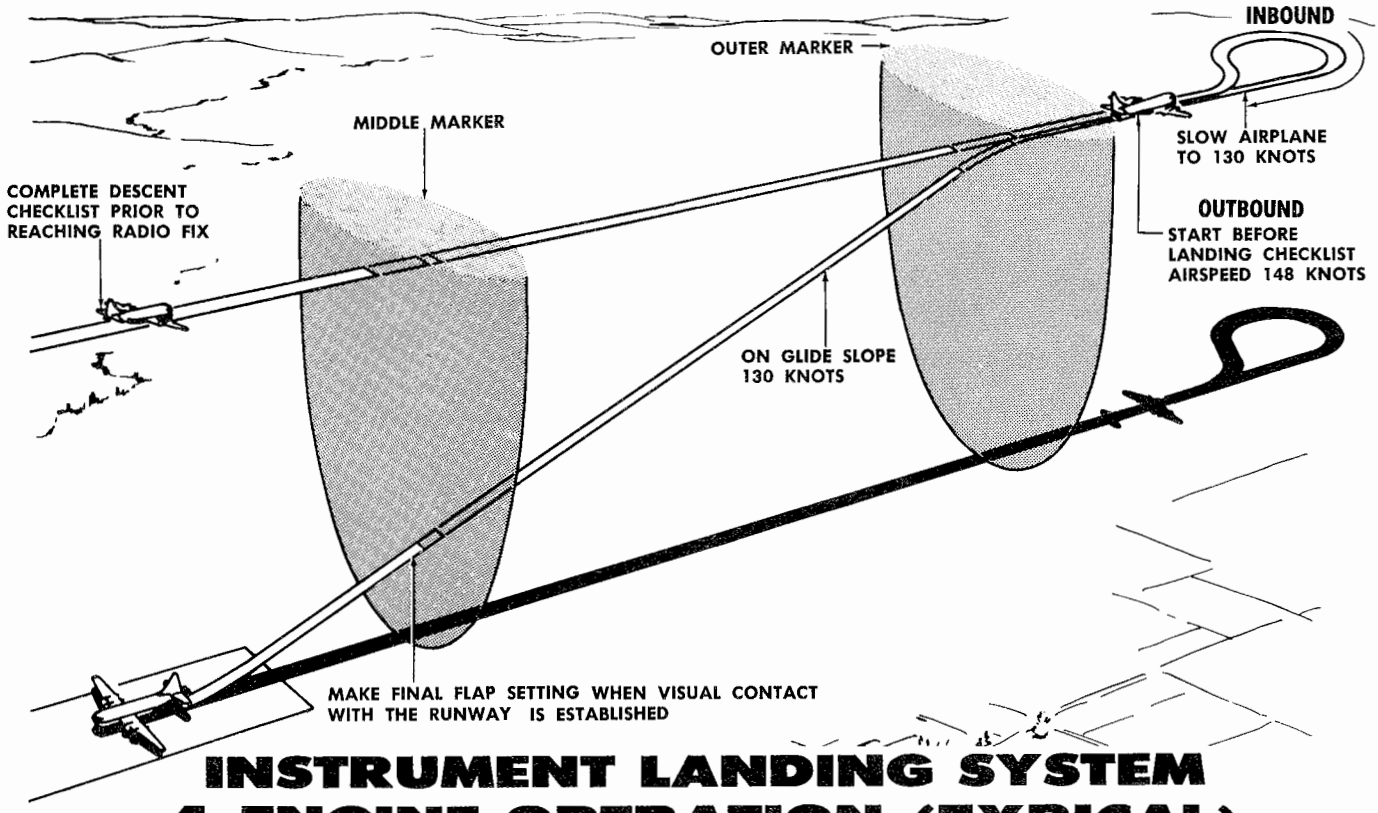


RADAR APPROACH LESS THAN 4-ENGINE OPERATION (TYPICAL)

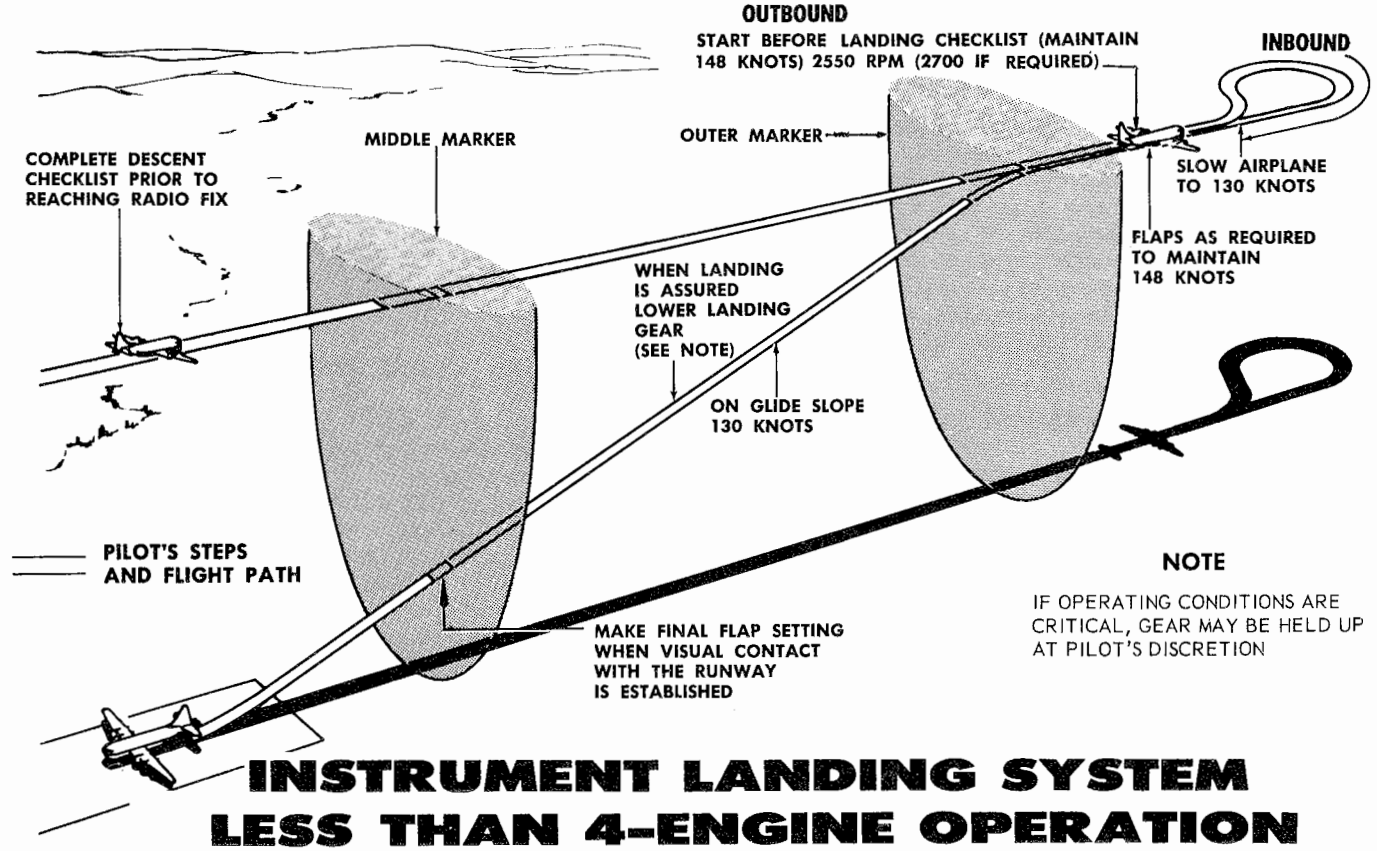
NOTE

IF OPERATING CONDITIONS ARE CRITICAL, GEAR MAY BE HELD UP AT PILOT'S DISCRETION

Figure 9-2



INSTRUMENT LANDING SYSTEM 4-ENGINE OPERATION (TYPICAL)



INSTRUMENT LANDING SYSTEM LESS THAN 4-ENGINE OPERATION (TYPICAL)

Figure 9-3

3. After turning final approach, slow airplane to 130 knots IAS. If operating conditions are critical, gear may be held up at pilot's discretion. Maintain rate of descent as required by radar controller.

4. Make final flap setting when visual contact with the runway is established.

ILS — 4 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 airspeed 148 knots IAS.

3. After completing procedure turn inbound, slow airplane to 130 knots IAS.

4. Make final flap setting when visual contact with the runway is established.

ILS — LESS THAN 4 ENGINES

1. Complete the DESCENT checklist prior to reaching the radio fix.

2. Start the BEFORE LANDING checklist (except for gear) after passing the outer marker outbound. 2550 rpm or 2700 if required. Flaps as required to maintain 148 knots IAS.

3. After completing procedure turn inbound, slow airplane to 130 knots IAS. If operating conditions are critical, gear may be held up at pilots' discretion.

4. Make final flap setting when visual contact with the runway 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.

ICE AND RAIN

TAKEOFF WITH ICE AND SNOW ON WINGS

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.

ICING DURING FLIGHT

Rime and clear icing can be expected at any and all altitudes. Ice will normally adhere to the windshield, leading edge of wings, empennage and props. Control while on instruments becomes very sluggish when heavy icing accumulates on the airplane. Normally, airspeed cannot be regained with power as long as heavy ice formations remain on the airplane. Therefore, it is necessary to lose altitude to regain airspeed lost. If the above condition exists, be sure to use additional speed during approach and low altitude flight because of the added weight and change in air flow over the wings. If severe icing is suspected, proceed as follows:

1. If at all possible, avoid areas of heavy or extended icing.

2. Have all items of anti-icing and deicing equipment operating prior to entering icing area.

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 by-passing 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

See CARBURETOR ICING, Section VII.

PROP DEICING

When prop icing conditions are suspected, place the prop deice switch in the ON position to energize the circuit. Prop deicing will be indicated by the prop deicing indicators and by the loadmeter flicking as the timer selects each prop. Should it become apparent that one or more props are not properly deicing check the circuit breakers.

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.

FLIGHT IN TURBULENCE AND THUNDERSTORMS

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. Flight through a thunderstorm should be avoided if possible. However, since circumstances may force you at some time to enter a zone of severe turbulence, you 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. 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 is 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 figure 6-1 and figure 9-4.) Specific instructions for preparing to enter the storm and for flying in it are given in the following paragraphs.

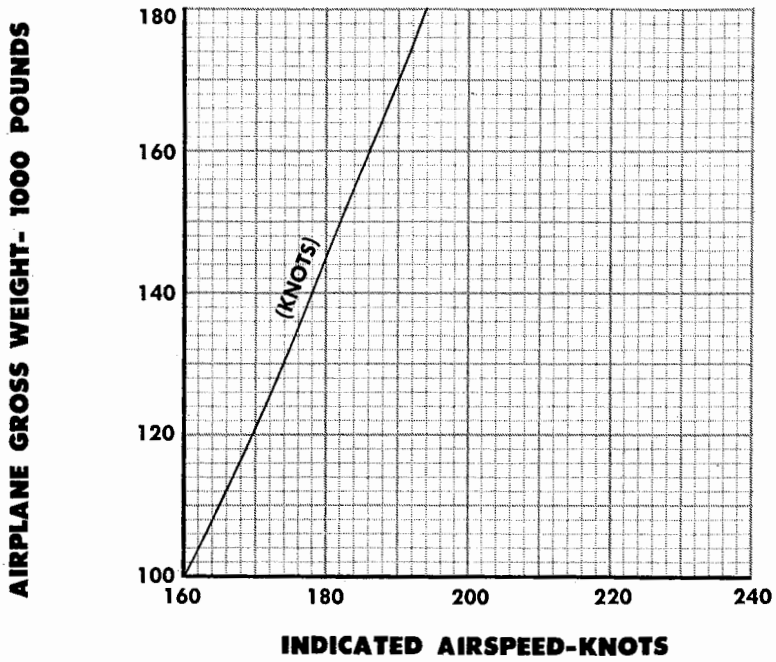
WARNING

Serious damage to the aircraft can result, due to hail and/or turbulence, during flights in known thunderstorm activity. Thunderstorms should be avoided or circumvented if at all possible. However, if thunderstorm penetration must be made then the above suggested penetration altitude (6000 feet or below) should be adhered to.

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 airplane's 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. Disengage autopilot, trim airplane.
2. Mixture levers AUTO RICH.
3. Master propeller synchronizer lever 2400 rpm for gyroscopic stability.
4. Pitot heater and surface anti-icing switches ON.



TURBULENT AIR PENETRATION SPEEDS

Figure 9-4

5. Carburetor heat - as required.

6. Throttles adjusted as necessary to obtain penetration speed.

7. Check gyro instruments for proper settings.

8. Safety belt tightened (Check with crew members).

9. Turn off any radio equipment rendered useless by static.

10. Turn cockpit lights full bright to minimize effect of lightning.

CAUTION

Do not lower 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 your 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 your 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 prop 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 except the VHF be turned off to prevent a discharge through the 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 whenever the angle of bank exceeds 30 degrees, 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 -26°C (-15°F) for a layover or turnaround period of four to six hours. To preheat the engines using the APU, proceed as follows:

1. Obtain preheat equipment from the storage space in the rear of the airplane.

Check against following list:

a. Two 9-inch hoses for each wing (total, four).
b. Four 6-inch hoses for each wing (total, eight).
c. Air flow divider (octopus), one for each wing.
d. Ram-air duct hose 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 hose to plug. Attach other end of hose to blower outlet.

4. Attach second 9-inch hose to heater outlet. Attach other end of this hose to large opening of octopus.

5. Attach four 6-inch hoses to smaller openings of each octopus.

6. Install nose plugs or nacelle covers on engines.

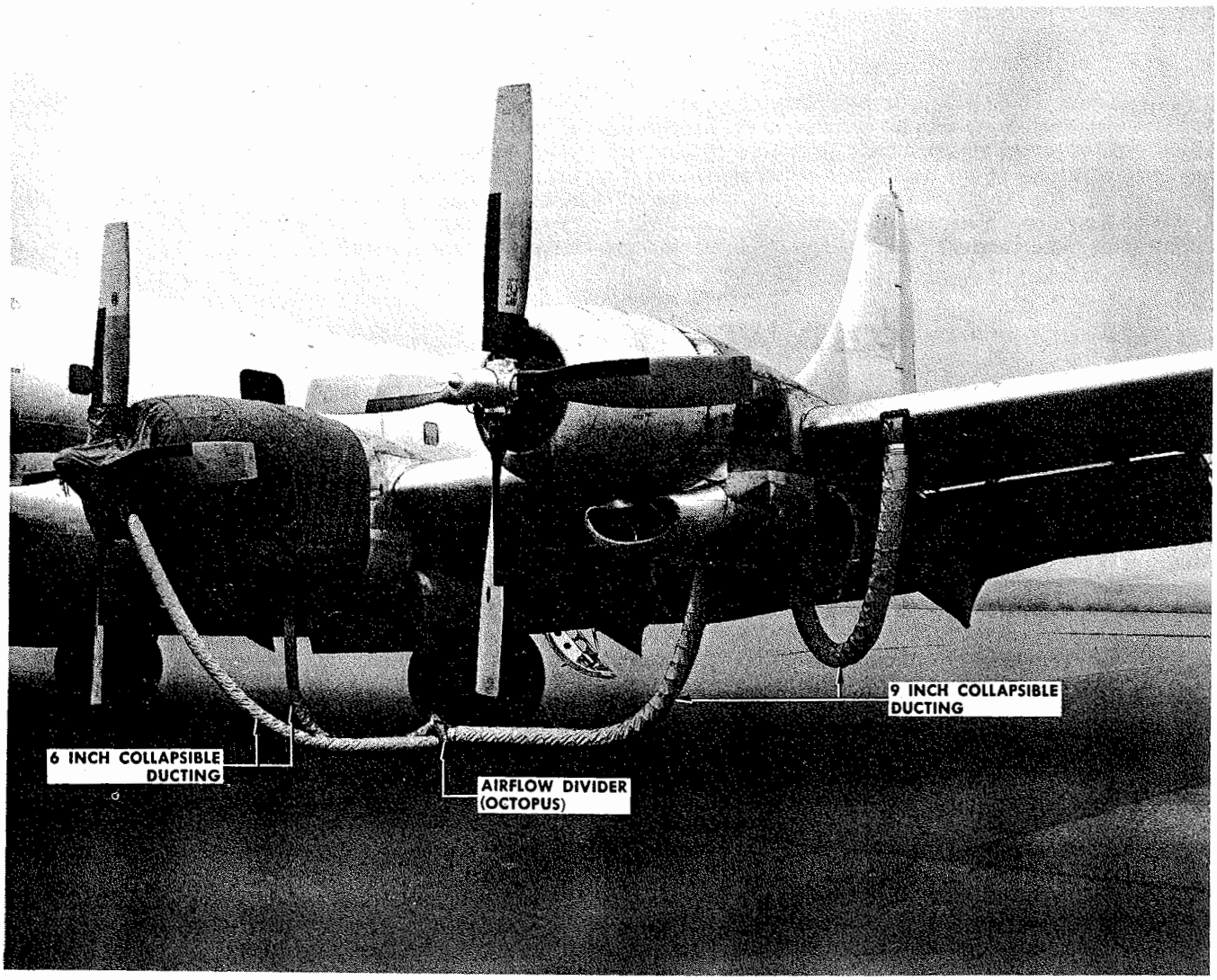
7. Install adapter in oil ventilator access door. Attach one 6-inch hose from octopus to this adapter, and tee with straps.

8. Attach one 6-inch hose 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 hoses to nacelle plug and two 6-inch adapters to oil vent for faster heating.

9. Operate APU in accordance with procedures given in AUXILIARY POWER UNIT (APU), Section IV.



COLLAPSIBLE DUCTING ARRANGEMENT

Figure 9-5

10. Turn the 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 1-22) on the engineer's instrument panel at ON.

13. Place the limited anti-ice switch (3, figure 1-22) 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. Disassemble hoses and adapters and stow.
6. Replace heater outlet cap.
7. Close heater cavity doors.
8. Leave APU 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 freezing the engines and cabin must be preheated if the airplane is not in a heated hangar.
2. Ensure 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. Check that engines have been preheated until a cylinder head temperature of -15°C 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 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. Check that sheltered air inlet filters have been removed.
7. Use external power.
8. Check 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 compartment 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 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. In addition to the normal procedure for starting engines, the airplane has a hot fuel prime system to aid in cold weather starting. Hot fuel prime may be used between 20°F and 0°F at the pilots' discretion; below 0°F, hot fuel prime should be used. Use the following procedure for cold weather starting.

1. If hot fuel prime is used; start engines in accordance with PROCEDURE FOR STARTING, Section VII and figure 7-2.

Cold weather starting, not using hot fuel prime; 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. See SYSTEMS OPERATION. Section VII for starting procedures.
- Twenty blades are required for any start made after 1 hour shutdown period. 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, shutdown 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. (See 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 is 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 airflow of at least 2 in. 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 CHT for takeoff.

3. Re-test oil transfer system. Repeat Step 2 as required.

WARNING

Make sure all instruments have warmed up sufficiently to insure 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 exists 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 props and exercise caution when operating in areas where ice, slush, or snow may be blown into props as extensive damage to props, engines, and engine mounts may result.

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. Make sure all instruments have warmed up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.
2. Operate wing flaps through at least one complete cycle.
3. To insure diverter action of the oil diverter segregator valve, a minimum oil temperature of 60°C on all engines is required.

Power Staging

Power staging is necessary prior to takeoff in order to minimize spark plug fouling at high 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 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: Five seconds per 100 rpm or one inch of manifold pressure in the normal range, and one second per 100 rpm or one 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 temperature 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 power plant.

3. Maintain carburetor air temperature at +15° C, if possible, to aid fuel vaporization.

4. At sub-zero temperatures, maximum power output will be obtained at a reduced manifold pressure due to the increase in air density. The torquemeters may be utilized to determine when maximum power is being delivered.

5. Operate the cabin heating system to assure proper functioning of the instruments.

6. 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. Check surface anti-icing systems 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. Whenever 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° C and +7° C.

3. Maintain a minimum of 2 in. Hg cabin air flow throughout the flight to warm the oil transfer lines.

CRUISE

Erratic engine operation and inefficient performance may sometimes be encountered due to a poor fuel vaporization, a low carburetor air temperature or 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 ten to fifteen 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 ten 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 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 props as extensive damage to props, engines, and engine mounts may result.

1. On runways covered with loose snow of undetermined depth, accomplish landings using only 55 to 80 percent flaps to prevent possible damage to the 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 15°F (-9°C).

1. Service nacelle oil tank from the central oil system. The amount of oil to be contained in the tank prior to dilution is found by taking oil tank capacity, 32.5 US gallons, and subtracting the amount of fuel to be added by dilution. This amount is one US gallon for each minute of dilution.

Example:

Dilution time required for (-6°F) expected minimum temperature is three minutes from figure 9-6. So, if one US gallon of fuel is added to the oil system for each minute of oil dilution, the amount of fuel added is three US gallons. Then 32.5 gallons tank capacity less three gallons fuel to be added gives 29.5 gallons, the level to which the nacelle oil tanks are to be serviced prior to dilution.

2. Idle engines at 1000 rpm with cowl flaps and oil cooler flaps open until cylinder head temperature has been reduced below 150°C and oil temperature has decreased to a minimum, preferably 50°C.

3. Dilute oil at 1000 rpm:

a. Turn fuel boost pump switches off.

b. Turn desired oil dilution engine selector switches on.

c. Hold master dilution switch on for the dilution time corresponding to the lowest OAT expected.

NOTE

If oil temperature rises above 55°C 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 before continuing.

4. At end of dilution period:

a. Move mixture controls to fuel cut-off.

b. Hold master dilution switch on until the propellers stop rotating.

NOTE

Enter time period of dilution and/or equivalent redilution in Form 781.

5. Leave cowl flaps approximately two inches open.

6. Preheat:

a. If the expected minimum temperature is to be at or below 0°F (-18°C), airplanes on alert status will be diluted to the schedule value shown in figure 9-6 for 0°F (-18°C) and preheat will be applied continuously in the engine and accessory section.

NOTE

In applying preheat it should be used to keep the CHT at from -15°C to 0°C.

b. If the expected minimum temperature is from 15° F (-9° C) to -25° F (-32° C) airplanes not on alert status will be diluted to the expected minimum temperature as shown in the schedule, figure 9-6 and preheat will be used in the accessory section as required before engine start. (Optional procedure.) For temperatures between 0° F (-18° C) and -25° F (-32° C) airplanes not on alert may dilute to the schedule for 0° F and use preheat as required to accomplish engine start.

c. If expected minimum temperatures are to be at or below -25° F (-32° C), airplanes not on alert will be diluted to the schedule, figure 9-6, for 0° F (-18° C) OAT, and use preheat as required in the engine and accessory section before engine start.

d. Dilution schedules are presented for temperatures down to -55° F; however, dilution below -25° F (-32° C) should only be accomplished for emergency operation when preheat is not available. Original dilution down to -25° F (-32° C) is safe from an oil film strength, viscosity and lubrication standpoint to accomplish takeoff and high power operation after a normal engine preflight runup has been accomplished. Dilution below -25° F results in excessive fuel in the oil tank with inadequate oil film strength to support takeoff and continuous high power operation, unless the engine is operated on the ground for at least one hour with a series of high power engine runs every 10 minutes of operation to effect fuel boil-off.

7. Redilution:

a. After ground operation:

(1) Redilution is not required for engine operating periods of five minutes or less.

(2) Engine ground operation in excess of five minutes will require redilution in accordance with the appropriate schedule in figure 9-6.

NOTE

Under normal conditions when the airplane is not on alert, only two redilutions will be accomplished prior to the next flight or oil change. For airplanes on alert, three redilutions may be accomplished provided previous dilutions have not exceeded the schedule for 0° F, (-18° C). Prior to the third redilution, an oil temperature of 60° C must be reached and maintained for a period of 5 minutes.

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 stagnant, 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.

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, 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. Check that all filters are installed and are clean of dust, corrosion, and mold.

2. Check oleos and surface control hinge points free of dust and sand. Check inflation of oleos and tires frequently. Changes in air pressure causes by wide changes in temperature result in improper inflation. Overinflation is most often encountered.

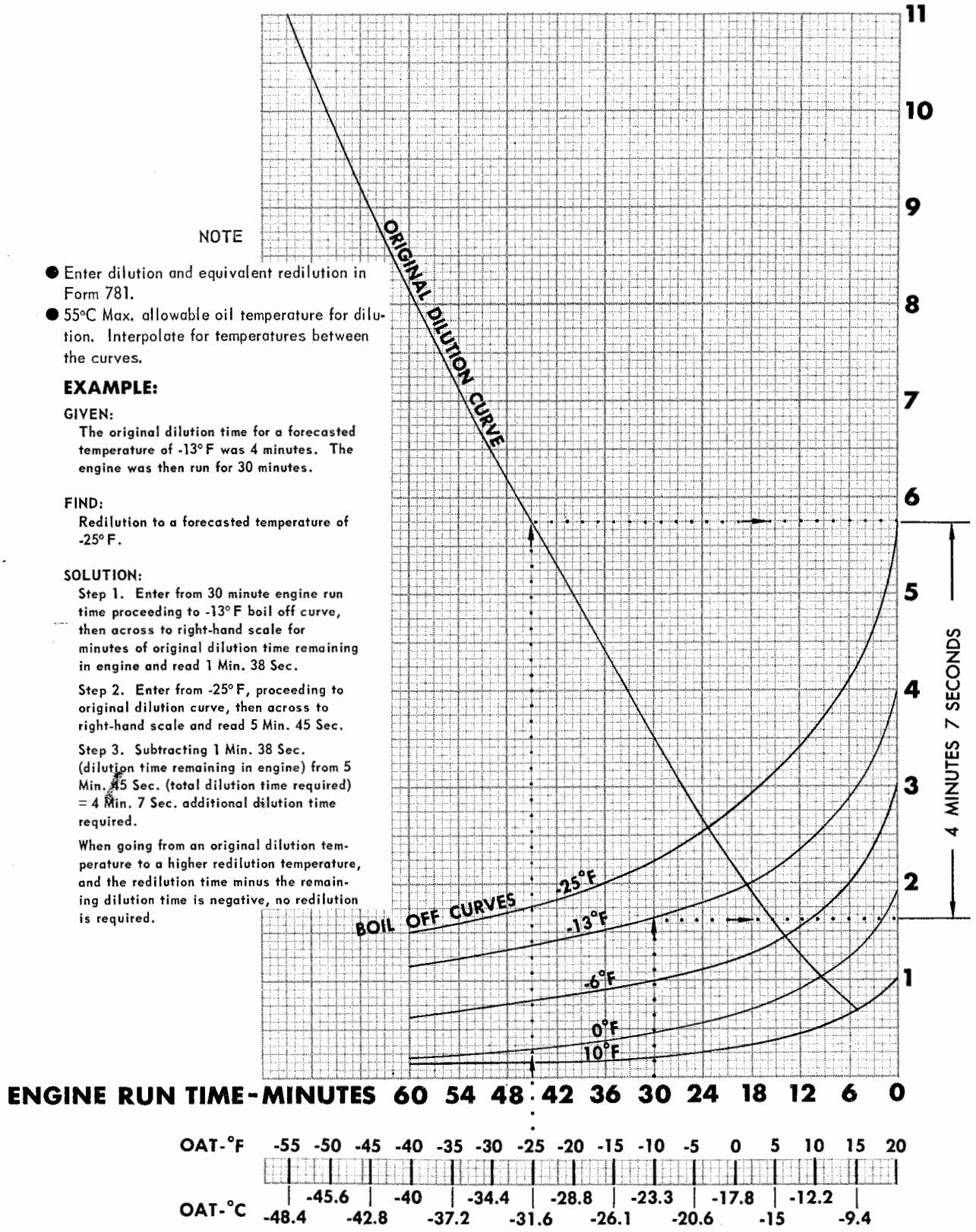
3. Check for leaks in hydraulic system since heat and moisture cause valve packings to swell.

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.



DILUTION AND REDILUTION CHART

Figure 9-6

2. Open windows, hatches, bulkhead doors, and entrance door 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. Be certain airplane is clear of other airplanes during ground operations. Use a platform or hard stand to check engines whenever or wherever possible.

TAXI

When taxiing, keep adequate distance between airplanes to prevent prop blown sand from 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, see POWER AVAILABLE FOR TAKEOFF in the Appendix.

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. See Section V for airspeed limitations during operation of sheltered air doors.

DESCENT

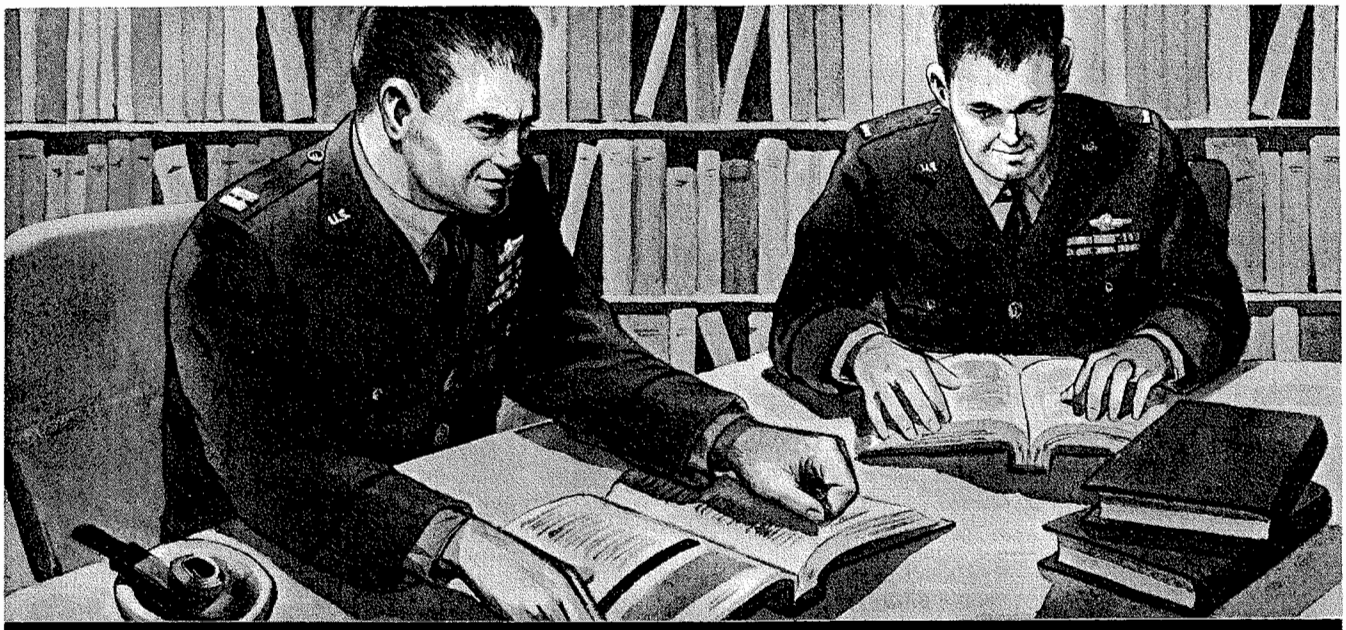
Before entering dust layer, position carburetor air switches to SHELT. See Section V for airspeed limitations during operation of sheltered air doors.

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 entrance 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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