20 APR 1976

T.O. 1C-135(K)A-1

USAF SERIES KC-135A AIRCRAFT
FLIGHT MANUAL

CONTRACT NO. F04606-67-A-0519
CONTRACT NO. F34601-75-D-0067



CHANGE NOTICE

LATEST CHANGED PAGES SUPERSEDE THE SAME PAGES OF PREVIOUS DATE

Insert changed pages into basic publication. Destroy superseded pages.

BASIC AND ALL CHANGES HAVE BEEN MERGED TO MAKE THIS A COMPLETE PUBLICATION.

THIS PUBLICATION INCOMPLETE WITHOUT T.O. 1C-135(K)A-1-1 PERFORMANCE DATA

FOR AIR REFUELING OPERATIONS, THIS PUBLICATION IS INCOMPLETE WITHOUT T.O. 1-1C-1 AND ITS APPLICABLE APPENDICES.



Commanders are responsible for bringing this publication to the attention of all Air Force personnel cleared for operation of subject aircraft.

This change replaces Operational Supplement -115. See Numerical Index and Requirement Table T.O. 0-1-1-3 for the current status of Flight Manuals, Safety Supplements, Operational Supplements, and Flight Crew Checklists.

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LIST OF EFFECTIVE PAGES

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Ground Crewman's	T.O. 1C-135(K)A-1CL-4	15 Feb 68, Changed 15 Jun 68

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

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

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STATUS OF SAFETY AND OPERATIONAL SUPPLEMENTS

This supplement status page is based on information available to the manual editor as of the date of this publication. The information may not be current as it must be updated by any subsequent supplement status pages and by reference to T. O. 0-1-1-3.

SUPPLEMENTS IN THIS CHANGE

Number	Date	Short Title	Section Affected
S-115	28 Mar 75	Standard Fuel Loads	Section VIII

OUTSTANDING SUPPLEMENTS

Number	Date	Short Title	Section Affected
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SEE T.O. 1C-135(K)A-1-1

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SCOPE. This manual must be used in conjunction with T.O. 1C-135(K)A-1-1 to obtain all the information necessary for safe and efficient operation of the KC-135. T.O. 1C-135(K)A-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.



POSSIBLE VS PRACTICABLE. The pilot's overall analysis of any malfunction or emergency is of prime importance in determining the urgency to land. The following terminology used throughout the flight manual provides general guidance:
Land As Soon As Possible - The mission will be terminated and an emergency declared. Landing should be accomplished at the nearest suitable airfield.
Land As Soon As Practicable - The mission should be terminated and landing accomplished at the planned destination or a suitable alternate at the discretion of the pilot.



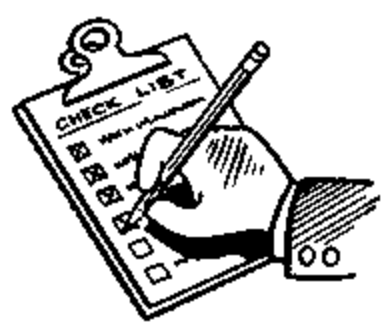
PERMISSIBLE OPERATIONS. The Flight Manual takes a "positive approach" and normally states only what you can do. Unusual operations or configurations (such as asymmetrical loading) are prohibited unless specifically covered herein. Clearance must be obtained from the Flight Manual Manager, OCAMA-OCNEAF,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



HOW TO BE ASSURED OF HAVING LATEST DATA. Refer to T.O. 0-1-1-3 which is normally issued semi-annually and contains a listing of all current Flight Manuals, Safety Supplements, Operational Supplements, and Checklists. T.O. 0-1-1-3 is normally supplemented monthly to assure an accurate, up-to-date listing of these publications.



STANDARDIZATION AND ARRANGEMENT. Standardization assures that the scope and arrangement of all Flight Manuals are identical. This manual is divided into nine fairly independent sections to simplify reading it straight through or using it as a reference manual. All sections must be read thoroughly and fully understood for safe and efficient mission accomplishment.



CHECKLISTS. The Flight Manual contains only amplified checklists. Abbreviated checklists have been issued as separate technical orders--see the back of the title page for T.O. number and date of your latest checklist. Line items in the Flight Manual and checklists are identical with respect to arrangement and item number. Whenever an interim Safety or Operational Supplement affects the 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.

SAFETY SUPPLEMENTS AND OPERATIONAL SUPPLEMENTS. Information involving safety will be promptly forwarded to you by Safety Supplements. TWX-type Safety Supplements covering loss of life (called Interim Safety Supplements), will get to you in 48 hours; those concerning serious damage to equipment within 10 days by mail (in a formal printed form). Operational information not involving safety but of an urgent nature will be forwarded to you by Operational Supplements. These will be forwarded by TWX (interim) or by mail (formal), depending upon the urgency of the information. Interim supplements are normally replaced by formal printed supplements at an early date. Formal printed supplements are identified by red letters "SS" for safety supplements and black letters "OS" for operational supplements printed around the borders of the pages. The currency of Safety Supplements and Operational Supplements affecting your airplane and Flight Manual can be determined by referring to the NI&RT, Cargo Aircraft (T.O. 0-1-1-3), or the Flyleaf pages of the latest Flight Manual, Safety Supplement, or Operational Supplement. The title block of each supplement and the title page of this manual should also be checked to determine the effect they may have an existing supplements. You must remain constantly aware of the status of all supplements - current supplements must be complied with, but there is no point in restricting your operation by complying with a replaced or rescinded supplement. As a further aid, a supplement summary for both Safety Supplements and Operational Supplements is included in this manual following the A pages; however, this summary can be only as current as this manual.



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



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

WARNING	Operating procedures, techniques, etc., which may result in personal injury or loss of life if not carefully followed.
CAUTION	Operating procedures, techniques, etc., which may result in damage to equipment if not carefully followed.
NOTE	An operating procedure, technique, etc., which is considered essential to emphasize.

The following definitions apply to the words "shall," "will," "should," and "may."

SHALL or WILL	The instructions or procedures prefaced by "shall" or "will" are mandatory.
SHOULD	Normally used to indicate a preferred but non-mandatory method of accomplishment.
MAY	An acceptable or suggested means of accomplishment.



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 submitted on AF Form 847 through channels established by Major Commands as directed by AFR 60-9 to Oklahoma City ALC/MMEAF, Tinker AFB, Oklahoma, 73145.



F-1356

Coding

All KC-135A and derivative, special purpose airplanes are covered in this manual except that special purpose airplanes may not have all the indicated equipment or modifications. Special purpose airplanes may be redesignated and have other modifications which may be covered by separate, partial manuals, e.g. EC-135P. Refer to T.O. 0-1-1-3 for a list of the partial manuals to be used with this manual for operation of special purpose airplanes.

Some of the information covered is applicable only to certain groups of airplanes. This information is identified by a code number reflecting that group of airplanes. Each paragraph applicable only to certain airplanes is coded along the title at the right. Items in illustrations, applicable only to some airplanes are generally coded alongside the nomenclature. When a paragraph or item is not coded it applies to all KC-135A airplanes. Improvements made in later airplanes may also have been incorporated into earlier airplanes by modifications. Information which is affected by accomplishment of a TCTO modification is coded by use of a special symbol bearing the TCTO dash number. The TCTO's which are reflected in this manual are listed following the airplane serial number list.

EXAMPLES OF CODES:

5 Indicates information is applicable only to airplane with serial No. AF55-3122

▶ Means "THRU" or "AND ON"

5▶ Indicates information is applicable to all airplanes beginning with serial Nos. AF55-3122 and on

5▶7 Indicates information is applicable to airplanes with serial Nos. AF55-3122 thru AF55-3124

1▶9 less TCTO K510 indicates information is applicable to airplanes AF55-3118 thru -3126 without T.O. 1C-135(K)A-510 incorporated.

12▶ plus TCTO K507 indicates information is applicable to all airplanes beginning with serial Nos. AF55-3129 and on with T.O. 1C-135(K)A-507 incorporated.

74 Indicates information is only applicable to airplanes with cargo loading kit installed

* An asterisk in front of a checklist step indicates a thru-flight checklist item

A reverse number on an illustration such as ❶ indicates reference to a note giving additional information

The term "PLACES" preceded by a number is used in an illustration to indicate the number of places that particular item is called out on an illustration, if more than once. It does not indicate the quantity of these items in the airplane.

The word **(TYPICAL)** following a figure title indicates the illustration applies to most airplanes. Small differences may be noticed between some airplanes and the illustration, particularly the panel illustrations.

In alphabetical steps the letters I and O have been omitted to avoid confusion with numbers one and zero.

CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.
1 ★	55-3118	16 ▲	55-3133	31	56-3592	46	56-3607	61	56-3622	76	56-3637
2 ★	55-3119	17 ★	55-3134	32	56-3593	47	56-3608	62	56-3623	77	56-3638
3	55-3120	18	55-3135	33	56-3594	48	56-3609	63	56-3624	78	56-3639
4 ★	55-3121	19	55-3136	34	56-3595	49	56-3610	64	56-3625	79	56-3640
5 ★	55-3122	20	55-3137	35 ★	56-3596	50	56-3611	65	56-3626	80	56-3641
6 ★	55-3123	21 ▲	55-3138	36 ▲	56-3597	51	56-3612	66	56-3627	81	56-3642
7 ★	55-3124	22	55-3139	37 ▲	56-3598	52 ▲	56-3613	67 ▲	56-3628	82	56-3643
8 ★	55-3125	23 ▲	55-3140	38 ▲	56-3599	53	56-3614	68 ▲	56-3629	83	56-3644
9	55-3126	24	55-3141	39	56-3600	54	56-3615	69	56-3630	84	56-3645
10 ★	55-3127	25	55-3142	40	56-3601	55	56-3616	70	56-3631	85	56-3646
11 ★	55-3128	26	55-3143	41 ▲	56-3602	56	56-3617	71	56-3632	86	56-3647
12 ★	55-3129	27 ▲	55-3144	42	56-3603	57 ▲	56-3618	72	56-3633	87	56-3648
13	55-3130	28	55-3145	43	56-3604	58	56-3619	73	56-3634	88	56-3649
14	55-3131	29	55-3146	44 ▲	56-3605	59	56-3620	74	56-3635	89	56-3650
15 ★	55-3132	30	56-3591	45	56-3606	60	56-3621	75	56-3636	90	56-3651

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CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.
91	56-3652	141	57-1461	191	57-1511	241 ▲	58-026	291	58-076	341	58-126
92	56-3653	142	57-1462	192	57-1512	242	58-027	292	58-077	342	58-127
93	56-3654	143	57-1463	193 ▲	57-1513	243	58-028	293	58-078	343	58-128
94 ▲	56-3655	144	57-1464	194	57-1514	244	58-029	294	58-079	344	58-129
95	56-3656	145	57-1465	195 ★	57-2589	245	58-030	295	58-080	345	58-130
96 ▲	56-3657	146 ▲	57-1466	196	57-2590	246	58-031	296	58-081	346	59-1443
97	56-3658	147	57-1467	197	57-2591	247	58-032	297	58-082	347	59-1444
98	57-1418	148	57-1468	198	57-2592	248	58-033	298	58-083	348	59-1445
99	57-1419	149	57-1469	199	57-2593	249	58-034	299	58-084	349	59-1446
100	57-1420	150	57-1470	200	57-2594	250	58-035	300	58-085	350	59-1447
101	57-1421	151	57-1471	201	57-2595	251	58-036	301	58-086	351	59-1448
102	57-1422	152	57-1472	202	57-2596	252	58-037	302	58-087	352	59-1449
103	57-1423	153	57-1473	203	57-2597	253	58-038	303	58-088	353	59-1450
104 ▲	57-1424	154	57-1474	204	57-2598	254 ▲	58-039	304	58-089	354	59-1451
105	57-1425	155	57-1475	205	57-2599	255	58-040	305	58-090	355	59-1452
106	57-1426	156	57-1476	206	57-2600	256	58-041	306	58-091	356	59-1453
107	57-1427	157	57-1477	207	57-2601	257	58-042	307	58-092	357	59-1454
108	57-1428	158	57-1478	208	57-2602	258	58-043	308	58-093	358	59-1455
109	57-1429	159	57-1479	209	57-2603	259	58-044	309	58-094	359	59-1456
110	57-1430	160	57-1480	210	57-2604	260	58-045	310	58-095	360	59-1457
111	57-1431	161	57-1481	211	57-2605	261	58-046	311	58-096	361	59-1458
112	57-1432	162	57-1482	212	57-2606	262	58-047	312	58-097	362	59-1459
113	57-1433	163	57-1483	213	57-2607	263 ▲	58-048	313	58-098	363	59-1460
114	57-1434	164	57-1484	214	57-2608	264	58-049	314	58-099	364	59-1461
115	57-1435	165	57-1485	215	57-2609	265	58-050	315	58-100	365	59-1462
116	57-1436	166	57-1486	216	58-001	266	58-051	316	58-101	366	59-1463
117	57-1437	167	57-1487	217 ▲	58-002	267	58-052	317	58-102	367	59-1464
118	57-1438	168	57-1488	218	58-003	268	58-053	318	58-103	368 ▲	59-1465
119	57-1439	169	57-1489	219	58-004	269	58-054	319	58-104	369	59-1466
120	57-1440	170	57-1490	220	58-005	270	58-055	320	58-105	370	59-1467
121	57-1441	171	57-1491	221	58-006	271	58-056	321	58-106	371	59-1468
122 ▲	57-1442	172	57-1492	222 ★	58-007	272	58-057	322	58-107	372	59-1469
123	57-1443	173	57-1493	223	58-008	273	58-058	323	58-108	373	59-1470
124 ▲	57-1444	174	57-1494	224	58-009	274	58-059	324	58-109	374	59-1471
125	57-1445	175	57-1495	225	58-010	275	58-060	325	58-110	375	59-1472
126 ▲	57-1446	176	57-1496	226 ★	58-011	276	58-061	326	58-111	376	59-1473
127	57-1447	177	57-1497	227	58-012	277	58-062	327	58-112	377	59-1474
128	57-1448	178 ▲	57-1498	228	58-013	278	58-063	328	58-113	378	59-1475
129 ▲	57-1449	179	57-1499	229	58-014	279	58-064	329	58-114	379	59-1476
130	57-1450	180 ▲	57-1500	230	58-015	280	58-065	330	58-115	380	59-1477
131	57-1451	181	57-1501	231	58-016	281	58-066	331	58-116	381	59-1478
132	57-1452	182	57-1502	232	58-017	282	58-067	332	58-117	382	59-1479
133	57-1453	183	57-1503	233 ★	58-018	283	58-068	333	58-118	383	59-1480
134	57-1454	184	57-1504	234 ★	58-019	284	58-069	334	58-119	384 ✕✕	59-1481
135	57-1455	185	57-1505	235	58-020	285	58-070	335	58-120	385	59-1482
136	57-1456	186	57-1506	236	58-021	286	58-071	336	58-121	386	59-1483
137 ▲	57-1457	187	57-1507	237 ★	58-022	287	58-072	337	58-122	387	59-1484
138	57-1458	188	57-1508	238	58-023	288	58-073	338	58-123	388	59-1485
139	57-1459	189	57-1509	239	58-024	289	58-074	339	58-124	389	59-1486
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CODE NO.	AIRPLANE SERIAL NO.
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655	63-7999
656	63-8000
657	★63-8001
658	63-8002
659	63-8003
660	63-8004
661	63-8005

CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.	CODE NO.	AIRPLANE SERIAL NO.
662	63-8006	674	63-8018	686	63-8030	698	▲63-8042	710	63-8879	722	64-14830
663	63-8007	675	63-8019	687	63-8031	699	63-8043	711	63-8880	723	64-14831
664	63-8008	676	★63-8020	688	63-8032	700	63-8044	712	★63-8881	724	64-14832
665	63-8009	677	63-8021	689	63-8033	701	63-8045	713	▲63-8882	725	64-14833
666	63-8010	678	63-8022	690	63-8034	702	63-8871	714	63-8883	726	64-14834
667	63-8011	679	63-8023	691	63-8035	703	63-8872	715	63-8884	727	64-14835
668	63-8012	680	63-8024	692	63-8036	704	63-8873	716	63-8885	728	64-14836
669	63-8013	681	63-8025	693	63-8037	705	63-8874	717	63-8886	729	64-14837
670	63-8014	682	63-8026	694	63-8038	706	63-8875	718	63-8887	730	64-14838
671	63-8015	683	63-8027	695	63-8039	707	63-8876	719	63-8888	731	64-14839
672	63-8016	684	63-8028	696	63-8040	708	63-8877	720	64-14828	732	64-14840
673	63-8017	685	63-8029	697	63-8041	709	63-8878	721	64-14829		

▲ AIRPLANES NO LONGER IN SERVICE
** FAA AIRPLANES
★ SPECIAL PURPOSE AIRPLANES

NOTE

THE FOLLOWING TIME COMPLIANCE TECHNICAL ORDERS (TCTO'S) ARE ONLY THOSE WHICH ARE REFERRED TO IN THIS PUBLICATION. WHEN TCTO MODIFICATIONS ARE COMPLETED ON ALL AIRPLANES, REFERENCES ARE DELETED FROM THE MANUAL.

TCTO 550 — INSTALLATION OF MARK II MODULATED ANTI-SKID BRAKE SYSTEM

TCTO 627 — INSTALLATION OF FIVE-ROTOR BRAKE ASSEMBLY

TCTO 738 — INSTALLATION OF LOW OIL PRESSURE WARNING LIGHTS

TCTO 864 — INSTALLATION OF TAKEOFF AND LANDING DATA CARD HOLDER

TCTO 879 — INSTALLATION OF AN/ASQ-141(V) POWER ON-OFF SWITCHES

TCTO 886 — INSTALLATION OF ESCAPE SLIDE, PART NO. 16D22230

TCTO 916 — REMOVAL OF AFT FIRE DETECTION SYSTEM

TCTO 920 — INSTALLATION OF CARTRIDGE/PNEUMATIC STARTER ON ALL ENGINES

TCTO 944 — INSTALLATION OF PROVISIONS FOR POWERED CARGO DOOR

TCTO 951 — INSTALLATION OF CARGO DOOR FLOOD LIGHTS

NOTE

THE LETTER "K" PRECEDING A TCTO NUMBER INDICATES THAT TCTO IS APPLICABLE TO THE KC-135A ONLY. THE TCTO NUMBERS WHICH DO NOT HAVE THE LETTER "K" PRECEDING THEM ALSO APPLY TO OTHER AIRPLANES.

ABBREVIATIONS AND DEFINITIONS

ABBREVIATION	DEFINITION
A/A	Air to Air (TACAN)
AC	Alternating Current
A/C	Air Conditioning
ACC	Accelerate
AC-CL	Accelerate-Climb
ACM	Air Cycle Machine (Air Conditioning)
ADF	Automatic Direction Finding
ADI	Attitude Director Indicator
ADIZ	Air Defense Identification Zone
AIP	Aircraft Improved Posture
ALTM	Altimeter
AM	Amplitude Modulation (Communi-cotion radios)
AME	Equivalent AM
amp	Ampere
ANN	Annunciator
AOA	Angle of Attack
AP, A/P	Autopilot
APPR	Approach
APU	Auxiliary Power Unit
ASR	Airport Surveillance Radar
A/R*	Air Refueling
ARR*	Air Refueling Receiver
ATA	Actual Time of Arrival
ATT	Attitude
AUTO-NAV	Automatic Navigation

ABBREVIATION	DEFINITION
AUX	Auxiliary
(BO)	Boom Operator
BOCBP	Boom Operator's Circuit Breaker Panel
BRT	Bright
°C	Degrees Centigrade
CAPT	Capture
CAS	Calibrated Airspeed
CB	Circuit Breaker
CBP	Circuit Breaker Panel
CCW	Counterclockwise (Preceded by "turn" or "rotate")
CDI	Course Deviation Indicator
CG, cg	Center of Gravity - (in percent of mean aerodynamic chord, MAC)
CIPP	Copilot's Instrument Power Panel
CMD	Command
CMPTR	Computer
COMP	Compass
COMM	Communications
(CP)	Copilot
(CW)	Continuous Wave
CW	Clockwise (Preceded by "turn" or "rotate")
CWT	Center Wing Tank
DC	Direct Current
DEV	Deviation

* See T.O. 1-1C-1 for air refueling terminology and abbreviations

ABBREVIATION	DEFINITION
DEFCON	Defense Condition
DF	Direction Finding
DN/R	Down/Right (ILS Test) (Inoperative)
DG	Directional Gyro
DR	Dead Reckoning
EGT	Exhaust Gas Temperature
EPR	Engine Pressure Ratio – (The ratio of engine turbine exit pressure to compressor inlet pressure)
ETA	Estimated Time of Arrival
°F	Degrees Fahrenheit
FLP	Flap
F/O	First Officer (Copilot) (on CBP), Fail Operative (on RGA interface unit)
fpm	Feet Per Minute
FT, ft	Feet
FWD, fwd	Forward
g	Acceleration of Gravity
GA, G/A	Go-Around
(GC)	Ground Crew
GCA	Ground Controlled Approach (PAR)
GMT	Greenwich Mean Time
GND SPD	Ground Speed
GPI	Ground Position Indicator
gpm	Gallons Per Minute
GS, G/S	Glide Slope
GSI	Glide Slope Indicator (ILS)
HAA	Height Above Airport
HAT	Height Above Touchdown

ABBREVIATION	DEFINITION
HDG	Heading
HF	High Frequency
Hg	Mercury
HSI	Horizontal Situation Indicator
HTR	Heater
IAS	Indicated Airspeed
ID	Indicator
IFF	Identification Friend or Foe
IFR	Instrument Flight Rules
ILS	Instrument Landing System
in.	Inch, Inches
IP	Initial Point
KC	Kilocycle
KCAS	Knots, Calibrated Airspeed
kHz	Kilohertz
KIAS	Knots, Indicated Airspeed
KTAS	Knots, True Airspeed
KVA	Kilovolt – ampere
KVARS	Kilovars
KWS	Kilowatts
L	Left
LB, lb	Pound, Pounds
LE	Leading Edge
LH	Left Hydraulic
LOC	Localizer
LOP	Line of Position
MAC	Mean Aerodynamic Chord – (A reference for the location of the wing center of lift and airplane center of gravity)

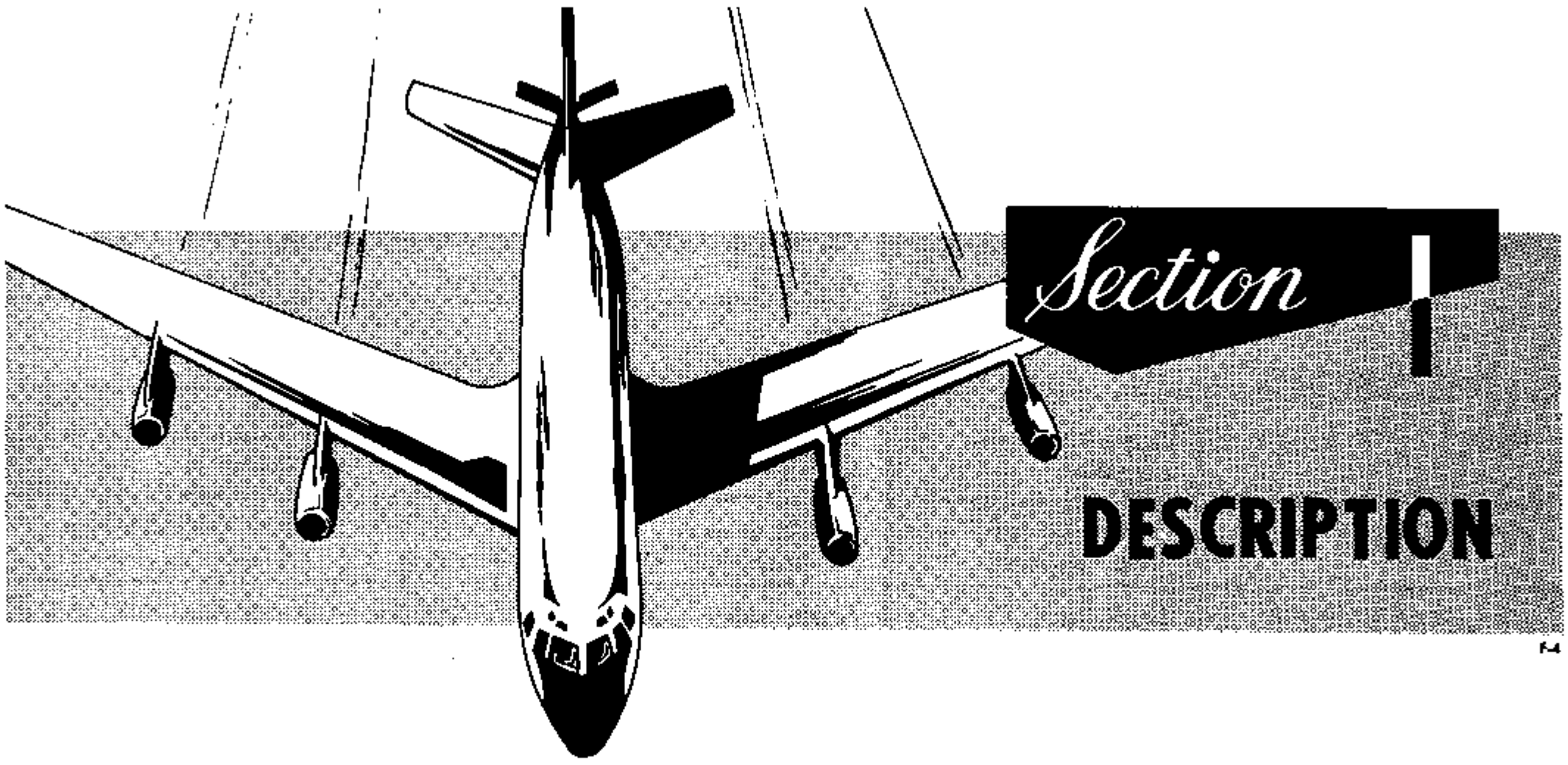
ABBREVIATION	DEFINITION
MACH NO.	Ratio of TAS to local speed of sound
MAN	Manual
Mag	Magnetic
MC	Megacycle
MCBP	Main Circuit Breaker Panel
MCW	Modulated Continuous Wave
MDA	Minimum Descent Altitude
MHz	Megahertz
MIN	Minimum
MPH, mph	Miles Per Hour
MRT	Military Rated Thrust - Maximum allowable thrust (no water) determined by EPR setting. Limited to 30 minutes in flight.
msl	Mean Sea Level
MSTR DISC	Master Disconnect
(N)	Navigator
NM	Nautical Miles
NAM	Nautical Air Miles
NAV	Navigation
No.	Number
NOZ	Nozzle
NRT	Normal Rated Thrust - Maximum allowable thrust for continuous operation determined by EPR setting.
OAT	Outside Air Temperature (Synonymous with Free Air Temperature, See Section I)
OWE	Operating Weight Empty
(P)	Pilot
PAR	Precision Approach Radar (GCA)
PCU	Power Control Unit
Ø	Phase
PM	Pounds Per Minute
pph	Pounds per hour
PPI	Plan - Position Indicator
PRB	Probe
PSI, psi	Pounds Per Square Inch
PWR	Power
RCR	Runway Condition Reading
RDO ALT	Radio Altimeter
RECPT	Receptacle
RGA	Rotation Go-Around
RH	Right Hydraulic
RMI	Radio Magnetic Indicator
RNWY	Runway
RPM, rpm	Revolutions Per Minute (For this airplane the revolutions per minute of the engine high pressure compressor rotor)
R/T	Receiver-Transmitter
SBCBP	Switched DC Bus Circuit Breaker Panel
SEL	Selection
SETTOAC	Start Engines, Taxi, Takeoff, and Accelerate
SIF	Selective Identification Feature
SPD DEV	Speed Deviation
SPR	Single Point Refueling
SSB	Single Sideband (Communications Radios)
Sta	Station
TACAN	Tactical Air Navigation
T/O	Takeoff
T-R	Transformer-Rectifier

ABBREVIATION	DEFINITION
TRT (wet)	Takeoff Rated Thrust With Water - Maximum allowable thrust with water injection determined by EPR setting. Limited to 5 minutes.
TRT (dry)	Takeoff Rated Thrust - No Water - Maximum allowable thrust without water injection determined by EPR setting. Limited to 5 minutes for static conditions. Analogous to MRT.
UHF	Ultra High Frequency
UP/L	Up/Left (ILS Test) (Inoperative)
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omni Range (VHF Navigational Aid)
V_{ROT}	Rotation Speed
WI	Water Injection
WOW	Weight On Wheels
X/MON	Cross Monitor



THE AIRPLANE

F-3



Section I
DESCRIPTION

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THE AIRPLANE

The KC-135A, designed and manufactured by The Boeing Company, is a four engine, swept wing, long range, high altitude, high speed airplane that is primarily a tanker but may also be used as a cargo carrier or troop transport. The normal crew consists of a pilot, copilot, navigator, and boom operator. As a tanker, the boom on the tail section is used to transfer a major portion of the 175,000 to 200,000 pound fuel load to other airplanes for refueling in flight. The large cargo compartment and load carrying capability of the airplane makes it possible to carry up to 83,000 pounds of cargo on cargo carrying missions. The carrying of troops is also possible because the cargo compartment is pressurized, air conditioned, and has provisions for seating 80 persons. This capacity is reduced to 41 persons for airplanes equipped with an arctic kit. The engines are Pratt and Whitney J57-P-59W or -43WB turbojets. See ENGINE THRUST and figure 1-7, this Section, for information on engine thrust. Provisions have been made for rapid installation of an arctic kit. The arctic kit consists of equipment that improves the cold weather operational capability of the airplane.

MAIN DIFFERENCES

ITEM	KC-135A	EC-135C	C-135A	C-135B
ENGINES	J57-P-59W or -43WB	TF33-P-9	J57-P-59W	TF33-P-5
WATER INJECTION	Yes	No	Yes	No
THRUST REVERSERS	No	No	No	Yes
FLAPS	Emergency manual operation	Emergency electrical operation	Emergency electrical operation	Emergency electrical operation
FUEL CAPACITY (USABLE)	31,200 gallons 202,800 pounds	29,026 gallons 188,669 pounds	29,026 gallons 188,669 pounds	29,026 gallons 188,669 pounds
AIR CONDITIONING	Single pack	Single pack	Double pack	Double pack
AIR REFUELING				
TANKER	Yes	Yes	No	No
RECEIVER	Reverse refueling only	Yes	No	No
MAXIMUM FLIGHT WEIGHT (FLAPS UP)	297,000 lb (See text gross weight)	299,000 lb	270,000 lb	274,000 lb
FUEL DUMP	Through boom	Through boom	Fuel dump tube	Fuel dump tube
FLOOR	Plywood	Rug over plywood	Metal	Metal
UPPER DECK FUEL TANK	Yes	No	No	No
AUXILIARY POWER UNIT	Yes	Yes	No	No

Figure 1-1

OVER-ALL DIMENSIONS

Approximate overall dimensions of the airplane are as follows:

Wing Span	130 feet 10 in.
Fuselage Length (Body)	128 feet 10 in.
Height to Top of Fin	41 feet 8 in.
Tread (Between struts)	22 feet 1 in.
Overall Length	
(Boom retracted)	136 feet 3 in.
(Boom extended)	156 feet
Turning Radius	See figure 2-2
Ground Clearance	See figure 2-2

GROSS WEIGHT

The airplane is in the 300,000 pound gross weight class. For specific weight information refer to WEIGHT LIMITATIONS in Section V.

SPECIAL FEATURES

The airplane has a tricycle type landing gear incorporating dual nose gear wheels and four truck-mounted main gear wheels on each side of the airplane, all of which retract into the fuselage. All flight control surfaces are free floating and are statically and aerodynamically balanced. The surfaces are aerodynamically controlled by tabs, cable operated from the

pilots' controls. The rudder has full range hydraulic assist working in conjunction with the aerodynamic balance panels. The balance panels and control tab provide limited rudder deflection in the event of hydraulic system failure (figure 3-5). Inboard and outboard ailerons are incorporated on each side of the airplane. Lateral control of the airplane is augmented with two sets of hydraulically operated spoilers on the upper surfaces of each wing. All spoilers on both sides can be raised in varying degrees simultaneously and symmetrically to act as speed brakes. 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 hangars. The following equipment is hydraulically operated: landing gear, flaps, spoilers, boom controls, brakes, nose gear steering, air refueling pumps, copilot's instrument power hydraulic motor and the powered rudder. The cargo door is opened and closed by means of a hand hydraulic pump. All other equipment is operated either electrically or mechanically. Quickly removable access doors are provided to permit easy access to areas requiring frequent inspections. The engine pods are accessible from the ground without use of special stands.

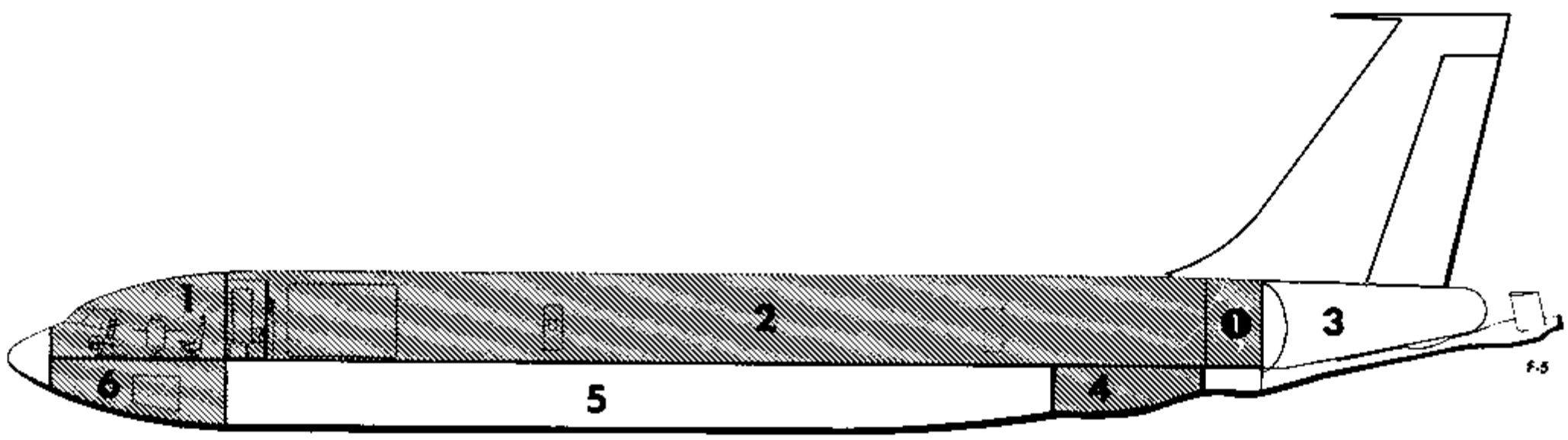
INTERIOR ARRANGEMENT AND CREW MOVEMENT

The fuselage is divided into a pressurized compartment and an unpressurized compartment. The pressurized compartment is further subdivided into smaller compartments as shown in figure 1-2. Hatches are provided for crew movement between these various subcompartments of the pressurized compartment as shown in figure 1-4.

ENGINES

The airplane is equipped with four Pratt and Whitney J57-P-59W or -43WB flat-rated thrust, dual axial flow turbojet engines. These engines are mounted individually in nacelles suspended below the wings. The engines are numbered from left to right, one through four. The engine has two compressors with their respective turbines which form the two rotor systems, mechanically independent but related as to air flow. See figure 1-6. This engine is designed to develop its sea level rated thrust over a wide range of temperatures and pressures. A hydromechanical fuel

COMPARTMENTS



PRESSURIZED AREA

1 CONTROL CABIN
2 CARGO COMPARTMENT
3 TAIL COMPARTMENT (UNPRESSURIZED)
4 BOOM OPERATOR'S COMPARTMENT
5 FUEL TANKS AND EQUIPMENT COMPARTMENTS (UNPRESSURIZED)
6 LOWER NOSE COMPARTMENT

❶ THIS AREA UNPRESSURIZED ON AIRPLANES WITH UPPER DECK TANK

Figure 1-2

GENERAL ARRANGEMENT DIAGRAM

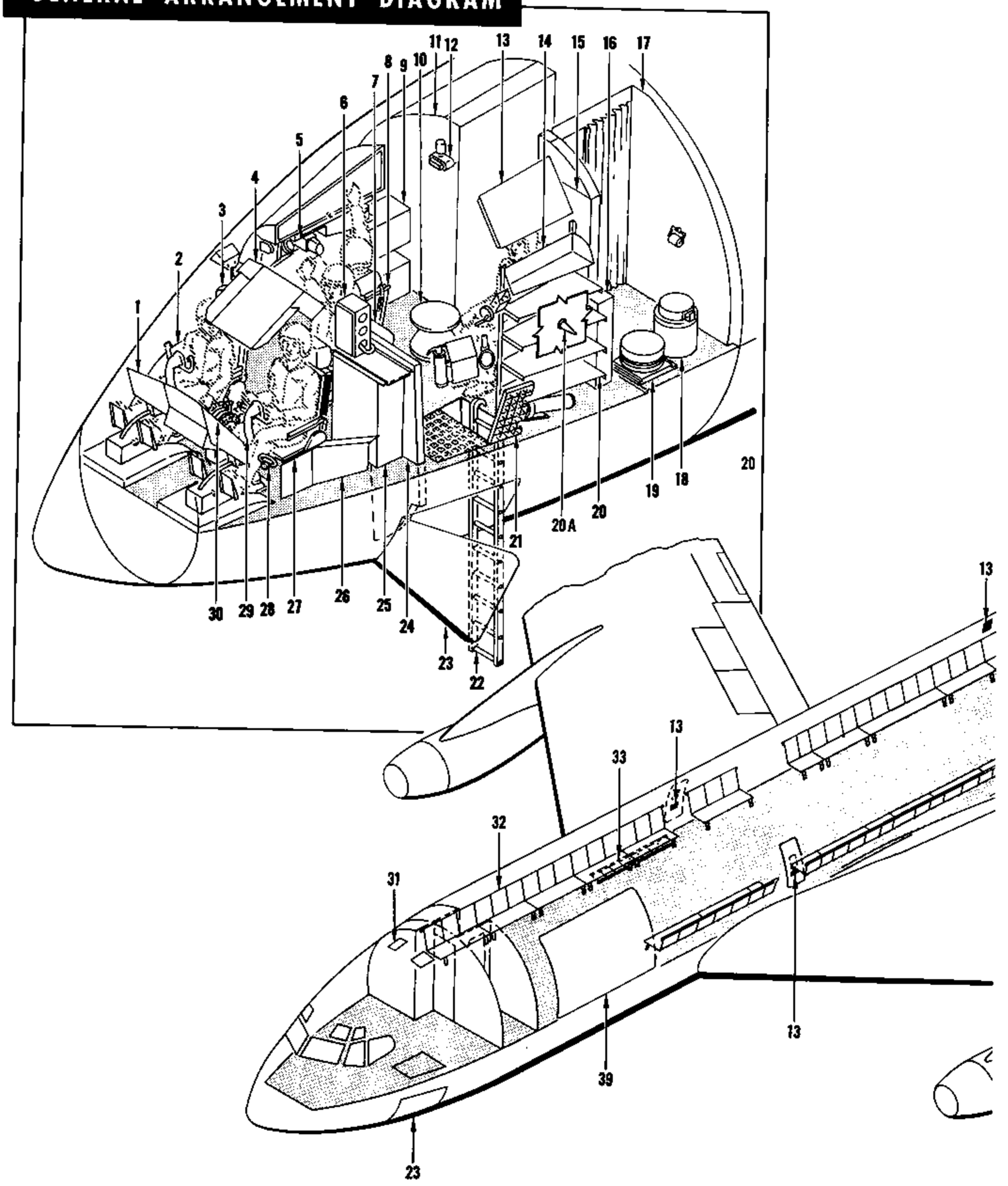
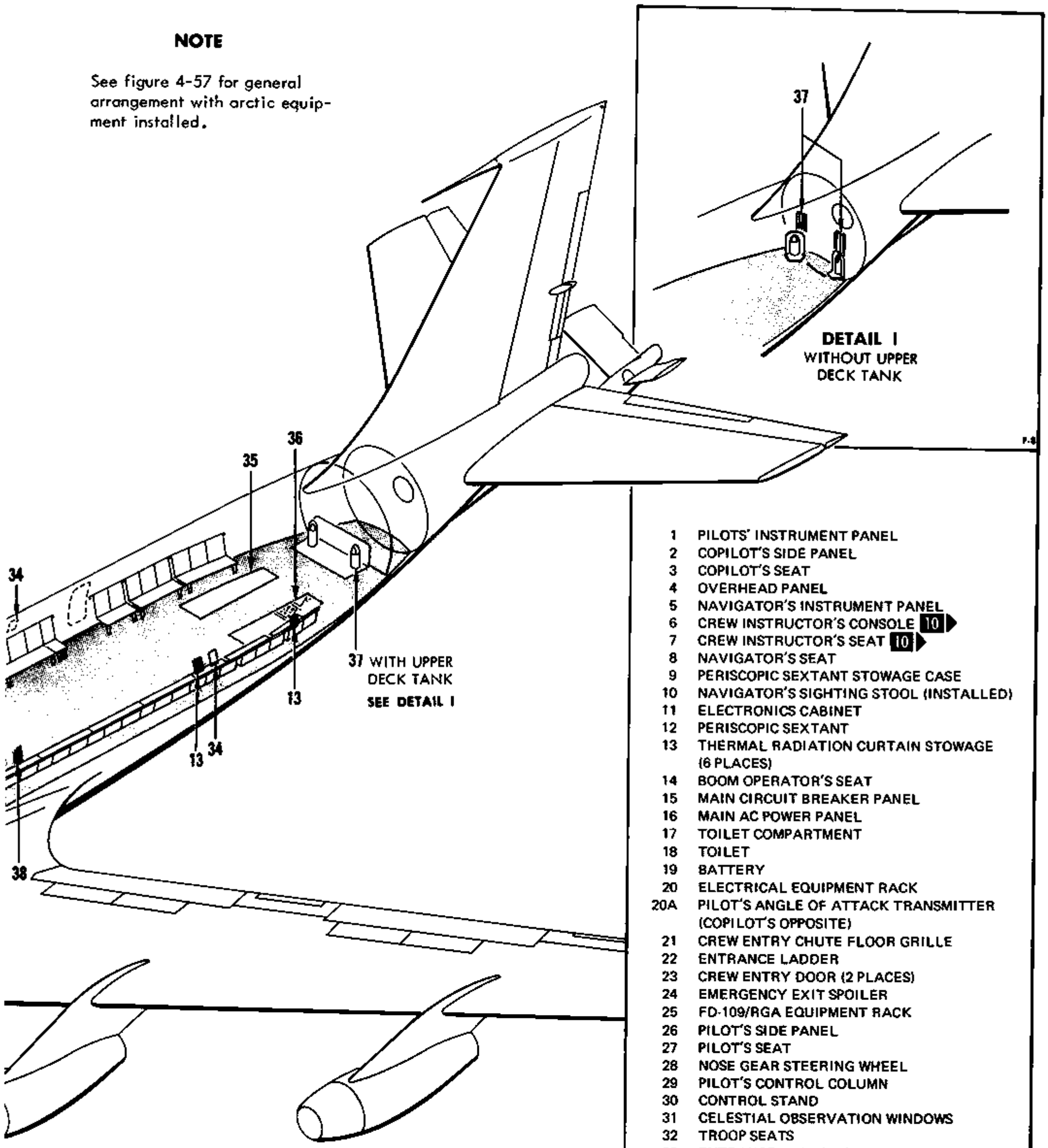


Figure 1-3 (Sheet 1 of 2)

NOTE

See figure 4-57 for general arrangement with arctic equipment installed.

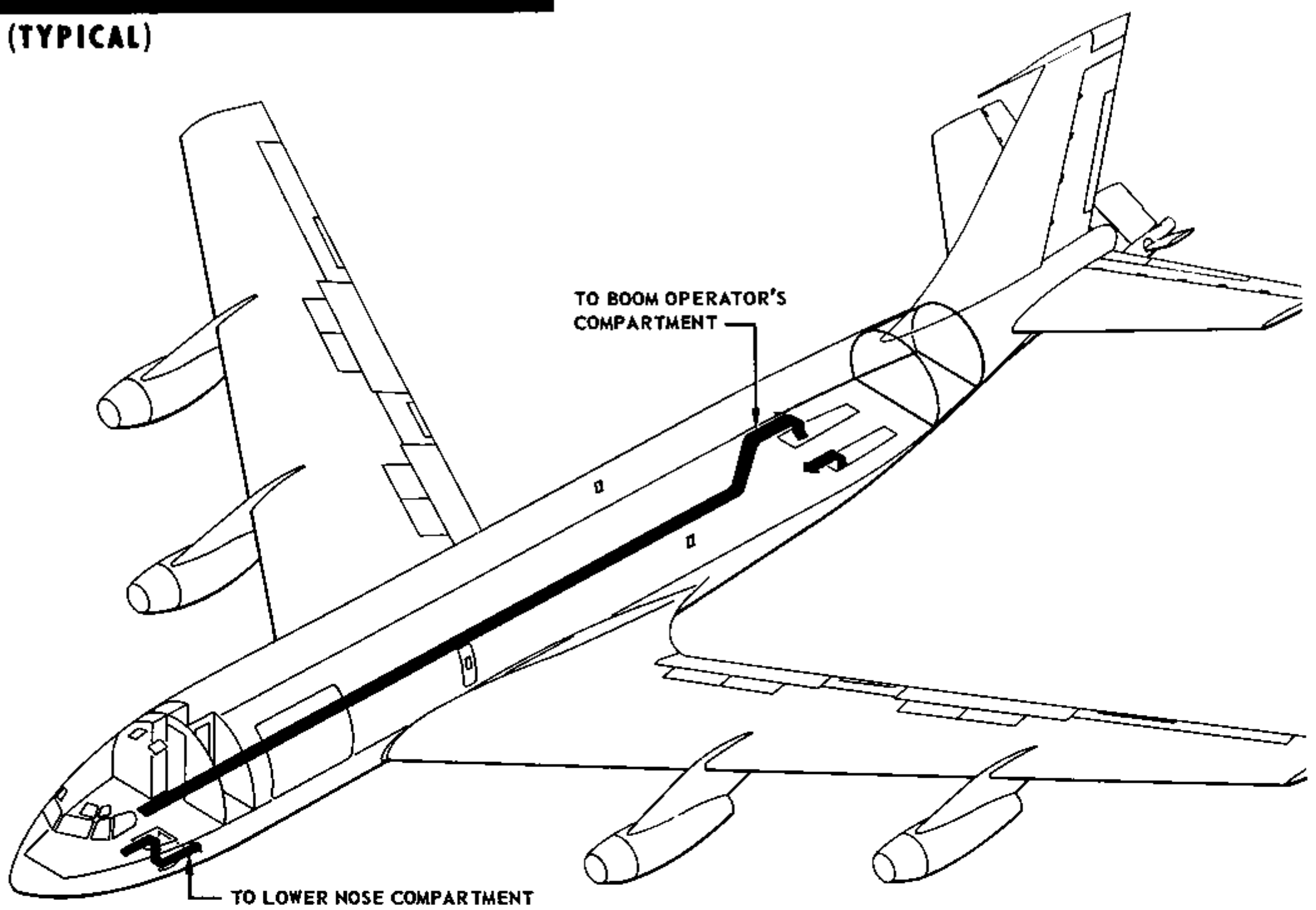


1 PILOTS' INSTRUMENT PANEL
2 COPILOT'S SIDE PANEL
3 COPILOT'S SEAT
4 OVERHEAD PANEL
5 NAVIGATOR'S INSTRUMENT PANEL
6 CREW INSTRUCTOR'S CONSOLE 10
7 CREW INSTRUCTOR'S SEAT 10
8 NAVIGATOR'S SEAT
9 PERISCOPIC SEXTANT STOWAGE CASE
10 NAVIGATOR'S SIGHTING STOOL (INSTALLED)
11 ELECTRONICS CABINET
12 PERISCOPIC SEXTANT
13 THERMAL RADIATION CURTAIN STOWAGE (6 PLACES)
14 BOOM OPERATOR'S SEAT
15 MAIN CIRCUIT BREAKER PANEL
16 MAIN AC POWER PANEL
17 TOILET COMPARTMENT
18 TOILET
19 BATTERY
20 ELECTRICAL EQUIPMENT RACK
20A PILOT'S ANGLE OF ATTACK TRANSMITTER (COPILOT'S OPPOSITE)
21 CREW ENTRY CHUTE FLOOR GRILLE
22 ENTRANCE LADDER
23 CREW ENTRY DOOR (2 PLACES)
24 EMERGENCY EXIT SPOILER
25 FD-109/RGA EQUIPMENT RACK
26 PILOT'S SIDE PANEL
27 PILOT'S SEAT
28 NOSE GEAR STEERING WHEEL
29 PILOT'S CONTROL COLUMN
30 CONTROL STAND
31 CELESTIAL OBSERVATION WINDOWS
32 TROOP SEATS
33 ENTRANCE LADDER STOWAGE
34 AFT SCANNING STATION (2 PLACES)
35 BOOM OPERATOR'S COMPARTMENT
36 BOOM OPERATOR'S INSTRUMENT PANEL
37 URINALS (2 PLACES)
38 EMERGENCY STATION
39 CARGO DOOR

Figure 1-3 (Sheet 2 of 2)

CREW MOVEMENT DIAGRAM

(TYPICAL)



F-9

Figure 1-4

control establishes the engine thrust output in accordance with a predetermined schedule set by the throttle. Low pressure compressor bleed air is used for pneumatic starters, window defrosting, and air conditioning. Low pressure bleed air also is provided for stabilizer trim actuator pressurization, through the air conditioning system. High pressure compressor bleed air is used for engine anti-icing, hydraulic reservoir pressurization, engine water injection pumps, and oil cooler ground air ejection. See figure 1-8 for engine pod views.

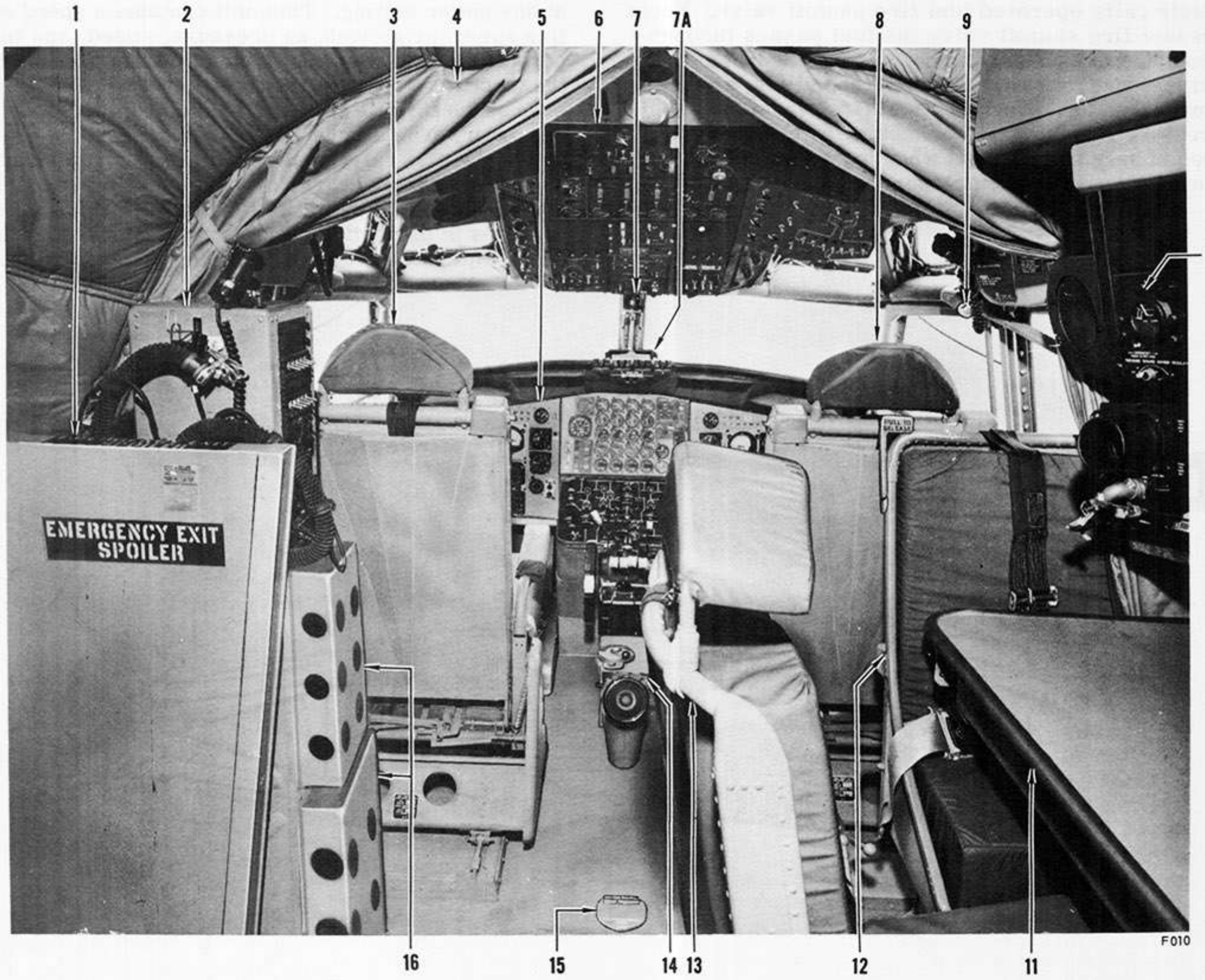
ENGINE THRUST

The primary purpose of the flat-rated engine is to provide constant thrust throughout an ambient temperature range. At sea level the engine, as installed on the airplane, will develop 12,845 pounds of thrust at all ambient temperatures from -65° F to approximately +5° F without use of water augmentation, and 12,925 pounds of thrust from +20° F to 100° F with water augmentation. Additional thrust is available for emergencies. See shaded area, figure 1-7. Above 100° F with water augmentation the thrust decreases with increasing ambient temperature. For dry takeoff conditions from approximately +5° F and up the thrust decreases with increasing temperature. See figure 1-7. For all ambient temperatures the throttles will be set to obtain a predetermined, static, takeoff EPR. To prevent engine compressor icing and obtain

a wet takeoff capability from +20° F to +40° F, water heated to +60° F must be provided. For takeoff procedures refer to NORMAL PROCEDURES, Section II. Takeoff thrust in terms of engine pressure ratio (EPR) for various OAT and altitudes up to 6000 feet is shown in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1. Engine operating and temperature limits are shown in Section V. Refer to ENGINE OPERATION, Section VII.

CONTROL CABIN

(TYPICAL)



1 EMERGENCY EXIT SPOILER
2 CREW INSTRUCTOR'S CONSOLE 10▶
3 PILOT'S STATION
4 BLACKOUT CURTAINS
5 PILOTS' INSTRUMENT PANEL
6 OVERHEAD PANEL
7 MAGNETIC COMPASS
7A TAKEOFF AND LANDING DATA CARD HOLDER TCTO 864
8 COPILOT'S STATION
9 EMERGENCY HYDRAULIC CROSSOVER VALVE LEVER
10 NAVIGATOR'S INSTRUMENT PANEL
11 NAVIGATOR'S STATION
12 CREW INSTRUCTOR'S SEAT 10▶ 215 (STOWED POSITION)
13 NAVIGATOR'S SEAT
14 CONTROL STAND
15 PILOTS' OVERHEAD PANEL FLOOD LIGHT
16 FD109/RGA EQUIPMENT RACK

Figure 1-5

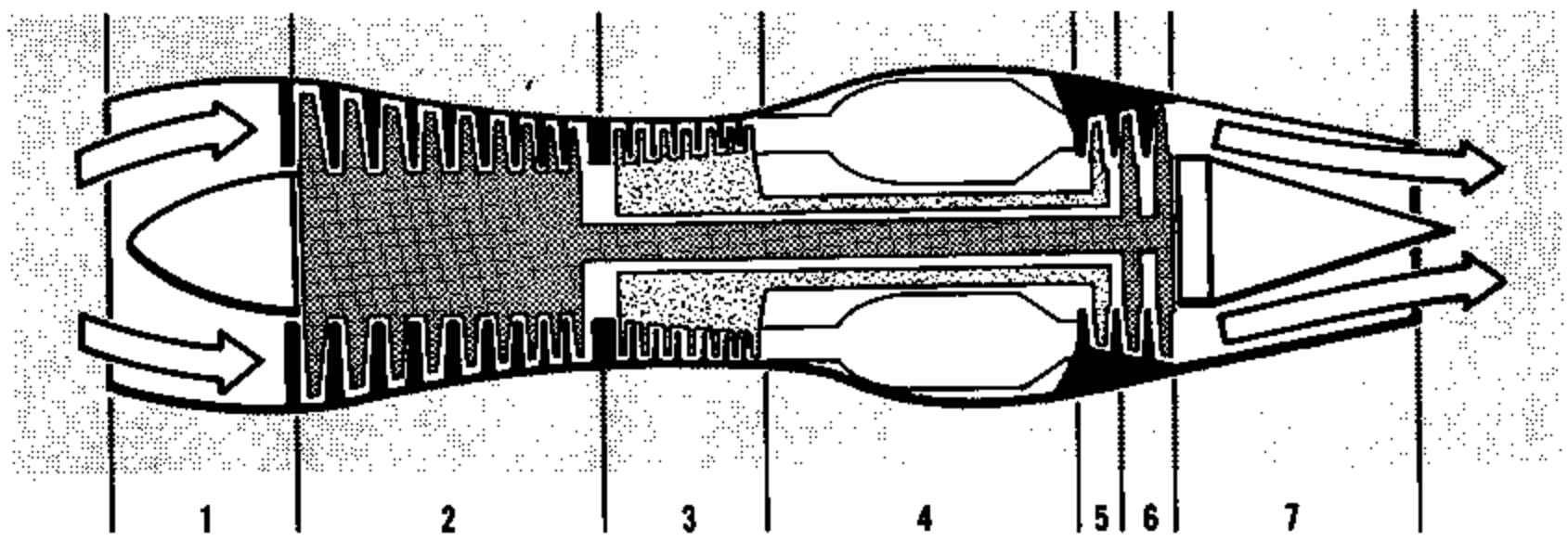
ENGINE FUEL CONTROL SYSTEM

An engine fuel control system (figure 1-12) on each engine automatically provides optimum engine performance for any throttle setting. This system makes it unnecessary to adjust the throttle to compensate for variations in inlet temperature, altitude or airspeed. Fuel from the tanks is routed through the fuel feed system to fuel control units which meter fuel to each engine. The throttle provides basic engine power control and operates through the fuel control unit to position a throttle valve. Engine fuel from the fuel feed system is also controlled by an electrically operated fuel fire shutoff valve. From the fuel fire shutoff valve the fuel passes through a two stage engine-driven fuel pump, a hydromechanical fuel control unit, fuel flow transmitter, and pressure regulator. Normally fuel flows from the pressure regulator to the combustion chambers in the primary manifold but when higher burner pressure is sensed by the pressure regulator, a second manifold will carry an additional amount of fuel to the combustion chambers. A manifold drain valve, which is held closed by fuel pressure, is opened by return spring pressure when the throttle is moved to the CUT-OFF position shutting off fuel pressure to the valve. The opening of this valve as fuel pressure drops allows fuel to drain from the fuel manifolds.

Fuel Control Unit

A hydromechanical fuel control unit (figure 1-12) meters proper fuel quantity for engine operation at any power setting. This unit contains a speed setting governor as well as pressure, speed, and temperature sensing servos which act in conjunction with the throttle to position the throttle valve. Fuel pressure at the throttle valve is maintained by a pressure regulator. The amount of fuel metered to the engine by the throttle valve is determined by a combination of compressor discharge pressure, engine inlet temperature, engine rpm, and throttle position. This unit aids in protecting the engine from overspeeding, overtemperature, compressor surge, and flameout.

ENGINE DIAGRAM



1 INLET
2 LOW PRESSURE COMPRESSOR
3 HIGH PRESSURE COMPRESSOR
4 BURNERS
5 HIGH PRESSURE TURBINE
6 LOW PRESSURE TURBINE
7 EXHAUST

F-11

Figure 1-6

ENGINE THRUST

CONDITIONS:

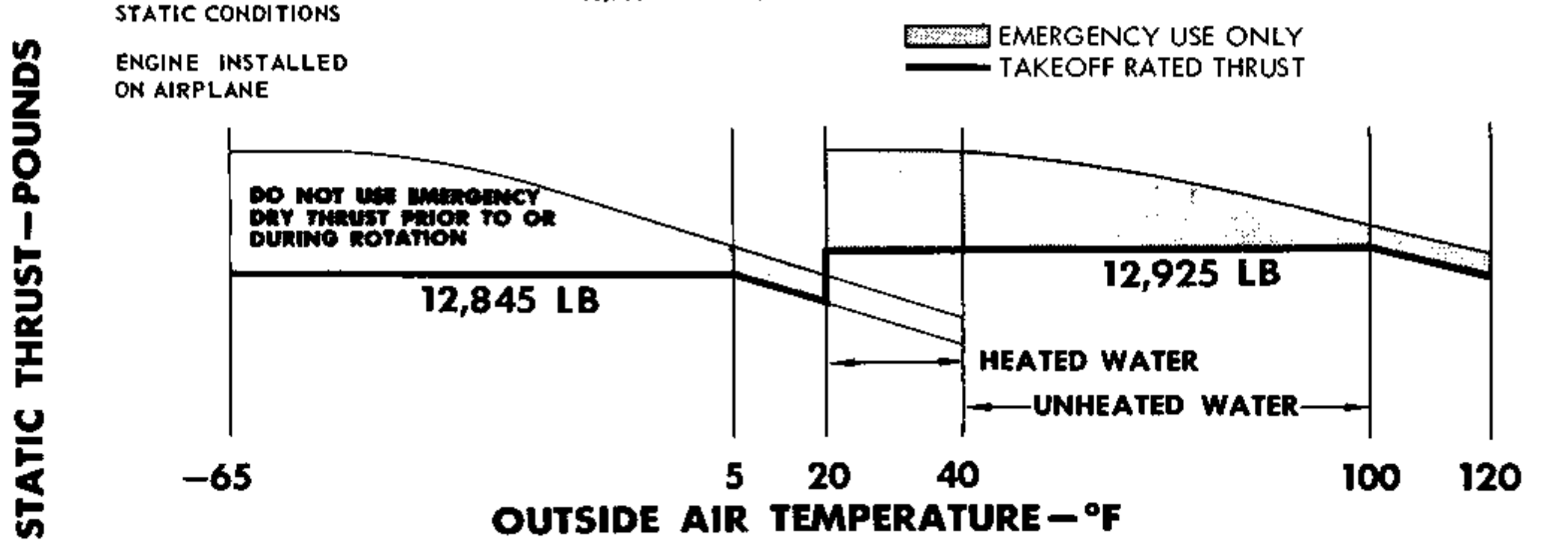
SEA LEVEL

STATIC CONDITIONS

ENGINE INSTALLED ON AIRPLANE

REMARKS:

ENGINE ON TEST STAND DEVELOPS 13,750 LB THRUST



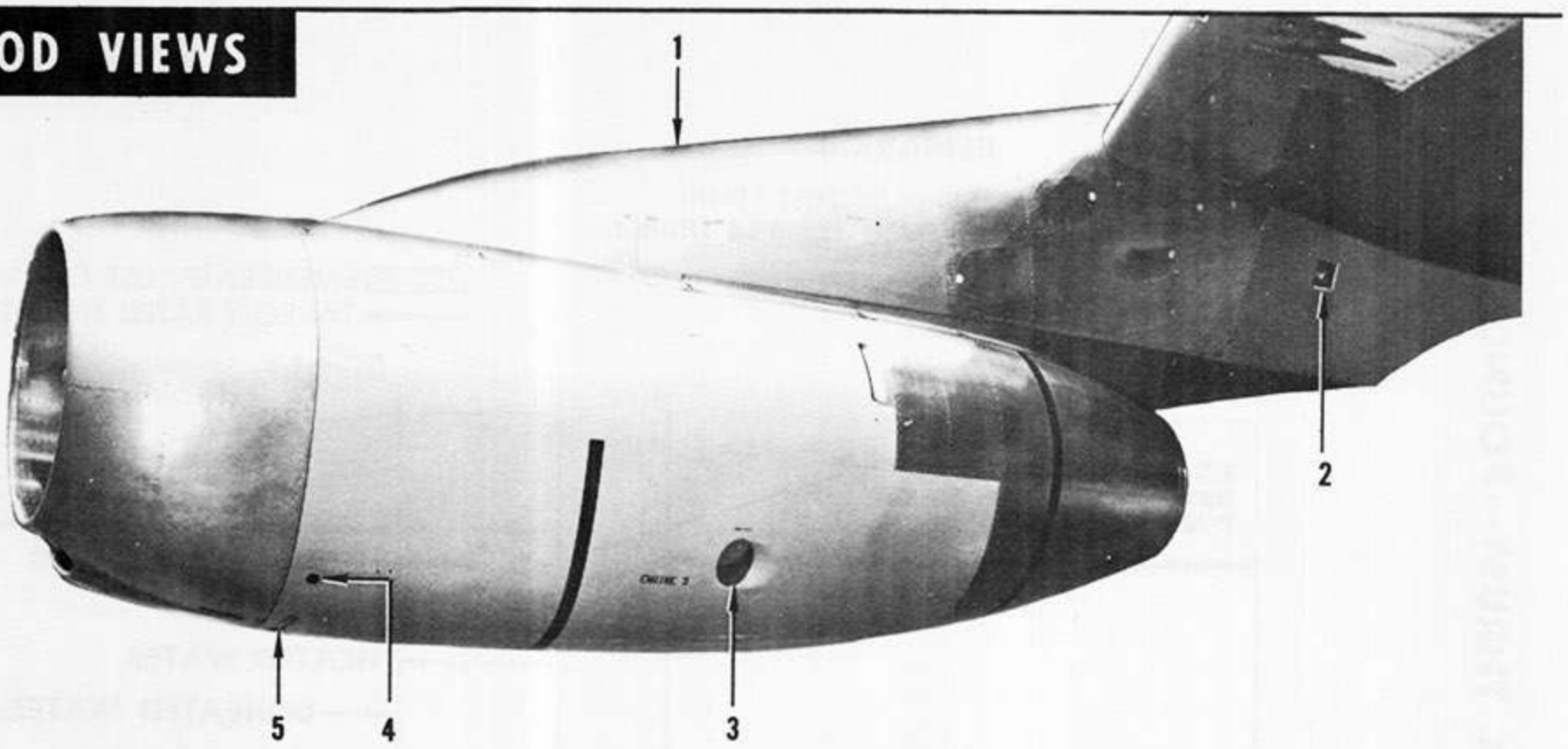
F-32

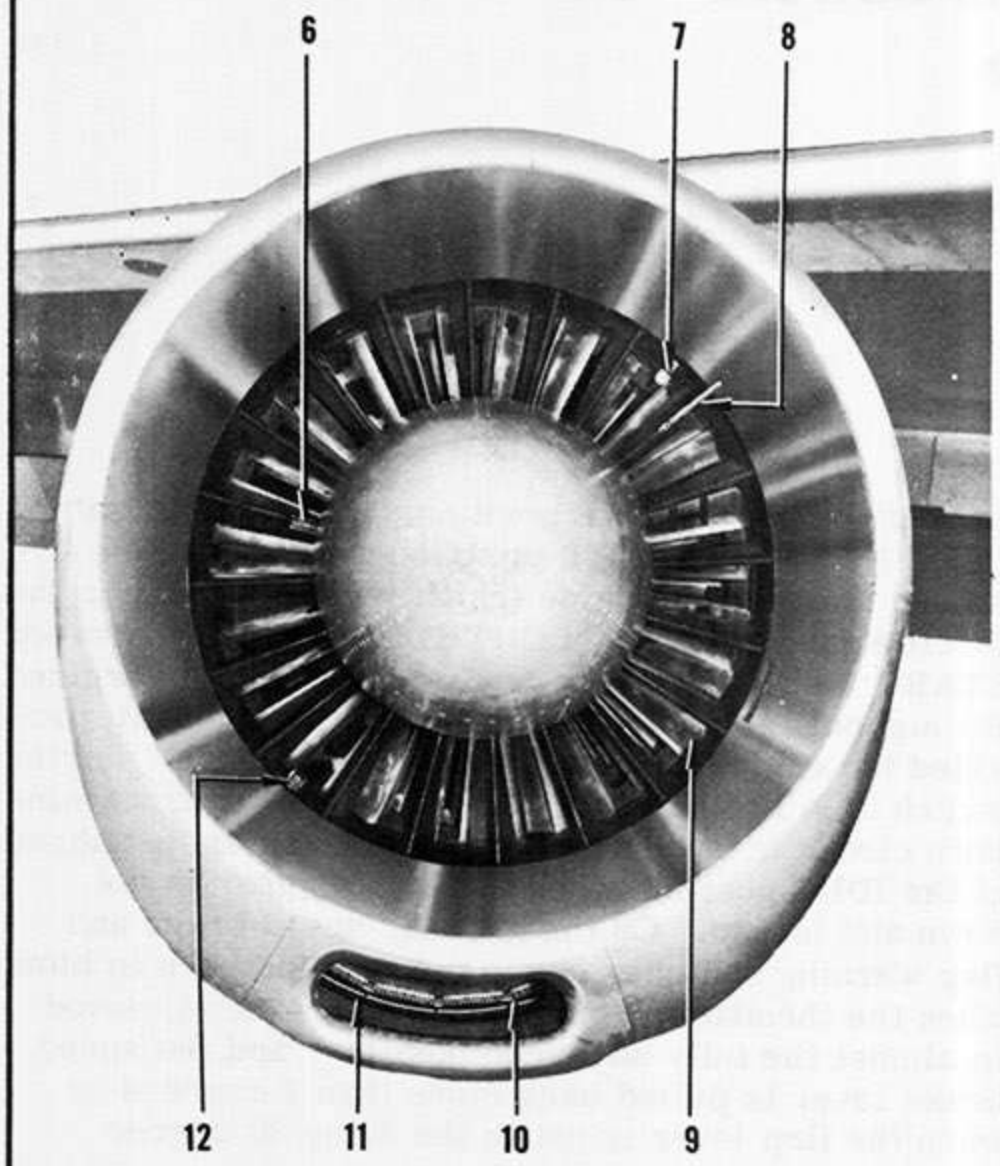
Figure 1-7

Throttles

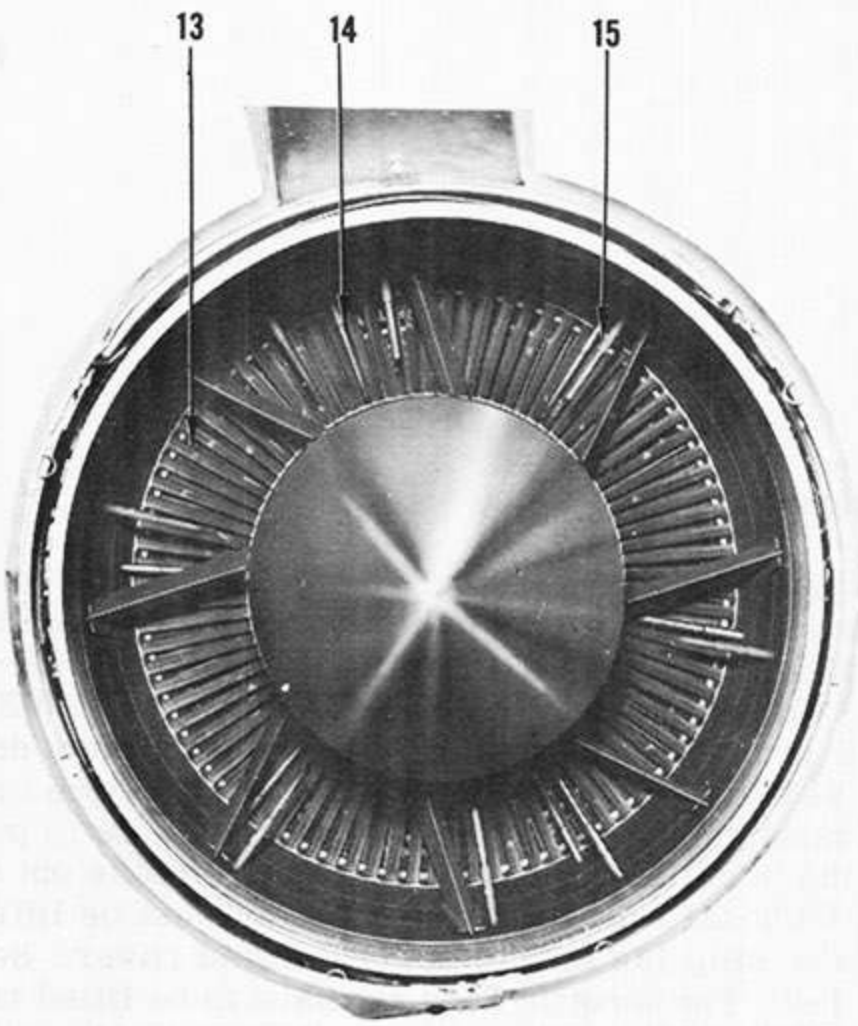
The engine throttles (2, figure 1-22) are on the control stand. Engine throttle positions are marked CUT-OFF--START--IDLE--INCREASE THRUST--OPEN. On airplanes 176▶ the MAX WET POWER RANGE is marked beginning with the maximum dry thrust setting for a 20°F day. The throttles are linked mechanically with the fuel control units to position the throttle valves. To move the throttle out of the aft CUT-OFF position the throttle must be lifted to clear a stop lug on the control stand cover. See figure 1-9. The throttle does not have to be lifted into this CUT-OFF position (latched) when the throttle is being retarded. When the throttle is advanced approximately one quarter of its travel from the CUT-OFF position it will contact another stop marked START. The throttles must be lifted over this stop to be placed in the IDLE position. If the starter switch is in GROUND START position and the engine fire switch closed, the engine ignition will energize in the throttle range just out of CUT-OFF to halfway between START and IDLE. The engine ignition is energized throughout the full range of throttle movement, provided the engine fire switch is closed, and the starter switch is in FLIGHT START. The landing gear warning horn circuit is energized when the throttle is just ahead of the IDLE position when the landing gear is not down and locked. On the ground, speed brake and flap warning switches cause the warning horn to blow when the throttle for number three engine is moved to almost the fully advanced position, and the speed brake lever is pulled back more than 2 degrees or when the flap lever is not in the 20 or 30 degree

ENGINE POD VIEWS





INLET AREA



EXHAUST AREA

1 STRUT
2 UNDER BODY ILLUMINATION LIGHT (INBOARD ENGINES)
3 SURGE BLEED VALVE
4 PRESSURE GAGE WINDOW
5 COWL LOCKS
6 SURGE BLEED TEMPERATURE SENSING PROBE
7 SURGE BLEED INLET PRESSURE PICKUP
8 EPR INLET PRESSURE PICKUP
9 COMPRESSOR BLADES
10 HAIL SHIELD
11 OIL COOLER
12 ENGINE FUEL CONTROL UNIT TEMPERATURE SENSING PROBE
13 TURBINE BLADES
14 EXHAUST PRESSURE PROBES (TOTAL OF 6)
15 EGT PROBES (TOTAL OF 8)

F-12
F-14
F-13

Figure 1-8

detent. The warning horn will sound if the No. 3 throttle is advanced near OPEN while the airplane is on the ground and the leading edge flaps are not fully extended. For additional information on warning horn operation see WARNING HORN AND CUTOUT SWITCH under FLIGHT CONTROL SYSTEMS in this Section. There is approximately 90 degrees of travel in the full range of throttle movement. The engine water pump control valves are energized open when their respective throttle is near the fully advanced position.

Throttle Brake Lever

A throttle brake lever (4, figure 1-22) on the control stand (to the right of the throttle) is used to adjust the amount of resistance to throttle movement and to hold the throttles in a desired position. In the forward position the throttle friction is increased and in the aft position the throttle friction is decreased.

Engine Fire Switches and Warning Lights

Refer to ENGINE FIRE SWITCHES AND WARNING LIGHTS under EMERGENCY EQUIPMENT in this Section.

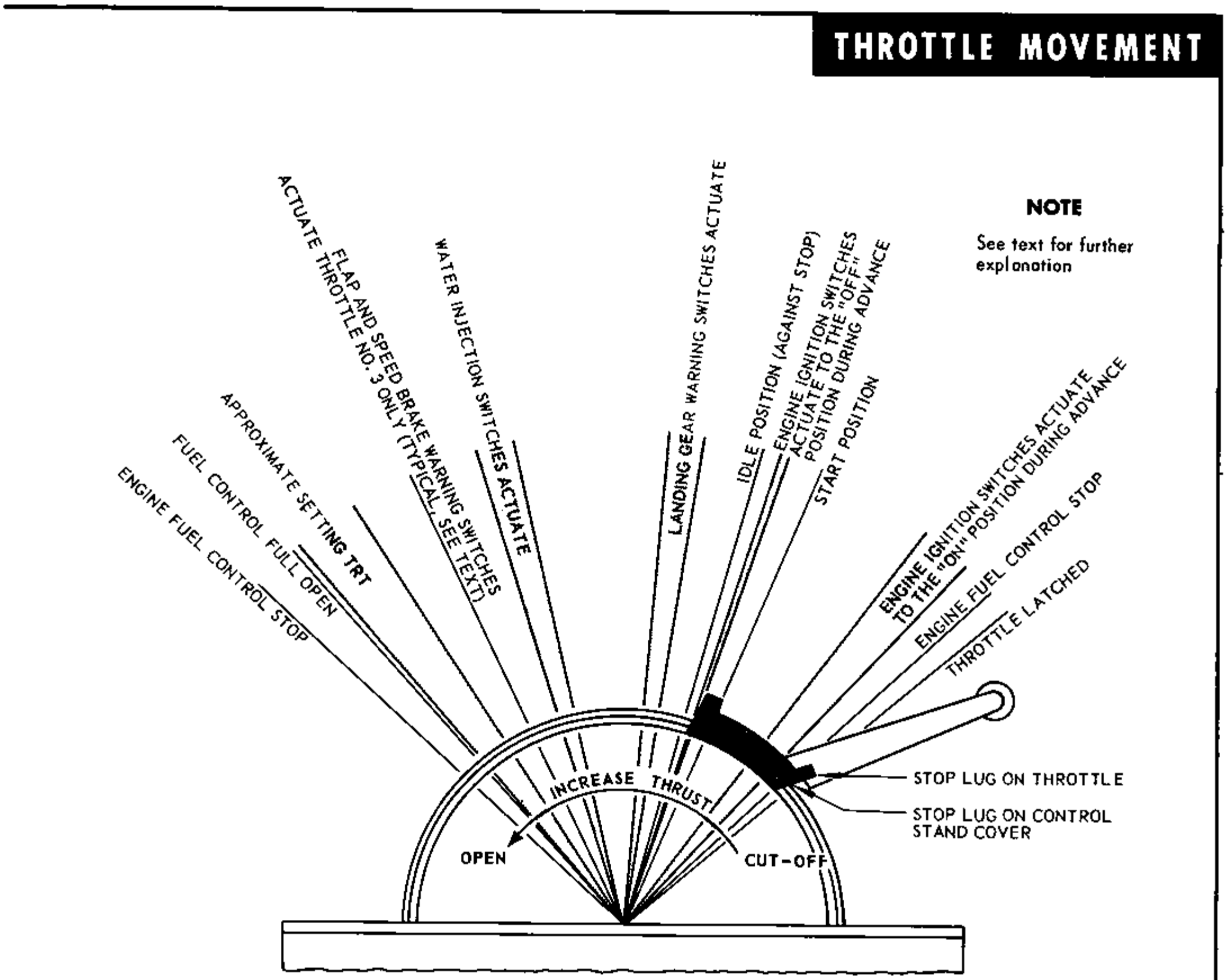
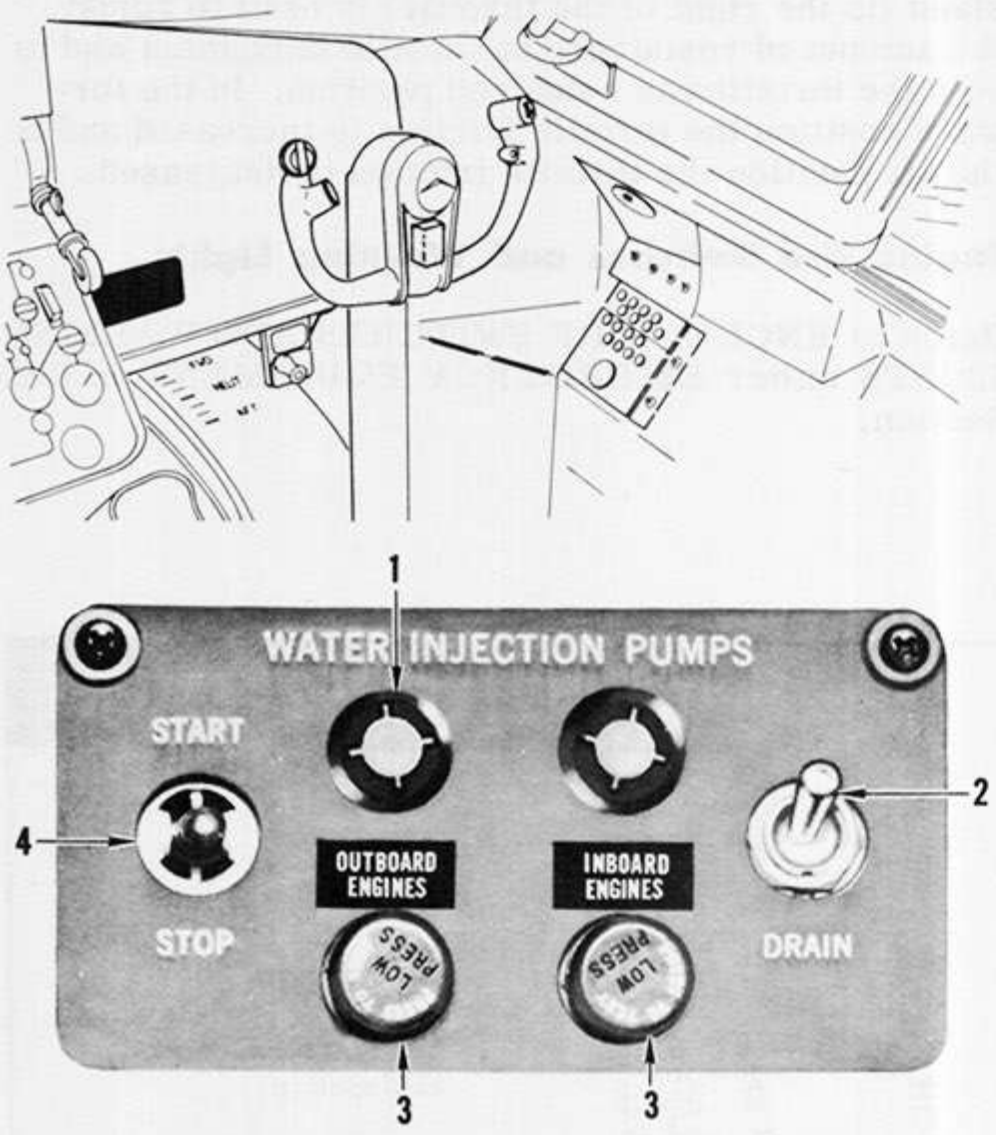


Figure 1-9

WATER BOOST PUMPS CONTROL PANEL



1 PANEL LIGHTS
2 WATER INJECTION TANK DRAIN VALVE SWITCH
3 WATER BOOST PUMP LOW PRESSURE WARNING LIGHTS (2 PLACES)
4 WATER BOOST PUMPS CONTROL SWITCH

Figure 1-10

Engine Fuel Flowmeter

Four engine fuel flowmeters (12, figure 1-17), calibrated in pounds per hour, are on the pilots' center instrument panel. Some airplanes have flowmeters calibrated from 0 to 12,000 pph and others have flowmeters calibrated from 0 to 15,000 pph. Operating power is 115 volt AC through a circuit breaker marked ENGINE FUEL FLOW on the GENERATOR NO. 2 section of the MCBP (figure 1-35, sheet 3). A transmitter on each engine measures the mass fuel flow and provides signals to the flowmeters. One power supply unit is used to operate the 4 engine transmitters and the boom fuel flow transmitter. Operating power is 28 volt DC through the circuit breaker marked INDICATOR, FUEL TRANSFERRED, adjacent to the circuit breaker marked UNDER WING ILLUM, on the BOCBP (figure 1-35, sheet 5).

WATER INJECTION SYSTEM

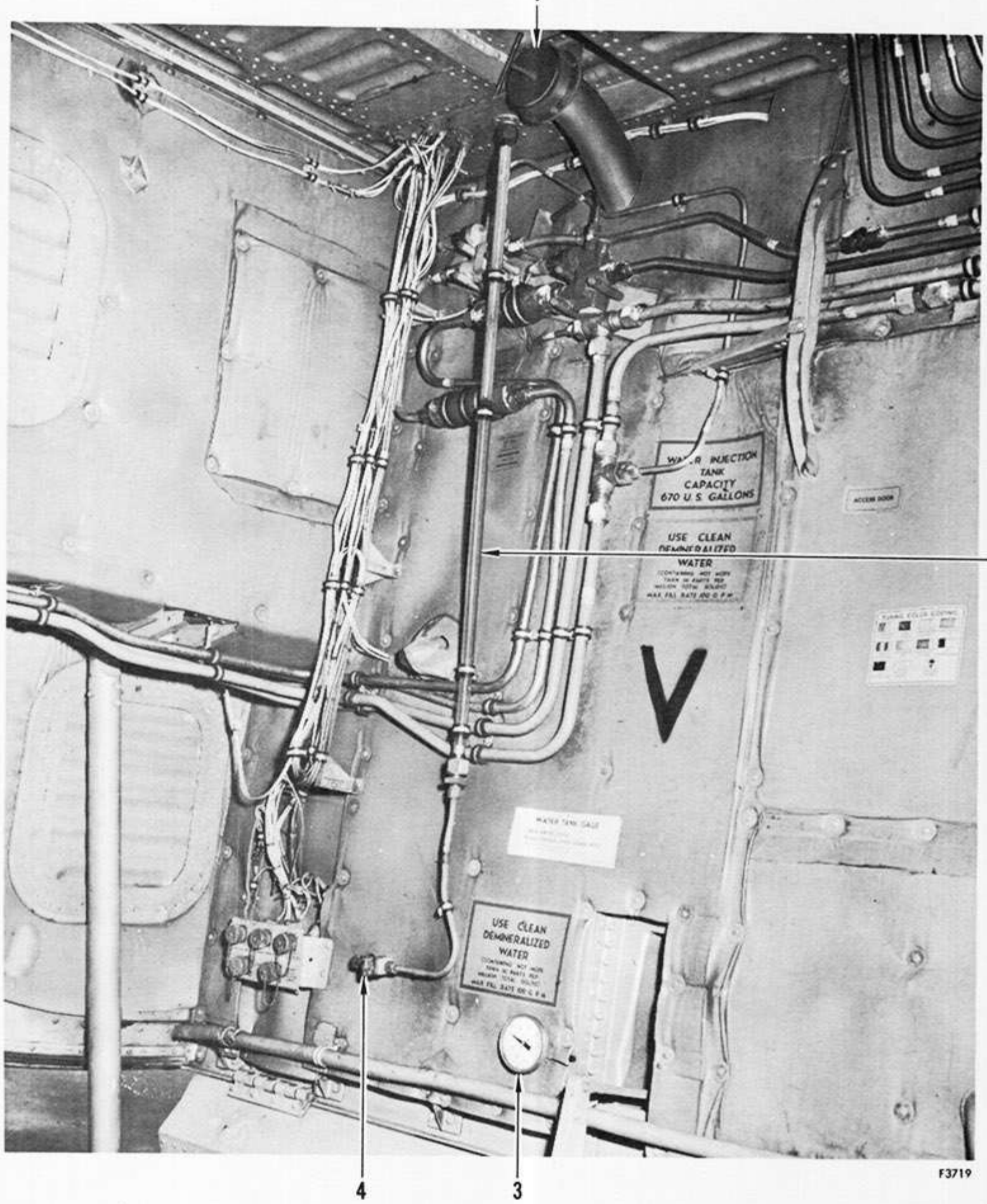
A water injection system (figure 1-12) provides thrust augmentation by allowing water to be sprayed into the air inlet and diffuser section of each engine. Water injected in this manner increases the density of inlet and combustion air allowing increased thrust. Eight electrical heating probes are in the water tanks, 6 probes in the keel beam tank and one probe in each saddle tank. These probes draw 5 KW each and are individually controlled (except for one keel beam tank heater and the two saddle tank heaters) from the water heater power panel. Water injection should be used for takeoff only. Water injection can be used on takeoff up to 6000 feet and must be turned off before reaching 8000 feet. The water injection equipment is designed for static operation at altitudes from sea level up to a pressure altitude of 6000 feet and inflight operation at altitudes up to 8000 feet pressure altitude. The water injection pumps will not provide sufficient pressure to actuate the water reset servo in the fuel control for takeoff above 6000 feet pressure altitude. Water injection should not be used at altitudes above 8000 feet because the water flow will not be proper for reliable engine operation. Water injection may be used down to 20° F (-6.7° C) with the water temperature not lower than 60° F (15.6° C). Water injection may be used when both the ambient and water temperatures are 40° F (4.4° C) and above.

NOTE

When an airplane is serviced with heated water, the temperature of the water should not exceed 130° F.

Two electrically driven water pumps furnish approximately 80 gallons per minute to each engine from an integral 670 gallon fuselage tank (figure 1-10A). The forward water boost pump supplies the No. 1 and 4 engines and the aft pump supplies the No. 2 and 3 engines. Water flows from these pumps to a high pressure compressor air driven turbine pump on each engine. Water then passes through a pressure controlled check valve to water flow regulators in the inlet and diffuser manifolds of each engine before entering the discharge nozzles. If the water boost pumps control switch has been moved to the START position and the throttles have been moved to the near fully advanced position, the engine water pump control valves are energized open. Thus, high pressure compressor air is admitted to drive the turbine driven engine water pumps provided the boost pumps are producing sufficient water pressure to hold the boost pump relays closed. When the throttles are retarded, the engine water pump control valves are closed.

WATER INJECTION TANK



1 FILLER NECK
2 SIGHT GAGE
3 THERMOMETER
4 DRAIN COCK

Figure 1-10A

CAUTION

Except in an emergency water injection must not be deactivated by retarding throttles. If necessary to deactivate the water system on all engines before water runout, it will be deactivated by moving the water boost pump control switch to the STOP position. This action is necessary since retarding throttles will cause a system surge with resultant damage to the water tank components. In those instances where water injection is being used on two or more engines and it is desired to deactivate water injection on one engine, the procedure will be to retard the throttle on that engine or pull the appropriate circuit breaker. During a takeoff abort or other emergency, water injection can be deactivated by retarding the throttles to below approximately 80% rpm. However, the water boost pumps switch should then be moved to the STOP position to deactivate the water boost pumps.

A motor operated drain valve drains the system after use to prevent remaining water from freezing in the lines from the tank. The time required to gravity drain the 670 gallon water injection tank on the ground is 18 minutes. A heated drain mast is provided. A warning light, actuated by a pressure switch for each water boost pump, indicates that sufficient water pressure is available for injection.

Water Tank Sight Gage

A sight gage (2, figure 1-10A) is installed in the right wheel well on the side of the water injection tank. The gage provides an external means of checking the water level in the tank and consists of a drain cock and a red and white float in a length of transparent plastic tubing. The water level is checked by opening the drain cock and placing a finger over the drain hole in the lower tube. Water will fill the tubing and raise the float to the water level within the tank. The tank is full when the float rises to the fitting at the top of the transparent tube. After the check, the drain cock is closed and the water in the sight gage drains out through the drain hole to prevent freezing in flight.

Water Boost Pumps Control Switch

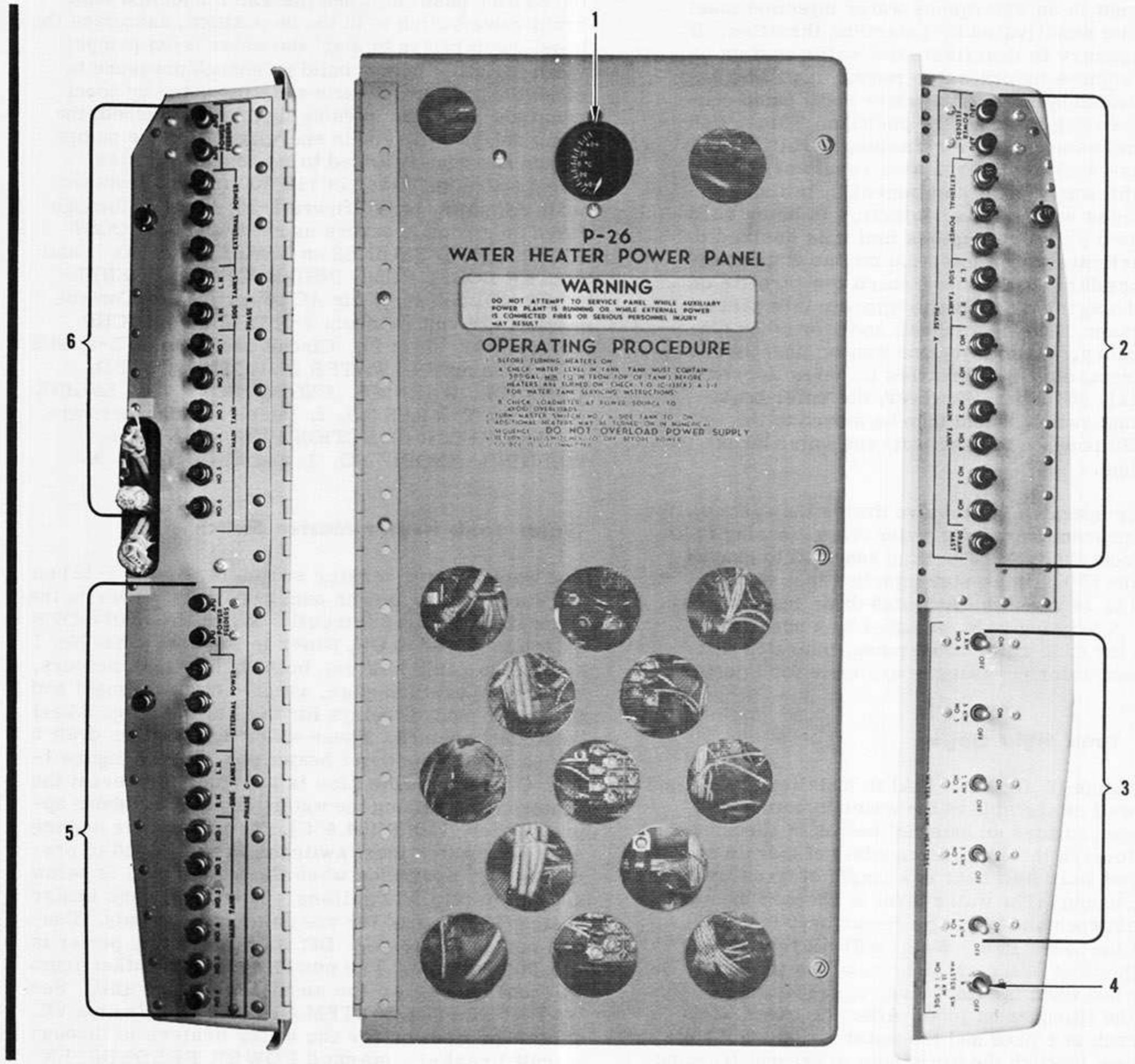
A water boost pumps control switch (4, figure 1-10) with START--NEUTRAL--STOP positions is on the water boost pumps control panel on the copilot's flight instrument panel (23, figure 1-19). It is spring loaded from the START and the STOP position to the neutral center position. Moving the pumps switch to the START position, when the water injection tank drain valve switch is in the up position, energizes the boost pump relays to start the water boost pumps. When the boost pumps build up enough pressure to close the pressure switches (as indicated by boost pump low pressure warning lights extinguished) the pump relays will remain energized after the pumps switch has been released to its neutral position. Pump operating power is 115/200 volt AC from the main AC power panel (figure 1-35, sheet 4) through fuses or circuit breakers marked WATER BOOST PUMP OUTBD ENGINES on GENERATOR NO. 1 and WATER BOOST PUMP INBD ENGINES on GENERATOR NO. 2 of the main AC power panel. Control power is 28 volt DC from T-R BUSSES on MCBP (figure 1-35, sheet 2). Circuit breakers on T-R BUS NO. 1 are marked WATER INJECTION OUTBD, CONTROL, WARNING, ENGINE NO. 1, and ENGINE NO. 4; on T-R BUS NO. 2, the circuit breakers are marked WATER INJECTION INBD, CONTROL, WARNING, ENGINE NO. 2, and ENGINE NO. 3.

Water Tank Heater Master Switch

The water heater master switch (4, figure 1-11) on the water heater power panel controls power to the water tank heater circuit. When this ON--OFF switch is placed to ON, power is supplied to the No. 1 keel beam tank heater, both saddle tank heaters, water temperature gage, water tank drain mast and the power control relays for the No. 2 through 6 keel beam tank heaters. These water tank heaters draw 5 KW each from the water heater power panel (figure 1-11). Overheat protection is provided to prevent the heaters from raising the water temperature above approximately 130° F (54.4° C). To protect the heating elements, water level switches are provided to prevent heater operation when the water level is below approximately 500 gallons. The water tank heater system is designed for use on the ground only. Control power is 28 volt DC and operating power is 115/200 volt AC. The power source is either from external power or the auxiliary power unit. See WATER HEATER SYSTEM OPERATION, Section VII. Circuit protection for the water heaters is through circuit breakers marked POWER FEEDERS, EXTERNAL POWER, SIDE TANKS and MAIN TANK on the water heater power panel (figure 1-11).

WATER HEATER POWER PANEL

(TYPICAL)



1 WATER TEMPERATURE GAGE
2 CIRCUIT PROTECTION (PHASE A)
3 WATER TANK HEATER SWITCHES
4 WATER TANK HEATER MASTER SWITCH
5 CIRCUIT PROTECTION (PHASE C)
6 CIRCUIT PROTECTION (PHASE B)

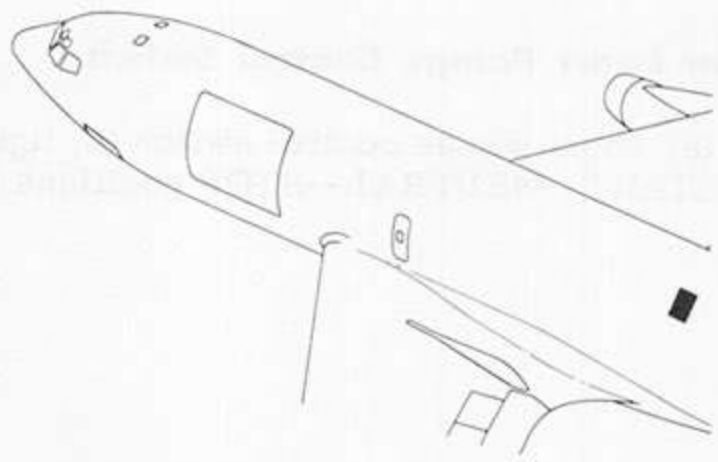


Figure 1-11

Water Tank Heater Switches

These five ON--OFF switches (3, figure 1-11) on the water heater power panel control power to keel beam tank heaters No. 2, 3, 4, 5, and 6. However, the water tank heater master switch (4, figure 1-11) must be ON, the water level above approximately 500 gallons, and the water temperature less than 130° F (54.4°C) before power is supplied through these switches to the heaters. Control power is 28 volt DC and operating power is 115/200 volt AC. The power source is from external power or the auxiliary power unit. See WATER HEATER SYSTEM OPERATION, Section VII. Circuit protection for the water heaters is through circuit breakers marked POWER FEEDERS, EXTERNAL POWER, SIDE TANKS and MAIN TANK on the water heater power panel (figure 1-11).

Water Injection Tank Drain Valve Switch and Override Handle

A water injection tank drain valve switch (2, figure 1-10) is on the water boost pumps control panel. The switch has a DRAIN position and an unmarked (up) position. This switch is spring loaded from the DRAIN position to the (up) position. The drain valve is opened electrically when this switch is held in the DRAIN position for a few seconds and cannot be closed by releasing the switch. The drain valve (18, figure 1-65) can be closed manually only by actuating an override handle through an access door in the bottom of the fuselage between the wheel well doors. The boost pump low pressure warning lights are extinguished when the drain valve switch has been placed in the DRAIN position. Operating power is 28 volt DC. Power is from T-R BUS NO. 1 through a circuit breaker marked WATER INJECTION OUTBD, CONTROL, and from T-R BUS NO. 2 through a circuit breaker marked WATER INJECTION INBD, CONTROL. A heated drain mast is provided to prevent water from freezing in the drain mast both in the air and on the ground. Power is supplied to the mast through the ground safety relay so that 115 volt AC is supplied to the mast at all times during flight. On the ground, when the water tank heater master switch (4, figure 1-11) is ON, the quantity of water in the tank is greater than 500 gallons and the water temperature is less than approximately 130°F (54.4°C), power is supplied to the mast from either external power or the auxiliary power unit. Circuit protection for the drain mast is through circuit breakers marked DRAIN MAST HEATER on the GENERATOR NO. 3 section of the MCBP (figure 1-35, sheet 3) and DRAIN MAST on the water heater power panel (figure 1-11).

Water Boost Pump Low Pressure Warning Lights

Two amber water boost pump low pressure warning lights (3, figure 1-10) are on the water boost pumps control panel. These lights are illuminated whenever there is insufficient pressure from the boost pumps to close the pressure switches provided the water injection tank drain valve is closed. These lights will not illuminate if the water tank heater master switch (4, figure 1-11) is ON. Operating power is 28 volt DC. Circuit breakers are marked WATER INJECTION OUTBD, WARNING on T-R BUS NO. 1 and WATER INJECTION INBD, WARNING on T-R BUS NO. 2.

Water Temperature Gage

A water temperature gage (1, figure 1-11) on the water heater power panel, indicates the temperature of the water in the tank in degrees Centigrade, provided the water tank heater master switch is ON. Operating power is 28 volt DC from either external power or the auxiliary power unit. A thermometer (3, figure 1-10A) on the side of the water tank in the right wheel well can also be used to check water temperature.

ENGINE IGNITION AND STARTING SYSTEM

Ignition System

The engine ignition system is a high energy, capacitor type ignition system which provides a high voltage spark capable of blasting carbon deposits, and vaporizing globules of fuel. Primary control of the system is through the engine ignition control and start panel (figure 1-15). Placing the starter switches (1, figure 1-15) in either GROUND START or FLIGHT START will energize the engine ignition units through the throttle control switches and engine fire switches. When the starter switch is placed in GROUND START the engine ignition will actuate in the throttle range from just out of CUT-OFF TO half way between START and IDLE. When the starter switch is placed in FLIGHT START, engine ignition

will be energized throughout the full range of throttle movement.

CAUTION

Excessive use of continuous ignition may cause engine igniters to fail. If conditions permit, limit the use of the FLIGHT START (continuous ignition) position on the ground to 5 minutes or less. Continuous ignition may be extended to 10 minutes in flight since cooling capability is increased.

Operating power is 28 volt DC, and circuit protection is provided on the SBCBP through circuit breakers marked ENGINE IGNITION, 1, 2, 3, and 4 (figure 1-35, sheet 1).

Starting System

The airplane is equipped with two different starter systems. The No. 4 engine has a cartridge-pneumatic starter while the other engines are equipped with pneumatic starters. The cartridge starter system permits engine starting without the aid of ground support equipment. Normal starting procedure calls for starting of engine No. 4 first. Engine bleed air is then bled from engine No. 4 low pressure compressor by the engine air bleed system (figure 4-1) at approximately 90-95% rpm to provide pressurized air for the pneumatic starters on the other engines.

With 1C10 920

All engines are equipped with a cartridge-pneumatic starter. The cartridge start capability on all engines permits starting in a minimum length of time and starting without the aid of ground power equipment. The pneumatic start capability on all engines permits starting from a ground power cart or from any other operating engine. Normally, engine No. 4 will be started first and the remaining engines will be started pneumatically from bleed air from engine No. 4. If mission requirements dictate minimum time starting, all engines can be started simultaneously using the cartridge start capability.

Pneumatic Starter System Without 1C10 920

The pneumatic starter system consists of a pressure regulating valve and an air turbine starter. The starter utilizes air from either a ground source or engine air bled from another operating engine. Engines Nos. 1, 2, and 3 have the pneumatic starter installed. See ENGINE AIR BLEED SYSTEM, Section IV.

Pneumatic Starter Switches Without 1C10 920

These pneumatic starter switches (1, figure 1-15), with GROUND START--OFF--FLIGHT START positions are on the ignition control and start panel. With the engine fire switch in the normal position, the throttle at START and the pneumatic starter switch in the GROUND START position engine bleed air is admitted to the starter air turbine, (external air may also be used in lieu of engine bleed air) and the engine ignition is energized. When the engine reaches the starter cutout speed of approximately 43 to 54% rpm, the air supply is cut off; except, when engine No. 4 reaches the starter cutout speed of approximately 44% rpm, the air supply is cut off. With the pneumatic starter switch in FLIGHT START, the engine ignition is energized throughout the full range of throttle movement. Circuit protection is through circuit breakers marked ENGINE STARTER 1, 2, and 3 on the SBCBP (figure 1-35, sheet 1).

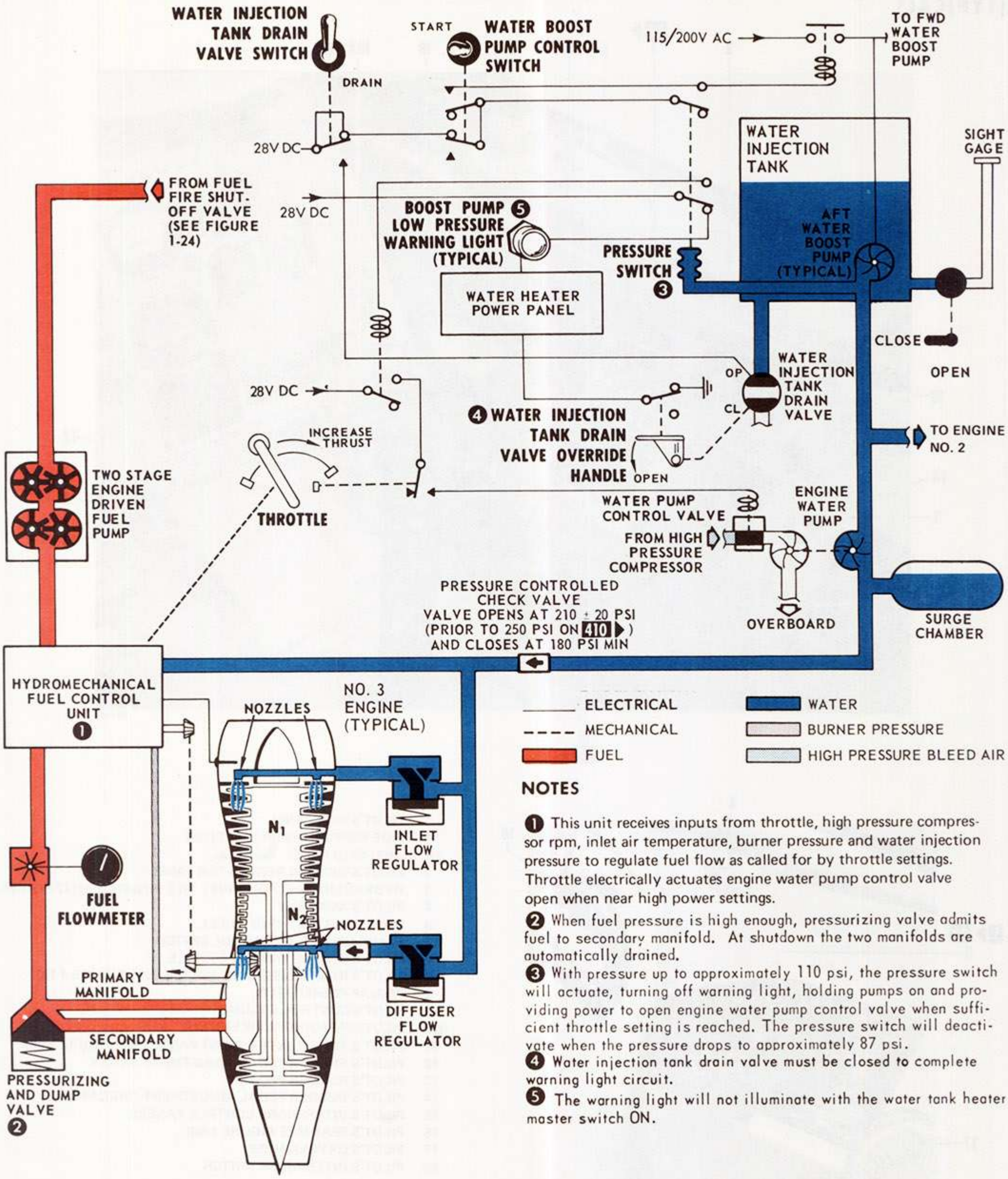
Cartridge—Pneumatic Starter System

The cartridge-pneumatic starter, installed on engine No. 4 on airplanes without 1C10 920 and on engines No. 1, 2, 3, and 4 on airplanes with 1C10 920, is a turbine starter which is operated in the cartridge mode by gases generated by a solid-propellant cartridge (type MXU-4/A) or, in the pneumatic mode, by compressed air from the engine bleed manifold. For overspeed protection, the starter contains a speed sensing device and an overspeed switch. The overspeed switch is used to control the pneumatic shutoff valve for pneumatic start protection. During a cartridge start, the solid-propellant cartridge is completely expended and must be replaced before making another cartridge start. Refer to figure 1-65 and also to the applicable maintenance manual for cartridge replacement procedure. Starter exhaust gases are vented overboard through an exhaust port in the left side cowl panel.

WARNING

- Except in an emergency, engine operation is prohibited when a live (unfired) cartridge is installed in the starter. Abnormal cartridge conditions of explosive nature could be generated due to the combination of vibration and high temperature that can exist in the engine nacelle.
- Do not remove a cartridge that has fired normally, hangfired or misfired until there is no evidence of exhaust smoke at the starter exhaust duct and at least 5 minutes have elapsed since start initiation. Wear asbestos gloves when removing cartridge. Do not point the screened end of the cartridge at personnel or equipment. Refer to Section V for definitions of hangfire and misfire, and conditions to be met if EWO or an impending disaster makes moving the airplane necessary.
- Do not allow the electrical contacts of a starter cartridge to contact any part of the surface of the airplane.

ENGINE FUEL FEED AND WATER INJECTION SYSTEM



NOTES

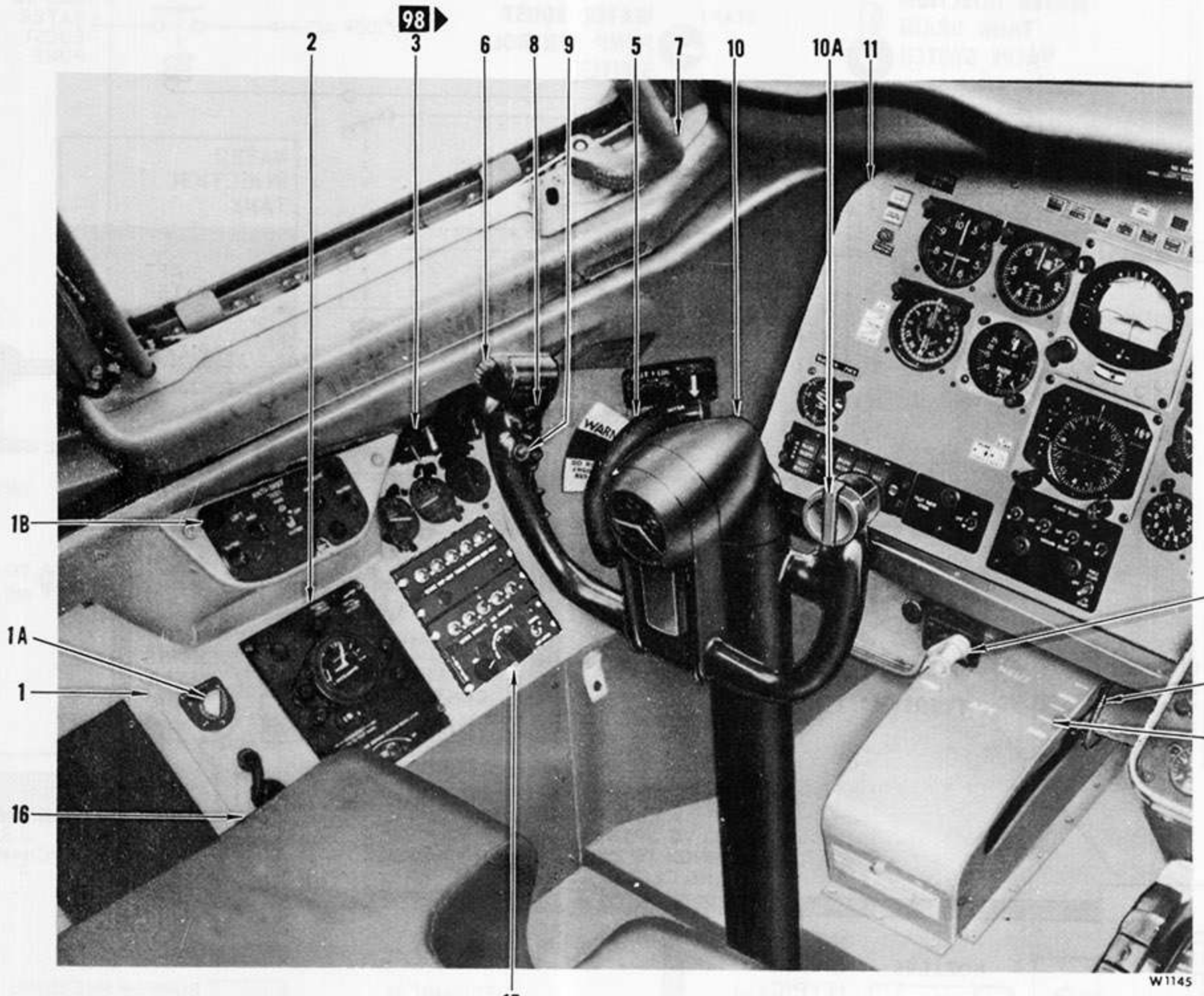
1. This unit receives inputs from throttle, high pressure compressor rpm, inlet air temperature, burner pressure and water injection pressure to regulate fuel flow as called for by throttle settings. Throttle electrically actuates engine water pump control valve open when near high power settings.
2. When fuel pressure is high enough, pressurizing valve admits fuel to secondary manifold. At shutdown the two manifolds are automatically drained.
3. With pressure up to approximately 110 psi, the pressure switch will actuate, turning off warning light, holding pumps on and providing power to open engine water pump control valve when sufficient throttle setting is reached. The pressure switch will deactivate when the pressure drops to approximately 87 psi.
4. Water injection tank drain valve must be closed to complete warning light circuit.
5. The warning light will not illuminate with the water tank heater master switch ON.

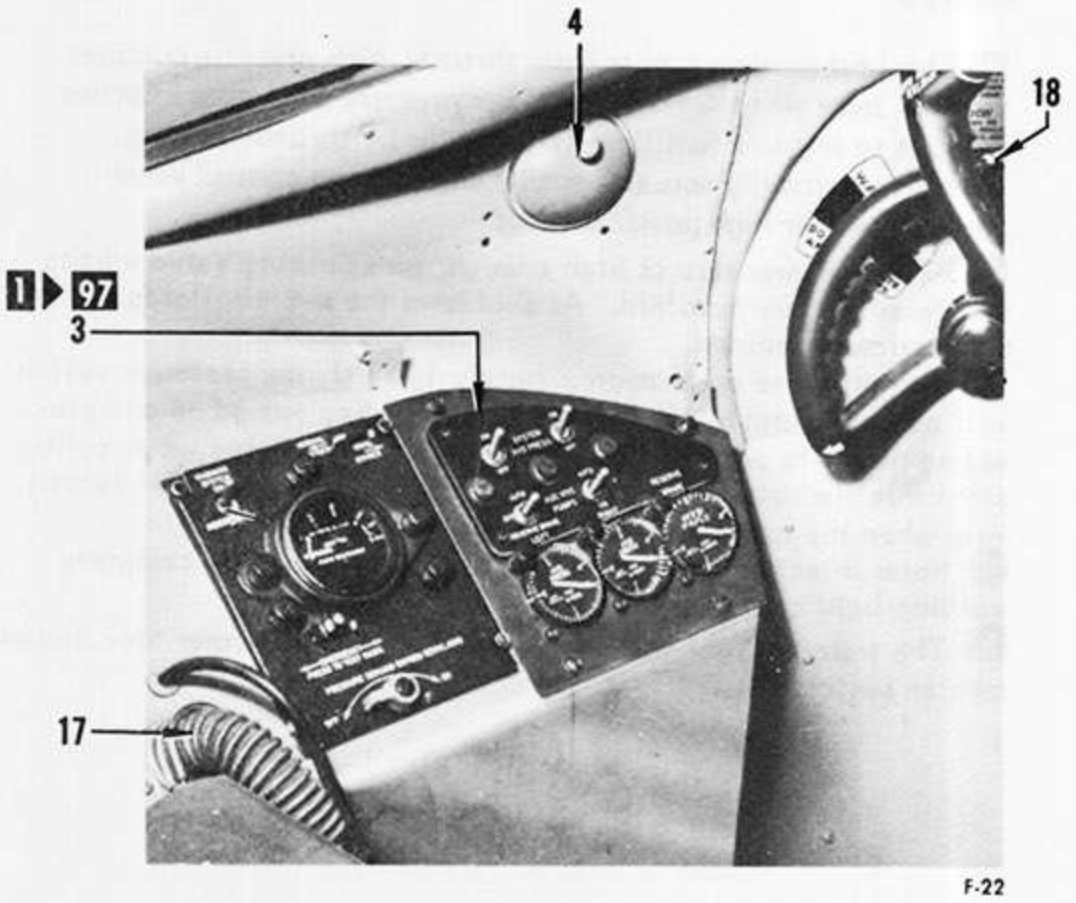
F-20

Figure 1-12

PILOT'S STATION

(TYPICAL)





1 PILOT'S SIDE PANEL
1A SIDE PANEL DIMMER RHEOSTAT
1B ANTI-SKID PANEL TCTO 550
2 PILOT'S OXYGEN REGULATOR PANEL
3 HYDRAULIC CONTROL PANEL (SEE FIGURE 1-38) (2 PLACES)
4 PILOT'S ASH TRAY
5 NOSE GEAR STEERING WHEEL
6 STABILIZER TRIM CONTROL SWITCH
7 PILOT'S SLIDING WINDOW HANDLE
8 PILOT'S INTERPHONE-MIKE SWITCH (SEE FIGURE 4-14)
9 RGA/AP PUSHBUTTON
10 PILOT'S CONTROL COLUMN
10A PILOT'S HEADING SLEW SWITCH
11 PILOT'S FLIGHT INSTRUMENT PANEL (SEE FIGURE 1-18)
12 PILOT'S RUDDER PEDAL ADJUSTMENT CRANK
13 PILOT'S RUDDER PEDALS
14 PILOT'S RUDDER PEDAL ADJUSTMENT INDICATOR
15 PILOT'S INTERPHONE CONTROL PANELS
16 PILOT'S SEAT (SEE FIGURE 1-66)
17 PILOT'S OXYGEN HOSE
18 PILOT'S INTERPHONE SWITCH

Figure 1-13

COPILOT'S STATION

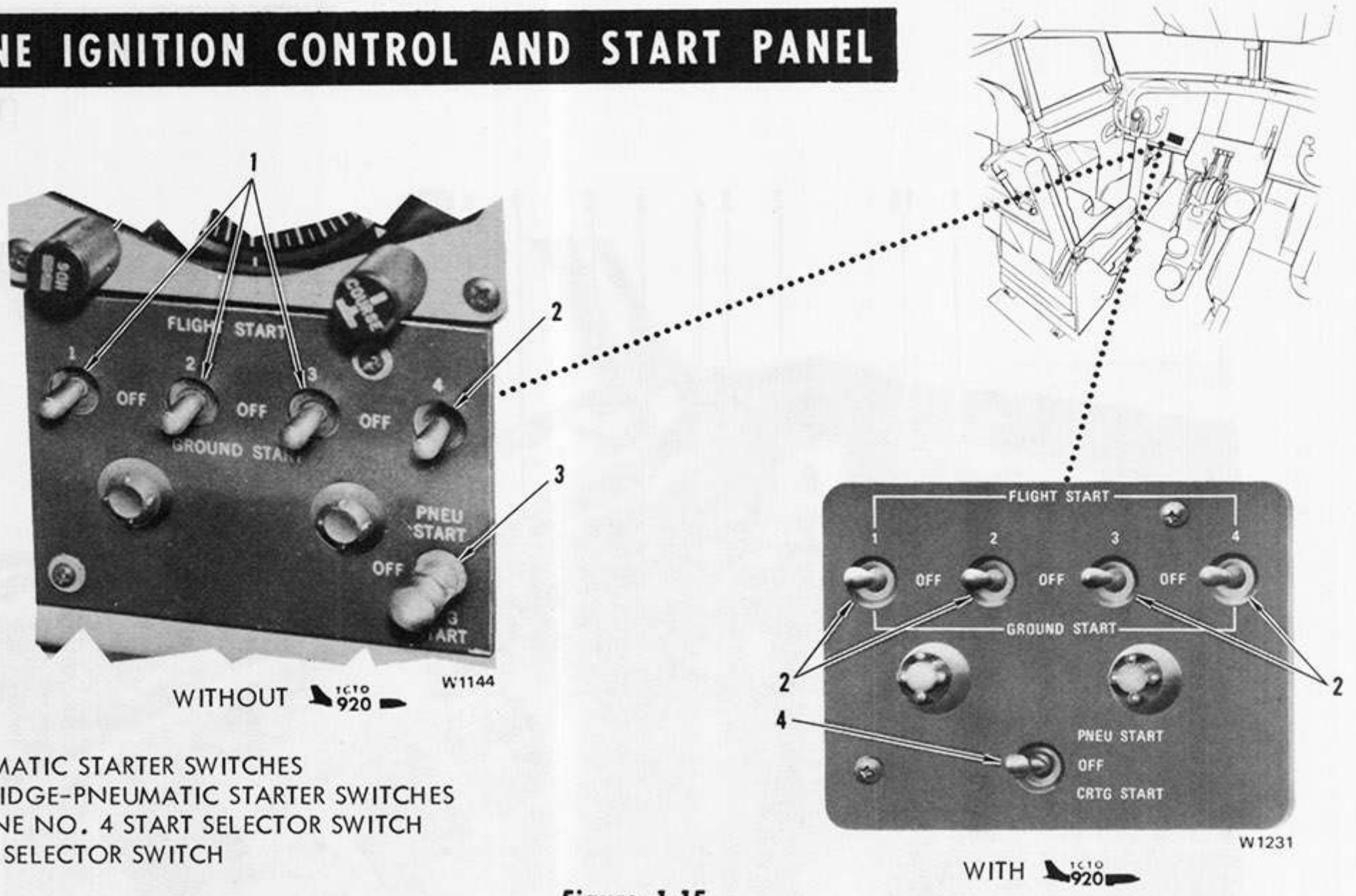
(TYPICAL)



1 COPILOT'S FLIGHT INSTRUMENT PANEL (SEE FIGURE 1-19)
1A COPILOT'S HEADING SLEW SWITCH
2 COPILOT'S CONTROL COLUMN
3 RGA/AP PUSHBUTTON
4 COPILOT'S INTERPHONE-MIKE SWITCH
5 STABILIZER TRIM CONTROL SWITCH
6 COPILOT'S SLIDING WINDOW HANDLE
7 COPILOT'S ASH TRAY
8 ANTI-ICING CONTROL PANEL (SEE FIGURE 4-11) (2 PLACES)
9 PORTABLE SIGNAL LAMP RECEPTACLE (28 VOLT AC)
10 J-4 COMPASS CONTROL PANEL (SEE FIGURE 4-45)
10A LIAISON RADIO CONTROL PANEL
11 COPILOT'S SEAT (SEE FIGURE 1-66)
12 LIQUID OXYGEN QUANTITY GAGE
13 COPILOT'S OXYGEN REGULATOR PANEL
14 COPILOT'S INTERPHONE CONTROL PANELS
15 PILOTS' SEARCH RADAR INDICATOR (SEE FIGURE 4-20)
16 COPILOT'S RUDDER PEDAL ADJUSTMENT INDICATOR
17 COPILOT'S RUDDER PEDAL ADJUSTMENT CRANK
18 SIDE PANEL DIMMER RHEOSTAT

Figure 1-14

ENGINE IGNITION CONTROL AND START PANEL



1 PNEUMATIC STARTER SWITCHES
2 CARTRIDGE-PNEUMATIC STARTER SWITCHES
3 ENGINE NO. 4 START SELECTOR SWITCH
4 START SELECTOR SWITCH

Figure 1-15

Engine No. 4 Start Selector Switch

Without TCTO 920

The start selector switch (3, figure 1-15) with PNEU START--OFF--CTG START positions is on the engine ignition control and start panel and is spring loaded from the CTG START position to the OFF position. To move it to the CTG START position, the switch must be pulled out and pressed down. This switch is armed only when the cartridge-pneumatic starter switch (2, figure 1-15) is in the GROUND START position. With the starter switch in the GROUND START position and the start selector switch pressed to CTG START, the cartridge in the starter is ignited and the starter rotates the engine high pressure compressor for starting. At the first positive indication of engine rpm, the start selector switch should be released from the CTG START position to OFF. With the starter switch in the GROUND START position and the start selector switch placed in PNEU START, the starter operates in the same manner as the pneumatic starters on engines 1, 2, and 3. Refer to PNEUMATIC STARTER SYSTEM, this Section. When operating in the cartridge start mode, two starts may be made per hour with a minimum interval of 5 minutes between starts. Operating power is 28 volt DC through a circuit breaker marked ENGINE STARTER 4 on the SBCBP (figure 1-35, sheet 1).

Start Selector Switch

With TCTO 920

A start selector switch (4, figure 1-15) is located on the engine ignition control and start panel. The switch has PNEU START--OFF--CRTG START positions and is spring-loaded from the CRTG START position to the OFF position. The switch controls the starting mode of all engines during starting. To place the switch in CRTG START position, the switch must be pulled out and pressed down. Provided the cartridge-pneumatic starter switch (2, figure 1-15) is in GROUND START position, switch actuation to CRTG START will ignite the cartridge in the starter which will introduce high pressure air into the starter turbine and cause engine rotation. At the first positive indication of engine rpm, the start selector switch should be released to the OFF position. With the starter selector switch in PNEU START, bleed air from an external air cart or from an operating engine is admitted to the starter air turbine. When the engine reaches the starter cutout speed of approximately 44% rpm, the air supply is cut off. When operating in the cartridge start mode, two starts may be made per hour with a minimum interval of 5 minutes between starts. Operating power is 28-volt DC through circuit breakers marked ENGINE STARTER 1, 2, 3, and 4 for engines No. 1, 2, 3, 4 respectively.

ENGINE INDICATORS

Tachometers

Engine high pressure compressor speed in percent rpm is indicated by four tachometers (2, figure 1-17) on the pilots' center instrument panel. Power, independent of the airplane electrical system, is supplied by engine-driven tachometer generator to operate the tachometers. Each instrument has two pointers. The larger pointer indication is read on a dial calibrated from 0 to 100% rpm. The small pointer indication is read on a dial calibrated from 0 to 10% rpm.

Exhaust Gas Temperature (EGT) Gages

Exhaust gas temperature of each engine is indicated by four gages (14, figure 1-17) on the pilots' center instrument panel. These gages are calibrated in degrees centigrade and indicate the temperature of the exhaust gases of each engine. Power, independent of the airplane electrical system, is supplied by engine thermocouples to operate the gages.

Engine Pressure Ratio (EPR) Gages

Four engine pressure ratio gages (3, figure 1-17) are on the pilots' center instrument panel. These gages indicate the ratio of the engine exhaust to inlet total pressure; this ratio is used as a measure of engine thrust. The advent of the split-compressor (two-spool) engines necessitated the change in thrust indicating instruments. Small variations in high pressure compressor rpm will result in large thrust changes in the high thrust range; 1% change in rpm results in about a 5% change in thrust. At idle power there is no indication on the EPR gage. Operating power is 115 volt AC and circuit protection is through circuit breakers marked PRESSURE RATIO INDICATOR NO. 4 and NO. 1 and PRESSURE RATIO INDICATOR NO. 3 and NO. 2 on the MCBP (figure 1-35, sheet 3). GENERATOR NO. 1 is the power source for indicators No. 1 and No. 4. GENERATOR NO. 3 is the power source for indicators No. 2 and No. 3.

Oil Pressure Gages

Engine oil pressure is indicated by four oil pressure gages (13, figure 1-17) on the pilots' center instrument panel. These gages operate on 28 volt AC power supplied through pressure transmitters in each engine oil system. Circuit protection is through circuit breakers marked OIL PRESSURE INDICATOR, ENGINE NO. 1, ENGINE NO. 2, ENGINE NO. 3, and ENGINE NO. 4 on the MCBP (figure 1-35, sheet 3).

NOTE

On some engines, oil pressure will have a tendency to follow the throttle due to a modified oil pressure relief valve. This condition is normal provided the pressure stabilizes between minimum and maximum limits.

Engine Oil Low Pressure Warning Lights Without 1610 738

Low engine oil pressure is indicated by four red press-to-test warning lights (14, figure 1-18) on the pilot's flight instrument panel. These lights complement the oil pressure indicating system by providing a cross-check to establish if a malfunction is occurring in the oil pressure indicating system or in the engine. The lights will be extinguished on rising oil pressure at a maximum of 39 psi and will illuminate on falling oil pressure at a minimum of 35 psi. Operating power for engine oil low pressure warning lights 1, 2, and 3 is 28 volts DC through a circuit breaker marked ENG 1, 2, 3 LOW OIL PRESS WARN on T-R BUS No. 1 (figure 1-35, sheet 2). Operating power for No. 4 engine oil low pressure warning light is 28 volts DC with circuit protection through a circuit breaker marked ENG No. 4 OIL PRESS WARN on the SBCBP (figure 1-35, sheet 1).

Without 1610 738

Engine No. 4 Oil Low Pressure Warning Light

An oil low pressure, red, press-to-test warning light (14, figure 1-18) is installed on the pilot's flight instrument panel to warn of low oil pressure during engine starting. The light will be extinguished at 36 psi on pressure increase and will illuminate at 28 psi on pressure decrease. Operating power is 28 volt DC with circuit protection through a circuit breaker marked ENG No. 4 OIL PRESS WARN on the SBCBP (figure 1-35, sheet 1).

Engine Fuel Flowmeter

Refer to ENGINE FUEL CONTROL SYSTEM, this Section.

ENGINE OIL SYSTEM

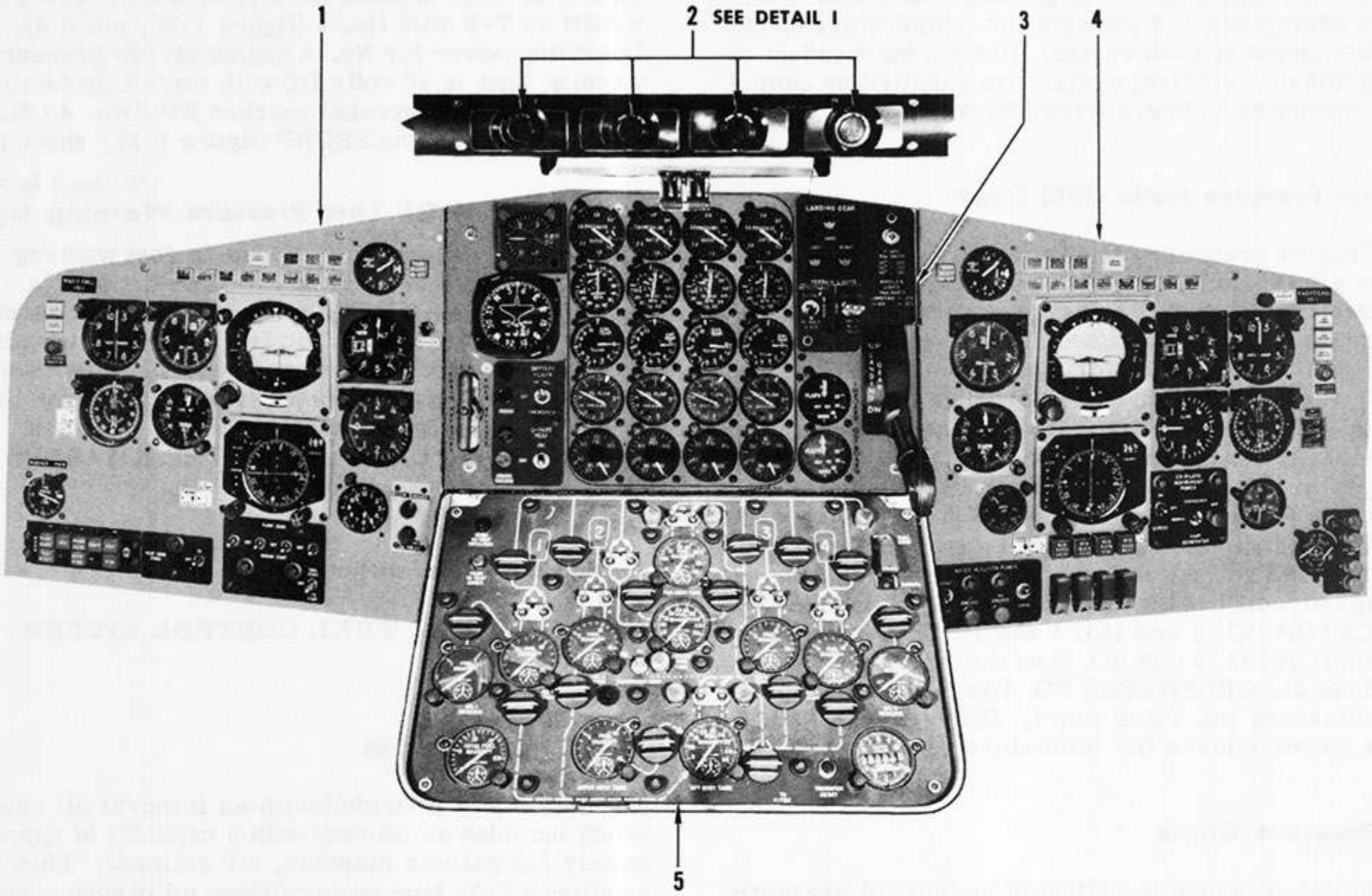
Each engine is provided with an integral oil system which includes an oil tank with a capacity of approximately 5.5 gallons (useable, 3.5 gallons). This tank supplies a gear type engine-driven oil pressure pump. Oil is supplied by the pressure pumps to the engine bearings and accessory drives in various engine compartments. Scavenge pumps remove oil from the engine compartments, route it through an oil cooler and return it to the tank. Proper oil temperature is maintained by a temperature sensing element in the engine oil system. When these elements sense high oil temperature, a valve opens admitting high pressure compressor bleed air to an air ejector in the aft portion of the oil cooler ducting, which in turn will increase the flow of ambient cooling air moving through the cooling coils. This ejector is in operation during ground operation only. When the oil is cold an automatic bypass is opened permitting oil to bypass the oil cooler. For oil servicing information, see figure 1-65.

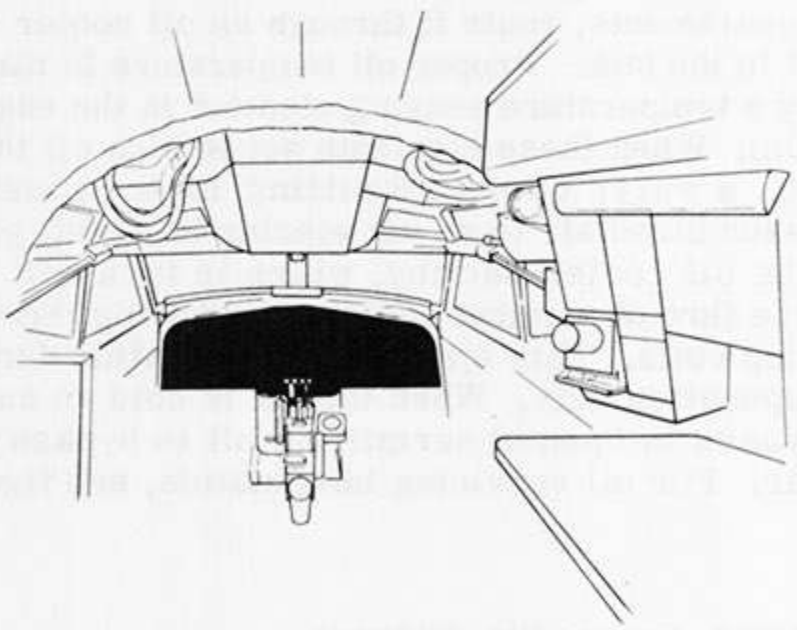
GENERATOR DRIVE OIL SYSTEM

The generator drives on engine Nos. 1, 2, and 3 each have an oil system separate from the engine oil system. Each system has a six quart oil tank. The oil temperature for this system is controlled in the same manner as the engine oil system. For servicing information, see figure 1-65.

PILOTS' INSTRUMENT PANEL

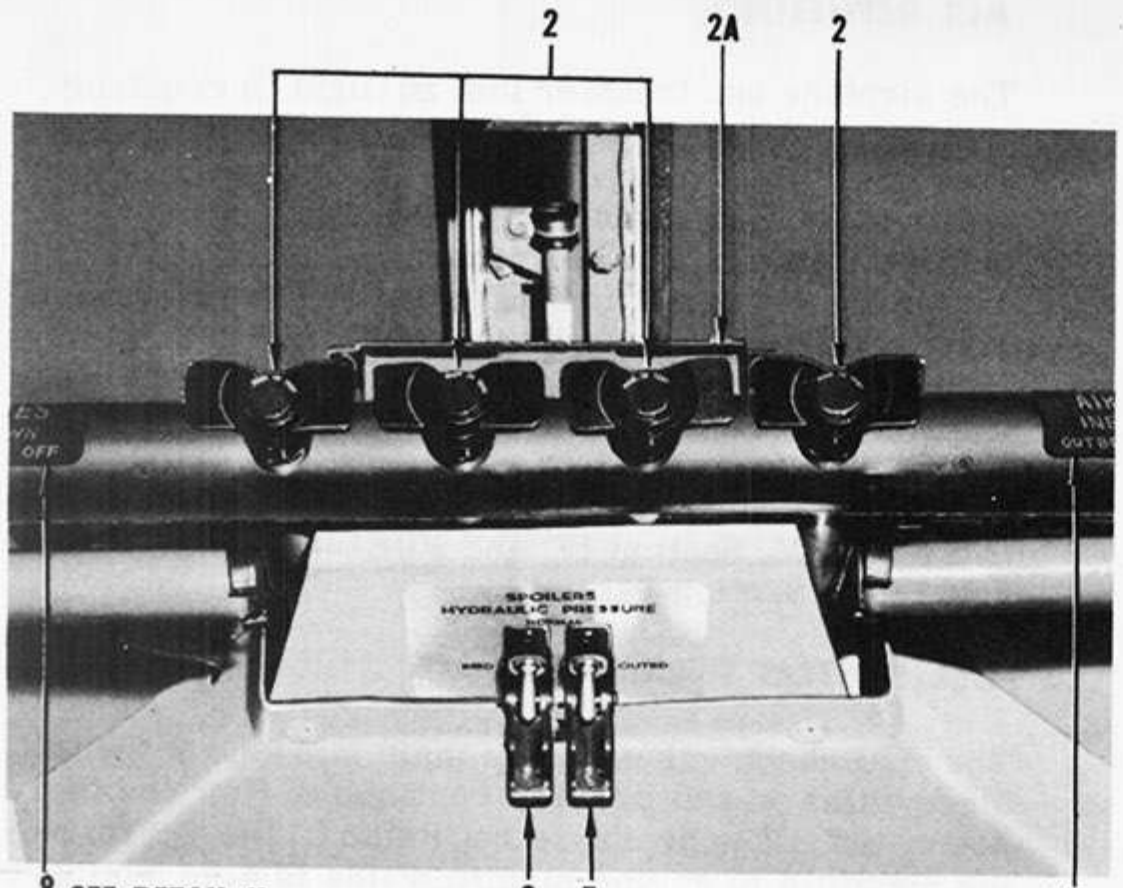
(TYPICAL)





1 PILOT'S FLIGHT INSTRUMENT PANEL (SEE FIGURE 1-18)
2 ENGINE FIRE SWITCHES AND WARNING LIGHTS (2 PLACES)
2A TAKEOFF AND LANDING DATA CARD HOLDER TCTO 864
3 PILOTS' CENTER INSTRUMENT PANEL (SEE FIGURE 1-17)
4 COPILOT'S FLIGHT INSTRUMENT PANEL (SEE FIGURE 1-19)
5 FUEL PANEL (SEE FIGURE 1-25)
6 INBOARD SPOILER SWITCH
7 OUTBOARD SPOILER SWITCH
8 EMERGENCY TRIM DECALS (2 PLACES)

Figure 1-16 (Sheet 1 of 2)



DETAIL I

PITCH TRIM – SPOILERS
TO RAISE NOSE: INBD (LEFT) SWITCH OFF
TO LOWER NOSE: OUTBD (RIGHT) SWITCH OFF
BACM9T12M

DETAIL II

PITCH TRIM – SPLIT FLAPS
TO RAISE NOSE: INBD FLAPS DOWN
TO LOWER NOSE: OUTBD FLAPS DOWN
BACM9T12L

DETAIL III

F27
F1674

Figure 1-16 (Sheet 2 of 2)

FUEL SYSTEM

The airplane fuel system (figure 1-24) consists of 6 integral wing tanks and a combination bladder and integral center section tank with the necessary manifolds, valves, and pumps. The integral tanks are formed by sealing off certain structural areas in the wings. The fuselage portion of the center section tank is the conventional nonself-sealing bladder cell. The airplane body fuel system consists of a forward body tank, and an aft body tank in the lower body lobe below the main deck floor beams. On airplanes 10▶ the body fuel system also includes an upper deck tank. The forward body tank is ahead of the front wing spar and consists of 3 bladder type cells. On airplanes with an upper deck tank, the forward body tank consists of four bladder cells. The aft body tank is aft of the main gear wheel wells and consists of 5 bladder cells. The upper deck tank is in the main fuselage compartment between the boom operator's compartment and the aft pressure bulkhead. The outermost wing tanks are designated No. 1 reserve tank (left) and No. 4 reserve tank (right). The reserve tanks drain by gravity into the No. 1 and 4 adjacent main tanks through interconnecting lines and control valves. The No. 1 and 4 main tanks are inboard of the reserve tanks, and between the dry bay areas. The No. 2 and 3 main tanks are inboard of and adjacent to the No. 1 and 4 main tanks respectively, and also adjacent to the center wing tank. See figure 1-23 for fuel quantity data. There is no interconnection between the main tanks or between the main tanks and the center wing tank. The main tanks can be drained into the aft body tank by gravity through the single point refueling manifold down to amounts indicated in figure 7-6 for each main tank. The center wing tank can be drained by gravity to the forward body tank. See figure 1-24. The upper deck tank drains by gravity into the aft body tank. Valves are installed in the system to control the gravity flow. Primary control of the fuel system is from the fuel panel (figure 1-25) at the pilots' station. There are 3

manual valves shown in figure 1-24 which are ground operated only. They are designated the manual refueling valves and the manual defueling valve. Refer also to SINGLE POINT REFUELING SYSTEM and AIR REFUELING SYSTEM, Section IV. Normally fuel is fed to each engine fuel feed system (figure 1-12) through the normally open fuel fire shutoff valves from its respective main tank. However, the engine can be fed directly from any tank or tanks in the airplane except the reserve tanks and the upper deck tank. This operation is through the engine manifold which interconnects the engines for crossfeed operations. See figure 1-24. Two electrically driven centrifugal boost pumps are in each main tank. These pumps are normally used for all operations of the airplane except under conditions noted in FUEL SYSTEM OPERATION, Section VII, and FUEL SYSTEM EMERGENCY OPERATION, Section III. The center wing tank has 2 electrically driven centrifugal override pumps which can override the main tank boost pumps whenever the engines are being fed from the center wing tank. Boost pumps in tanks 1, 2, 3 and 4 therefore, can be left on while using fuel from the center wing tank. This prevents engine fuel starvation if the center wing tank is pumped dry. Engine feed operations from the body tanks to the engines are through a control valve and pressure regulator-check valve connecting the air refueling manifold with the engine manifold. The pressure from the air refueling pumps will override the main tank boost pumps in the same manner as the override pumps in the center wing tank. For fuel specification, see figure 1-65. For alternate fuel grade limits, refer to Section V.

FUEL QUANTITY DATA

See figure 1-23 for fuel quantity data.

NOTE

For fuel loading, refer to Section VIII, figure 8-6 and T.O. 1C-135(K)A-2-2

SINGLE POINT REFUELING

The airplane is equipped with a single point refueling receptacle in the right wheel well (figure 4-76) which can be used to refuel and defuel the airplane on the ground. See SINGLE POINT REFUELING in Section IV.

AIR REFUELING

The airplane can transfer fuel in flight to receiver airplanes. See figures 1-24, 4-65, 4-74 and 4-75. Fuel for this purpose is carried in 2 body tanks with additional fuel available from any other tank or tanks in the airplane. Most airplanes have an upper deck tank in the aft cargo compartment. This tank provides additional fuel capacity and drains into the aft body tank. All fuel in the airplane is available for transfer to a receiver airplane except amounts, as indicated in figure 7-6, in each main tank which are available to the engines only. Refer to AIR REFUELING SYSTEM, Section IV, and FUEL SYSTEM OPERATION, Section VII.

FUEL SYSTEM THERMAL RELIEF

The dual check valves in the main tanks have thermal bleed holes which provide continuous flow for thermal relief. The pressure regulator in the air refueling manifold to engine manifold line is also equipped with a bleed hole for constant thermal relief.

NOTE

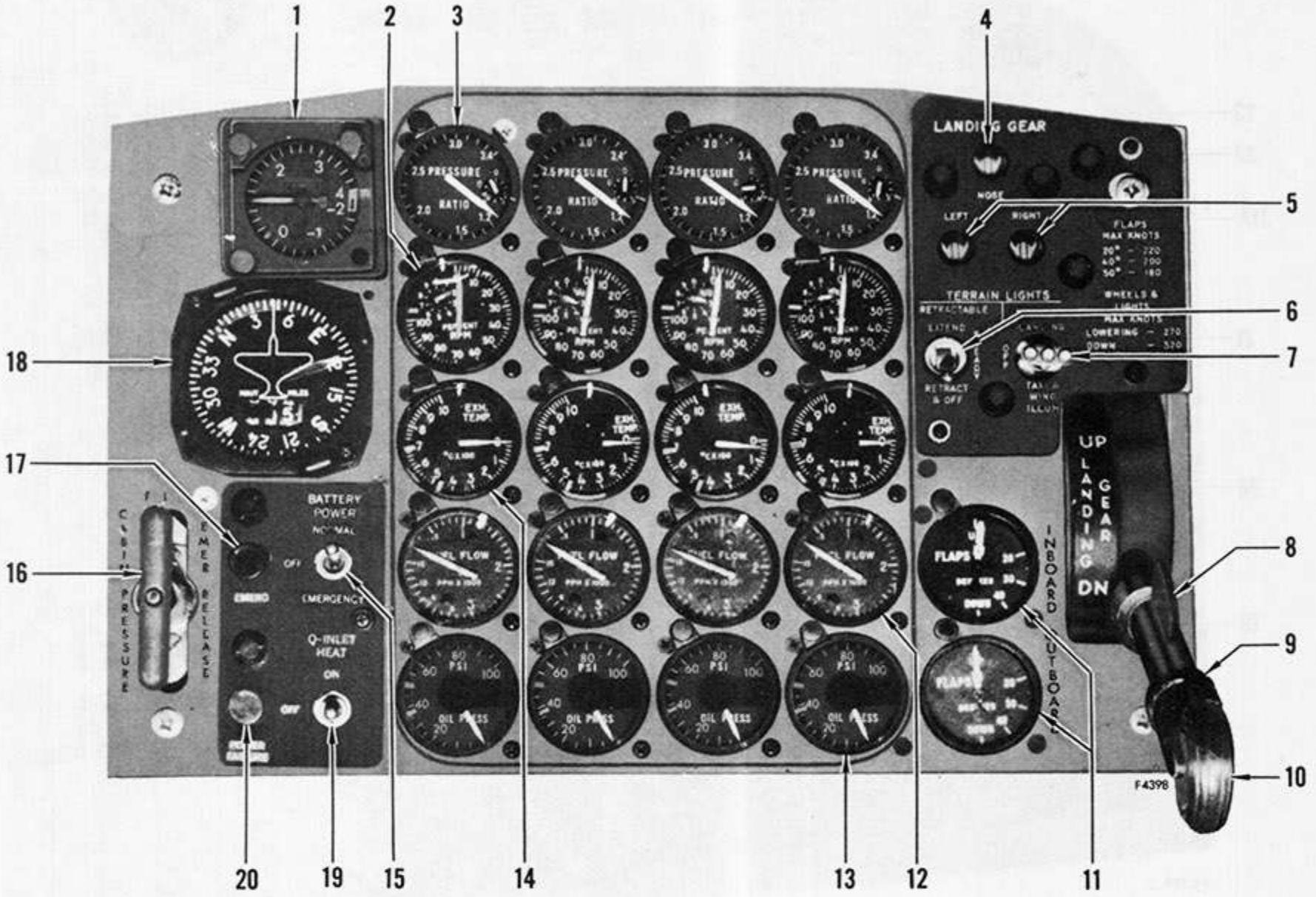
On airplanes 1, 3, and 25▶, when feeding the engines from either the body tanks or the center wing tank, a gradual buildup of main wing tank fuel quantity may be noted. This is normal and is due to bleed back through the thermal relief bleed holes in the dual check valves.

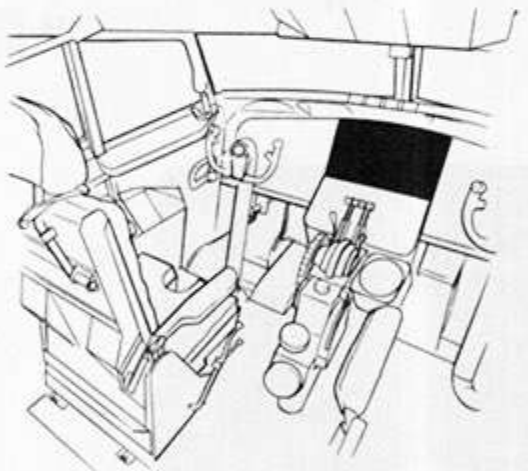
FUEL TANK VENTING

The center wing, mains, and reserve tanks are vented through channel stringers in the upper portion of the wing to a 5.5 gallon surge tank in each wing tip. The surge tank is fitted with a ram air scoop which pressurizes the wing tank vent system with ram air. The surge tank is also fitted with a check valve and drain connection to the aft body tank through the single point refueling manifold. On airplanes 43▶ the surge tank is not connected to the single point manifold for drainage to the aft body tank, but is connected to the reserve tank only. The surge tank and vent system is required to prevent boil off in ascent and tank collapse in descent. The wing vent system also collects fuel surge and splash. The body tanks are vented to the top of the fuselage through three vent lines which meet in a common cavity vent for each body tank near the top of the fuselage. The two cavities are in turn vented to the atmosphere.

PILOTS' CENTER INSTRUMENT PANEL

(TYPICAL)



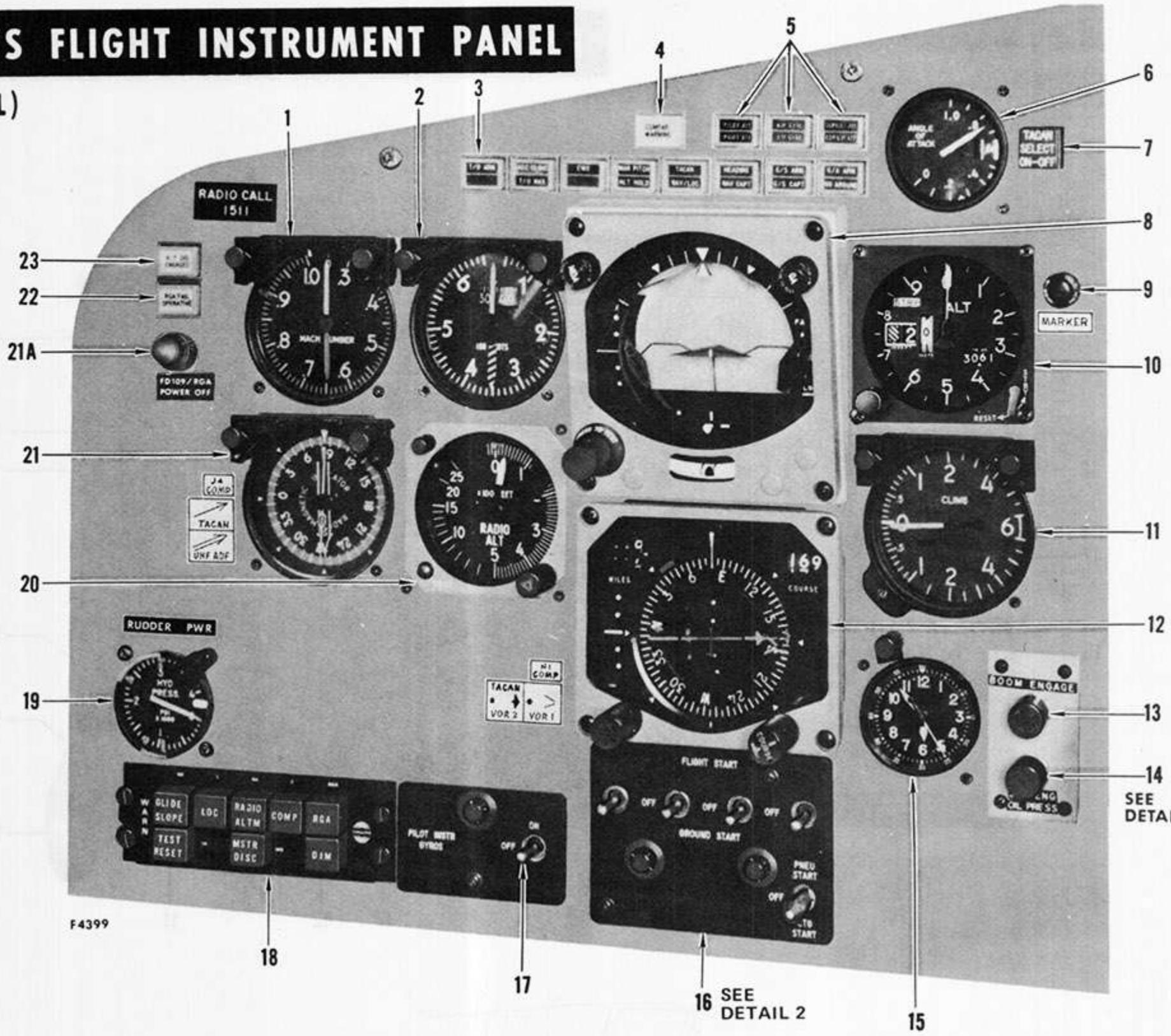


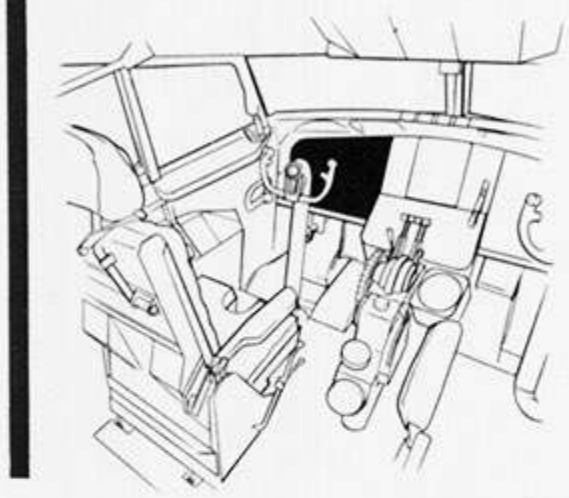
1 ACCELEROMETER
2 TACHOMETER
3 ENGINE PRESSURE RATIO GAGES
4 NOSE GEAR POSITION INDICATOR
5 MAIN LANDING GEAR POSITION INDICATORS
6 TERRAIN LIGHT SWITCH
7 LANDING, TAXI AND WING ILLUMINATION LIGHT SWITCH
8 LANDING GEAR OVERRIDE TRIGGER
9 LANDING GEAR LEVER
10 LANDING GEAR WARNING LIGHT KNOB
11 FLAP POSITION INDICATORS
12 ENGINE FUEL FLOWMETER
13 OIL PRESSURE GAGE
14 ENGINE EXHAUST GAS TEMPERATURE GAGE
15 BATTERY POWER SWITCH
16 CABIN PRESSURE EMERGENCY RELEASE HANDLE
17 SWITCHED DC BUS FAILURE LIGHT
18 DESTINATION INDICATOR
19 Q-INLET HEAT SWITCH
20 Q-INLET HEAT FAILURE WARNING LIGHT

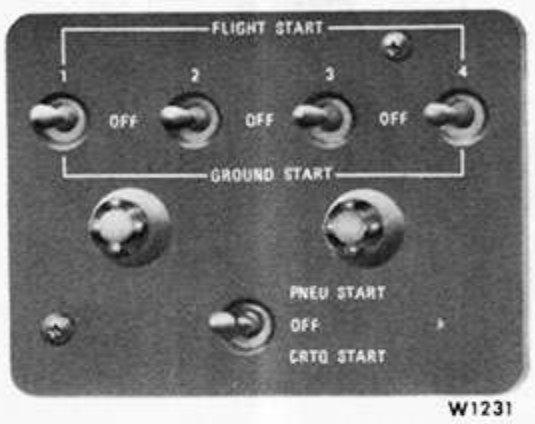
Figure 1-17

PILOT'S FLIGHT INSTRUMENT PANEL

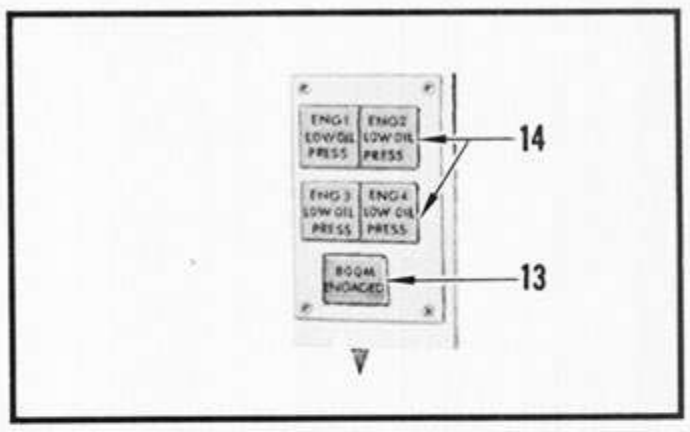
(TYPICAL)







DETAIL II WITH TCTO 920



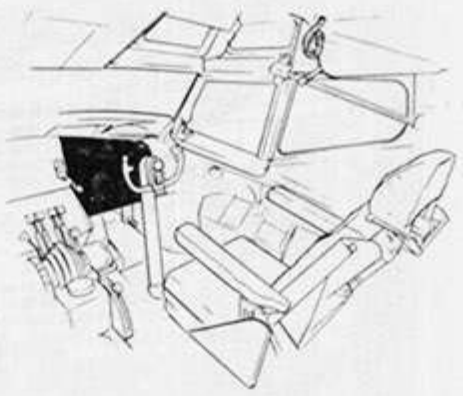
DETAIL I WITH TCTO 738

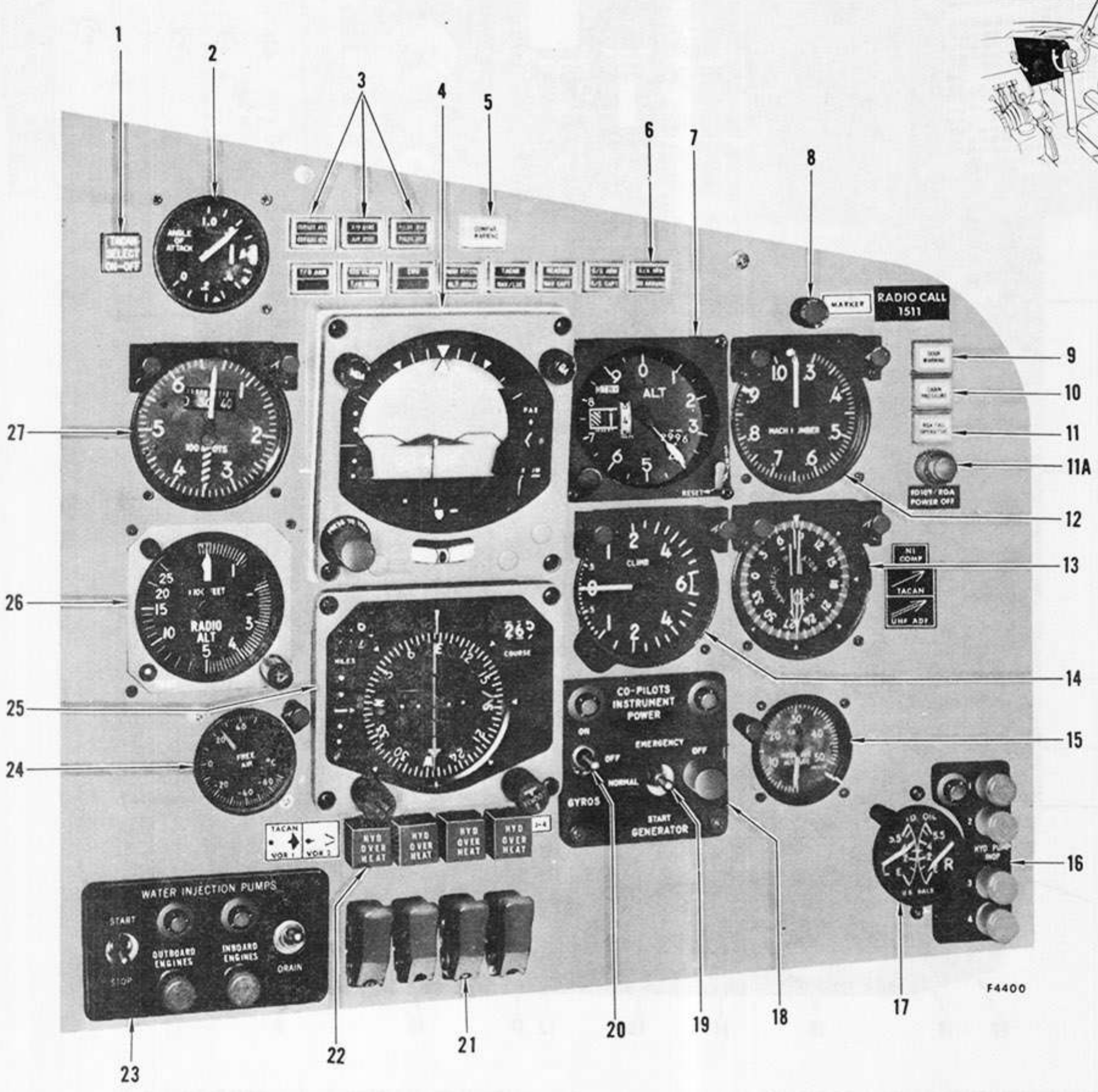
1 MACH INDICATOR
2 AIRSPEED INDICATOR
3 FD-109/RGA SYSTEM ANNUNCIATORS
4 COMPARATOR WARNING SWITCH ANNUNCIATOR
5 ATTITUDE WARNING INDICATORS
6 ANGLE OF ATTACK INDICATOR
7 TACAN SELECT SWITCH
8 ATTITUDE DIRECTOR INDICATOR (SEE FIGURE 4-30C)
9 MARKER BEACON LIGHT
10 ALTIMETER (SEE FIGURE 1-58)
11 VERTICAL VELOCITY INDICATOR
12 HORIZONTAL SITUATION INDICATOR (SEE FIGURE 4-30D)
13 BOOM ENGAGED LIGHT
14 ENGINE OIL LOW PRESSURE WARNING LIGHT(S)
15 CLOCK
16 ENGINE IGNITION AND START PANEL (SEE FIGURE 1-15)
17 PILOT'S INSTRUMENT GYROS SWITCH
18 COMPARATOR WARNING MONITOR PANEL
19 RUDDER POWER HYDRAULIC PRESSURE GAGE
20 LOW RANGE RADIO ALTIMETER
21 RADIO MAGNETIC INDICATOR (RMI)
21A FD-109/RGA POWER-OFF LIGHT (WITH TCTO 879)
22 RGA FAIL OPERATIVE LIGHT
23 AUTOPILOT DISENGAGED LIGHT

Figure 1-18

COPILOT'S FLIGHT INSTRUMENT PANEL

(TYPICAL)

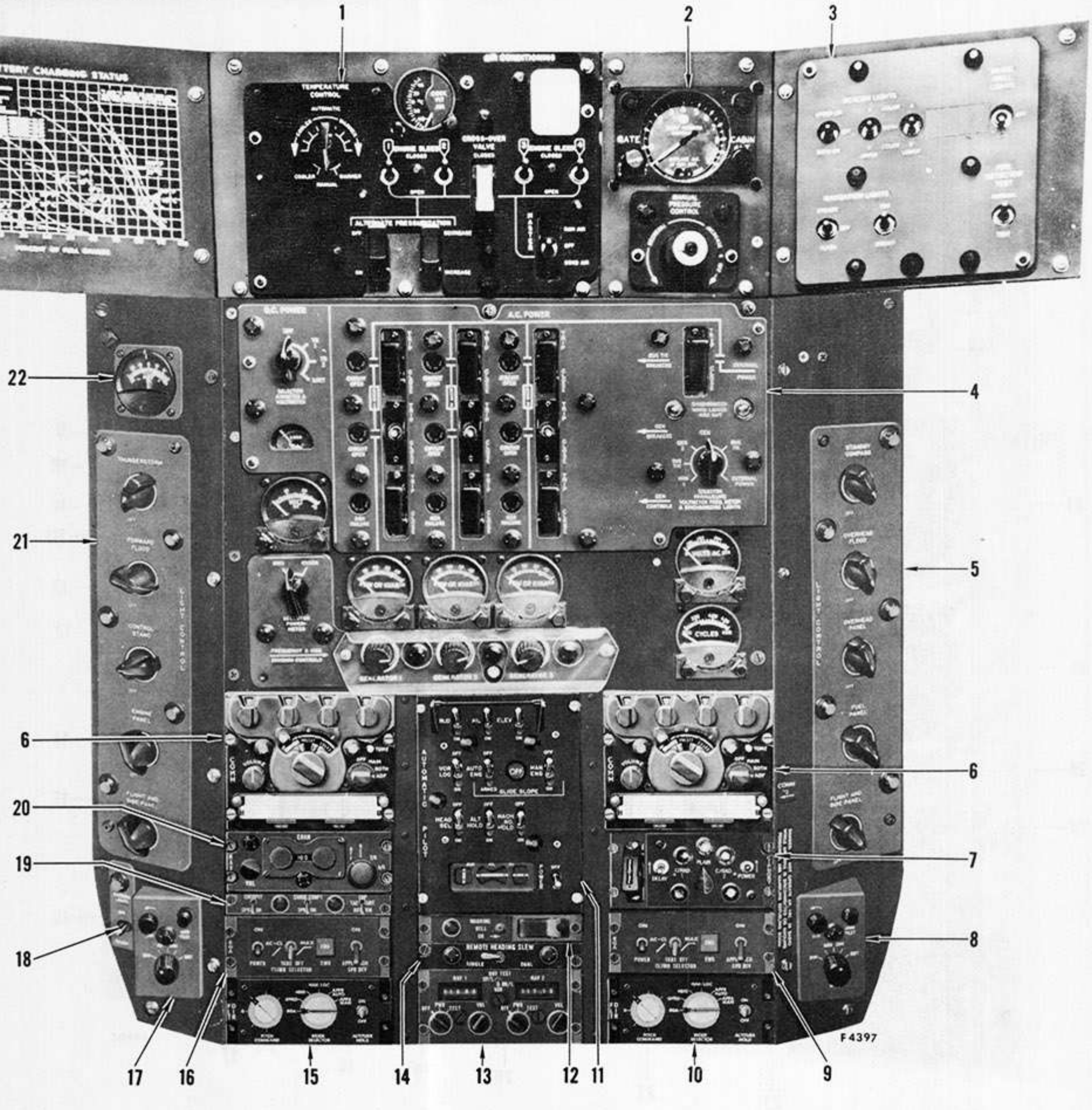




1 TACAN SELECT SWITCH
2 ANGLE OF ATTACK INDICATOR
3 ATTITUDE WARNING INDICATORS
4 ATTITUDE DIRECTOR INDICATOR (SEE FIGURE 4-30C)
5 COMPARATOR WARNING SWITCH ANNUNCIATOR
6 FD-109/RGA SYSTEM ANNUNCIATORS
7 ALTIMETER (SEE FIGURE 1-58)
8 MARKER BEACON LIGHT
9 CARGO DOOR OR HATCH NOT LATCHED WARNING LIGHT
10 CABIN PRESSURE WARNING LIGHT
11 RGA FAIL OPERATIVE LIGHT
11A FD-109/RGA POWER-OFF LIGHT (WITH TCTO 879)
12 MACH INDICATOR
13 RADIO MAGNETIC INDICATOR (RMI)
14 VERTICAL VELOCITY INDICATOR
15 CABIN AIR PRESSURE GAGE (CABIN ALTIMETER)
16 HYDRAULIC PUMP INOPERATIVE LIGHTS
17 HYDRAULIC OIL QUANTITY GAGE
18 COPILOT'S INSTRUMENT POWER-OFF LIGHT
19 COPILOT'S INSTRUMENT POWER GENERATOR SWITCH
20 COPILOT'S INSTRUMENT GYROS SWITCH
21 HYDRAULIC PUMP SUPPLY SWITCHES
22 HYDRAULIC OVERHEAT WARNING LIGHTS
23 WATER INJECTION BOOST PUMPS CONTROL PANEL (SEE FIGURE 1-10)
24 FREE AIR TEMPERATURE GAGE (OAT)
25 HORIZONTAL SITUATION INDICATOR (SEE FIGURE 4-30D)
26 LOW RANGE RADIO ALTIMETER
27 AIRSPEED INDICATOR

Figure 1-19

OVERHEAD PANEL (TYPICAL)

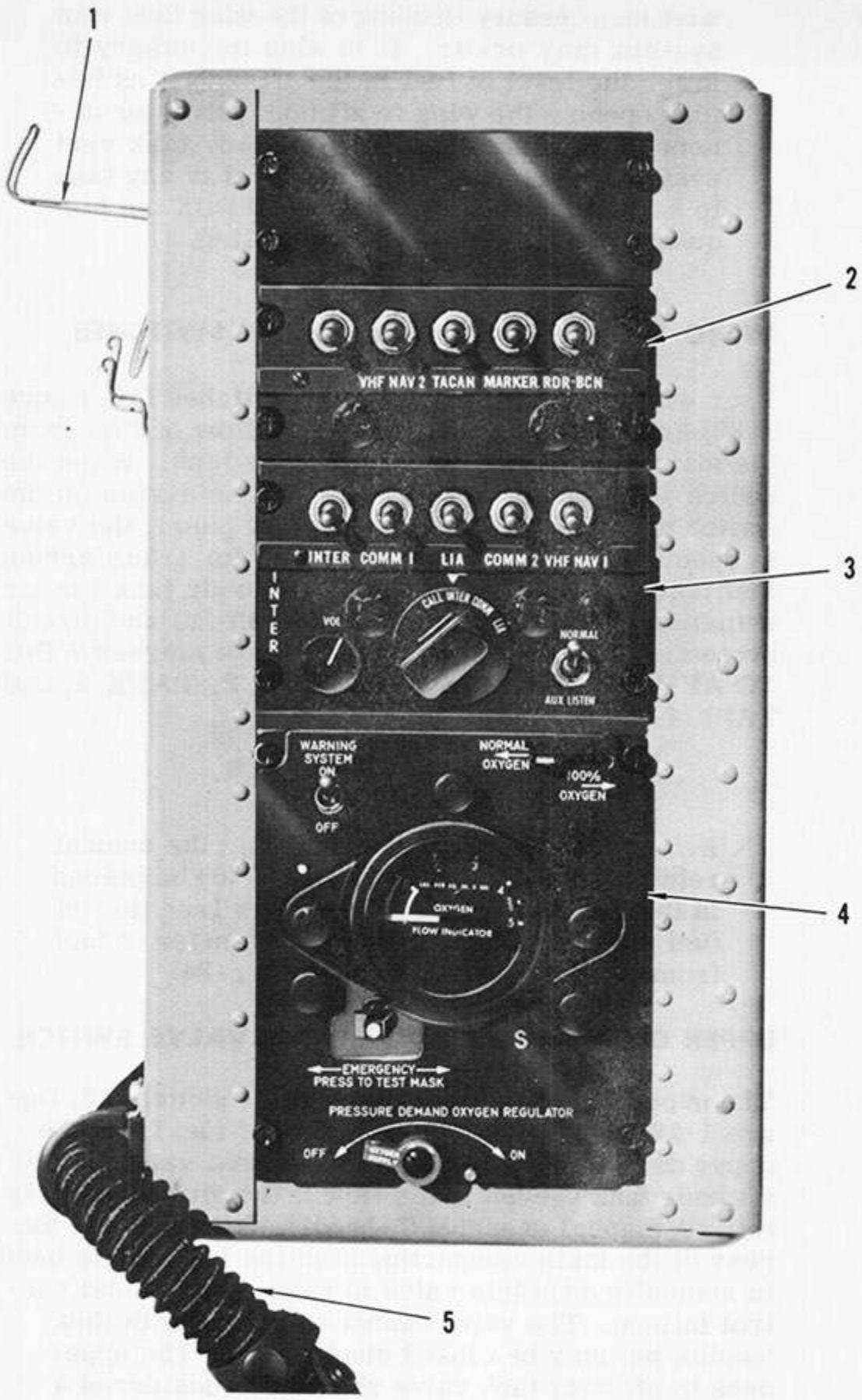


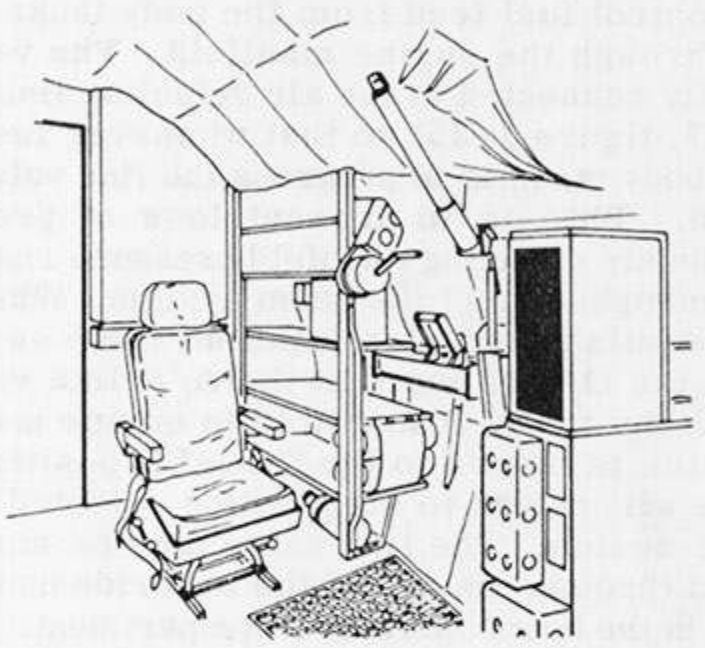
1 AIR CONDITIONING CONTROL PANEL (SEE FIGURE 4-5)
2 CABIN PRESSURE CONTROLLERS (SEE FIGURE 4-8)
3 COPILOT'S EXTERIOR LIGHT CONTROL PANEL (SEE FIGURE 4-34)
4 ELECTRICAL CONTROL PANEL (SEE FIGURE 1-30)
5 COPILOT'S OVERHEAD LIGHT CONTROL PANEL (SEE FIGURE 4-34)
6 UHF COMMAND RADIO CONTROL PANEL (2 PLACES) (SEE FIGURE 4-16)
7 CIPHONY CONTROL PANEL (SEE FIGURE 4-16A)
8 COPILOT'S FLIGHT DIRECTOR DIMMER CONTROL PANEL (SEE FIGURE 4-34)
9 COPILOT'S ROTATION GO-AROUND CONTROL PANEL (SEE FIGURE 4-30J)
10 COPILOT'S FLIGHT DIRECTOR CONTROL PANEL (SEE FIGURE 4-30E)
11 AUTOPILOT CONTROL PANEL (SEE FIGURE 4-40)
12 WARNING BELL CONTROL PANEL
13 VHF NAVIGATION CONTROL PANEL (SEE FIGURE 4-18)
14 DUAL REMOTE HEADING SLEW SWITCH
15 PILOT'S FLIGHT DIRECTOR CONTROL PANEL (SEE FIGURE 4-30E)
16 PILOT'S ROTATION GO-AROUND CONTROL PANEL (SEE FIGURE 4-30J)
17 PILOT'S FLIGHT DIRECTOR DIMMER CONTROL PANEL (SEE FIGURE 4-34)
18 WARNING LIGHTS BRIGHT - DIM SWITCH
19 LOUDSPEAKER AND TACAN ANTENNA CONTROL PANEL
20 TACAN (UHF-NAV) CONTROL PANEL (SEE FIGURE 4-18)
21 PILOT'S OVERHEAD LIGHT CONTROL PANEL (SEE FIGURE 4-34)
22 BATTERY CHARGING AMMETER

Figure 1-20

CREW INSTRUCTOR'S CONSOLE

AIRPLANES 10▶ (TYPICAL)





1. HEADSET HANGER
2. INTERPHONE MIXER CONTROL PANEL (SEE FIGURE 4-14)
3. INTERPHONE CONTROL PANEL (SEE FIGURE 4-14)
4. OXYGEN REGULATOR PANEL (SEE FIGURE 4-37)
5. OXYGEN HOSE

Figure 1-21

F-34

TANK TO ENGINE MANIFOLD VALVE SWITCHES

Four tank to engine manifold valve switches (2, figure 1-25) on the fuel control panel are used to control electric motor operated slide valves between the tank to engine lines and the engine manifold. When the switch is rotated to align the white stripe on the switch with the flow line on the fuel panel, the valve is open. These valves are used in the control of engine crossfeed operations. Operating power is 28 volt DC and circuit protection is through circuit breakers marked TANK TO ENGINE MANIFOLD VALVE NO. 4 and NO. 3; and TANK TO ENGINE MANIFOLD VALVE NO. 2 and NO. 1 on the MCBP (figure 1-35). On airplanes 250▶ the circuit protection is through circuit breakers marked TANK TO ENG. MANIFOLD 1, 2, 3 and 4 located on the SBCBP.

CENTER WING TO FORWARD BODY TANK VALVE SWITCHES

Two center wing to forward body tank valves switches (7, figure 1-25) control gravity flow from the center wing to the forward body tank. When the switches are rotated to align the white stripe on the switch with the flow line on the fuel control panel, the valves are open. These valves are used to transfer fuel to the forward body tank. Operating power is 28 volt DC and circuit protection is through circuit breakers marked CENTER WING TO FWD TANK, LH, and RH on the SBCBP (figure 1-35).

AIR REFUELING MANIFOLD TO ENGINE MANIFOLD VALVE SWITCH

The air refueling manifold to engine manifold valve switch (8, figure 1-25) controls the flow of fuel under pressure from the A/R pumps in the body tanks to the engine manifold. When the switch is rotated to align the white stripe on the switch with the flow line on the fuel panel, the valve is open. This valve is used to control fuel feed from the body tanks to the engines through the engine manifold. The valve is electrically connected to the air refueling line valve switch (17, figure 1-25) so that whenever fuel feed from the body tanks is in progress the line valve will be closed. This is to prevent loss of pressure through the air refueling manifold pressure regulator or other components of the boom system. Whenever the A/R manifold to engine manifold valve switch is moved to the OPEN position the A/R line valve is closed. When the A/R manifold to engine manifold valve switch is moved to the CLOSED position, the line valve will return to the position selected by the line valve switch. The line valve may be manually positioned through the use of the override handle on the valve in the boom operator's compartment. Operating power is 28 volt DC and circuit protection is through a circuit breaker marked AR MANF ENG MANF and LINE VALVE on the SBCBP (figure 1-35).

RESERVE TANK VALVE SWITCHES

Two reserve tank valve switches (11, figure 1-25) are used to control the gravity flow of fuel from the reserve tanks to the No. 1 and No. 4 mains. When the switches are rotated to align the white stripe on the switch with the flow line on the fuel panel, the valve is open. Operating power is 28 volt DC and circuit protection is through circuit breakers marked RESERVE NO. 4 TO TANK NO. 4 and RESERVE NO. 1 TO TANK NO. 1 on the MCBP (figure 1-35).

NOTE

On tanker airplanes it is necessary to reduce airplane gross weight to 268,000 lb (cargo airplanes to 214,000 lb) due to structural limitations before transferring reserve tank fuel to the outboard mains. It is also necessary to lower the quantity of fuel in the No. 1 and No. 4 main tanks to 10,000 lb each before transferring reserve fuel to the outboard mains; otherwise unnecessary flooding of the wing tank vent system may occur. It is also necessary to lower the level of fuel in the aft body tank before opening the wing to aft tank valves or unnecessary flooding of the aft body tank vent system may occur. The fuel level in any tank to be filled should be monitored with the fuel quantity gage to prevent overfilling.

WING TO AFT BODY TANK VALVE SWITCHES

Four wing to aft body tank valve switches (16, figure 1-25) are used to control gravity flow of fuel from the main wing tanks to the aft body tank. When the switch is rotated to align the white stripe on the switch with the flow line on the fuel panel, the valve is open. These switches are used for transferring fuel from the wing tanks to the aft body tank for air refueling. Operating power is 28 volt DC and circuit protection is through circuit breakers marked WING TO AFT TANKS, TANK 1, TANK 2, TANK 3, and TANK 4 on the SBCBP (figure 1-35).

NOTE

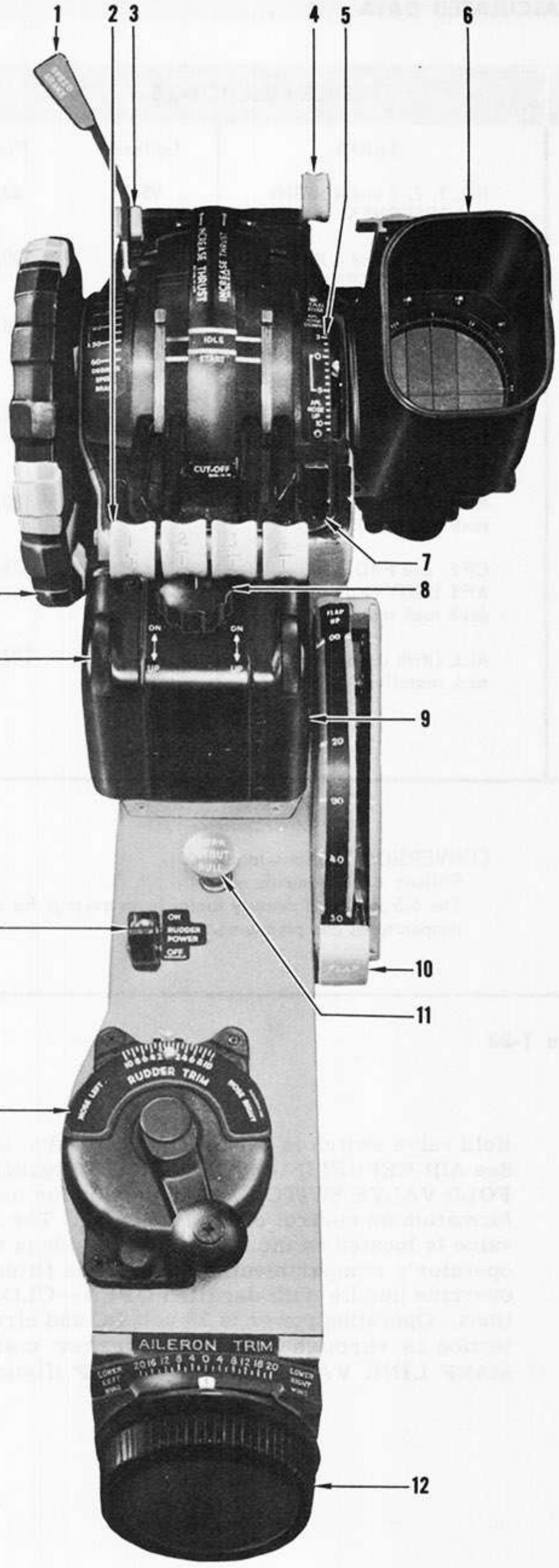
Before takeoff, it is important that the manual refueling valves handle (figure 4-76) be placed in the FLIGHT POSITION to allow free flow of fuel to the aft body tank during transfer of fuel from the main tanks. See figure 1-24.

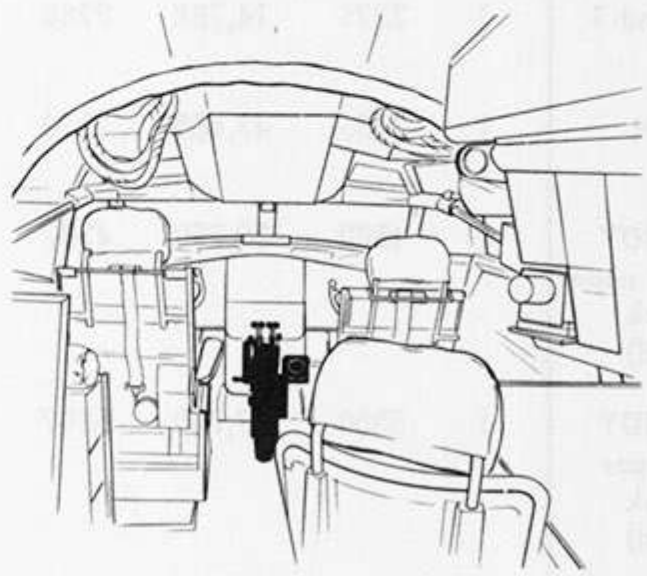
UPPER DECK TO AFT BODY TANK VALVE SWITCH

The upper deck to aft body tank valve switch (18, figure 1-25) controls the gravity flow of fuel from the upper deck to the aft body tank. A float valve in the aft body tank prevents this flow if the aft body tank is full. A manual override T-handle on the floor at the rear of the main compartment on the left side is used to manually open this valve in case of electrical control failure. The valve cannot be closed with this handle, but may be closed electrically. The upper deck to aft body tank valve should be considered a normally closed valve. This valve should ordinarily be opened only when an A/R pump is operating in the aft body tank or when there is enough volume in the aft body tank to receive all the fuel remaining in the upper deck tank. Refer to FUEL SYSTEM OPERATION, Section VII. Operating power is 28 volt DC through a circuit breaker marked UPPER DECK TO AFT TANK on the SBCBP (figure 1-35).

CONTROL STAND

(TYPICAL)





1 SPEED BRAKE LEVER AND INDICATOR
2 THROTTLES
3 PARKING BRAKE HANDLE
4 THROTTLE BRAKE LEVER
5 STABILIZER TRIM INDICATOR
6 PILOT'S SEARCH RADAR INDICATOR (SEE FIGURE 4-20)
7 STABILIZER TRIM CUT-OUT SWITCH
8 AUTOPILOT TURN KNOB
9 AUTOPILOT FLIGHT CONTROLLER (SEE FIGURE 4-41)
10 FLAP LEVER AND INDICATOR
11 WARNING HORN CUT-OUT SWITCH
12 AILERON TRIM CONTROL WHEEL AND INDICATOR
13 RUDDER TRIM CONTROL WHEEL AND INDICATOR
14 AUTOPILOT PITCH KNOB
15 STABILIZER TRIM CONTROL WHEEL
16 RUDDER POWER SWITCH

Figure 1-22

F1728

FUEL QUANTITY DATA

DATA AS OF: MARCH 1958
DATA BASIS: CALCULATED DATA

TANK	NO. OF TANKS	USABLE FUEL (EA)		FULLY SERVICED (EA)	
		Gallons	Pounds	Gallons	Pounds
NO. 1 and 4 RESERVES	2	434	2821	435	2828
NO. 1 and 4 MAINS	2	2062	13,403	2067	13,436
NO. 2 and 3 MAINS	2	2275	14,788	2288	14,872
CENTER WING	1	7306	47,489	7310	47,515
FWD BODY (Without upper deck tank installed)	1	4500	29,250	4507	29,296
FWD BODY (With upper deck tank installed)	1	5800	37,700	5807	37,746
AFT BODY	1	6378	41,457	6415	41,698
UPPER DECK	1	2174	14,131	2184	14,196

USABLE FUEL TOTALS		
TANKS	Gallons	Pounds
NO. 1, 2, 3 and 4 MAINS and RESERVES	9542	62,024
NO. 1, 2, 3 and 4 MAINS CWT, and RESERVES	16,848	109,512
CWT, and FWD and AFT BODY (Without upper deck tank installed)	18,184	118,196
FWD and AFT BODY (Without upper deck tank installed)	10,878	70,707
ALL (Without upper deck tank installed)	27,726	180,219
CWT, and FWD and AFT BODY (With upper deck tank installed)	19,484	126,646
ALL (With upper deck tank installed)	31,200	202,800

NOTE

Due to manufacturing tolerances of bladder fuel cells, a variation of ± 1.5% may exist in individual body tank capacities. Consequently the quoted capacities are representative only and should not be used as exact values for any particular airplane.

CONVERSION - Gallons to pounds
Gallons x 6.5 = pounds of fuel
The 6.5 JP-4 fuel density factor is an average for std. day temperatures and pressures.

Figure 1-23

AIR REFUELING LINE VALVE SWITCH

The air refueling line valve switch (17, figure 1-25) is used as an additional positive shutoff of the air refueling manifold during A/R manifold to engine manifold fuel feed operation or ground maintenance. When the switch is rotated to align the white stripe on the switch with the flow line on the fuel panel, the valve is open. When the A/R manifold to engine manifold valve switch is opened, the line valve is closed. See AIR REFUELING MANIFOLD TO ENGINE MANIFOLD VALVE SWITCH in this Section for further information on control of the line valve. The A/R line valve is located on the right forward side of the boom operator's compartment. The valve is fitted with an override handle with decalled OPEN--CLOSE positions. Operating power is 28 volt DC and circuit protection is through a circuit breaker marked AR MANF LINE VALVE on the SBCBP (figure 1-35).

BOOST PUMP SWITCHES

Eight boost pump switches (3, figure 1-25) are on the fuel control panel. They control the electrically driven centrifugal fuel pumps; two boost pumps in each of the four main tanks. Each switch is a two position switch; the up position is ON, and the undecalled center position is OFF. The left switch is decalled F for the forward pump in the tank and the right switch is decalled A for the aft pump in the tank. The reserve tanks do not have fuel pumps. Control power is 28 volt DC and circuit protection is through circuit breakers marked FUEL BOOST CONTROL, NO. 4 AFT, NO. 3 AFT, NO. 2 FORWARD, and NO. 1 AFT FUEL BOOST CONTROL NO. 4 FORWARD, NO. 3 FORWARD, NO. 2 AFT, and NO. 1 FORWARD on the MCBP (figure 1-35). Operating power is 115/200 volt AC and circuit protection is through circuit breakers marked FUEL BOOST NO. 1 AFT, FUEL BOOST NO. 3 FORWARD, FUEL BOOST NO. 4 AFT, FUEL BOOST NO. 2 FORWARD, FUEL BOOST NO. 3 AFT, FUEL BOOST NO. 1 FORWARD, FUEL BOOST NO. 2 AFT, and FUEL BOOST NO. 4 FORWARD on the MCBP (figure 1-35).

CAUTION

Boost pumps should not be run dry. If boost pumps operate dry for a period exceeding two minutes, damage to pumps may result.

OVERRIDE PUMP SWITCHES

Two override pump switches (5, figure 1-25) on the fuel control panel, control the two electrically driven centrifugal fuel pumps in the center wing tank. The switches are two position; the up position is ON, and the down undecalled position is OFF. The override pumps higher pump pressure will override main wing tank boost pump pressure when operating in the center wing tank to engines configuration, see CENTER WING TANK TO ENGINES, Section VII. Operating power is 115/200 volt AC and circuit protection is through circuit breakers marked OVERRIDE PUMP LEFT HAND and OVERRIDE PUMP RIGHT HAND on the MCBP (figure 1-35). When operating the override pumps to feed engines from the center wing tank, monitor fuel quantity frequently as the center wing tank approaches empty. When the gage reads 1000 pounds, turn the override pumps off. When gravity transfer is possible, this fuel should be transferred to the forward body tank. The fuel can then be used for engine operation.

CAUTION

Override pumps should not be run dry. If override pumps operate dry for a period exceeding five minutes, damage to pumps may result.

AIR REFUELING PUMP SWITCHES

Four air refueling pump switches (6, figure 1-25) on the fuel control panel, control the flow of hydraulic fluid to the hydraulic motor driven centrifugal air refueling pumps. The two body tanks each contain two air refueling pumps which may be used for fuel feed as well as air refueling operations. The two switches decalled F (one for each tank) control the forward pumps of each tank. The two switches decalled A (one for each tank) control the aft pump of each tank. The switches are two position; the up position is ON, and the down undecalled position is OFF. When the switch is ON, a solenoid valve opens admitting hydraulic fluid under pressure to the air refueling pumps hydraulic motors. For hydraulic fluid to be admitted to the pumps, it is necessary that either the A/R manifold to engine manifold valve switch is open; the fuel dump switch is in the FUEL DUMP position; the signal system is in contact made condition; or the emergency contact made switch is depressed when the emergency override switch is in the OVERRIDE position. On airplanes 140▶ a time delay has been added to the A/R pump control relay (figure 4-74) such that a 10 to 14 second delay will be insured when turning on the forward pump in the forward body tank, and the aft pump in the aft body tank. This prevents possible surging in the A/R fuel system caused by all four pumps beginning operation at the same time. Whenever the pump switches are placed in the OFF position or power is removed from the A/R pump circuit, there will be a 30 second time delay to reset the time delay circuits. Operating power is 28 volt DC and circuit protection is through circuit breakers marked REFUEL PUMP, FWD TANK, FWD, and AFT; AFT TANK, FWD, and AFT on the SBCBP (figure 1-35).

CAUTION

Air refueling pumps should not be run dry. If air refueling pumps operate dry for a period exceeding two minutes, damage to pumps may result.

FUEL SYSTEM

CONDITION: MAIN TANKS TO ENGINES

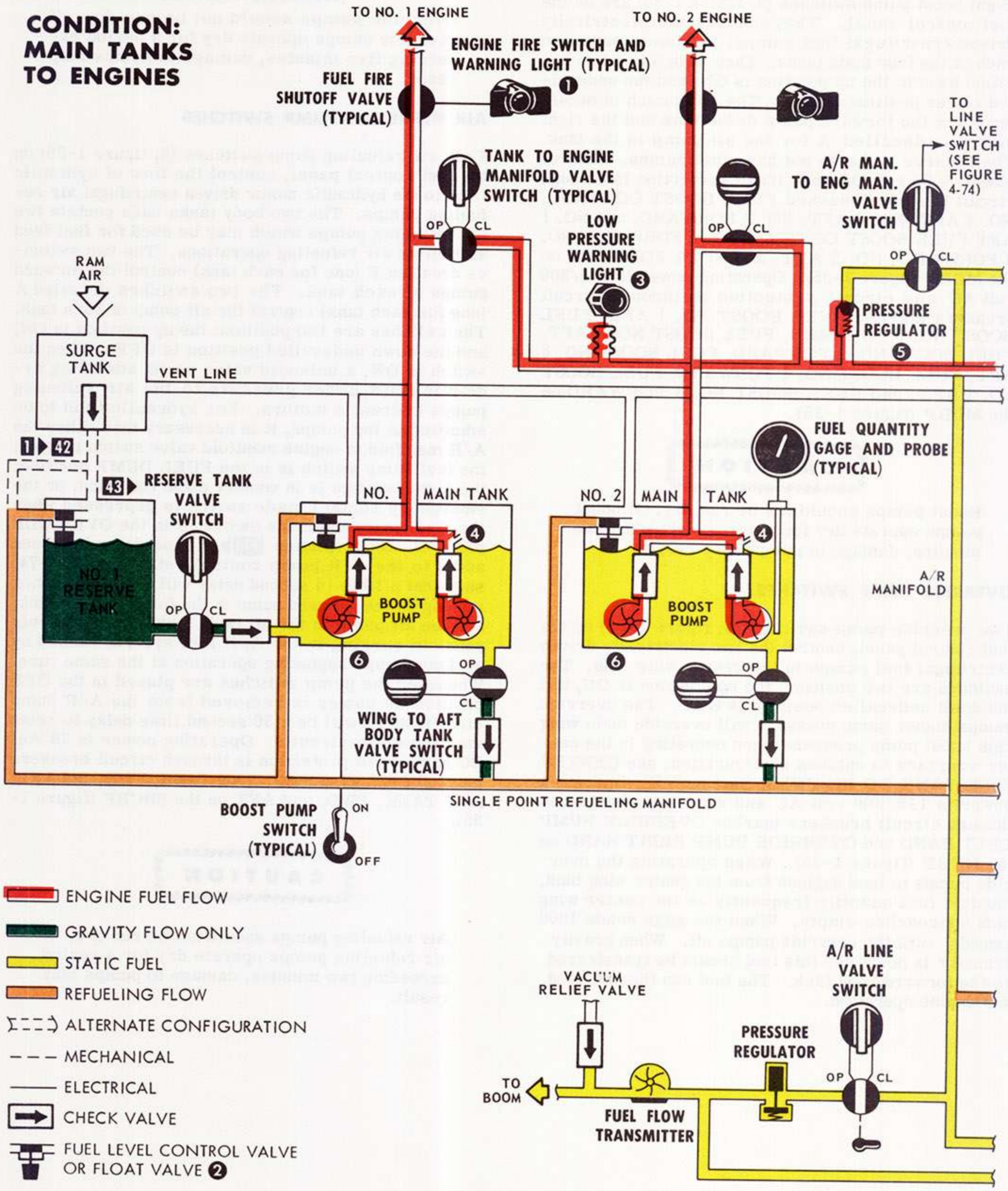
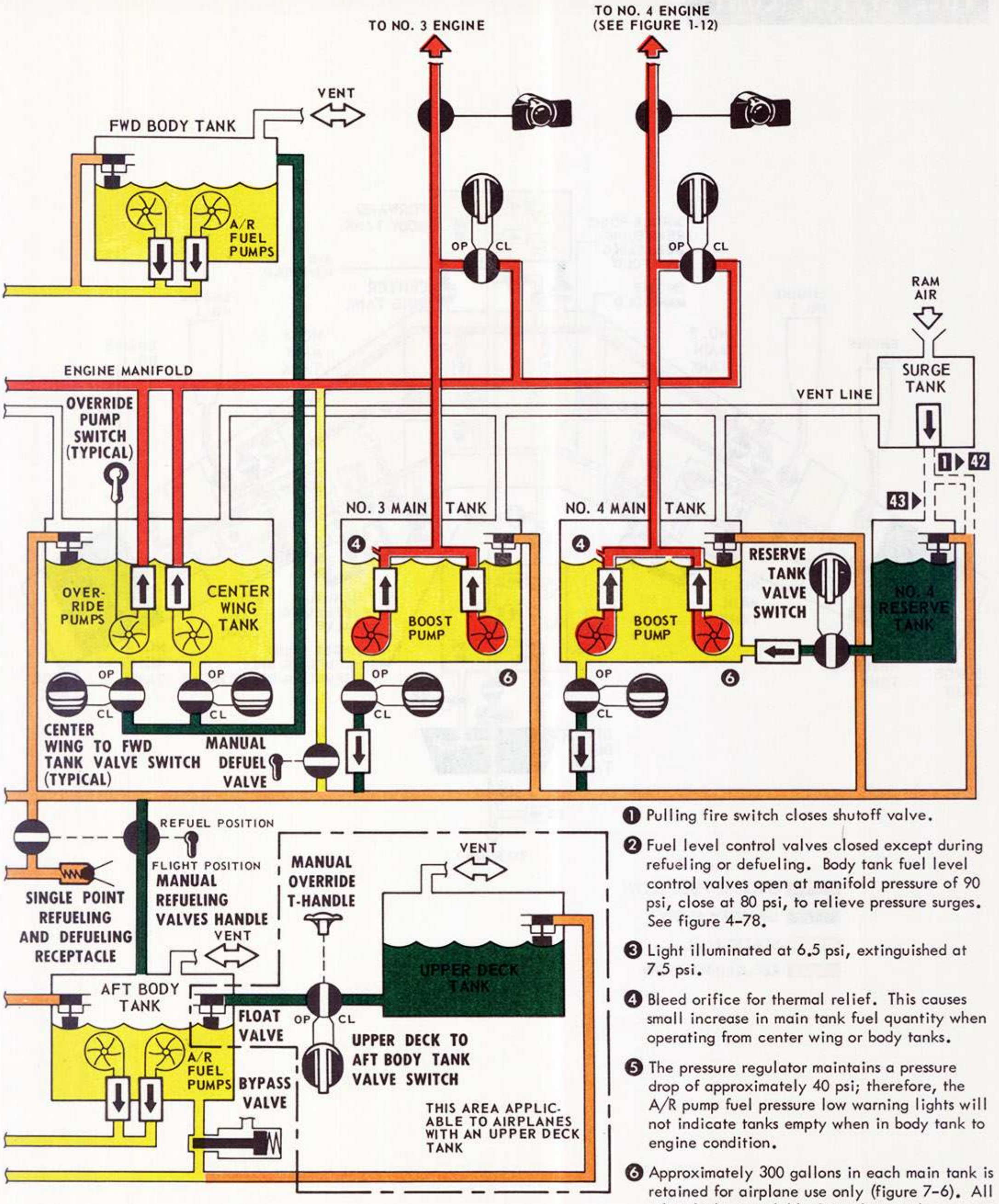


Figure 1-24 (Sheet 1 of 3)



1. Pulling fire switch closes shutoff valve.
2. Fuel level control valves closed except during refueling or defueling. Body tank fuel level control valves open at manifold pressure of 90 psi, close at 80 psi, to relieve pressure surges. See figure 4-78.
3. Light illuminated at 6.5 psi, extinguished at 7.5 psi.
4. Bleed orifice for thermal relief. This causes small increase in main tank fuel quantity when operating from center wing or body tanks.
5. The pressure regulator maintains a pressure drop of approximately 40 psi; therefore, the A/R pump fuel pressure low warning lights will not indicate tanks empty when in body tank to engine condition.
6. Approximately 300 gallons in each main tank is retained for airplane use only (figure 7-6). All other fuel is available for either airplane use or A/R off load.

Figure 1-24 (Sheet 2 of 3)

FUEL SYSTEM (CONT)

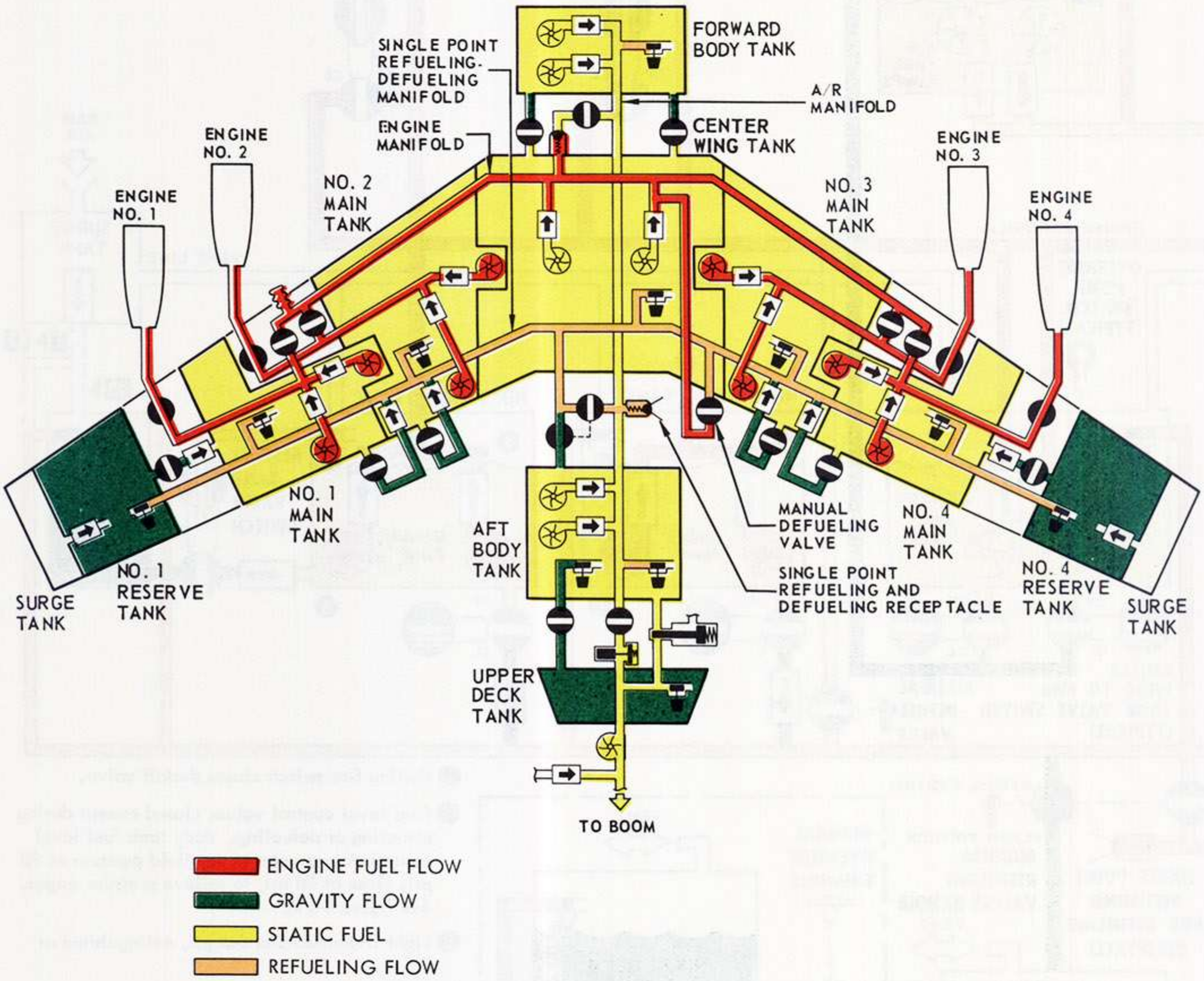


Figure 1-24 (Sheet 3 of 3)

FUEL DUMP SWITCH

A guarded two position switch (10, figure 1-25) with FUEL DUMP--OFF, NORMAL positions is provided on the fuel control panel to dump fuel out the boom. With the guard up the switch may be placed in the up, FUEL DUMP position. On airplanes 483▶, with the guard down the switch is in the OFF, NORMAL position. On airplanes 1▶482 it will be necessary to move the switch to the OFF, NORMAL position before the switch guard is snapped down. When the fuel dump switch is placed in the FUEL DUMP position, the A/R fuel bypass control valve is energized open if the boom is extended; the A/R pumps are energized if the A/R pump switches are ON; and the boom hydraulic auto retract valve is energized open. The line valve is not connected to the dump switch. When the boom is fully retracted, placing the boom retraction limit switch in the retract position; the A/R fuel bypass valve is closed and the fuel dump valve is actuated, depressing the nozzle check valve. See figure 4-65. Operating power is 28 volt DC and circuit protection is through a circuit breaker marked FUEL DUMP, located on the SBCBP (figure 1-35).

PUSH-TO-TEST GAGES BUTTON

A push-to-test gages button (1, figure 1-25) is on the fuel control panel to test all fuel quantity gages. The button is spring loaded to the OFF position. When the button is depressed, all quantity gages will go down scale. When the button is released, all quantity gages will return to the correct reading. The button supplies a path to ground, unbalancing the amplifier which drives the gages down scale.

NOTE

When quantities of fuel are near zero in tanks to be checked, observe the sub-dial on the quantity gage when actuating the push-to-test gages button.

PUSH-TO-TEST TOTALIZER BUTTON

On those airplanes equipped with an upper deck tank, a push-to-test totalizer button (20, figure 1-25) is used to test the total fuel quantity gage. When the button is depressed, the total fuel quantity gage will go down scale. When the button is released, the total fuel quantity gage will return to the correct reading. The button supplies a path to ground, unbalancing the amplifier which drives the gage down scale.

TOTALIZER RESET BUTTON

On those airplanes without an upper deck tank, a totalizer reset button (15, figure 1-25) is on the fuel control panel. This button is used to reset the fuel flow rate and totalizer gage (13, figure 1-25). The boom operator's master switch must be ON to provide power to the fuel flow rate and totalizer gage. When the button is depressed, the fuel flow rate and totalizer gage is returned to zero. The button is spring loaded to the OFF position. When the button is released, the flow rate pointer will return to the flow rate indication existing in the boom at that time; and the totalizer counter will record from zero all fuel transferred from that instant. Operating power is 115 volt AC, control power is 28 volt DC and circuit protection is located on the BOCBP (figure 1-35)

TRANSFER RESET BUTTON

On those airplanes equipped with an upper deck tank, a transfer reset button (14, figure 1-25) is used to reset the total fuel transferred counter to zero in the fuel flow rate and totalizer gage. The boom operator's master switch must be ON to provide power to fuel flow rate and totalizer gage. Operating power is 115 volt AC, control power is 28 volt DC, and circuit protection is provided on the BOCBP (figure 1-35).

FUEL QUANTITY GAGES

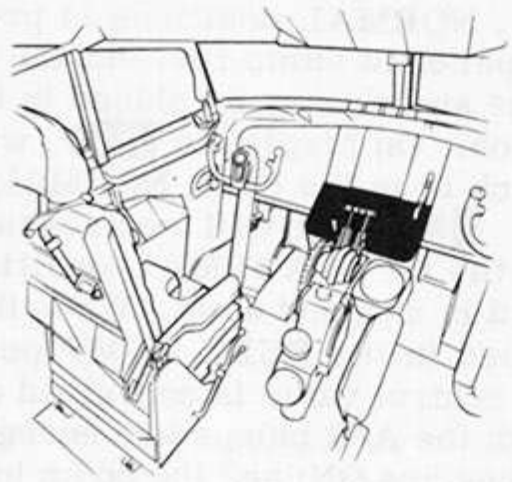
A fuel quantity gage (12, figure 1-25) is provided for each tank in the airplane. Each tank contains fuel probes which transmit fuel quantity indication to the gages. The gages indicate the pounds of fuel in each tank. Operating power is 115 volt AC, control power is 28 volt DC, and circuit protection is located on the MCBP (figure 1-35). The control power circuit breakers are marked FUEL QUANTITY (FORWARD BODY, CENTER WING, AFT BODY, and NO. 4); FUEL QUANTITY (NO. 3, NO. 2, NO. 1, RESERVE NO. 4, and RESERVE NO. 1). The operating power circuit breakers are marked identically to the control power circuit breakers. For those airplanes with an upper deck tank, there will be a control power and operating power circuit breaker marked UPPER DECK.

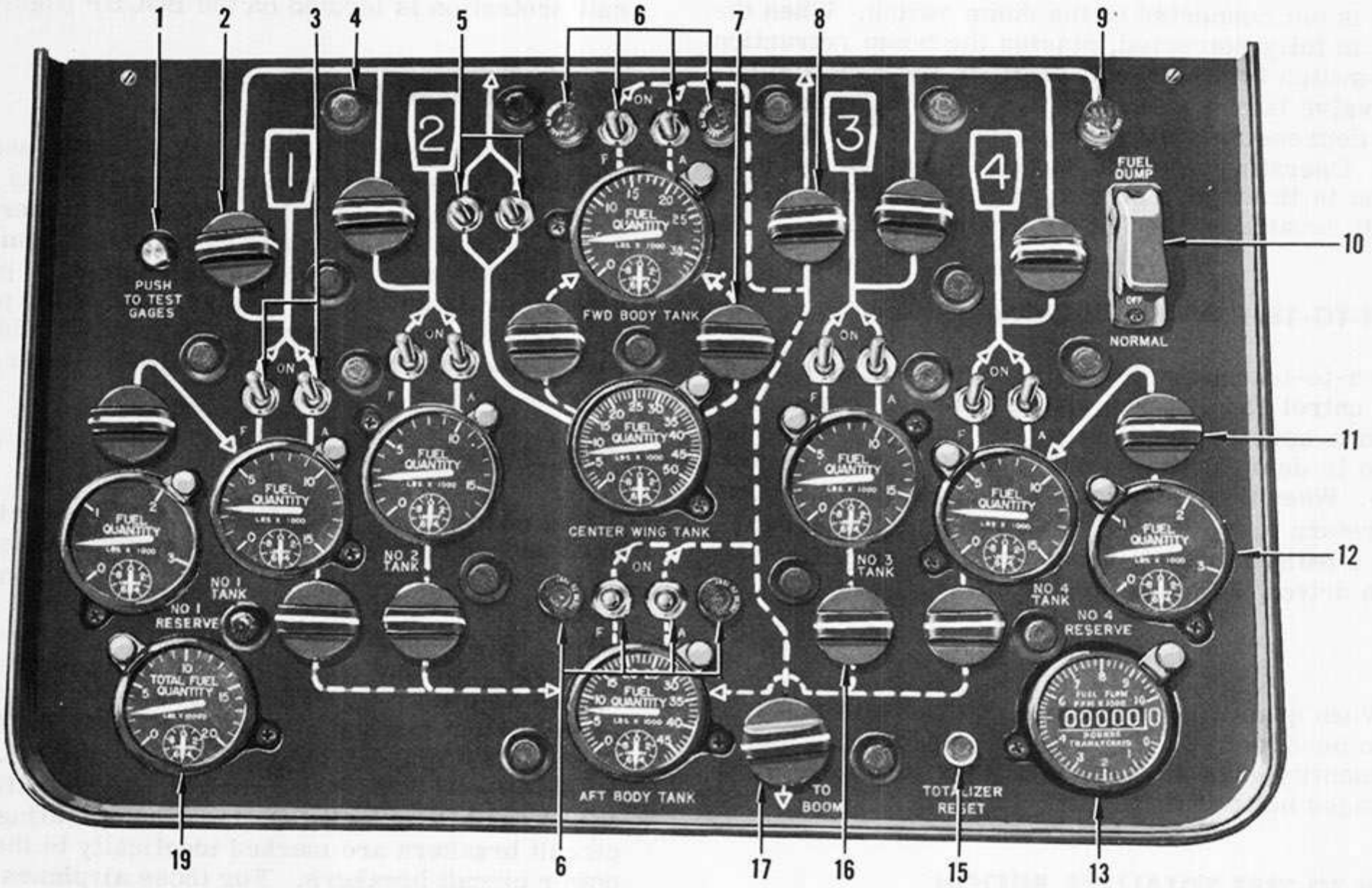
TOTAL FUEL QUANTITY GAGE

A total fuel quantity gage (19, figure 1-25) on the fuel panel sums, in pounds, the quantity indications from all other fuel quantity gages. Control power is 28 volt DC and operating power is 115 volt AC with circuit protection through two circuit breakers marked FUEL QUANTITY TOTAL on the MCBP (figure 1-35).

FUEL PANEL

(NO UPPER DECK TANK)





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1 PUSH TO TEST GAGES BUTTON (2 PLACES)
2 TANK TO ENGINE MANIFOLD VALVE SWITCHES (2 PLACES)
3 BOOST PUMP SWITCHES (2 PLACES)
4 PANEL LIGHTS (2 PLACES)
5 OVERRIDE PUMP SWITCHES (2 PLACES)
6 AIR REFUELING PUMP SWITCHES AND FUEL LOW PRESSURE WARNING LIGHTS (4 PLACES)
7 CENTER WING TO FORWARD BODY TANK VALVE SWITCHES (2 PLACES)
8 AIR REFUELING MANIFOLD TO ENGINE MANIFOLD VALVE SWITCH (2 PLACES)
9 ENGINE MANIFOLD FUEL LOW PRESSURE WARNING LIGHT (2 PLACES)
10 FUEL DUMP SWITCH (2 PLACES)
11 RESERVE TANK VALVE SWITCHES (2 PLACES)
12 FUEL QUANTITY GAGES (2 PLACES)
13 FUEL FLOW RATE AND TOTALIZER GAGE (2 PLACES)
14 TRANSFER RESET BUTTON (SHEET 2)
15 TOTALIZER RESET BUTTON (SHEET 1)
16 WING TO AFT BODY TANK VALVE SWITCHES (2 PLACES)
17 AIR REFUELING LINE VALVE SWITCH (2 PLACES)
18 UPPER DECK TO AFT BODY TANK VALVE SWITCH (SHEET 2)
19 TOTAL FUEL QUANTITY GAGE (2 PLACES)
20 PUSH TO TEST TOTALIZER BUTTON (SHEET 2)

Figure 1-25 (Sheet 1 of 2)

(WITH UPPER DECK TANK)

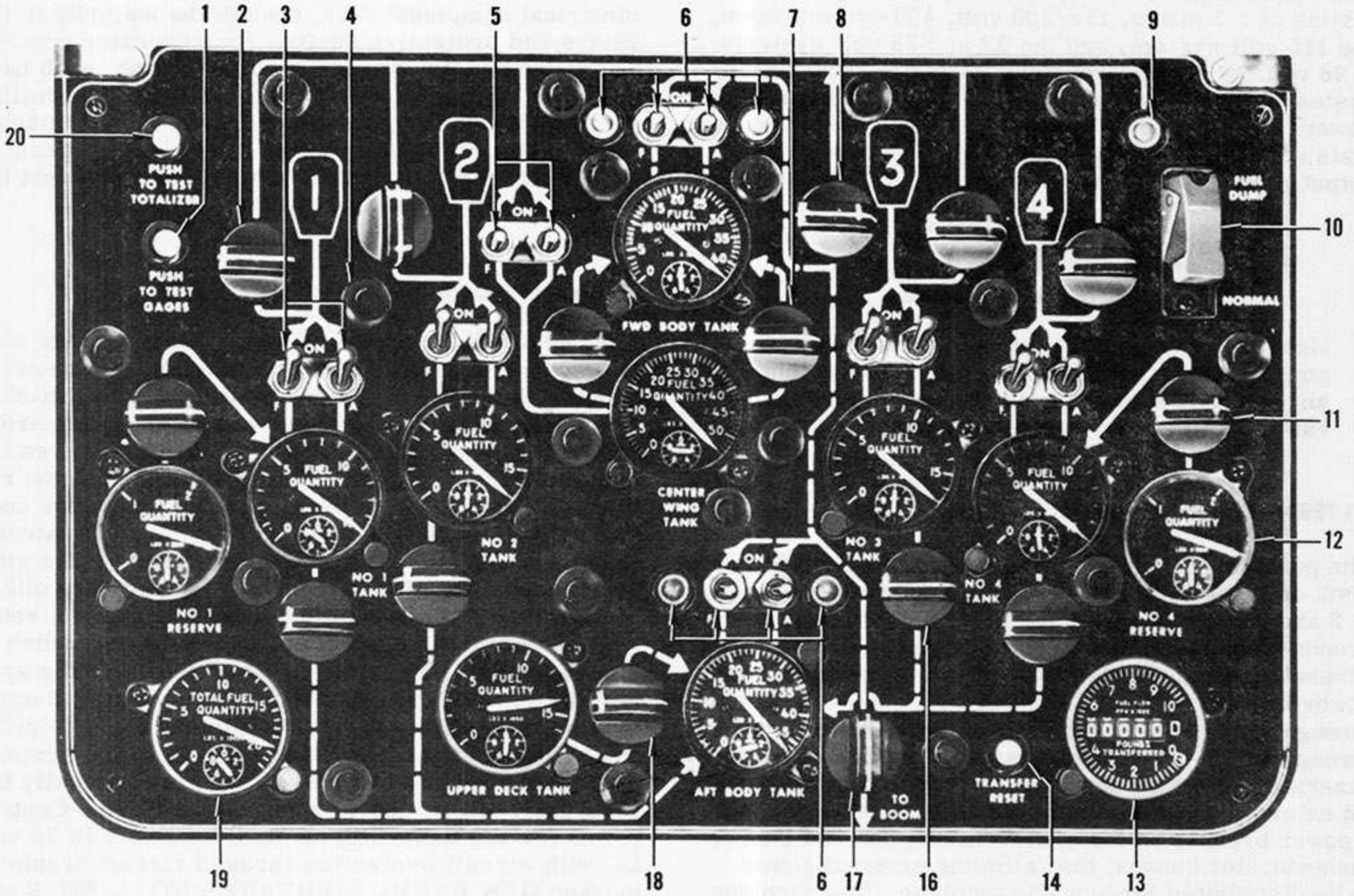


Figure 1-25 (Sheet 2 of 2)

F-39

FUEL LOW PRESSURE WARNING LIGHTS

An engine manifold, fuel low pressure warning light (9, figure 1-25) is on the fuel panel. This is a press-to-test light and is set to illuminate whenever fuel pressure in the engine manifold drops below 6.5 psi. The light will be extinguished when pressure raises to 7.5 psi. This light is amber and is functional only in the tank to engine manifold configuration. Power for the light is 28 volt DC through a circuit breaker marked FUEL PRESS ENG MANF on the SBCBP (figure 1-35). A warning light (6, figure 1-25) with the same limits as above is installed beside each A/R pump switch. The warning lights will not illuminate when operating the engines from the body tanks due to trapped fuel pressure; therefore, the engine manifold low pressure warning light would be the only indication of fuel low pressure to the engines. Any operation with the line valve open will relieve fuel pressure; therefore, the A/R pump low pressure warning will operate normally. Power for all lights is 28 volt DC through four circuit breakers marked REFUEL PUMP, FWD TANK, FWD and AFT, AFT TANK, FWD and AFT on the SBCBP (figure 1-35).

ELECTRICAL SYSTEMS

The airplane electrical system is primarily AC, consisting of a 3 phase, 115/200 volt, 400 cycle system, the 115 volt system, and the 32 and 28 volt systems. A 28 volt DC system receives its power from the AC system with a battery as a secondary source of power. The copilot's instrument power system consists of a hydraulically powered generator with an output of 115/200 volts AC.

WARNING

Never attempt to work on equipment using AC power. Call a qualified technician as touching any one wire while in contact with the airplane can be deadly.

ALTERNATING CURRENT SYSTEM

The primary AC system shown in figure 1-27 consists of 3, 40 KVA generators driven by engines No. 1, 2 and 3 through generator drives. The generators produce 3 phase, 115/200 volts at 400 cycles. These generators are connected to their busses through power breakers. The busses are interconnected through power breakers to a synchronizing bus through which the generators may be paralleled; the generators may be operated in parallel or isolated. An external power receptacle is connected through a power breaker to the synchronizing bus and then to the generator busses; thus allowing external power to be distributed through the airplane. The airplane has an auxiliary power unit (APU) with a 30 KVA generator. This generator is connected to the main airplane electrical system through the external power breaker; therefore, it cannot be paralleled with the engine driven generators. See ARCTIC CAPABILITY, Section IV, and figure 1-34 for distribution of the electrical power supplied by the APU.

External Power Receptacle

The external power receptacle (41, figure 1-65) for AC power is located on the outside of the airplane just aft of and to the right of the nose wheel well.

NOTE

The external power receptacle will accept an external power plug that supplies AC power for airplane loads and DC power to close the external power breaker. An external power plug that supplies only AC power is acceptable provided the plug has a jumper wire from pin E to F (DC power pins). In this case power for the external power breaker operation will come from the airplane battery.

Generator Control Panels

The generator control panels (19, figure 1-26), in the electrical equipment rack, contain the majority of the relays and protective devices for generator control. The three panels, one for each generator, each have a circuit breaker for the power circuit controlling the trip-out of the generator breaker. The manual reset feature on the front of each control panel is used to reset the generator control relay in event the battery bus is de-energized.

Generator Control Switch

Each generator circuit has a guarded generator control switch (7, figure 1-30) on the electrical control panel with TRIP--CLOSE positions. The switches are spring loaded from these positions to a guarded NEUTRAL position. The TRIP position removes the generator from service and the CLOSE position returns the generator to service. The generator control switch controls a relay that is mechanically latched in the TRIP or CLOSE position when the generator control switch is momentarily moved to either of these two positions. The generator control relay will remain in the CLOSE position until the switch is moved to the TRIP position or until one of the system protective devices operates to unlatch and move the power breaker to the TRIP position. The relay can be moved from the TRIP to the CLOSE position only by the generator control switch. Normally the generator will not be tripped on shutdown. Control power for the generator control switches is 28 volt DC with circuit protection through circuit breakers marked GEN PANEL & BREAKER NO. 1, NO. 2 and NO. 3 on the Battery Circuit Breaker Panel (figure 1-35, sheet 1), and through a circuit breaker on the generator control panel (19, figure 1-26) in the electrical equipment rack.

Generator Failure Light

Three red press-to-test generator failure lights (6, figure 1-30) are on the electrical control panel to the left of each of the three generator control switches. If the generator control relay is tripped with the fire switch in the normal position the light will illuminate. Operating power for the lights is 28 volt DC through circuit breakers marked GEN PANEL & BREAKER NO. 1, NO. 2, NO. 3 on the battery circuit breaker panel (figure 1-35, sheet 1).

Generator Breaker Switches

The three channel guarded generator breaker switches (5, figure 1-30) on the electrical control panel have TRIP--CLOSE positions. They are spring loaded from the TRIP and CLOSE positions to a NEUTRAL position. The CLOSE position connects the

generator to its load bus. The TRIP position disconnects the generator from its load bus. The generator breaker switch controls a power breaker that is mechanically latched in the TRIP or CLOSE position when the generator breaker switch is momentarily moved to either of these two positions. The power breaker will remain in the CLOSE position until the switch is moved to the TRIP position or until one of the system protective devices operates to unlatch and move the power breaker to the TRIP position. The power breaker can be moved from the TRIP to the CLOSE position only by the generator breaker switch. The power breaker will go to the TRIP position every time the engines are shutdown. Operating power for the generator breaker switches is 28 volt DC and circuit protection is through circuit breakers marked GEN PANEL & BREAKER NO. 1, NO. 2 and NO. 3 on the Battery Circuit Breaker Panel (figure 1-35, sheet 1) and through a circuit breaker on the generator control panel (19, figure 1-26) in the electrical equipment rack.

Generator Breaker Circuit Open Lights

The three amber press-to-test circuit open lights (4, figure 1-30), left of each generator breaker switch on the electrical control panel, will illuminate when the generator breaker is in the trip condition. Operating power for the lights is 28 volt DC with circuit protection through circuit breakers marked GENERATOR CONTROL INDICATOR LIGHTS on the SBCBP (figure 1-35, sheet 1).

Bus Tie Breaker Switches

The three guarded bus tie breaker switches (3, figure 1-30) on the electrical control panel have TRIP--CLOSE positions and are spring loaded from these positions to a guarded NEUTRAL position. The CLOSE position of each switch connects the generator bus through the synchronizing bus to the other generator busses or to external power. The TRIP position isolates the generator and its bus from the rest of the system. The bus tie breaker switch controls a power breaker that is mechanically latched in the TRIP or CLOSE position when the bus tie breaker switch is momentarily moved to either of these two positions. The power breaker will remain in the CLOSE position until the switch is moved to the TRIP position or until one of the system protective devices operates to unlatch and move the power breaker to the TRIP position. The power breaker can be moved from the TRIP to the CLOSE position only by the bus tie breaker switch. The power breaker will normally be in the CLOSE position. Operating power for the bus tie breaker switches is 28 volt DC with circuit protection through circuit breakers marked GENERATOR CONTROL BUS TIE BREAKERS NO. 1, NO. 2 and NO. 3 on the SBCBP (figure 1-35, sheet 1).

Bus Tie Breaker Circuit Open Lights

These three amber press-to-test circuit open lights (2, figure 1-30) to the left of each of the bus tie breaker switches on the electrical control panel, will illuminate when the bus tie breaker is in the trip condition. Operating power for the lights is 28 volt DC with circuit protection through circuit breakers marked GENERATOR CONTROL INDICATOR LIGHTS on the SBCBP (figure 1-35, sheet 1).

External Power Switch

The guarded external power switch (8, figure 1-30) on the electrical control panel has TRIP--CLOSE positions and is spring loaded from these positions to a NEUTRAL position. When external or APU power is connected and all generator power breakers (controlled by the generator breaker) are tripped, the guard can be lifted and the switch moved momentarily to the CLOSE position to connect external or APU power. External or APU power is connected to the system through the normally closed bus tie breakers. When any generator is operating and its generator breaker switch is placed momentarily in the CLOSE position, the external power breaker will automatically go to the trip condition and remove external or APU power from the system. The external power switch controls a power breaker that is mechanically latched in the TRIP or CLOSE position when the external power switch is moved to either of these two positions. The power breaker will remain in the CLOSE position until the switch is moved to the TRIP position or until one of the system protective devices operates to unlatch and move the power breaker to the TRIP position.

NOTE

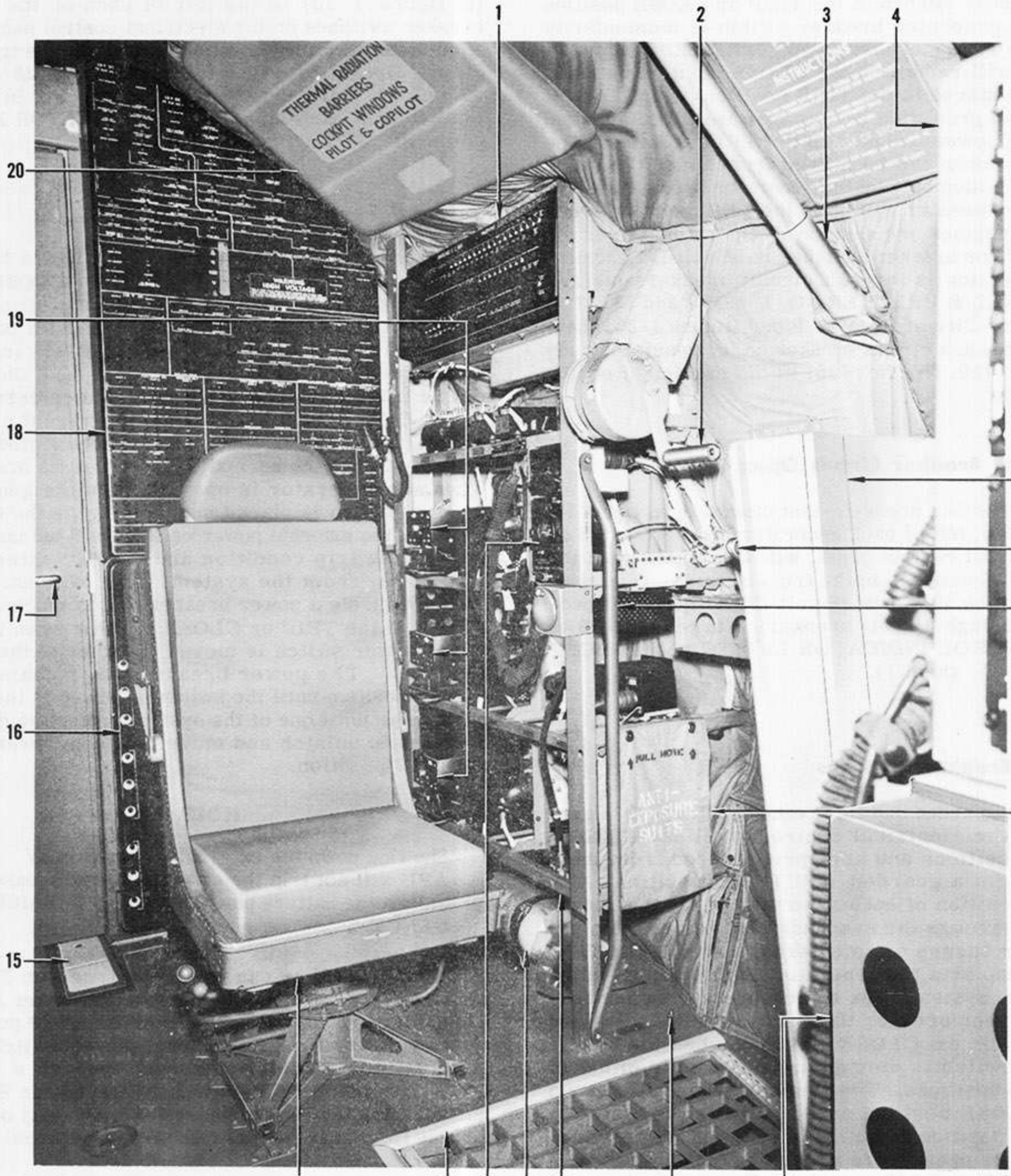
Shutting down the external power cart or APU will not trip the external power breaker unless the battery power switch is in EMERGENCY.

The power breaker can be moved from the TRIP to the CLOSE position only by the external power switch. The power breaker is normally in the TRIP position. Control power for the external power switch is 28 volt DC with circuit protection through a circuit breaker marked EXTERNAL RECP on the Battery Circuit Breaker Panel (figure 1-35, sheet 1) or from 28 volt DC control power from the external power cart.

Paralleling Selector, Voltmeter And Frequency Meter

The paralleling selector (10, figure 1-30) on the electrical control panel is a rotary type switch with GEN 1--BUS TIE--GEN 2--GEN 3--BUS TIE--EXTERNAL POWER positions. The paralleling selector provides a circuit through the generator breaker switch to the

CONTROL CABIN ELECTRICAL EQUIPMENT AREA



1 SWITCHED DC BUS CIRCUIT BREAKER PANEL (SEE FIGURE 1-35)
2 CREW ENTRY DOOR WINCH
3 CHINNING BAR
4 CREW INSTRUCTOR'S CONSOLE 10 ▶
5 EMERGENCY EXIT SPOILER
6 CREW ENTRY DOOR INTERIOR LATCH HANDLE
7 ASSIST HANDLE
8 ANTI-EXPOSURE SUIT STOWAGE (2 SUITS)
8A FD-109/RGA EQUIPMENT RACK
9 CREW ENTRY DOOR LOCK INDICATOR
10 ELECTRICAL EQUIPMENT RACK
11 OXYGEN BOTTLE
12 OXYGEN REGULATOR PANEL (SEE FIGURE 4-37)
13 CREW ENTRY CHUTE FLOOR GRILLE
14 BOOM OPERATOR'S SEAT (SEE FIGURE 4-80)
15 NOSE GEAR DOOR RELEASE AND ACCESS COVER
16 MAIN AC POWER PANEL (SEE FIGURE 1-35)
17 CONTROL CABIN DOOR
18 MAIN CIRCUIT BREAKER PANEL (SEE FIGURE 1-35)
19 GENERATOR CONTROL PANELS
20 THERMAL RADIATION CURTAINS

F-40

Figure 1-26

AC POWER SYSTEM GENERATION

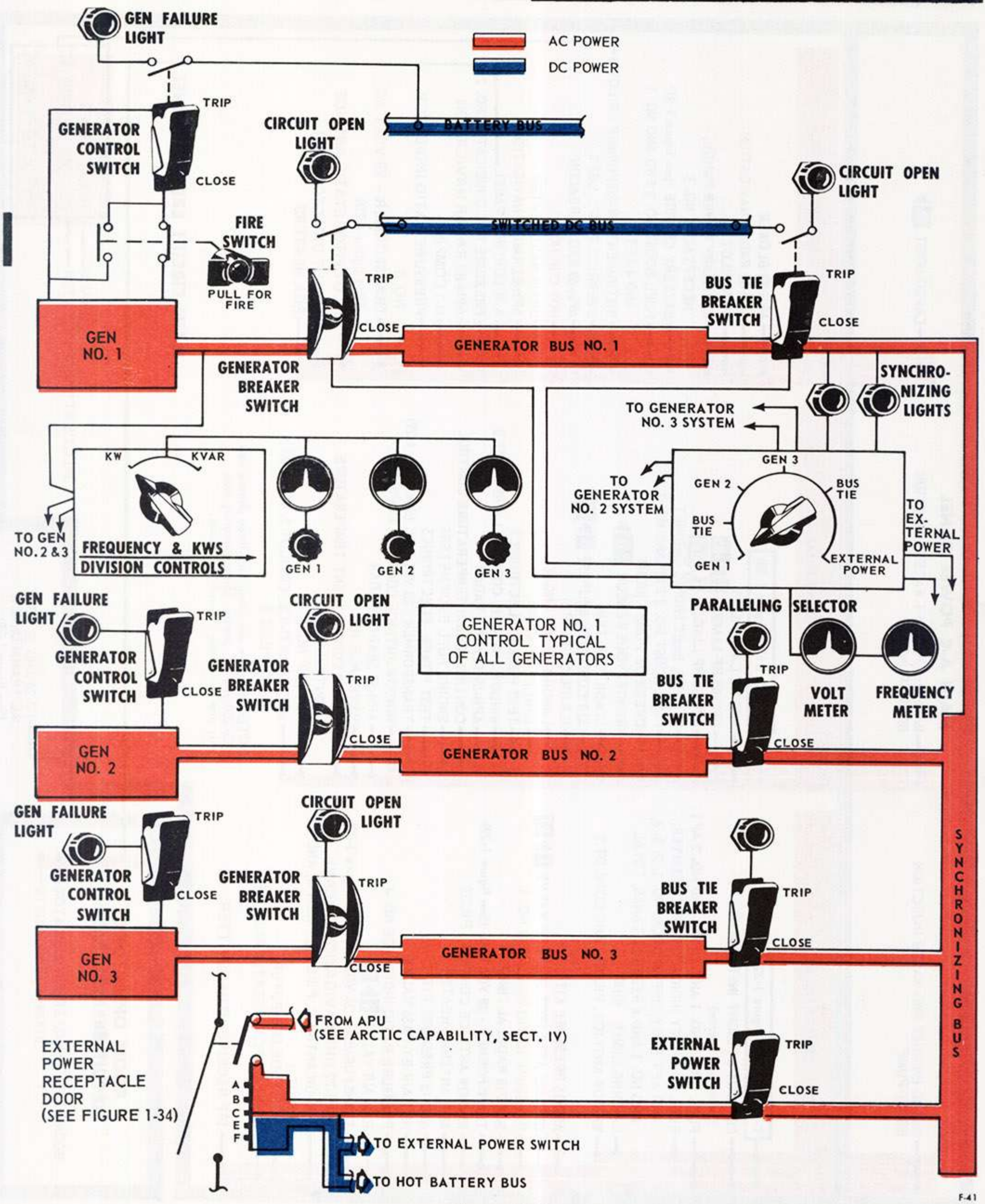


Figure 1-27

115/200 VOLT A-C POWER DISTRIBUTION

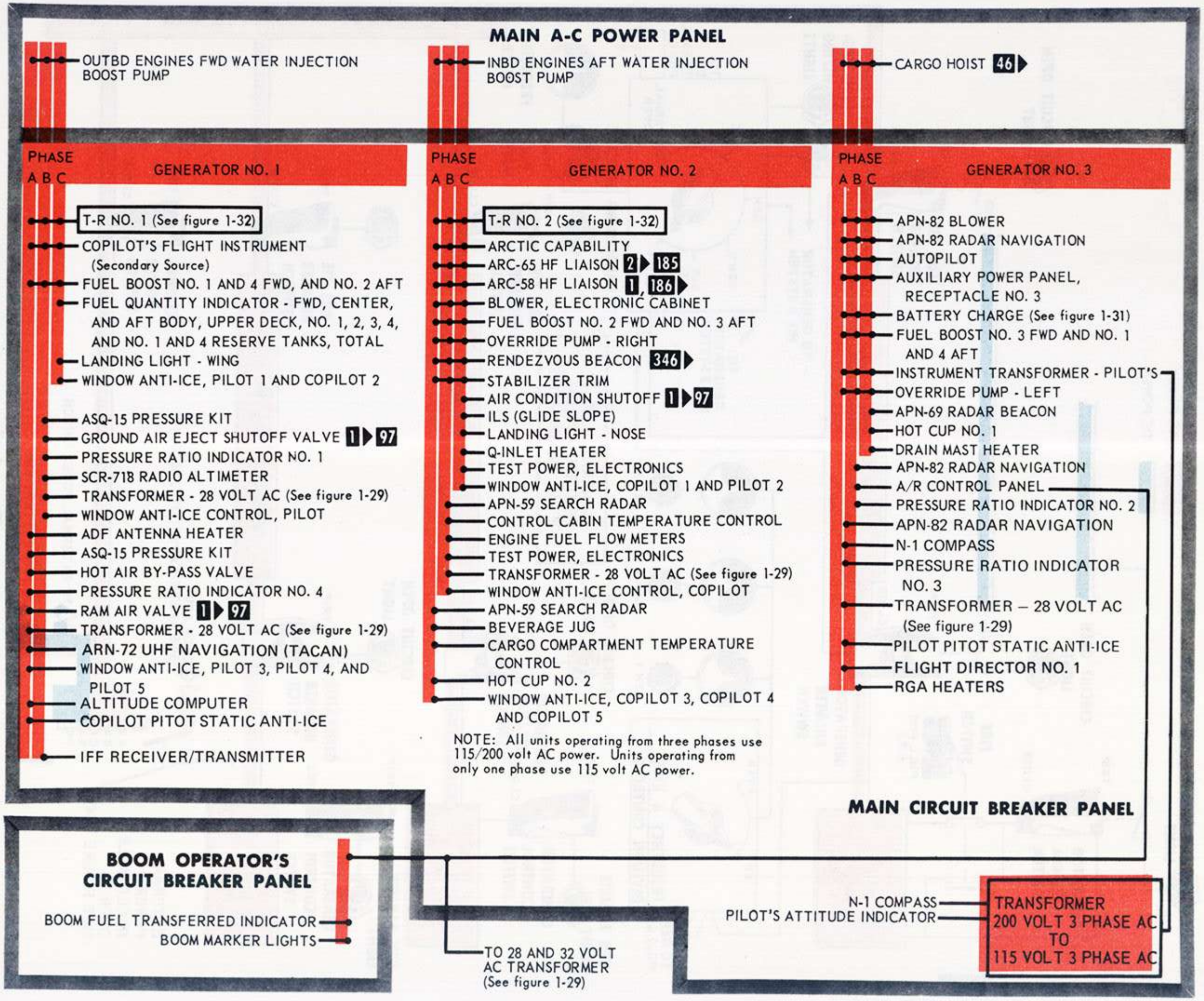
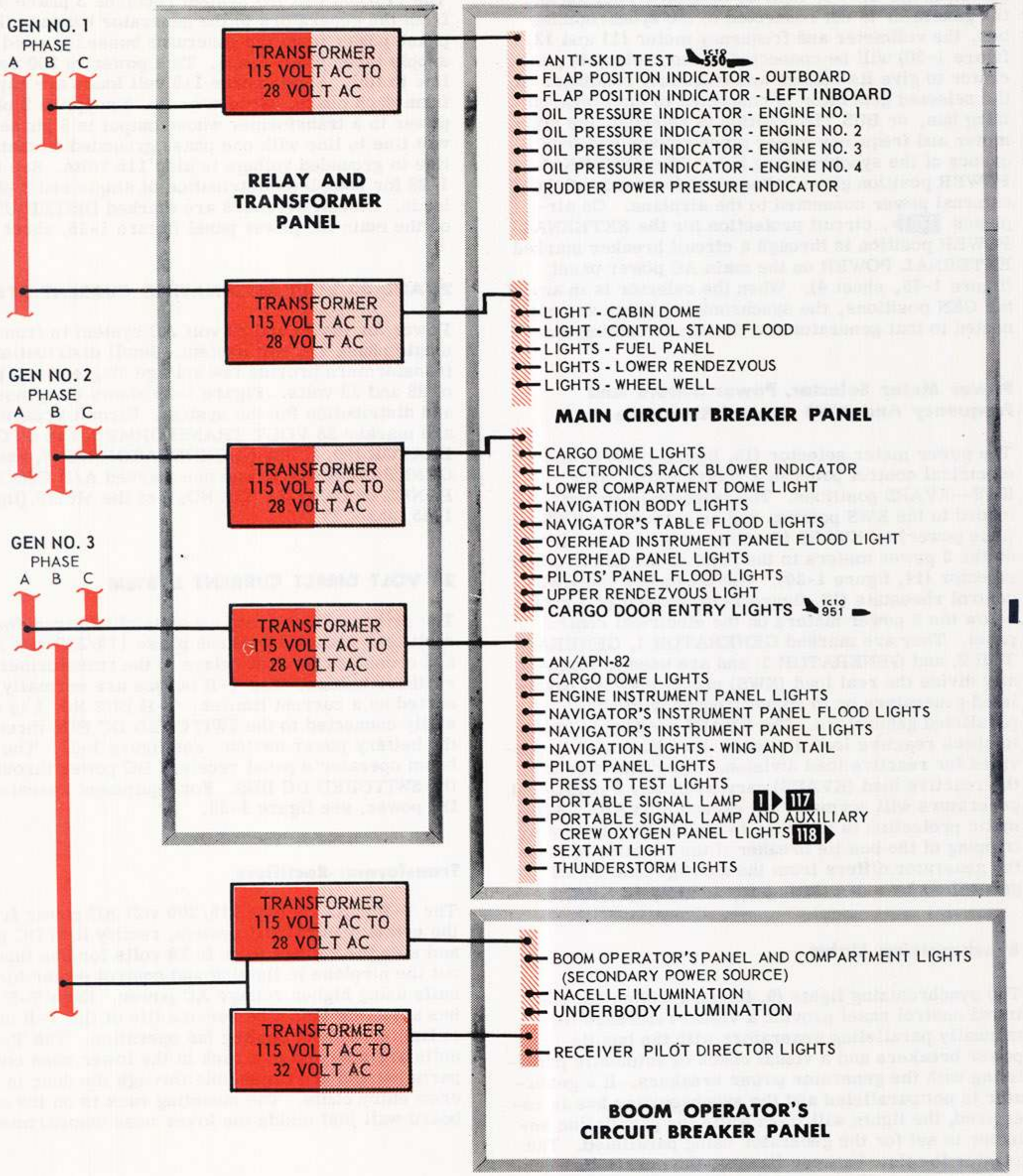


Figure 1-28

28 AND 32 VOLT AC POWER DISTRIBUTION



F-43

Figure 1-29

automatic paralleling control to automatically parallel the generators. When the paralleling selector is placed in the GEN 1, GEN 2, or GEN 3 position and the generator is not connected to the synchronizing bus, the voltmeter and frequency meter (11 and 12, figure 1-30) will be connected to the applicable generator to give its voltage and frequency readings. If the selected generator is connected to the synchronizing bus, or BUS TIE position is selected, the voltmeter and frequency meter gives voltage and frequency of the synchronizing bus. The EXTERNAL POWER position gives voltage and frequency of the external power connected to the airplane. On airplanes 340▶, circuit protection for the EXTERNAL POWER position is through a circuit breaker marked EXTERNAL POWER on the main AC power panel (figure 1-35, sheet 4). When the selector is in any of the GEN positions, the synchronizing lights are connected to that generator and the synchronizing bus.

Power Meter Selector, Power Meters And Frequency And KWS Control Rheostats

The power meter selector (15, figure 1-30) on the electrical control panel is a rotary switch with KWS--KVARS positions. The selector is spring loaded to the KWS position and selects either KWS (true power) or KVARS (reactive power) to be shown on the 3 power meters to the right of the power meter selector (14, figure 1-30). The frequency and KWS control rheostats (13, figure 1-30) consist of 3 knobs below the 3 power meters on the electrical control panel. They are marked GENERATOR 1, GENERATOR 2, and GENERATOR 3; and are used to manually divide the real load (KWS) evenly between paralleled generators or to adjust frequency of non-paralleled generators. The KVARS position is used to check reactive load division. No adjustment is provided for reactive load division. The difference in the reactive load (KVARS) carried by any 2 paralleled generators will normally not exceed 6 KVARS. Automatic protection is provided to isolate any system by tripping of the bus tie breaker if the reactive load on the generator differs from the average load on all generators by more than approximately 13 KVARS.

Synchronizing Lights

The synchronizing lights (9, figure 1-30) on the electrical control panel provide a visual reference for manually paralleling generators with the bus tie power breakers and a visual check of automatic paralleling with the generator power breakers. If a generator is not paralleled and the synchronizing bus is energized, the lights will flash while the paralleling selector is set for the generator being paralleled. The greater the time between flashes, the nearer that generator or generators supplying the synchronizing bus are to being at the same speed. Paralleling of the generators should occur, both manually and automatically, during the dark period of the synchronizing lights. For automatic and manual paralleling of generators, refer to ELECTRICAL SYSTEM OPERATION, Section VII.

115/200 VOLT ALTERNATING CURRENT SYSTEM

The 115/200 volt AC system receives 3 phase power from the generators to the generator busses. The 3 phase power from the generator busses is used to supply three phase loads. This power is 200 volts line to line. Single phase 115 volt loads are supplied from each phase. Generator No. 3 supplies 3 phase power to a transformer whose output is 3 phase 115 volt line to line with one phase grounded so that the line to grounded voltage is also 115 volts. See figure 1-28 for complete distribution of single and 3 phase loads. Circuit breakers are marked DISTRIBUTION on the main AC power panel (figure 1-35, sheet 4).

28 AND 32 VOLT ALTERNATING CURRENT SYSTEM

Power for the 28 and 32 volt AC system is from the single phase 115 volt system. Small distribution transformers provide low voltage single phase power of 28 and 32 volts. Figure 1-29 shows the phase used and distribution for the system. Circuit breakers are marked 28 VOLT TRANSFORMER, two on GENERATOR NO. 1, one on GENERATOR NO. 2, one on GENERATOR NO. 3, and one marked A/R CONTROL PANEL on GENERATOR NO. 3 of the MCBP (figure 1-35, sheet 3).

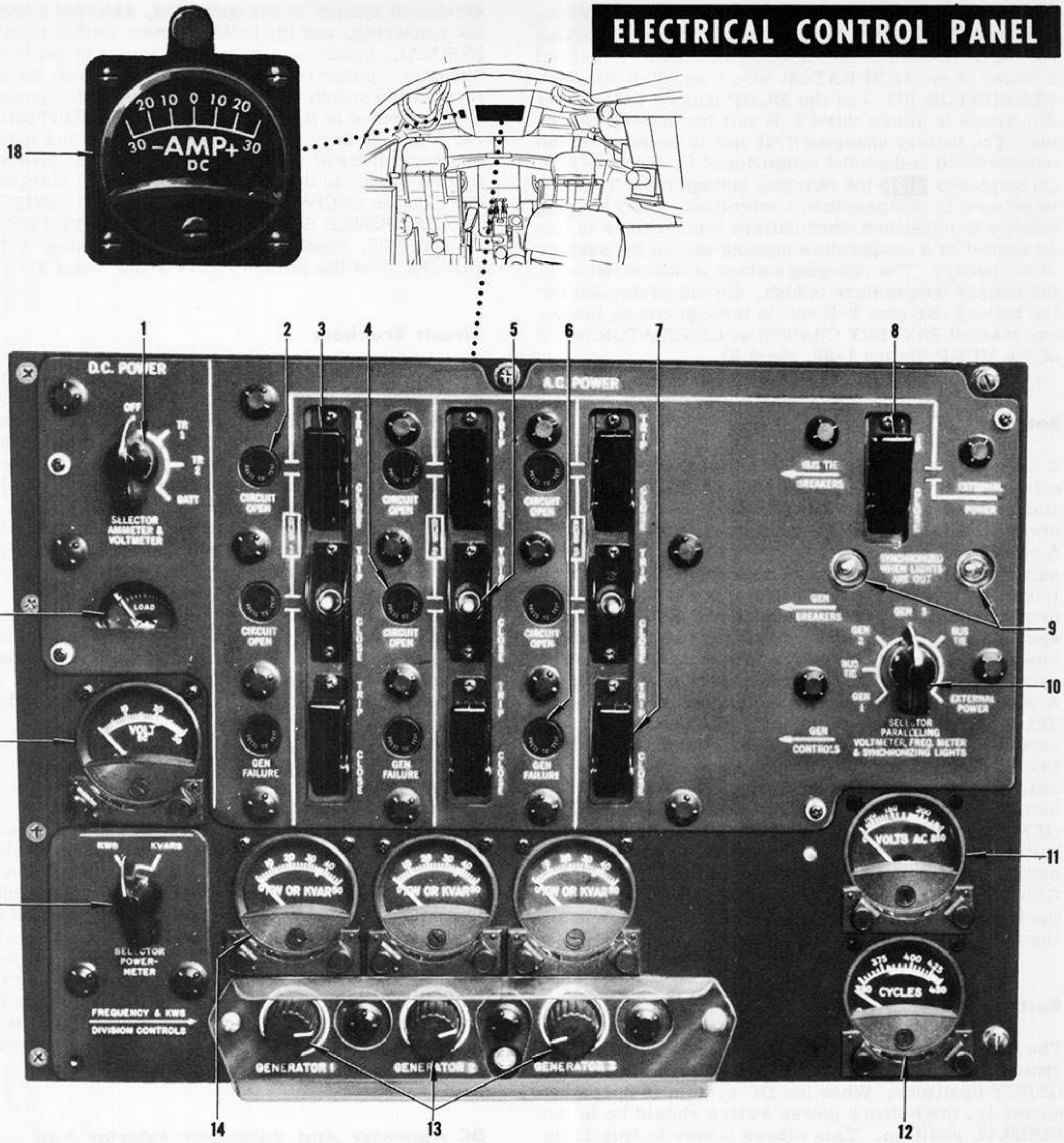
28 VOLT DIRECT CURRENT SYSTEM

The primary DC system consists of two transformer-rectifiers powered by three phase 115/200 volt AC and connected through relays to the transformer-rectifier busses. The T-R busses are normally connected by a current limiter. T-R BUS NO. 1 is normally connected to the SWITCHED DC BUS through the battery power switch. See figure 1-31. The boom operator's panel receives DC power through the SWITCHED DC BUS. For equipment operated by DC power, see figure 1-32.

Transformer-Rectifiers

The T-R units receive 115/200 volt AC power from the primary electrical system, rectify it to DC power, and step the voltage down to 28 volts for use throughout the airplane in lighting and control power for units using higher voltage AC power. Each T-R unit has a cooling fan. The service life of the T-R units is limited without cooling fan operation. The T-R units are mounted in a rack in the lower nose compartment and are accessible through the door in the crew entry chute. The mounting rack is on the outboard wall just inside the lower nose compartment

ELECTRICAL CONTROL PANEL



1 DC AMMETER AND VOLTMETER SELECTOR
2 BUS TIE BREAKER CIRCUIT OPEN LIGHTS
3 BUS TIE BREAKER SWITCHES
4 GENERATOR BREAKER CIRCUIT OPEN LIGHTS
5 GENERATOR BREAKER SWITCHES
6 GENERATOR FAILURE LIGHTS
7 GENERATOR CONTROL SWITCHES
8 EXTERNAL POWER SWITCH
9 SYNCHRONIZING LIGHTS
10 GENERATOR PARALLELING SELECTOR
11 AC VOLTMETER
12 FREQUENCY METER
13 FREQUENCY AND KWS CONTROL RHEOSTATS
14 POWER METERS
15 POWER METER SELECTOR
16 DC VOLTMETER
17 DC AMMETER
18 BATTERY CHARGING AMMETER

F-218
F-44

Figure 1-30

with the T-R units mounted one on top of the other, T-R unit No. 2 being the top one. Circuit protection for the T-R units is through circuit breakers marked T-R No. 1 on GENERATOR NO. 1 and T-R No. 2 on GENERATOR NO. 2 of the MCBP (figure 1-35, sheet 3). There is also a third T-R unit for battery charging. The battery charging T-R unit is mounted on the outboard wall of the toilet compartment (4, figure 4-83). On airplanes 372▶ the charging voltage from T-R unit to battery is temperature controlled. The charging voltage is increased when battery temperature is low as sensed by a temperature sensing unit on the surface of the battery. The charging voltage is decreased when the battery temperature is high. Circuit protection for the battery charging T-R unit is through circuit breakers marked BATTERY CHARGE on GENERATOR NO. 3 of the MCBP (figure 1-35, sheet 3).

Battery

A 24 volt 22 amp hour nickel-cadmium battery is located in the toilet compartment. Provisions for installation of a 36 amp hour battery are made if increased battery life is needed for extended missions. A 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. A separate T-R unit is provided to charge the battery. This T-R unit is wired direct to the battery bus and receives 115/200 volt AC power from GENERATOR NO. 3. The battery is charged anytime AC power is available from the main AC electrical system and the battery power switch is in the NORMAL or EMERGENCY position. Battery power is available to the hot battery bus at all times; to the battery bus when the battery power switch is in the NORMAL or EMERGENCY position; and to the SWITCHED DC BUS when the battery power switch is in the EMERGENCY position.

Battery Power Switch

The battery power switch (15, figure 1-17) on the pilots' center instrument panel has NORMAL--OFF--EMERGENCY positions. When the DC system is operating normally, the battery power switch should be in the NORMAL position. This allows power to flow from T-R BUS NO. 1 and T-R BUS NO. 2 to the SWITCHED DC BUS. If both T-R units fail and the battery power switch is changed to the EMERGENCY position, power for the SWITCHED DC BUS will be obtained through the BATTERY BUS from the battery charging T-R unit and/or battery. When the battery power switch is in the OFF position, the hot battery bus and the battery are isolated from the rest of the system and the SWITCHED DC BUS is dead. When the AC electrical system is not operating, external power is not connected, and the battery power switch is in NORMAL, battery power will be routed to the battery bus only. Under these same conditions with the battery power switch in EMERGENCY, battery power will be routed to the battery bus and the SWITCHED DC BUS. Battery power is always on the hot battery bus regardless of switch position. Circuit protection for the switch is through circuit breakers marked DC DIST on the SBCBP (figure 1-35, sheet 1), SWITCHED DC BUS POWER SUPPLY on the BATTERY CBP (figure 1-35, sheet 1) and SWITCHED BUS on T-R BUS NO. 1 of the MCBP (figure 1-35, sheet 2).

Circuit Breakers

The circuit breaker affords a good means of circuit protection against high current loads. All circuit breakers are of a trip-free design; that is, they cannot be manually held in to override the circuit breaker and force it to remain in a reset position. Heating of a bimetallic strip causes the actuator to trip; therefore, after a circuit breaker has been tripped, it must cool before it can be reset. The cooling time required before reset can be accomplished is approximately 3.5 seconds. Circuit breakers may be pulled and reset without damage to the circuit breaker; however, circuit breaker pulling should be kept to a minimum as switches are provided to cut the power to electrically operated equipment. The plunger of the circuit breaker has a luminescent band.This band will be visible anytime the circuit breaker is tripped, but will be invisible when reset.

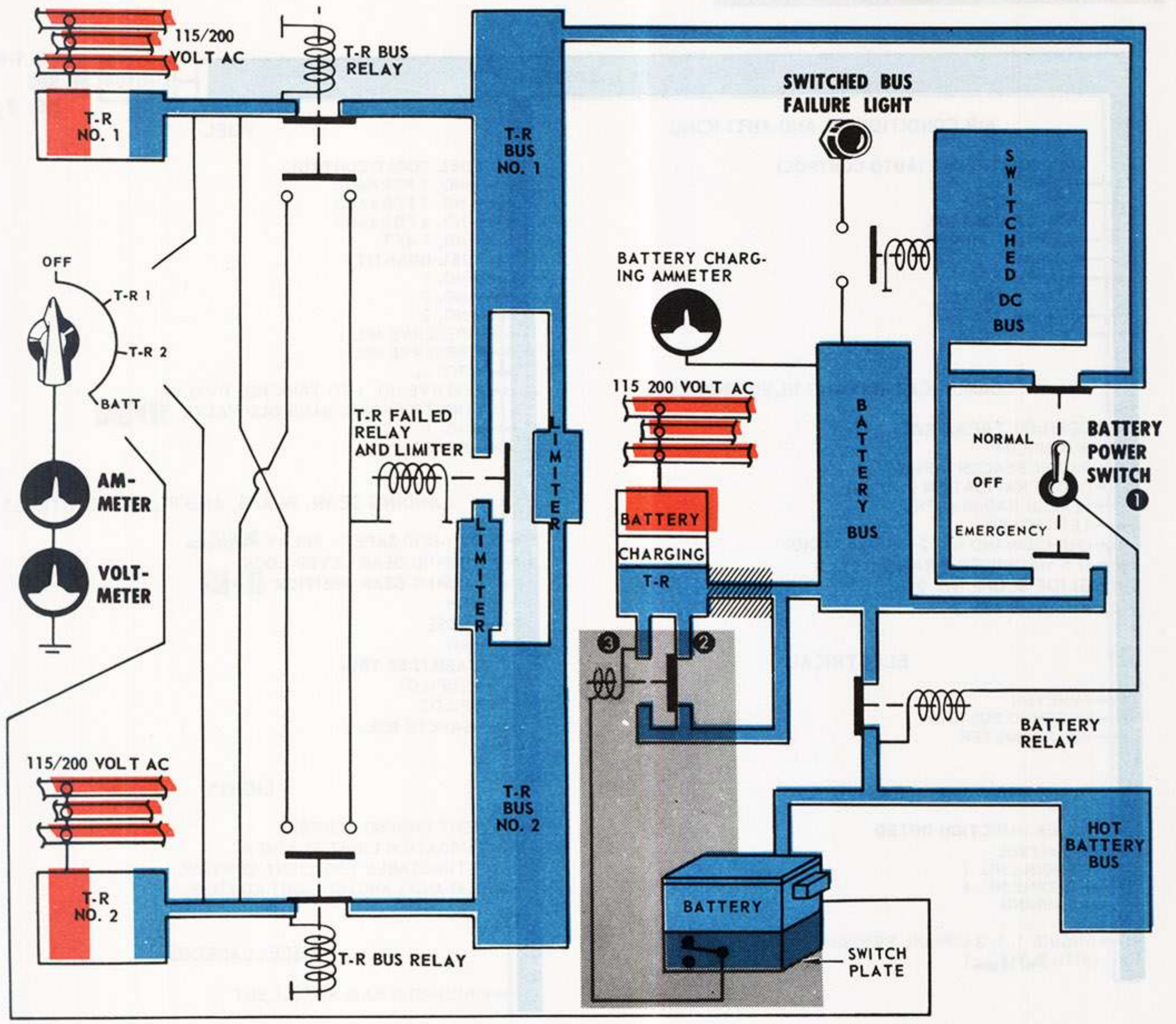
Switched DC Bus Failure Light

This red, press-to-test light (17, figure 1-17) on the pilots' center instrument panel will illuminate when power to the SWITCHED DC BUS fails. The light will remain illuminated when the battery power switch is placed in the OFF position if the BATTERY BUS is energized. When the battery power switch is placed in the EMERGENCY position, the light will be extinguished indicating power is being received from the BATTERY BUS to the SWITCHED DC BUS. The light is operated by 28 volt DC through a circuit breaker marked SW. BUS FAILURE LIGHT on the battery circuit breaker panel (figure 1-35, sheet 1).

DC Ammeter And Voltmeter Selector And DC Ammeter And DC Voltmeter

A rotary selector switch (1, figure 1-30) on the electrical control panel with OFF--TR 1--TR 2--BATT positions provides a means of monitoring operation of T-R No. 1, T-R No. 2, and the battery. The DC ammeter and voltmeter (16 and 17, figure 1-30) will indi-

DC POWER SYSTEM



NOTE

System shown in a power on condition. When power is supplied from either transformer-rectifier its T-R bus relay will close and supply power to its bus and in turn supply power to the other bus; this will then supply power to all of the system. Current limiters between the busses prevent loss of both busses if one T-R is faulted.

❶ When this switch is in the NORMAL position, power is routed from T-R No. 1 to the switched dc bus. With the switch in the EMERGENCY position, power is routed from the battery bus; if the Battery Charging T-R is inoperative, power will be routed from the battery. In the OFF position the switched dc bus and the hot bat. bus and battery are isolated from the system.

❷ NORMAL CHARGE RATE OUTPUT. The charge control relay is controlled by thermal switches under the battery. With the battery temperature normal, the charge control relay connects the T-R normal temperature charge rate to the battery bus.

❸ HIGH/LOW CHARGE RATE OUTPUT. When the battery temperature is too low or high, the charge control relay connects the T-R high-low temperature charge rate to the battery bus.

115/200 VOLT AC
28 VOLT DC POWER
ELECTRICAL
MECHANICAL
26, 28, 269 372▶
1▶ 371 LESS 26, 28, 269

F-46

Figure 1-31

DC POWER DISTRIBUTION

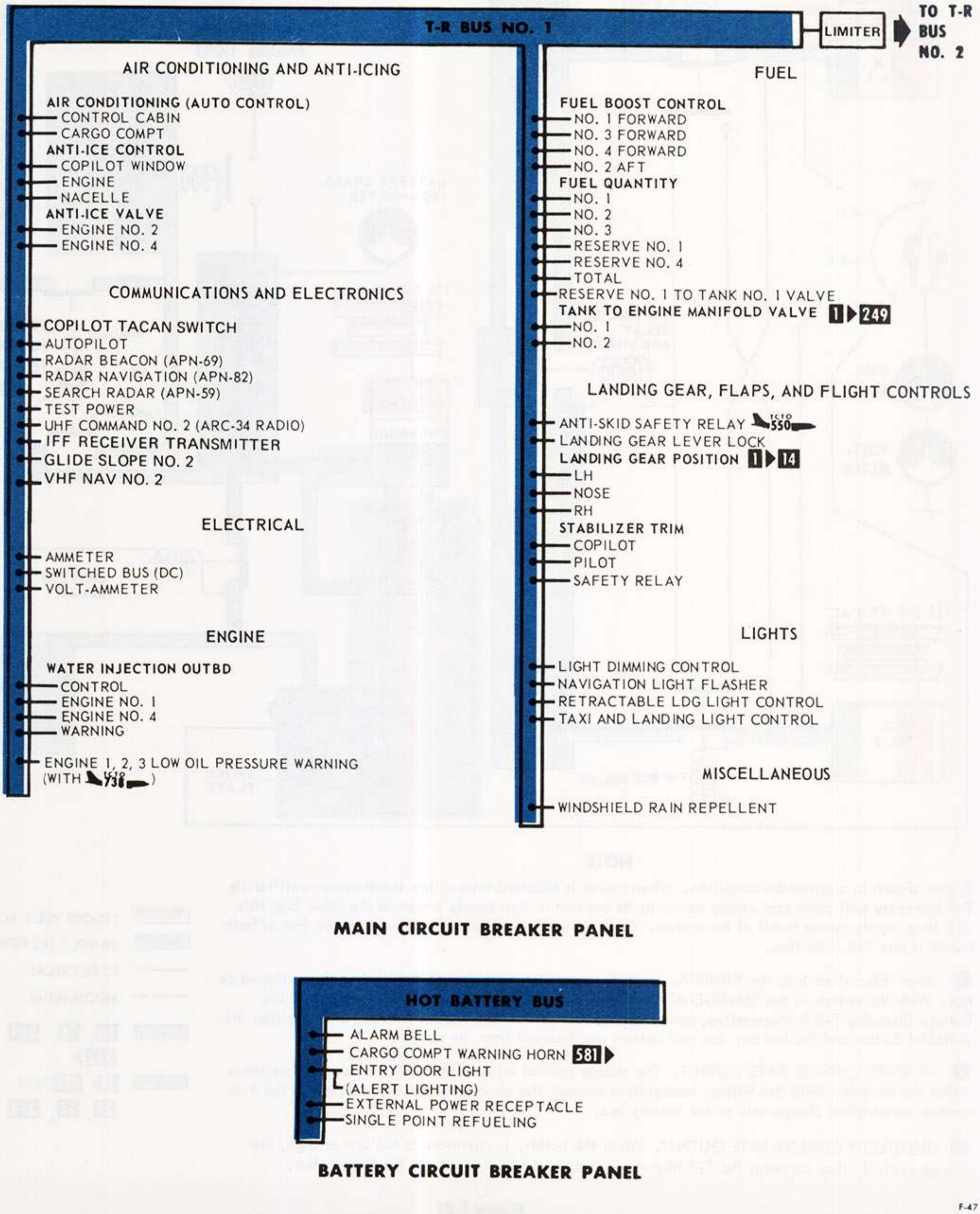


Figure 1-32 (Sheet 1 of 3)

28 VOLT DC POWER

T-R BUS NO. 2 → TO T-R BUS NO. 1

AIR CONDITIONING AND ANTI-ICING

ANTI-ICE CONTROL
- PILOT WINDOW

ANTI-ICE VALVE
- ENGINE NO. 1
- ENGINE NO. 3
- CABIN TEMPERATURE INDICATOR
- FREE AIR TEMPERATURE INDICATOR

COMMUNICATIONS AND ELECTRONICS

- HF LIAISON (ARC-58) 1, 186 ▶ (ARC-65) 2 ▶ 185
- GLIDE SLOPE NO. 1
- MARKER (BEACON; ARN-12)
- N-1 COMPASS & PILOT ATTITUDE IND
- RENDEZVOUS BEACON (APN-134)
- SECURE VOICE
- UHF HOMING (ARA-25)
- UHF NAVIGATION (TACAN; ARN-72)
- VHF NAVIGATION NO. 1
- FLIGHT DIRECTOR NO. 1
- PILOT TACAN SWITCH
- TACAN ANT SELECT

ELECTRICAL

- AMMETER
- BUS TIE (2 FUSES)
- COPILOTS FLIGHT INSTRUMENTS (SECONDARY POWER SOURCE)
- SAFETY SWITCH RELAY (GROUND)
- VOLT-AMMETER

ENGINE

WATER INJECTION INBD
- CONTROL
- ENGINE NO. 2
- ENGINE NO. 3
- WARNING

FUEL

FUEL BOOST CONTROL
- NO. 2 FORWARD
- NO. 1 AFT
- NO. 3 AFT
- NO. 4 AFT

FUEL (CONT)

FUEL QUANTITY
- AFT BODY
- CENTER WING
- FORWARD BODY
- NO. 4
- UPPER DECK

OVERRIDE PUMP (CONTROL)
- LEFT HAND
- RIGHT HAND
- RESERVE TANK TO TANK NO. 4 (VALVE)

TANK TO ENGINE MANIFOLD VALVE 1 ▶ 249
- NO. 3
- NO. 4

HYDRAULICS

- HYDRAULIC OIL QUANTITY INDICATOR
- HYDRAULIC PUMP CONTROL (RIGHT AUXILIARY)
- LH HYD PUMP (FUSE; OPERATING POWER)
- RH HYD PUMP (FUSE; OPERATING POWER)

SPOILER HYDRAULIC PRESSURE (CONTROL)
- INBOARD
- OUTBOARD

LANDING GEAR, FLAPS, AND FLIGHT CONTROLS

- ANTI-SKID (LESS ICTO 550)
- ANTI-SKID, INBOARD, OUTBOARD ICTO 550

LANDING GEAR WARNING (RELAY) 1 ▶ 14
- LH
- NOSE
- RH

LIGHTS

- ALERT LIGHTING (RELAY)
- CARGO LIGHTS CONTROL
- DOOR WARNING

MISCELLANEOUS

- OXYGEN QUANTITY (INDICATOR)
- Q-INLET HEATER WARNING

MAIN CIRCUIT BREAKER PANEL

BATTERY BUS

- AIC-10A INTERPHONE, ALL STATIONS 98 ▶
- BATTERY AMMETER
- BATTERY AMMETER AND VOLTMETER
- BATTERY CHARGE
- GENERATOR SYSTEM CONTROL
- CARGO DOOR ICTO 944

- LEFT HYDRAULIC PUMP (RESERVE BRAKE POSITION)
- LEFT AUXILIARY HYDRAULIC PUMP CONTROL
- SWITCHED DC BUS
- SWITCHED DC BUS FAIL LIGHT
- WINDSHIELD WIPERS – PILOT'S, COPILOT'S

BATTERY CIRCUIT BREAKER PANEL

F-48

Figure 1-32 (Sheet 2 of 3)

DC POWER DISTRIBUTION (CONT)

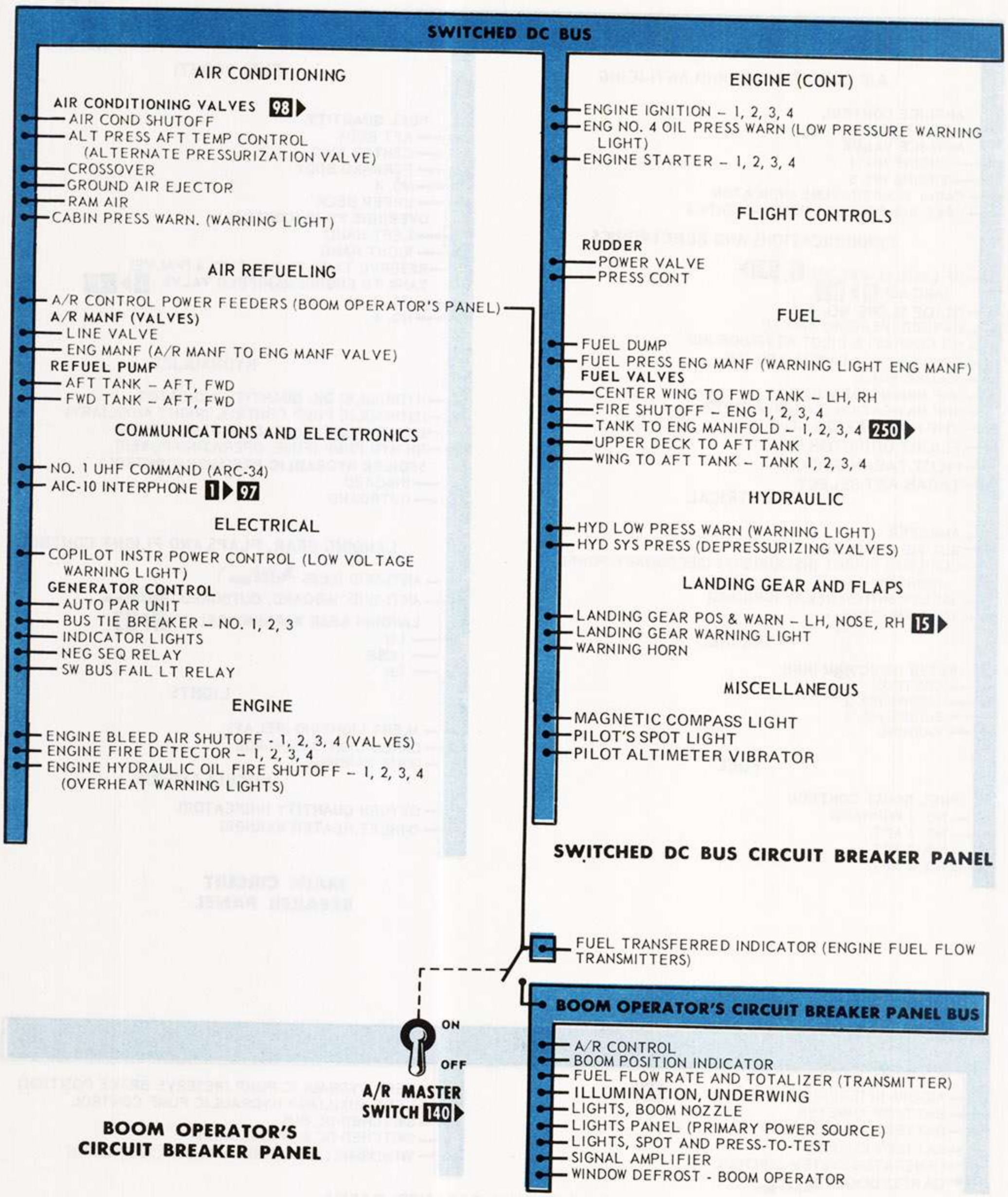
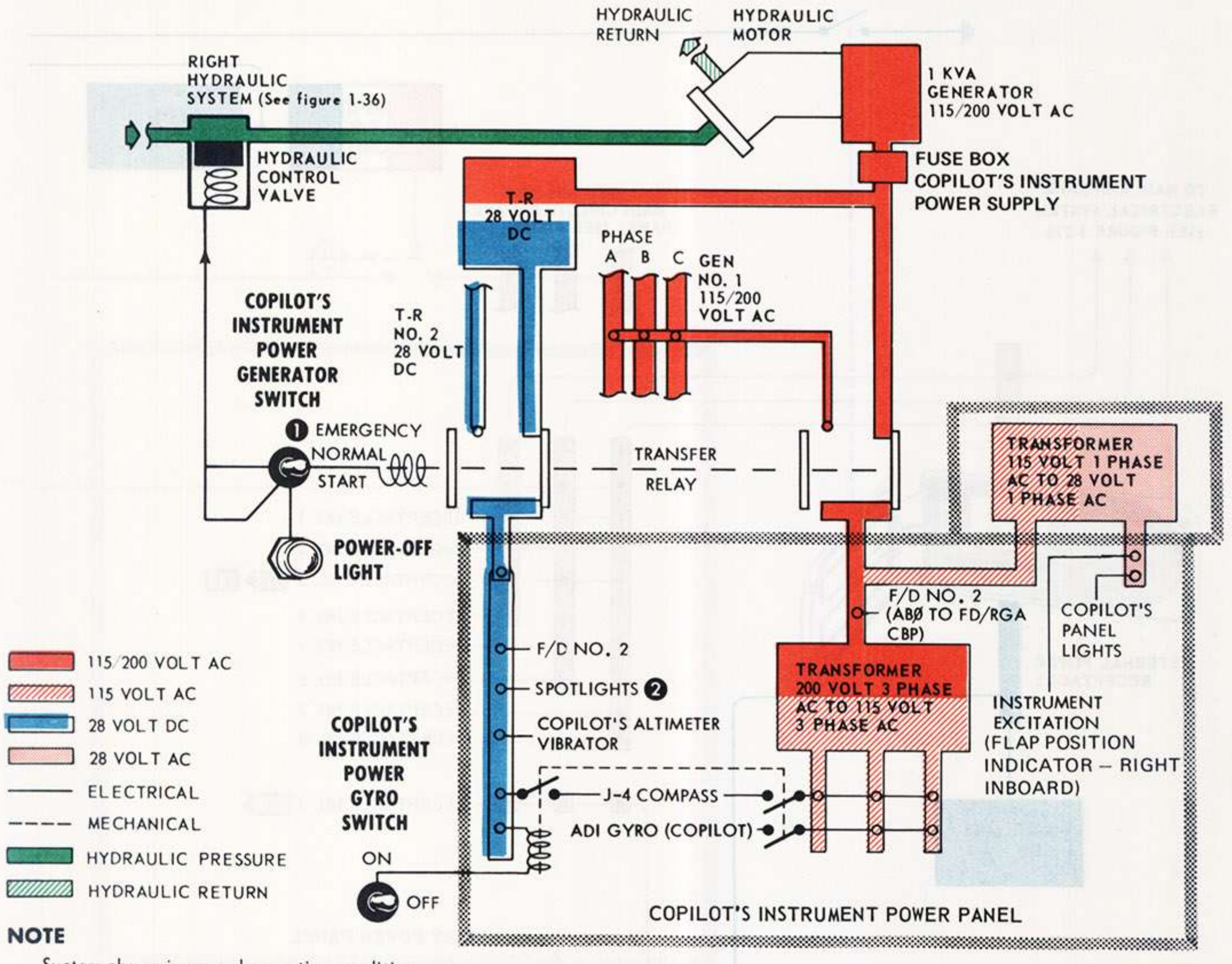


Figure 1-32 (Sheet 3 of 3)

COPILOT'S INSTRUMENT POWER SYSTEM (GENERATION AND DISTRIBUTION)



NOTE

System shown in normal operating condition.

1 This switch is spring-loaded from START position to NORMAL position. In the EMERGENCY position power is released from the hydraulic control valve and the transfer relay.

2 Equipment rack and Copilots and Navigators work and spotlight

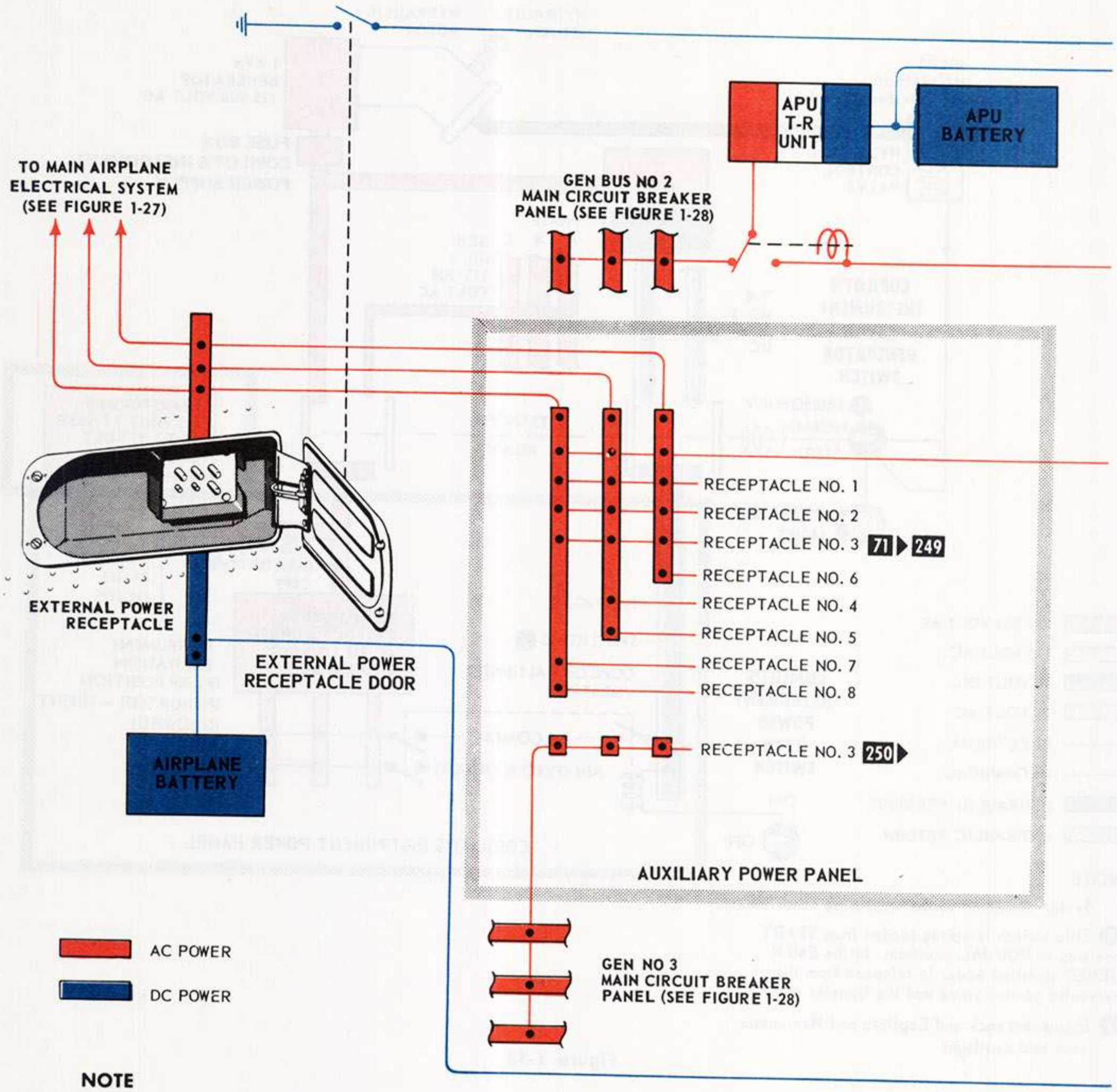
Figure 1-33

cate fraction of load and volts for the T-R unit selected by the selector switch. The BATT position displays only battery voltage (not current load) for the battery system. On airplanes 372▶ the voltmeter may pulse between approximately 31.5 and 27 volts when the battery approaches full charge.

Battery Charging Ammeter

The battery charging ammeter (18, figure 1-30) on the pilot's overhead light control panel shows the charging rate of the battery. The ammeter needle is zero centered with a plus 30 amp to the right and a minus 30 discharge rate to the left. Charging rate of the battery varies with the state of charge, charging voltage, and temperature. A fully discharged battery will draw maximum charging current for a considerable length of time. A fully charged battery will have an initial in-rush of current which will rapidly decrease to a trickle charge current. On this airplane, a charging current of approximately 7 amperes at 22°C (72°F) is taken by a battery with a 50 percent charge. On airplanes 372▶ the ammeter may pulse when the battery approaches full charge.

APU AND EXTERNAL POWER DISTRIBUTION



NOTE

❶ The no. 1 water tank heater is on any time the master switch is on and the power control relays are closed.

Figure 1-34 (Sheet 1 of 2)

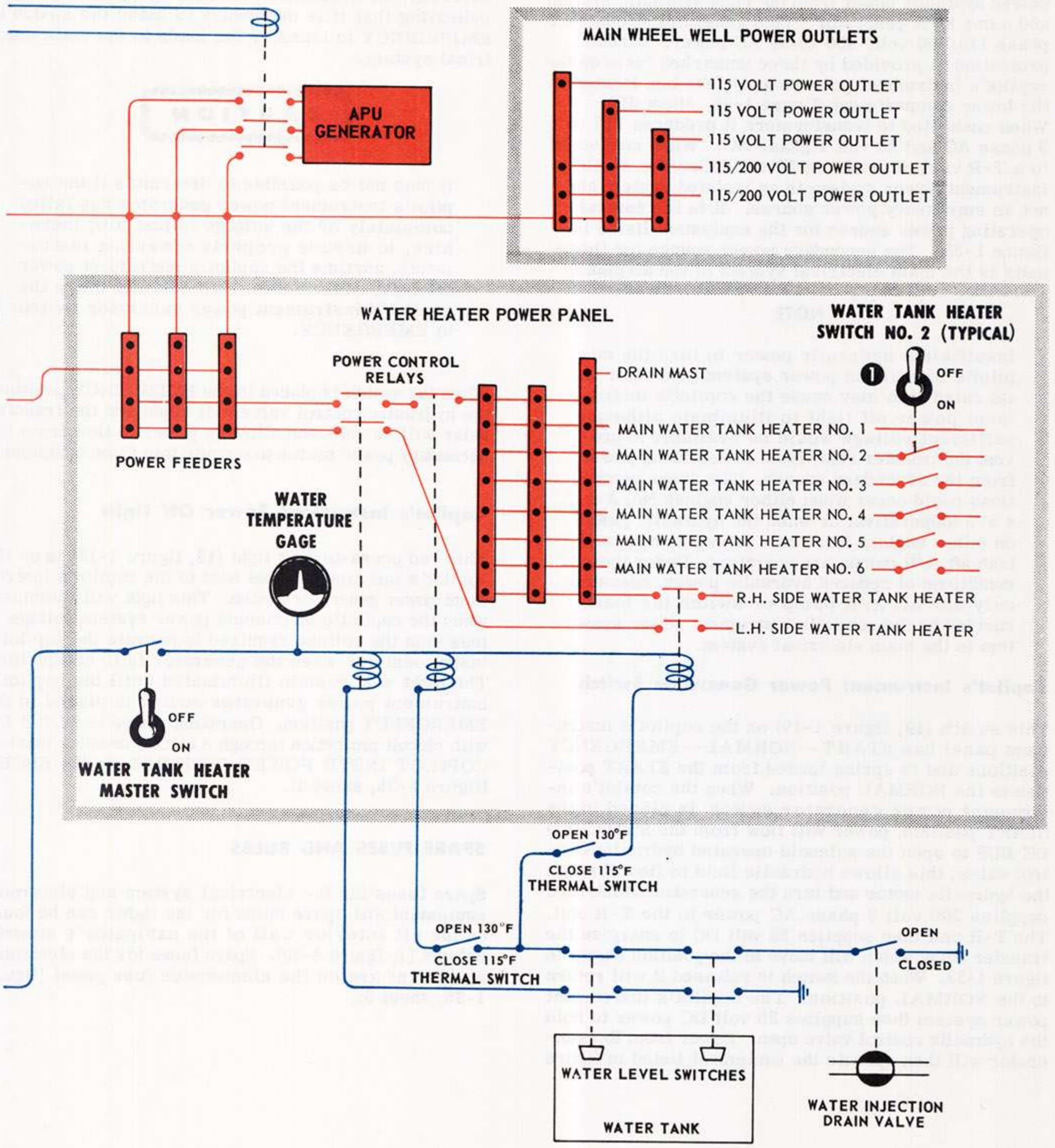


Figure 1-34 (Sheet 2 of 2)

COPILOT'S INSTRUMENT POWER SYSTEM

The copilot's instrument power system, shown in figure 1-33, is a hydraulically powered electrical system. The system consists of a hydraulic motor which receives hydraulic power from the right hydraulic system and a one KVA generator. This generator produces 3 phase 115/200 volt, 400 cycle AC power. Circuit protection is provided by three unmarked fuses on the copilot's instrument power supply fuse box located in the lower compartment (figure 1-35, sheet 8B). When connected to transformers it produces 115 volt 3 phase AC and 28 volt 1 phase AC. When connected to a T-R unit, it produces 28 volt DC. The copilot's instrument power system is an isolated system and not an emergency power source. It is the normal operating power source for the equipment listed in figure 1-33. The secondary power source for these units is the main electrical system of the airplane.

NOTE

Insufficient hydraulic power to turn the copilot's instrument power system generator at its rated rpm may cause the copilot's instrument power off light to illuminate although sufficient voltage would be available to prevent the transfer relay from transferring power from the secondary source. The above conditions could occur when either engines No. 3 or 4 are inoperative, or when the hydraulic pump on either engines No. 3 or 4 is inoperative, and both aft A/R pumps are operating. Under these conditions of reduced hydraulic power, operate only one aft A/R pump or switch the loads carried by the copilot's instrument power system to the main electrical system.

Copilot's Instrument Power Generator Switch

This switch (19, figure 1-19) on the copilot's instrument panel has START--NORMAL--EMERGENCY positions and is spring loaded from the START position to the NORMAL position. When the copilot's instrument power generator switch is placed in the START position, power will flow from the SWITCHED DC BUS to open the solenoid operated hydraulic control valve; this allows hydraulic fluid to flow through the hydraulic motor and turn the generator which then supplies 200 volt 3 phase AC power to the T-R unit. The T-R unit then supplies 28 volt DC to energize the transfer relay which will move to the position shown in figure 1-33. When the switch is released it will return to the NORMAL position. The copilot's instrument power system then supplies 28 volt DC power to hold the hydraulic control valve open. Power from the generator will then operate the equipment listed in figure 1-33. If the copilot's instrument power generator fails completely, the copilots' instrument power off light will illuminate and the transfer relay will automatically connect its load to the main electrical system. If the voltage is too low to operate the copilot's instruments correctly, the instrument power off light will illuminate, indicating that it is necessary to move the switch to EMERGENCY to transfer the loads to the main electrical system.

CAUTION

It may not be possible to determine if the copilot's instrument power generator has failed completely or the voltage is just low; therefore, to assure properly operating instruments, anytime the copilot's instrument power off light illuminates, immediately move the copilot's instrument power generator switch to EMERGENCY.

When the switch is placed in the EMERGENCY position, the hydraulic control valve will close and the transfer relay will be released allowing power to flow from the secondary power source to operate this same equipment.

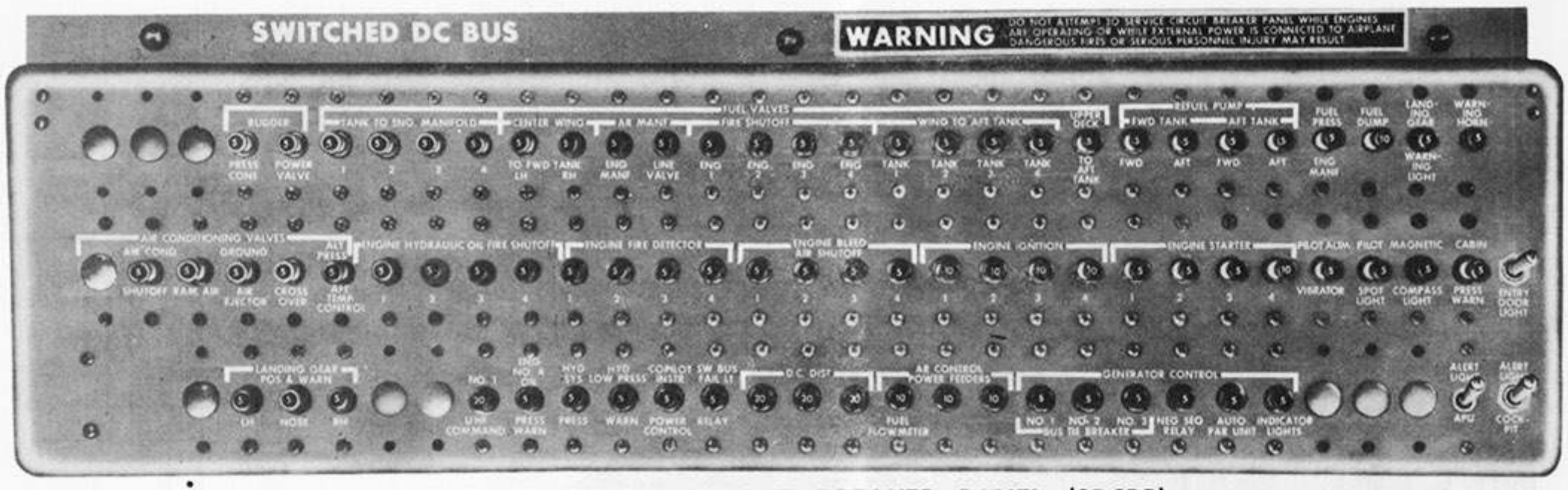
Copilot's Instrument Power Off Light

This red press-to-test light (18, figure 1-19) is on the copilot's instrument panel next to the copilot's instrument power generator switch. This light will illuminate when the copilot's instrument power system voltage is less than the voltage required to operate the copilot's instruments or when the generator fails completely. The light will remain illuminated until the copilot's instrument power generator switch is placed in the EMERGENCY position. Operating power is 28 volt DC with circuit protection through a circuit breaker marked COPILOT INSTR POWER CONTROL on the SBCBP (figure 1-35, sheet 1).

SPARE FUSES AND BULBS

Spare fuses for the electrical system and electronic equipment and spare bulbs for the lights can be found on the aft interior wall of the navigator's stowage cabinet (1, figure 4-30). Spare fuses for the electronic equipment are on the electronics fuse panel (figure 1-35, sheet 5).

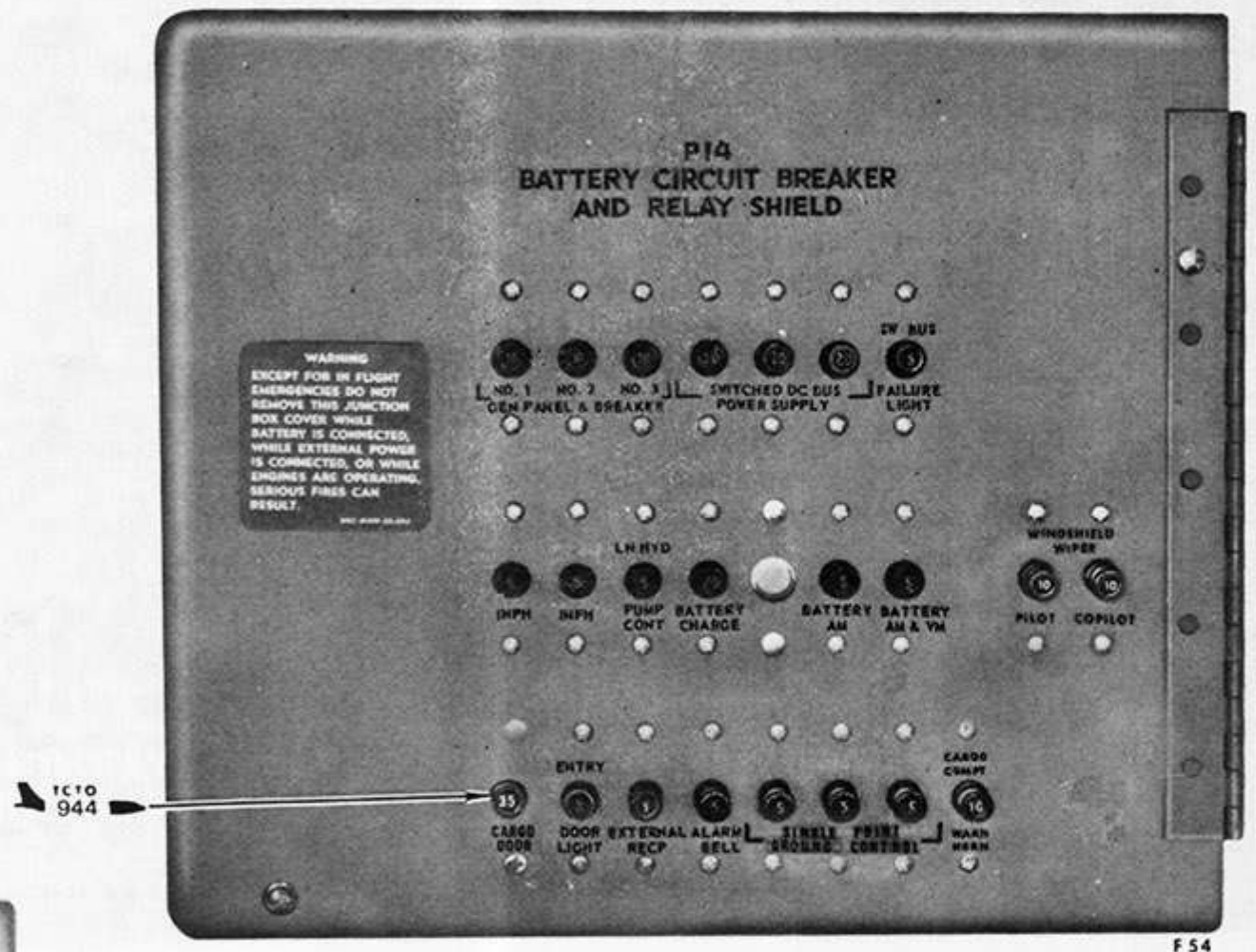
(TYPICAL) CIRCUIT BREAKER PANELS



SWITCHED DC BUS CIRCUIT BREAKER PANEL (SBCBP)

F 053





TCTO 944

F 54

BATTERY CIRCUIT BREAKER PANEL



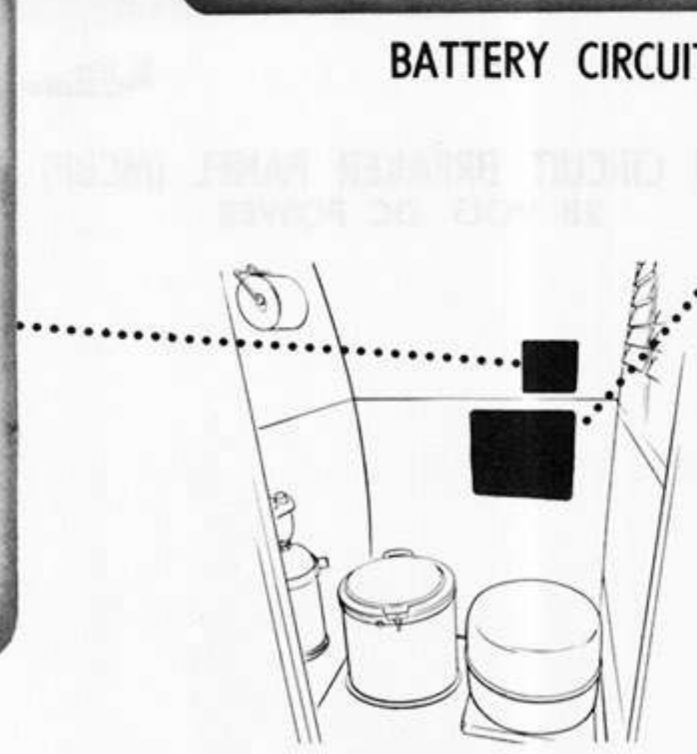


Figure 1-35 (Sheet 1 of 8)

CIRCUIT BREAKER PANELS (CONT) (TYPICAL)



MAIN CIRCUIT BREAKER PANEL (MCBP)
28 VOLT DC POWER

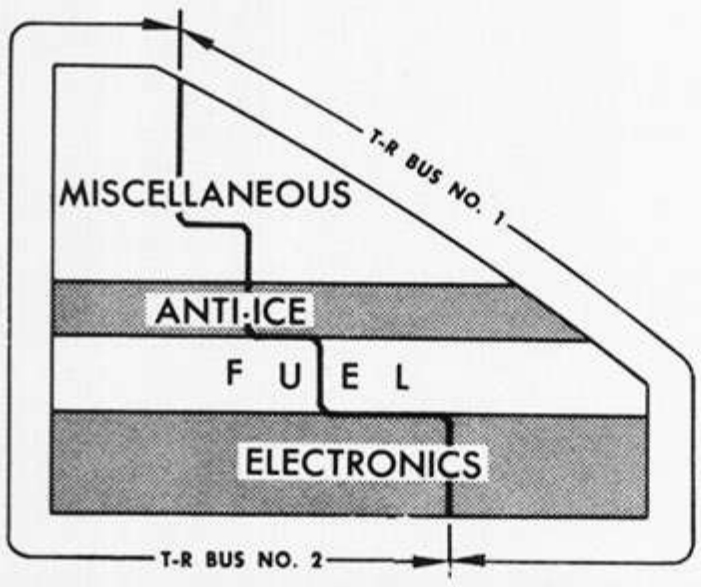
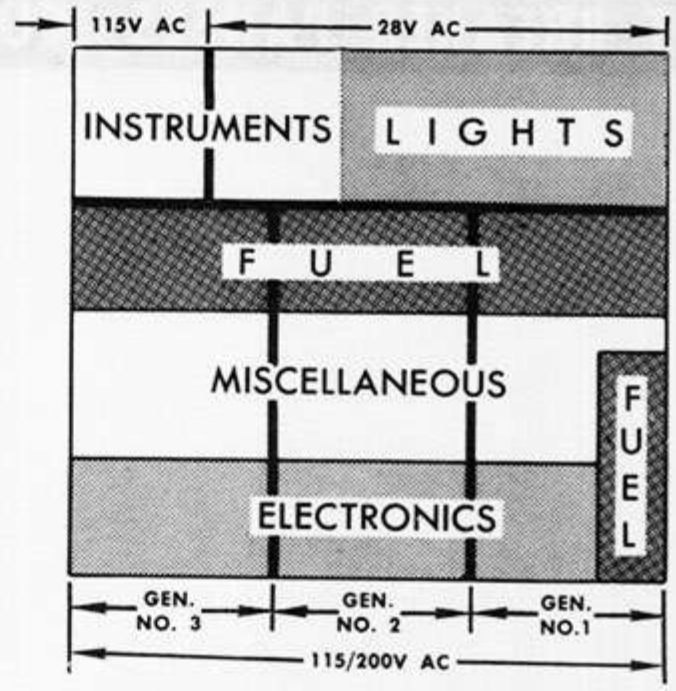
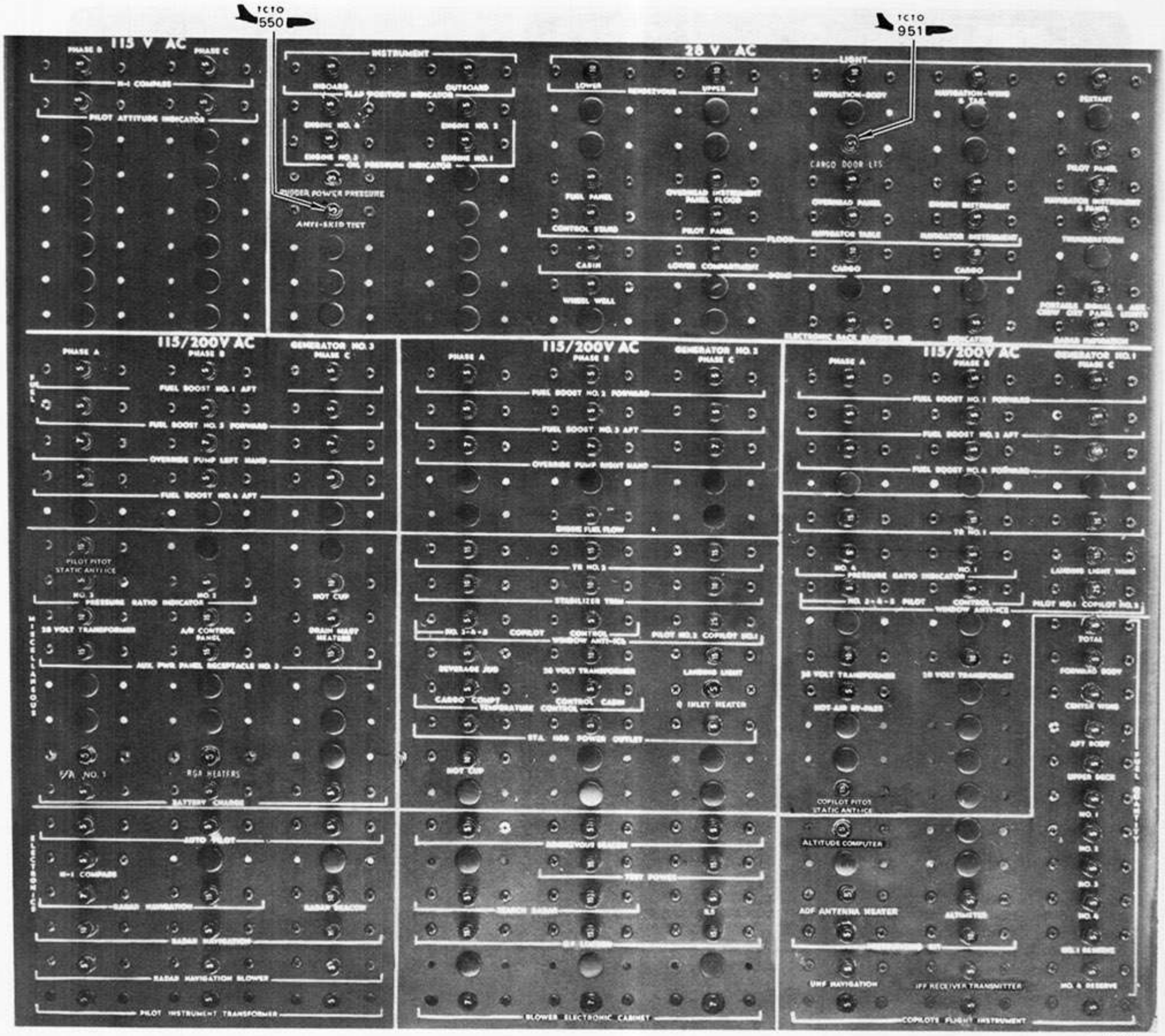


Figure 1-35 (Sheet 2 of 8)







F57-1

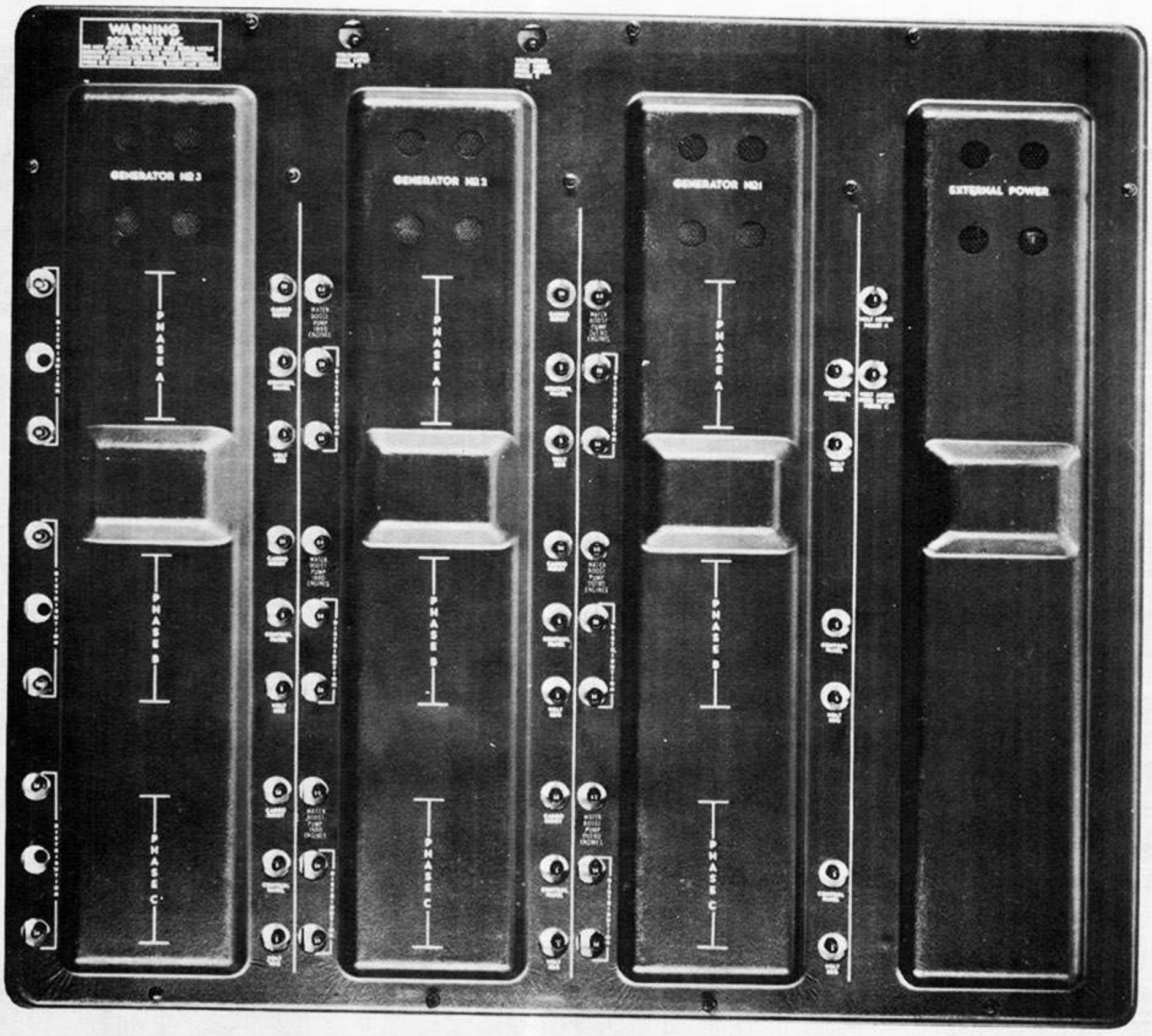
AC POWER
MAIN CIRCUIT BREAKER PANEL (MCBP)

Figure 1-35 (Sheet 3 of 8)

CIRCUIT BREAKER PANELS (CONT)

(TYPICAL)

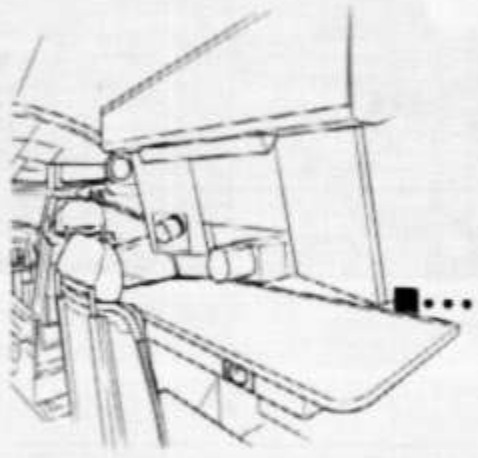


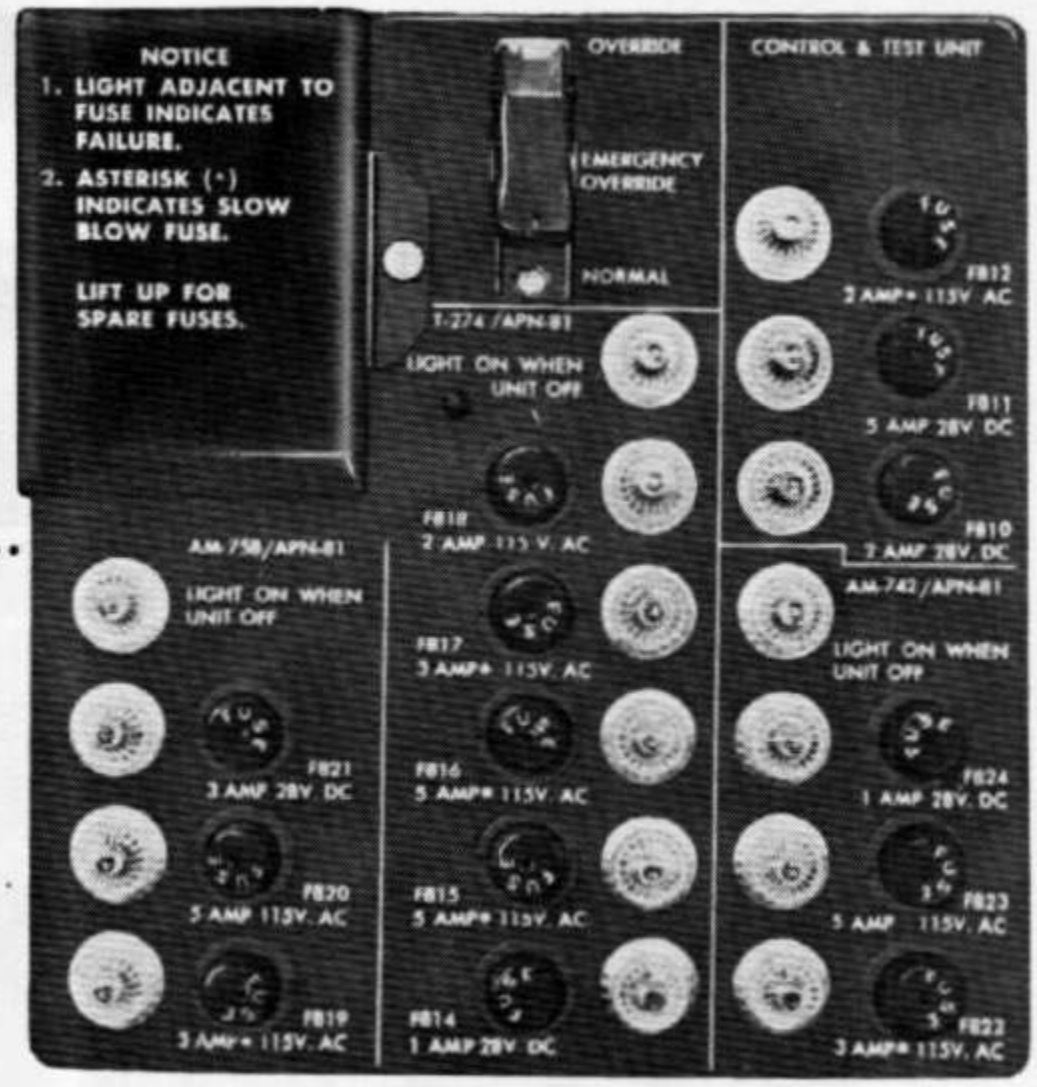


MAIN AC POWER PANEL

F-58

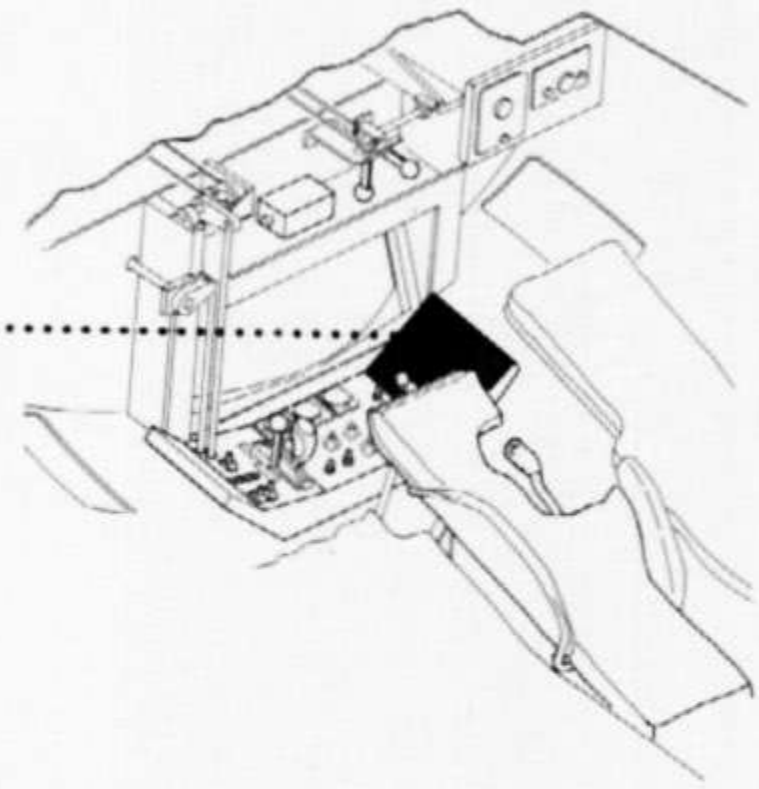
Figure 1-35 (Sheet 4 of 8)





ELECTRONICS FUSE PANEL





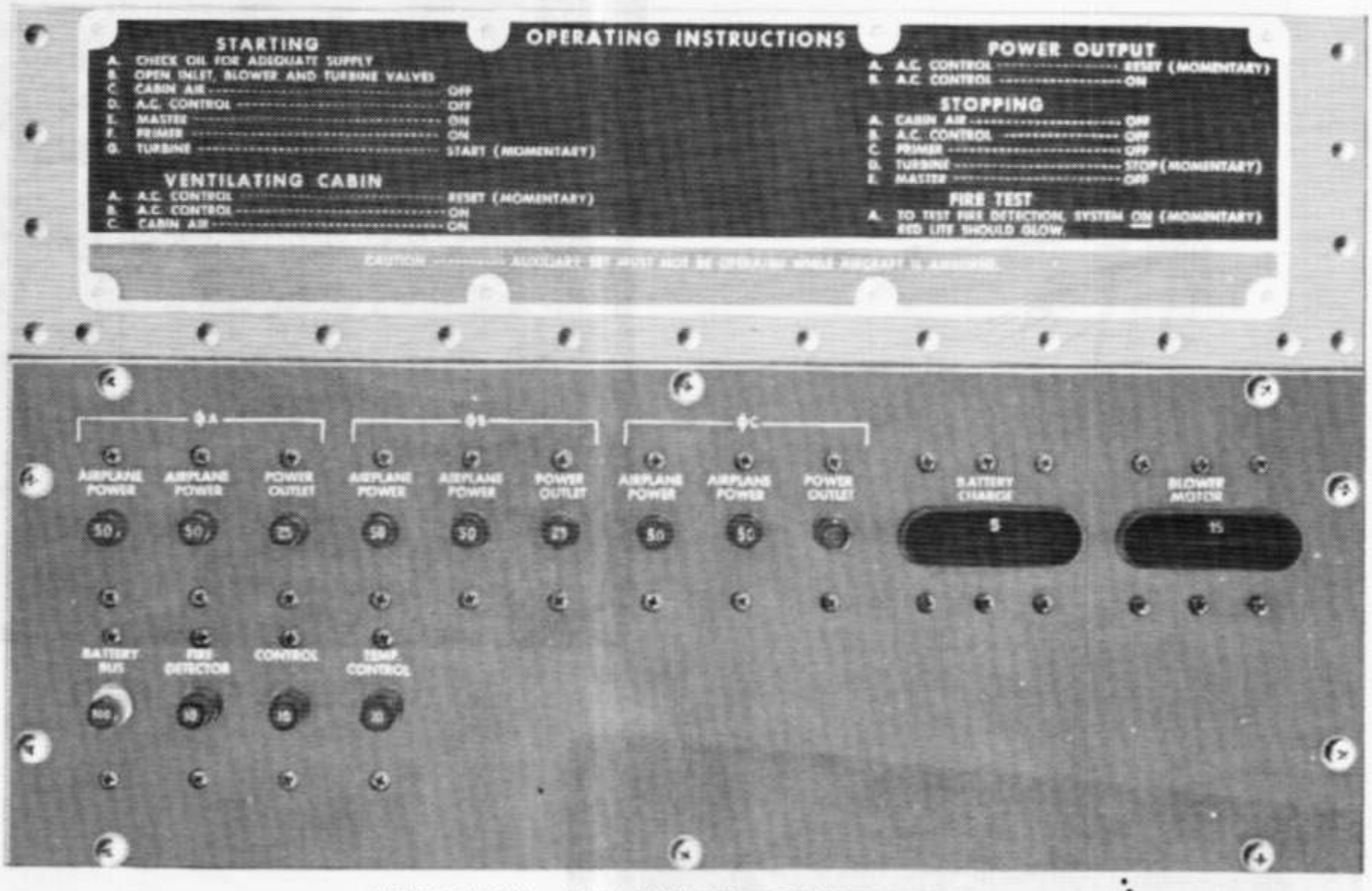
BOOM OPERATOR'S CIRCUIT BREAKER PANEL (BOCBP)

F-59
F-60

Figure 1-35 (Sheet 5 of 8)

CIRCUIT BREAKER PANELS (CONT)

(TYPICAL)



AIRESEARCH APU CIRCUIT BREAKER PANEL

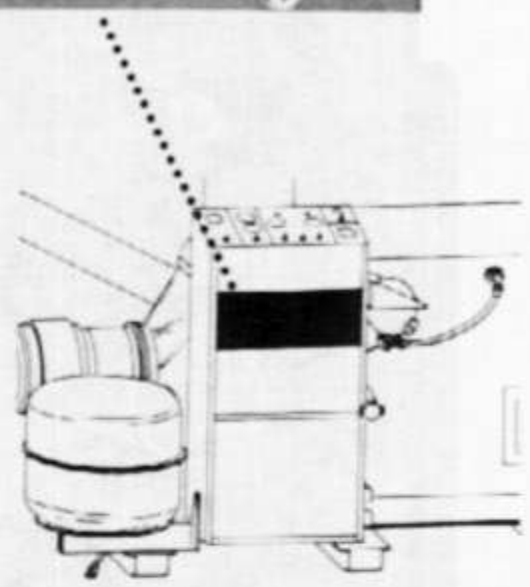
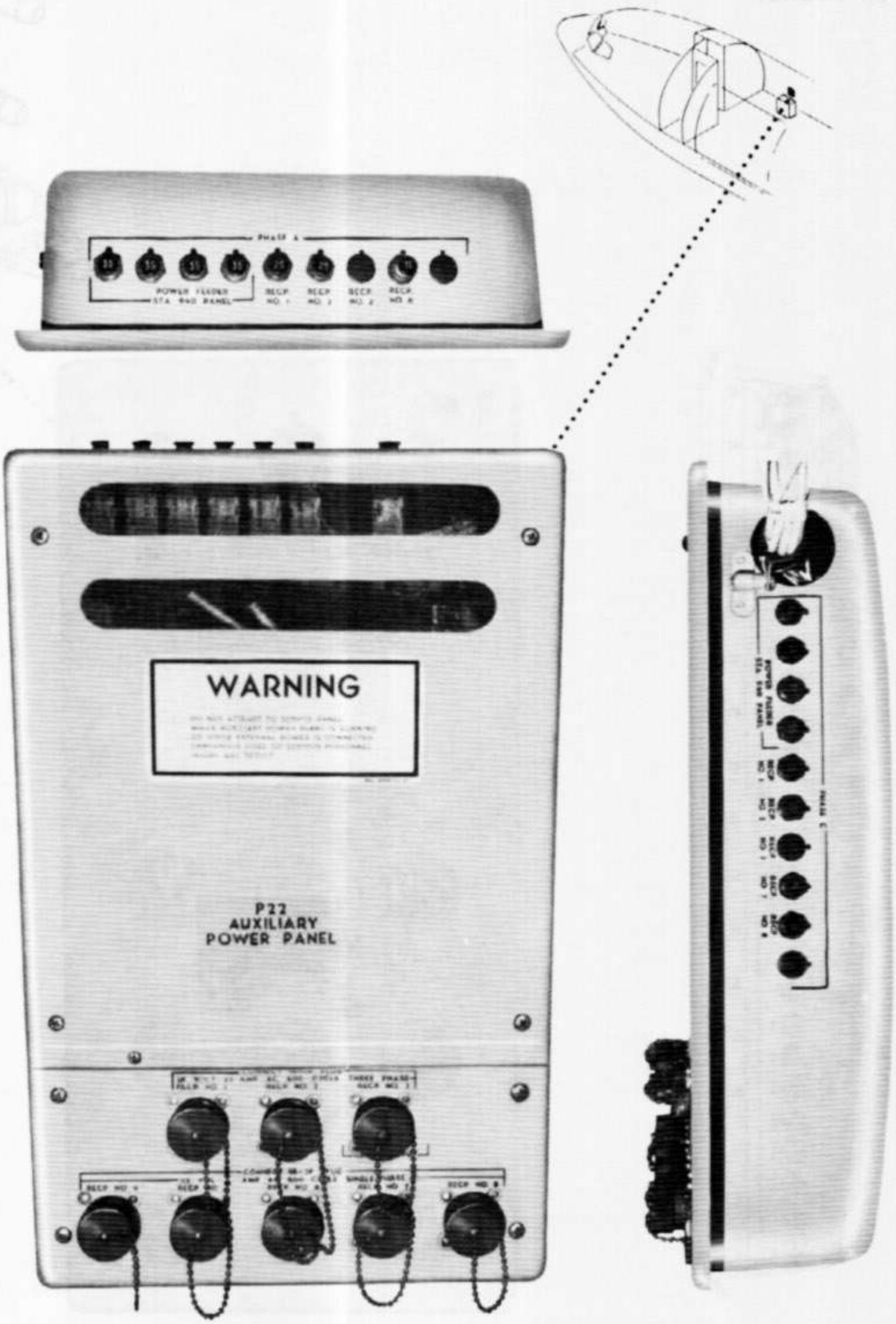


Figure 1-35 (Sheet 6 of 8)



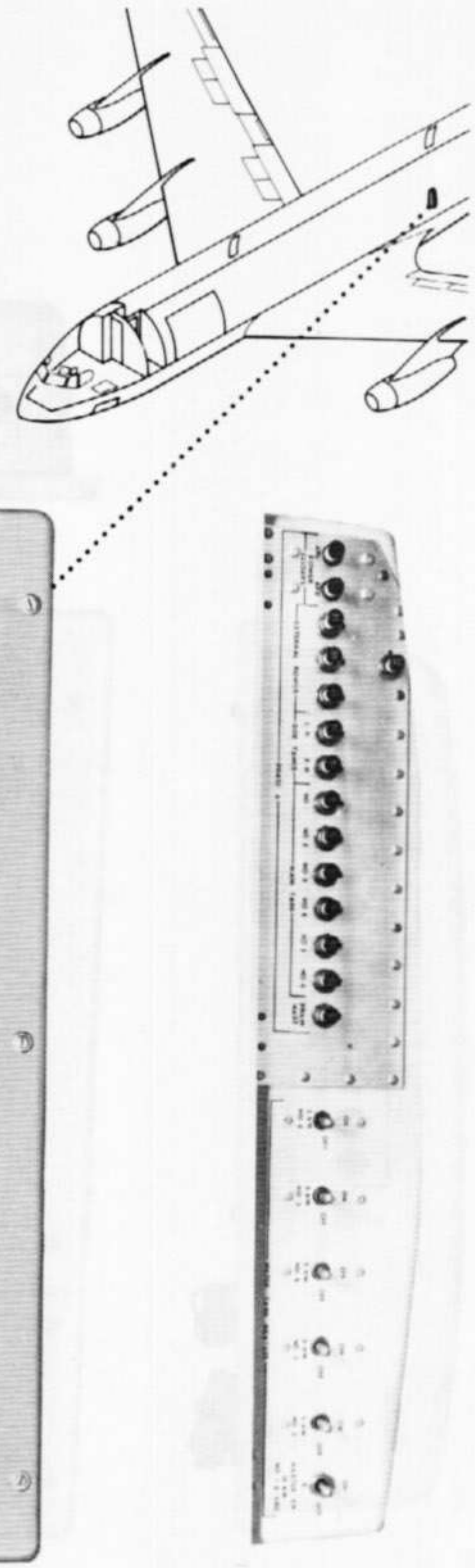
AUXILIARY POWER PANEL

F-64
F-68
F-60
F-65

Figure 1-35 (Sheet 7 of 8)

CIRCUIT BREAKER PANELS (CONT)

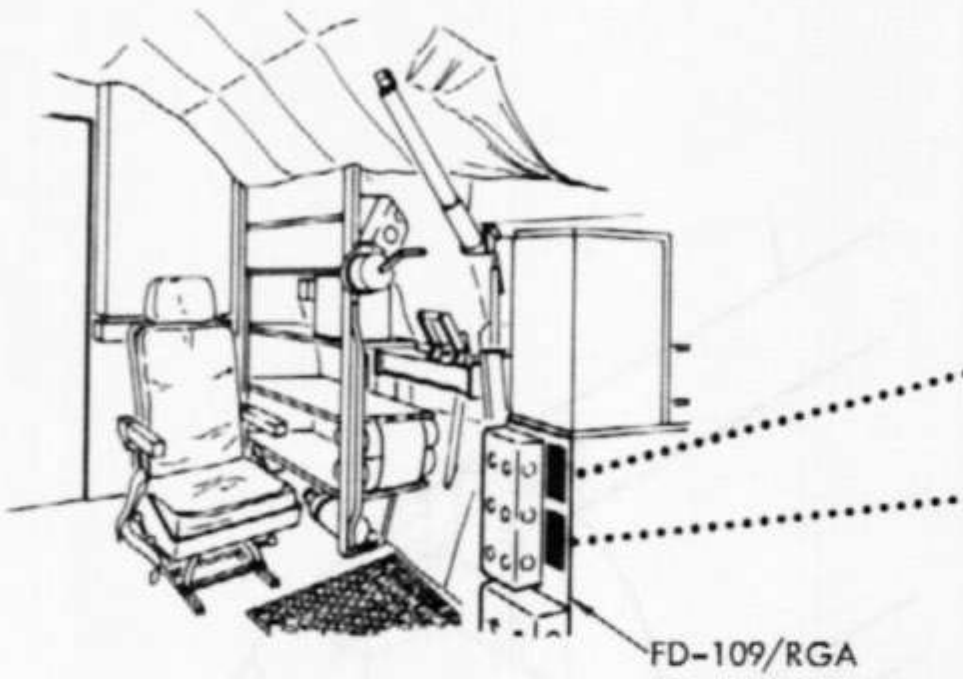
(TYPICAL)



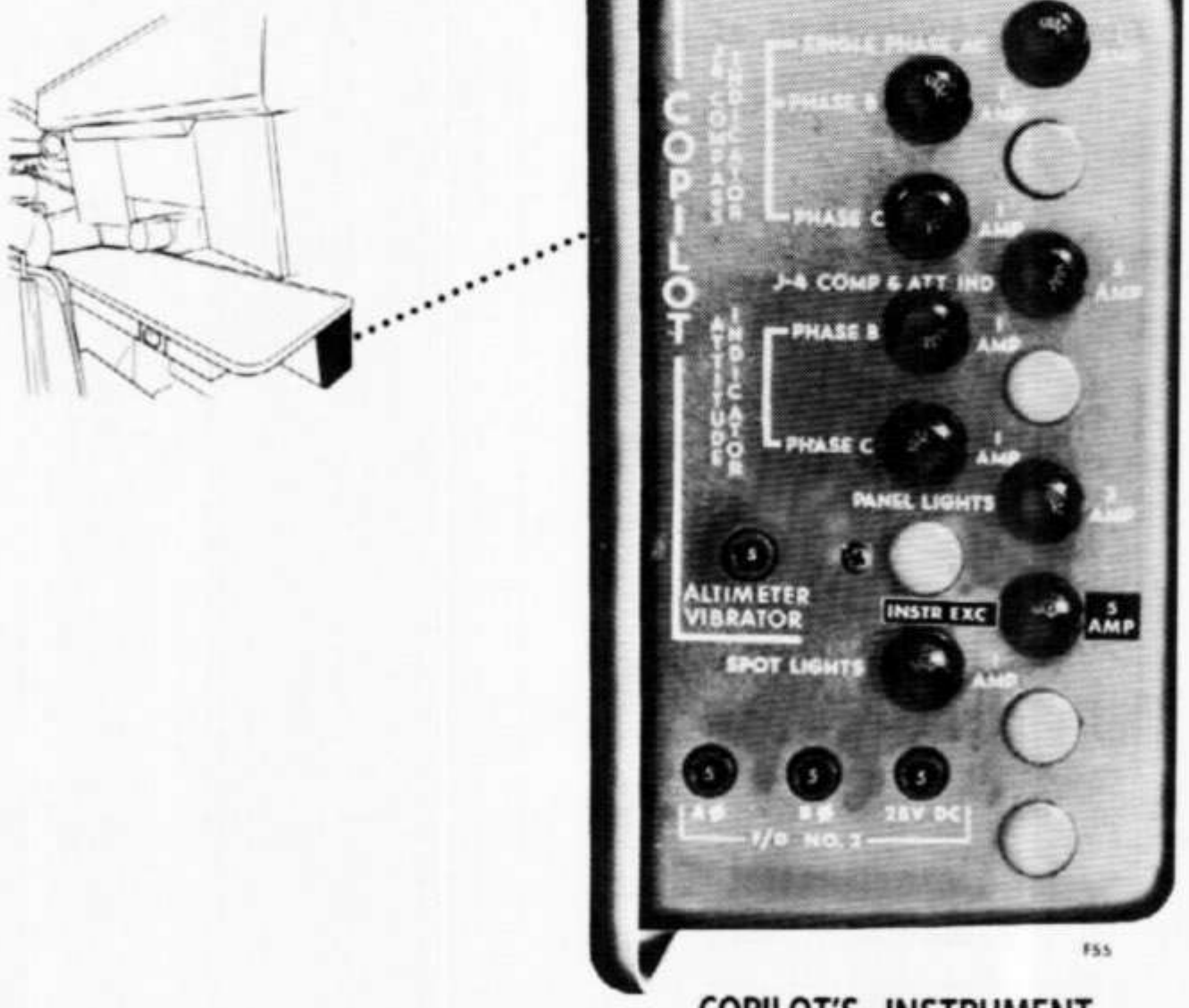
WATER HEATER POWER PANEL (TYPICAL)

F-17
F-18
F-19

Figure 1-35 (Sheet 8 of 8)



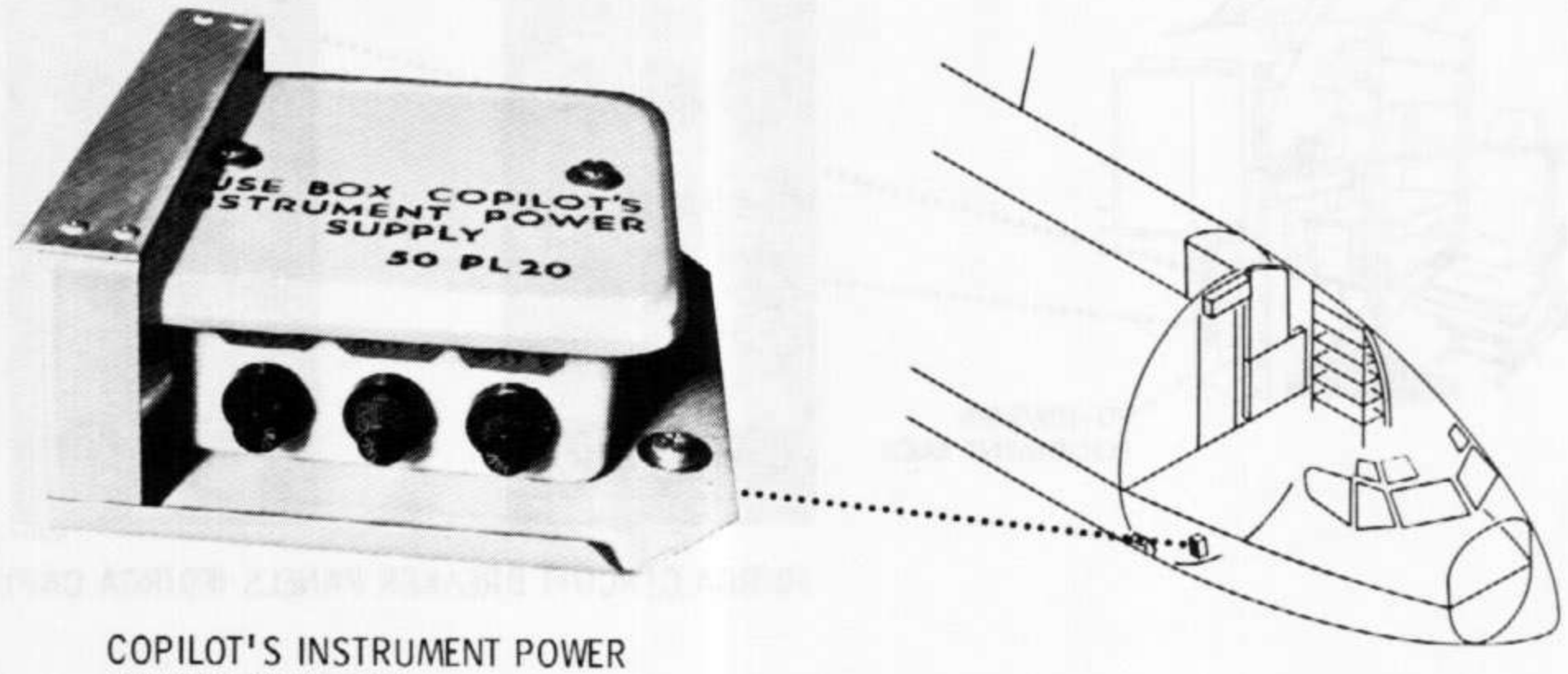
FD/RGA CIRCUIT BREAKER PANELS (FD/RGA CBP)



COPILOT'S INSTRUMENT POWER PANEL (CIPP)

Figure 1-35 (Sheet 8A of 8)

CIRCUIT BREAKER PANELS (CONT)



COPILOT'S INSTRUMENT POWER
SUPPLY FUSE BOX

Figure 1-35 (Sheet 8B of 8)

CIRCUIT PROTECTION AND LOCATION

NOTE

This chart is designed to locate circuit protection devices for both operating and control power of electrical equipment. Circuit titles are the same as decalled on the circuit breaker panels in most cases. Explanatory statements follow circuit titles when considered necessary for clarity. This chart may be used as a guide for emergency isolation of electrical equipment by opening the desired circuits at their protective devices.

The following abbreviations will be used on this chart:

Main Circuit Breaker Panel - MCBP
Switched DC Bus Circuit Breaker Panel - SBCBP
Boom Operator's Circuit Breaker Panel - BOCBP
Copilot's Instrument Power Panel - CIPP

CIRCUIT TITLE	NO. CB's	OPERATING POWER	CIRCUIT BREAKER LOCATION
AIR CONDITIONING, PRESSURIZATION, AND VENTILATING			
A/C AUTOMATIC CONTROL (cabin temp control) 1▶70	1	28V DC	T-R BUS NO. 1 MCBP
A/C CONTROL CABIN (cabin temperature) 71▶	1	28V DC	T-R BUS NO. 1 MCBP
A/C CROSSOVER VALVE 98▶	1	28V DC	SBCBP
A/C SHUTOFF VALVE 1▶97	1	115V AC	GENERATOR NO. 2 MCBP
98▶	1	28V DC	SBCBP
CABIN PRESSURE WARN (light)	1	28V DC	SBCBP
CABIN TEMPERATURE INDICATOR	1	28V DC	T-R BUS NO. 2 MCBP
CARGO COMPT AIR CONDITIONING (temp selector)	1	28V DC	T-R BUS NO. 1 MCBP
CARGO COMPT TEMP CONTROL	1	115V AC	GENERATOR NO. 2 MCBP
CONTROL CABIN TEMP CONTROL 71▶	1	115V AC	GENERATOR NO. 2 MCBP
ALT PRESS & AFT TEMP CONTROL	1	28V DC	SBCBP
ENGINE BLEED AIR SHUTOFF VALVES, NOS. 1, 2, 3, 4	4	28V DC	SBCBP
GROUND AIR EJECTOR VALVE 1▶97	1	115V AC	GENERATOR NO. 1 MCBP
98▶	1	28V DC	SBCBP
HOT AIR BYPASS VALVE 1▶97	1	115V AC	GENERATOR NO. 1 MCBP
98▶	1	28V DC	SBCBP
TEMPERATURE CONTROL (cabin) 1▶70	1	115V AC	GENERATOR NO. 2 MCBP
AIR REFUELING SYSTEM			
AIR REFUELING CONTROL PANEL	1	115V AC	GENERATOR NO. 3 MCBP
	6	28V DC	SBCBP AND BOCBP
AIR REFUELING PUMPS (shutoff valves)	4	28V DC	SBCBP
BOOM OPERATOR'S PANEL AND COMPT LIGHTS	1	28V AC	BOCBP
BOOM POSITION INDICATORS	1	28V DC	BOCBP
FUEL TRANSFERRED INDICATOR (fuel flow rate and totalizer gage)	1	115V AC	BOCBP
FUEL TRANSFERRED INDICATOR (transmitter power supply)	1	28V DC	BOCBP
FUEL VALVE, A/R MANIFOLD LINE VALVE	1	28V DC	SBCBP
FUEL VALVE, A/R MANIFOLD TO ENGINE MANIFOLD	1	28V DC	SBCBP
LIGHTS, BOOM MARKER	1	115V AC	BOCBP
LIGHTS, BOOM NOZZLE	1	28V DC	BOCBP
RECEIVER PILOT DIRECTOR LIGHTS	2	32V AC	BOCBP
SIGNAL AMPLIFIER	1	28V DC	BOCBP

Figure 1-36 (Sheet 1 of 8)

CIRCUIT PROTECTION AND LOCATION (CONT)

CIRCUIT TITLE	NO. CB's	OPERATING POWER	CIRCUIT BREAKER LOCATION
ANTI-ICING SYSTEM			
RGA HEATERS	1	115V AC	GENERATOR NO. 3 MCBP
ENGINE ANTI-ICE			
ENGINE ANTI-ICE CONTROL (anti-ice switch & light)	1	28V DC	T-R BUS NO. 1 MCBP
ENGINE NO. 1 ANTI-ICE VALVE	1	28V DC	T-R BUS NO. 2 MCBP
ENGINE NO. 2 ANTI-ICE VALVE	1	28V DC	T-R BUS NO. 1 MCBP
ENGINE NO. 3 ANTI-ICE VALVE	1	28V DC	T-R BUS NO. 2 MCBP
ENGINE NO. 4 ANTI-ICE VALVE	1	28V DC	T-R BUS NO. 1 MCBP
NACELLE ANTI-ICE CONTROL	1	28V DC	T-R BUS NO. 1 MCBP
PITOT ANTI-ICE			
COPILOT PITOT-STATIC ANTI-ICE	1	115V AC	GENERATOR NO. 1 MCBP
Q-INLET HEATER	1	115V AC	GENERATOR NO. 2 MCBP
Q-INLET HEATER WARNING	1	28V DC	T-R BUS NO. 2 MCBP
PILOT PITOT-STATIC ANTI-ICE	1	115V AC	GENERATOR NO. 3 MCBP
WINDOW ANTI-ICE			
COPILOT WINDOW ANTI-ICE CONTROL (controller)	1	28V DC	T-R BUS NO. 1 MCBP
COPILOT WINDOW ANTI-ICE CONTROL (heat switch)	1	115V AC	GENERATOR NO. 2 MCBP
PILOT WINDOW ANTI-ICE CONTROL (controller)	1	28V DC	T-R BUS NO. 2 MCBP
PILOT WINDOW ANTI-ICE CONTROL (heat switch)	1	115V AC	GENERATOR NO. 1 MCBP
WINDOW ANTI-ICE COPILOT NO. 1 PILOT NO. 2	1	115V AC	GENERATOR NO. 2 MCBP
WINDOW ANTI-ICE, COPILOT NO. 3-4-5	1	115V AC	GENERATOR NO. 2 MCBP
WINDOW ANTI-ICE, PILOT NO. 1 COPILOT NO. 2	1	115V AC	GENERATOR NO. 1 MCBP
WINDOW ANTI-ICE, PILOT NO. 3-4-5	1	115V AC	GENERATOR NO. 1 MCBP
WINDOW DEFROST, BOOM OPERATOR (control)	1	28V DC	BOCBP
WINDOW DEFROST, BOOM OPERATOR (operating power)	1	115V AC	GENERATOR NO. 3 MCBP
ARCTIC CAPABILITY			
APU – AIRESEARCH			
BATTERY CHARGE	3	115/200V AC	APU CIRCUIT BREAKER PANEL
AUXILIARY POWER SOURCE (STA 1180 POWER OUTLET)	3	115/200V AC	GENERATOR NO. 2 MCBP
BATTERY BUS	1	28V DC	APU CIRCUIT BREAKER PANEL
BLOWER MOTOR	3	115/200V AC	APU CIRCUIT BREAKER PANEL
CONTROL	1	28V DC	APU CIRCUIT BREAKER PANEL
AC POWER CONTROL SWITCH			
MASTER SWITCH			
OIL PRESSURE AND OIL TEMPERATURE WARNING LIGHTS			
PRIMER SWITCH			
START-STOP SWITCH			
FIRE DETECTOR (fire test switch and warning light)	1	28V DC	APU CIRCUIT BREAKER PANEL
POWER DISTRIBUTION (airplane)	6	115/200V AC	APU CIRCUIT BREAKER PANEL
TEMP CONTROL	1	28V DC	APU CIRCUIT BREAKER PANEL
APU TEMPERATURE CONTROL			
CABIN AIR SWITCH			
APU – SOLAR			
BATTERY CHARGE	3	115/200V AC	APU CIRCUIT BREAKER PANEL
AUXILIARY POWER SOURCE (STA 1180 POWER OUTLET)	3	115/200V AC	GENERATOR NO. 2 MCBP

Figure 1-36 (Sheet 2 of 8)

CIRCUIT TITLE	NO. CB's	OPERATING POWER	CIRCUIT BREAKER LOCATION
ARCTIC CAPABILITY (CONT)			
BLOWER MOTOR	3	115/200V AC	APU CIRCUIT BREAKER PANEL
HEATER CONTROL (blower switch)	1	28V DC	APU CIRCUIT BREAKER PANEL
ENGINE CONTROL	1	28V DC	APU CIRCUIT BREAKER PANEL
POWER SWITCH			
PRIMER SWITCH			
OIL PRESSURE, OIL TEMPERATURE AND FUEL PRESSURE WARNING LIGHTS			
START-STOP SWITCH			
TURBINE DISCHARGE TEMPERATURE GAGE			
FIRE CONTROL	1	28V DC	APU CIRCUIT BREAKER PANEL
FIRE DETECTOR TEST SWITCH AND WARNING LIGHT			
GENERATOR SWITCH	9	115/200V AC	APU CIRCUIT BREAKER PANEL
HEATER CONTROL			
CABIN HEAT TEMPERATURE GAGE	1	28V DC	APU CIRCUIT BREAKER PANEL
POWER SWITCH			
ENGINE CONTROL	1	28V DC	APU CIRCUIT BREAKER PANEL
HEATER CONTROL	1	28V DC	APU CIRCUIT BREAKER PANEL
ELECTRICAL OUTLETS			
POWER OUTLETS			
RIGHT HAND WHEEL WELL	3	115/200V AC	APU CIRCUIT BREAKER PANEL
(2) 115/200V AC RECP			
(3) 115V AC RECP			
AUXILIARY POWER PANEL			
(3) 115/200V AC RECP	9	115/200V AC	AUXILIARY POWER PANEL
(5) 115V AC RECP	5	115V AC	AUXILIARY POWER PANEL
GALLEY EQUIPMENT (AUX PWR PANEL RECP NO. 3)	3	115/200V AC	GENERATOR NO. 3 MCBP
PORTABLE AIR COMPRESSOR	3	115/200V AC	AUXILIARY POWER PANEL
PORTABLE ELECTRIC HEATER	3	115/200V AC	AUXILIARY POWER PANEL
COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT			
ADF ANTENNA HEATER	1	115VAC	GENERATOR NO. 1 MCBP
ALTITUDE COMPUTER	1	115V AC	MCBP
ALTIMETER (High range radio) SCR-718 1▶547			
OR APN/133 ON 548▶	1	115V AC	GENERATOR NO. 1 MCBP
AUTOPILOT	3	115/200V AC	GENERATOR NO. 3 MCBP
	1	28V DC	T-R BUS NO. 1 MCBP
BLOWER ELECTRONIC CABINET	3	115/200V AC	GENERATOR NO. 2 MCBP
COPILOT TACAN SWITCH	1	28V DC	T-R BUS NO. 1 MCBP
ELECTRONIC RACK BLOWER IND	1	28V AC	MCBP
FLIGHT DIRECTOR NO. 1	1	115V AC	GENERATOR NO. 3 MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
FLIGHT DIRECTOR NO. 2	2	115V AC	CIPP
	1	28V DC	CIPP
FLIGHT DIRECTOR SYSTEM - COPILOT'S (F/O)			
ATTITUDE	1	115V AC	FD-109/RGA EQUIP RACK
COMMAND	1	115V AC	FD-109/RGA EQUIP RACK

Figure 1-36 (Sheet 3 of 8)

CIRCUIT PROTECTION AND LOCATION (CONT)

CIRCUIT TITLE	NO. CB's	OPERATING POWER	CIRCUIT BREAKER LOCATION
COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT (CONT)			
FLIGHT DIRECTOR	1	28V DC	FD-109/RGA EQUIP RACK
HEADING	1	115V AC	FD-109/RGA EQUIP RACK
MAJORITY LOGIC	1	115V AC	FD-109/RGA EQUIP RACK
MAJORITY LOGIC	1	28V DC	FD-109/RGA EQUIP RACK
RADIO ALTIMETER	1	115V AC	FD-109/RGA EQUIP RACK
RGA PROBE HEATER	1	115V AC	FD-109/RGA EQUIP RACK
RGA SYSTEM	1	115V AC	FD-109/RGA EQUIP RACK
RGA SYSTEM	1	28V DC	FD-109/RGA EQUIP RACK
RATE OF TURN GYRO	1	115V AC	FD-109/RGA EQUIP RACK
RUNWAY	1	115V AC	FD-109/RGA EQUIP RACK
FLIGHT DIRECTOR SYSTEM - PILOT'S			
ATTITUDE	1	115V AC	FD-109/RGA EQUIP RACK
COMMAND	1	115V AC	FD-109/RGA EQUIP RACK
FLIGHT DIRECTOR	1	28V DC	FD-109/RGA EQUIP RACK
HEADING	1	115V AC	FD-109/RGA EQUIP RACK
MONITOR WARNING	2	115V AC	FD-109/RGA EQUIP RACK
RADIO ALTIMETER	1	115V AC	FD-109/RGA EQUIP RACK
RGA PROBE HEATER	1	115V AC	FD-109/RGA EQUIP RACK
RGA SYSTEM	1	115V AC	FD-109/RGA EQUIP RACK
RGA SYSTEM	1	28V DC	FD-109/RGA EQUIP RACK
RATE OF TURN GYRO	1	115V AC	FD-109/RGA EQUIP RACK
RUNWAY	1	115V AC	FD-109/RGA EQUIP RACK
GLIDE SLOPE NO. 1	1	28V DC	T-R BUS NO. 2 MCBP
GLIDE SLOPE NO. 2	1	28V DC	T-R BUS NO. 1 MCBP
HF LIAISON	3	115V AC	GENERATOR NO. 2 MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
IFF RECEIVER TRANSMITTER	1	115/200V AC	GENERATOR NO. 1 MCBP
AIC-10 INPH (INTERPHONE) 1 ▶ 97	1	28V DC	SBCBP
INPH (INTERPHONE) 98 ▶	2	28V DC	BATTERY CBP
ILS (GLIDE SLOPE)	1	115V AC	GENERATOR NO. 2 MCBP
	1	28V AC	T-R BUS NO. 2 MCBP
MARKER, BEACON, ARN-12	1	28V DC	T-R BUS NO. 2 MCBP
N-1 COMPASS	2	115V AC	MCBP
	1	115V AC	GENERATOR NO. 3 MCBP
PILOT TACAN SWITCH	1	28V DC	T-R BUS NO. 2 MCBP
PRESSURIZING KIT (RADAR), ASQ-15	2	115V AC	GENERATOR NO. 1 MCBP
RADAR BEACON, APN-69	1	115V AC	GENERATOR NO. 3 MCBP
	1	28V DC	T-R BUS NO. 1 MCBP
RADAR NAVIGATION, APN-82	2	28V DC	T-R BUS NO. 1 MCBP
	1	28V AC	MCBP
	5	115/200V AC	GENERATOR NO. 3 MCBP
RADAR NAVIGATION BLOWER, APN-82	3	115/200V AC	GENERATOR NO. 3 MCBP
RADAR NAVIGATION (APN-99) 98 ▶	5	115/200V AC	GENERATOR NO. 3 MCBP
	2	28V DC	T-R BUS NO. 1 MCBP
	1	28V AC	MCBP
RADAR NAVIGATION BLOWER (APN-99) 98 ▶	3	115/200V AC	GENERATOR NO. 3 MCBP
RENDEZVOUS BEACON (APN-134) 346 ▶	3	115/200V AC	GENERATOR NO. 2 MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
SEARCH RADAR, APN-59	2	115/200V AC	GENERATOR NO. 2 MCBP
	1	28V DC	T-R BUS NO. 1 MCBP

Figure 1-36 (Sheet 4 of 8)

CIRCUIT TITLE	NO. CB's	OPERATING POWER	CIRCUIT BREAKER LOCATION
COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT (CONT)			
SECURE VOICE	1	28V DC	T-R BUS NO. 2 MCBP
TACAN ANTENNA SELECT	1	28V DC	T-R BUS NO. 2 MCBP
TEST POWER	2	115V AC	GENERATOR NO. 2 MCBP
	1	28V DC	T-R BUS NO. 1 MCBP
UHF COMMAND NO. 1, ARC-34	1	28V DC	SBCBP
UHF COMMAND NO. 2	1	28V DC	T-R BUS NO. 1 MCBP
UHF HOMING, ARA-25	1	28V DC	T-R BUS NO. 2 MCBP
UHF NAVIGATION (ARN-72) (TACAN)	1	115V AC	GENERATOR NO. 1 MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
VHF NAV NO. 1	1	28V DC	T-R BUS NO. 2 MCBP
VHF NAV NO. 2	1	28V DC	T-R BUS NO. 1 MCBP
ELECTRICAL			
AMMETER (T-R No. 1)	1	28V DC	T-R BUS NO. 1 MCBP
AMMETER (T-R No. 2)	1	28V DC	T-R BUS NO. 2 MCBP
BATTERY AM AND VM	1	28V DC	BATTERY CBP
BATTERY AMMETER	1	28V DC	BATTERY CBP
BATTERY CHARGE (T-R unit input)	3	115/200V AC	GENERATOR NO. 3 MCBP
(T-R unit output)	1	28V DC	BATTERY CBP
COPILOT'S FLIGHT INSTR (EMERGENCY position of copilot's instrument power switch)	1	28V DC	T-R BUS NO. 2 MCBP
COPILOT'S FLIGHT INSTR (secondary power source)	3	115/200V AC	GENERATOR NO. 1 MCBP
COPILOT'S INSTR POWER CONTROL (relay, light & hydraulic valve)	1	28V DC	SBCBP
COPILOT'S INSTRUMENT POWER SYSTEM	3 Fuses	115/200V AC	COPILOT'S INSTR POWER SUPPLY FUSE BOX
DC DISTRIBUTION	3	28V DC	SBCBP
EXTERNAL RECP (external power receptacle)	1	28V DC	BATTERY CBP
GENERATOR CONTROL BUS TIE BREAKERS - NOS. 1, 2, & 3	3	28V DC	SBCBP
GENERATOR CONTROL - NEG SEQ RELAY, AUTO PARALLEL UNIT, INDICATOR LIGHTS	3	28V DC	SBCBP
GENERATOR PANEL AND BREAKER - NOS. 1, 2, & 3	3	28V DC	BATTERY CBP
PILOT'S INSTRUMENT TRANSFORMER	3	115/200V AC	GENERATOR NO. 3 MCBP
STA 1180 POWER OUTLETS (APU battery charging circuit)	3	115/200V AC	GENERATOR NO. 2 MCBP
SW BUS FAIL LT	1	28V DC	BATTERY CBP
SWITCHED BUS FAIL LT RELAY	1	28V DC	SBCBP
SWITCHED DC BUS POWER SUPPLY (battery power)	3	28V DC	BATTERY CBP
(T-R power)	3	28V DC	T-R BUS NO. 1 MCBP
T-R NO. 1	3	115/200V AC	GENERATOR NO. 1 MCBP
T-R NO. 2	3	115/200V AC	GENERATOR NO. 2 MCBP
VOLT-AMMETER (T-R No. 1)	1	28V DC	T-R BUS NO. 1 MCBP

Figure 1-36 (Sheet 4A of 8)

CIRCUIT TITLE	NO. CB's	OPERATING POWER	CIRCUIT BREAKER LOCATION
ELECTRICAL (CONT)			
VOLT-AMMETER (T-R No. 2)	1	28V DC	T-R BUS NO. 2 MCBP
28 VOLT TRANSFORMER	2	115V AC	GENERATOR NO. 1 MCBP
28 VOLT TRANSFORMER	1	115V AC	GENERATOR NO. 2 MCBP
28 VOLT TRANSFORMER	1	115V AC	GENERATOR NO. 3 MCBP
ENGINES			
ENGINE BLEED AIR SHUTOFF	4	28V DC	SBCBP
ENGINE FIRE DETECTOR - NOS. 1, 2, 3, & 4 (lights)	4	28V DC	SBCBP
ENGINE FUEL FLOW (indicators)	1	115V AC	GENERATOR NO. 2 MCBP
(power supply unit)	1	28V DC	BOCBP
ENGINE IGNITION - NOS. 1, 2, 3, & 4	4	28V DC	SBCBP
ENG. 1, 2, 3 LOW OIL PRESS WARN (WITH [illegible])	1	28V DC	T-R BUS NO. 1 MCBP
ENGINE NO. 4 OIL PRESS. WARN (light)	1	28V DC	SBCBP
ENG OIL PRESS IND - NOS. 1, 2, 3, & 4	4	28V AC	MCBP
ENGINE STARTER - NOS. 1, 2, 3, & 4	4	28V DC	SBCBP
PRESSURE RATIO INDICATORS (EPR gage)	4	115V AC	GENERATOR NOS. 1 AND 3 MCBP
FLIGHT CONTROLS			
FLAP POSITION INDICATOR			
OUTBOARD	1	28V AC	MCBP
INBOARD (left pointer)	1	28V AC	MCBP
INSTRUMENT EXCITATION (right pointer)			
of inboard flap position indicator)	1 FUSE	28V AC	CIPP
RUDDER POWER			
CONTROL (rudder power switch)	1	28V DC	SBCBP
PRESSURE CONTROL	1	28V DC	SBCBP
PRESSURE INDICATOR	1	28V AC	MCBP
SPOILER HYDRAULIC PRESSURE - INBOARD, OUTBOARD	2	28V DC	T-R BUS NO. 2 MCBP
STABILIZER TRIM (drive motor)	3	115/200V AC	GENERATOR NO. 2 MCBP
PILOT (control)	1	28V DC	T-R BUS NO. 1 MCBP
COPILOT (control)	1	28V DC	T-R BUS NO. 1 MCBP
SAFETY RELAY (control)	1	28V DC	T-R BUS NO. 1 MCBP
WARNING HORN	1	28V DC	SBCBP
FUEL AND WATER INJECTION			
BOOST PUMP SWITCHES			
FUEL BOOST NO. 1 AFT	3	115/200V AC	GENERATOR NO. 3 MCBP
FUEL BOOST CONTROL NO. 1 AFT	1	28V DC	T-R BUS NO. 2 MCBP
FUEL BOOST NO. 2 AFT	3	115/200V AC	GENERATOR NO. 1 MCBP
FUEL BOOST CONTROL NO. 2 AFT	1	28V DC	T-R BUS NO. 1 MCBP
FUEL BOOST NO. 3 AFT	3	115/200V AC	GENERATOR NO. 2 MCBP
FUEL BOOST CONTROL NO. 3 AFT	1	28V DC	T-R BUS NO. 2 MCBP

Figure 1-36 (Sheet 5 of 8)

CIRCUIT PROTECTION AND LOCATION (CONT)

CIRCUIT TITLE	NO. CB's	OPERATING POWER	CIRCUIT BREAKER LOCATION
FUEL AND WATER INJECTION (CONT)			
FUEL BOOST NO. 4 AFT	3	115/200V AC	GENERATOR NO. 3 MCBP
FUEL BOOST CONTROL NO. 4 AFT	1	28V DC	T-R BUS NO. 2 MCBP
FUEL BOOST NO. 1 FORWARD	3	115/200V AC	GENERATOR NO. 1 MCBP
FUEL BOOST CONTROL NO. 1 FORWARD	1	28V DC	T-R BUS NO. 1 MCBP
FUEL BOOST NO. 2 FORWARD	3	115/200V AC	GENERATOR NO. 2 MCBP
FUEL BOOST CONTROL NO. 2 FORWARD	1	28V DC	T-R BUS NO. 2 MCBP
FUEL BOOST NO. 3 FORWARD	3	115/200V AC	GENERATOR NO. 3 MCBP
FUEL BOOST CONTROL NO. 3 FORWARD	1	28V DC	T-R BUS NO. 1 MCBP
FUEL BOOST NO. 4 FORWARD	3	115/200V AC	GENERATOR NO. 1 MCBP
FUEL BOOST CONTROL NO. 4 FORWARD	1	28V DC	T-R BUS NO. 1 MCBP
FUEL DUMP (switch)	1	28V DC	SBCBP
FUEL PRESS ENG MANF (warning light)	1	28V DC	SBCBP
FUEL QUANTITY GAGES (operating power) TOTAL; FORWARD BODY; CENTER WING; AFT BODY; UPPER DECK; NOS. 1, 2, 3 & 4; NO. 1 RESERVE; NO. 4 RESERVE	11	115V AC	GENERATOR NO. 1 MCBP
FUEL QUANTITY GAGES (control power) TOTAL; NOS. 1, 2, & 3; RESERVE NO. 1, RESERVE NO. 4	6	28V DC	T-R BUS NO. 1 MCBP
FORWARD BODY; CENTER WING; AFT BODY; NO. 4; UPPER DECK	5	28V DC	T-R BUS NO. 2 MCBP
FUEL VALVE SWITCHES			
CENTER WING TO FWD TANK - LH, RH	2	28V DC	SBCBP
FIRE SHUTOFF - NOS. 1, 2, 3, & 4	4	28V DC	SBCBP
TANK TO ENG MANIFOLD - NOS. 1, 2, 3, & 4 750▶	4	28V DC	SBCBP
TANK TO ENG MANIFOLD NOS. 1 & 2 1▶249	2	28V DC	T-R BUS NO. 1 MCBP
TANK TO ENG MANIFOLD NOS. 3 & 4 1▶249	2	28V DC	T-R BUS NO. 2 MCBP
UPPER DECK TO AFT TANK	1	28V DC	SBCBP
WING TO AFT TANK - NOS. 1, 2, 3, & 4	4	28V DC	SBCBP
RESERVE NO. 1 TO TANK NO. 1 VALVE	1	28V DC	T-R BUS NO. 1 MCBP
RESERVE NO. 4 TO TANK NO. 4	1	28V DC	T-R BUS NO. 2 MCBP
OVERRIDE PUMP LEFT HAND	3	115/200V AC	GENERATOR NO. 3 MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
OVERRIDE PUMP RIGHT HAND	3	115/200V AC	GENERATOR NO. 2 MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
FUEL PRESS ENG MANF (warning light)	1	28V DC	SBCBP
SINGLE POINT GROUND REFUEL	3	28V DC	BATTERY CBP
WATER INJECTION OUTBD	4	28V DC	T-R BUS NO. 1 MCBP
WATER INJECTION INBD	4	28V DC	T-R BUS NO. 2 MCBP
WATER INJECTION PUMPS	6	115/200V AC	MAIN AC POWER PANEL
WATER TANK DRAIN MAST HEATER	1	115V AC	GENERATOR NO. 3 MCBP
	1	115V AC	WATER HEATER POWER PANEL
WATER TANK HEATERS	39	115/200V AC	WATER HEATER POWER PANEL

Figure 1-36 (Sheet 6 of 8)

CIRCUIT TITLE	NO. CB's	OPERATING POWER	CIRCUIT BREAKER LOCATION
HYDRAULIC SYSTEM			
ENGINE HYDRAULIC OIL FIRE SHUTOFF - NOS. 1, 2, 3, & 4	4	28V DC	SBCBP
HYD LOW PRESS WARN	1	28V DC	SBCBP
HYDRAULIC OIL QUANTITY INDICATOR	1	28V DC	T-R BUS NO. 2 MCBP
HYDRAULIC PUMP CONTROL (RH)	1	28V DC	T-R BUS NO. 2 MCBP
HYD SYS PRESS.	1	28V DC	SBCBP
LH HYD PUMP CONTROL (RESERVE BRAKE OR AUTO POSITION)	1	28V DC	BATTERY CBP
LH HYD PUMP (operating power RESERVE BRAKE)	FUSE	28V DC	BATTERY CBP
LH HYD PUMP (operating power AUTO POSITION)	FUSE	28V DC	T-R BUS NO. 2 MCBP
RH HYD PUMP (operating power)	FUSE	28V DC	T-R BUS NO. 2 MCBP
INSTRUMENTS			
COPILOT ATTITUDE INDICATOR	2 FUSES	115V AC	CIPP
	FUSE	28V DC	CIPP
FREE AIR TEMPERATURE INDICATOR	1	28V DC	T-R BUS NO. 2 MCBP
J-4 COMPASS	3 FUSES	115V AC	CIPP
	FUSE	28V DC	CIPP
OXYGEN QUANTITY	1	28V DC	T-R BUS NO. 2 MCBP
PILOT ATTITUDE INDICATOR	2	115V AC	MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
LANDING GEAR			
ANTI-SKID (LESS 1C10-550)	1	28V DC	T-R BUS NO. 2 MCBP
ANTI-SKID, INBOARD, OUTBOARD 1C10-550	2	28V DC	T-R BUS NO. 2 MCBP
ANTI-SKID TEST 1C10-550	1	28V AC	MCBP
ANTI-SKID SAFETY RELAY 1C10-550	1	28V DC	T-R BUS NO. 1 MCBP
LANDING GEAR LEVER LOCK	1	28V DC	T-R BUS NO. 1 MCBP
LANDING GEAR POSITION - LH, NOSE, RH 1▶14	3	28V DC	T-R BUS NO. 1 MCBP
LANDING GEAR POS & WARN - LH, NOSE, RH 15▶	3	28V DC	SBCBP
LANDING GEAR WARNING LIGHT	1	28V DC	SBCBP
SAFETY SWITCH RELAY	1	28V DC	T-R BUS NO. 2 MCBP
WARNING HORN	1	28V DC	SBCBP
LIGHTING			
EXTERIOR LIGHTS			
BOOM MARKER LIGHTS	1	115V AC	BOCBP
BOOM NOZ LIGHT	1	28V DC	BOCBP
LANDING LIGHT			
WING	1	115V AC	GENERATOR NO. 1 MCBP
TAXI & LANDING LIGHT CONTROL	1	28V DC	T-R BUS NO. 2 MCBP
RETRACTABLE LDG LIGHT CONTROL	1	28V DC	T-R BUS NO. 1 MCBP
NACELLE ILLUMINATION - EXTERNAL LIGHTS NAC	1	28V AC	BOCBP
NAVIGATION - BODY	1	28V AC	MCBP
NAVIGATION LIGHT FLASHER	1	28V DC	T-R BUS NO. 1 MCBP

Figure 1-36 (Sheet 7 of 8)

CIRCUIT PROTECTION AND LOCATION (CONT)

CIRCUIT TITLE	NO. CB's	OPERATING POWER	CIRCUIT BREAKER LOCATION
LIGHTING (CONT)			
NAVIGATION - WING & TAIL	1	28V AC	MCBP
MAGNETIC COMPASS LIGHT	1	28V DC	SBCBP
RECEIVER PILOT DIRECTOR LIGHTS	2	32V AC	BOCBP
RENDEZVOUS - UPPER, LOWER	2	28V AC	MCBP
SIGNAL LAMP (portable)	1	28V AC	MCBP
UNDER BODY ILLUM	1	28V AC	BOCBP
UNDER WING ILLUM	1	28V DC	BOCBP
WHEEL WELL LIGHTS	1	28V AC	MCBP
INTERIOR LIGHTS			
ALERT LIGHTING	1	28V DC	BATTERY CBP
ALERT LIGHTING (RELAY)	1	28V DC	T-R BUS NO. 2 MCBP
AUX CREW OXY PANEL LIGHTS	1	28V AC	MCBP
BOOM OPERATOR PANEL LIGHTS	1	28V DC	BOCBP
COMPASS LIGHT	1	28V DC	SBCBP
DOME LIGHTS			
CABIN	1	28V AC	MCBP
CARGO	2	28V AC	MCBP
LOWER COMPARTMENT	1	28V AC	MCBP
FLOOD LIGHTS			
CARGO DOOR ▶ ICTO 951 ◀	1	28V AC	MCBP
CONTROL STAND	1	28V AC	MCBP
NAVIGATOR INSTRUMENT	1	28V AC	MCBP
NAVIGATOR TABLE	1	28V AC	MCBP
PILOT PANEL	1	28V AC	MCBP
PANEL LIGHTS - COPILOT	FUSE	28V AC	CIPP
PANEL LIGHTS - ENGINE INSTRUMENT AND FUEL PANEL	2	28V AC	MCBP
PANEL LIGHTS - NAVIGATOR INSTRUMENT AND PANEL	1	28V AC	MCBP
PANEL LIGHTS - OVERHEAD INSTRUMENT PANEL FLOOD	1	28V AC	MCBP
PANEL LIGHTS - OVERHEAD PANEL	1	28V AC	MCBP
PANEL LIGHTS - PILOT	1	28V AC	MCBP
SEXTANT LIGHT	1	28V AC	MCBP
SPOTLIGHT - COPILOT, ELECTRICAL EQUIPMENT RACK	FUSE	28V DC	CIPP
SPOTLIGHT - PILOT	1	28V DC	SBCBP
THUNDERSTORM	1	28V AC	MCBP
WARNING LIGHT DIMMING CONTROL	1	28V DC	T-R BUS NO. 1 MCBP
MISCELLANEOUS			
ALARM BELL	1	28V DC	BATTERY CBP
ALTIMETER VIBRATOR (COPILOT)	1	28V DC	CIPP
ALTIMETER VIBRATOR (PILOT)	1	28V DC	SBCBP
BEVERAGE JUG	1	115V AC	GENERATOR NO. 2 MCBP
CABIN PRESS. WARN (light)	1	28V DC	SBCBP
CARGO COMPT WARNING HORN 581 ▶	1	28V DC	BATTERY CBP
CARGO DOOR ▶ ICTO 944 ◀	1	28V DC	BATTERY CBP
DOOR WARNING	1	28V DC	T-R BUS NO. 2 MCBP
HOT CUP NO. 1	1	115V AC	GENERATOR NO. 3 MCBP
HOT CUP NO. 2	1	115V AC	GENERATOR NO. 2 MCBP
WINDSHIELD RAIN REPELLENT	1	28V DC	T-R BUS NO. 1 MCBP
WINDSHIELD WIPER - PILOT, COPILOT	2	28V DC	BATTERY CBP

Figure 1-36 (Sheet 8 of 8)

HYDRAULIC SYSTEMS

There are 2 independent systems, referred to as the left system and right system, to supply hydraulic fluid under pressure to the hydraulically operated components. See figure 1-37. The components supplied by each system are enumerated under the paragraph describing the respective system. The left system is pressurized by two pumps on the left side of the airplane, one on each engine. Similarly, the pumps on the right side of the airplane pressurize the right system. The pumps are self-lubricated and set to maintain 3025 ± 25 psi. The pumps operate when the engines are running; however, the position of the system hydraulic pressure switch determines whether a system will be pressurized or depressurized. A check valve in each pump pressure line prevents loss of system pressure if the pump fails. There are 2 self-sealing couplings on the right side of each engine for connecting a hydraulic ground cart to service or pressurize a hydraulic system. Although each system is independent, the landing gear, main flaps, boom controls, and the powered rudder can be operated with pressure from either system through the emergency hydraulic crossover valve at the copilot's station. There are 6 accumulators: one main accumulator for each system, a reserve brake accumulator, a boom hydraulic accumulator and 2 accumulators in the rudder hydraulic system. The reserve brake accumulator pressurizes the pilot's brakes if the left system fails. The boom hydraulic accumulator assures an ample supply of fluid for the initial part of a full speed (emergency) boom retraction. The primary function of the main accumulators is to absorb surges in the respective system. These accumulators do not maintain pressure on the system if the pumps fail. The accumulators are preloaded as indicated on the chart adjacent to each accumulator. Tubing connects the pressure gages for the hydraulic system to the air side of the accumulators. The air pressure in the accumulator is the same as the system pressure when fluid pressure exceeds accumulator precharge. With the systems depressurized, the pressure gages should read the accumulator preload for the corresponding temperature as shown in figure 1-65. Electrically driven auxiliary hydraulic pumps in each system supply pressure to their system mainly for ground test of hydraulic components, pressurization of the pilot's brakes, and inflight emergencies. Normally, the auxiliary pumps are OFF during flight since their volume rate of flow is only 0.7 gpm each. The capacity of each engine-driven pump is approximately 22.5 gpm at MRT (20 gpm at cruise power), with a total system capacity of 45 gpm. For servicing information and hydraulic fluid specifications see figure 1-65.

NOTE

- Although normal system pressure is 3025 psi, occasional surges in a system (due to spoiler blow down or other reasons) may cause pressure indications up to 3500 psi. These higher than normal pressures will bleed off from the main system; however, 3500 psi is retained in the reserve brake accumulator and the boom hydraulic accumulator until the respective units are used.
- Because of gage tolerances, hydraulic pressure can read as high as 3200 psi under normal conditions. Gage readings between 3050 and 3200 psi would occur only during sustained operation during periods of low demand on the hydraulic system.

LEFT HYDRAULIC SYSTEM

The left hydraulic system supplies power to operate the inboard spoilers, forward air refueling pumps in each body tank, landing gear, and the pilot's brakes. Pressure is normally supplied to the system by two engine-driven pumps, one each on No. 1 and No. 2 engines. In the event system pressure becomes inadequate, pressure can be supplied to the left system by use of the left system auxiliary pump. The left system cannot be fully pressurized with the auxiliary pump unless the inboard spoiler switch is in CUT-OFF. The total capacity of the left system is 21.5 gallons (this includes 5.5 gallons in the reservoir).

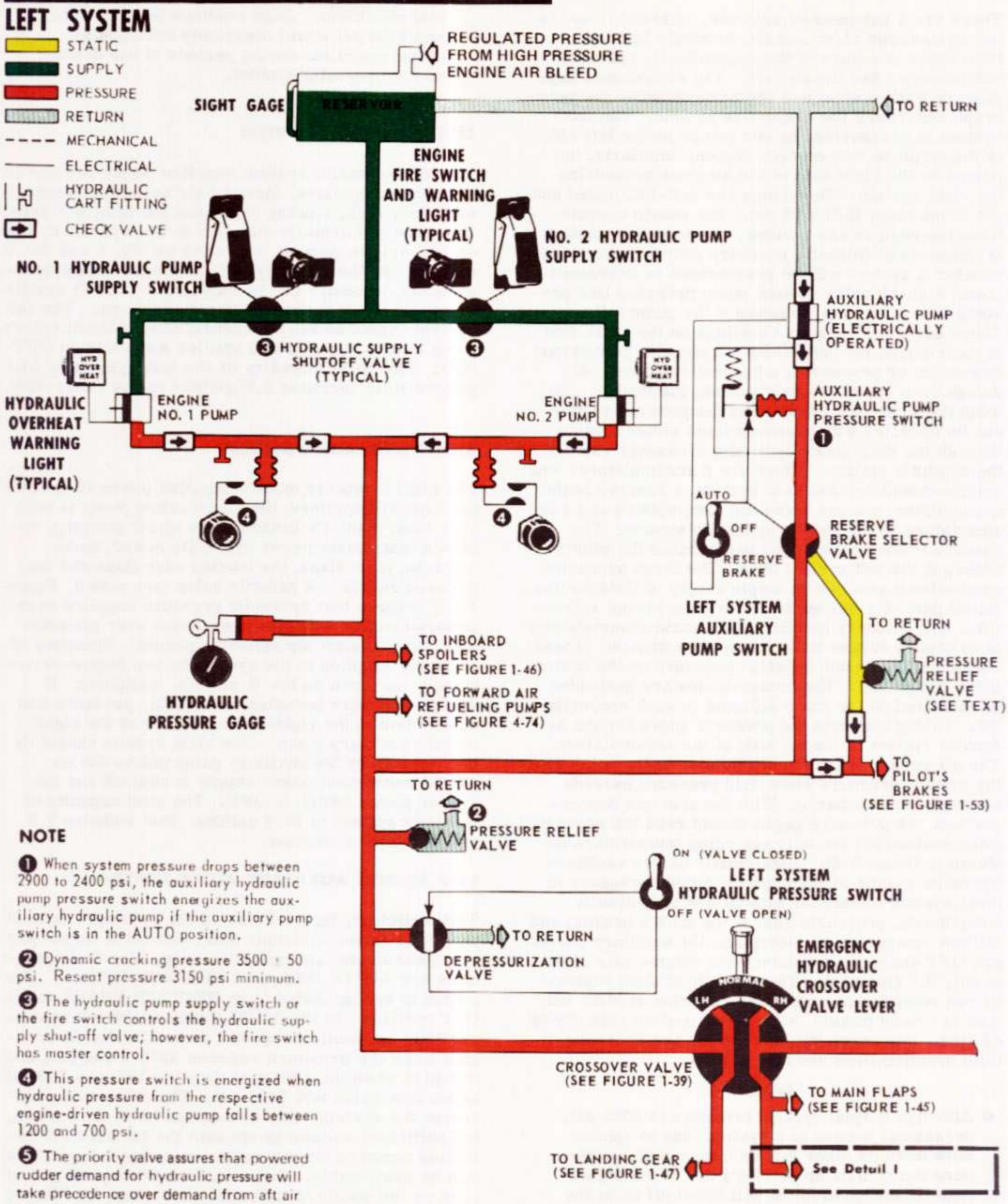
RIGHT HYDRAULIC SYSTEM

The right hydraulic system supplies power to operate the outboard spoilers, the aft refueling pump in each body tank, copilot's brakes, nose wheel steering, copilot's instrument power hydraulic motor, boom controls, main flaps, the leading edge flaps and the powered rudder. A priority valve (see note 5, figure 1-37) assures that hydraulic pressure supplied to the powered rudder will take precedence over pressure supplied to the aft air refueling pumps. Pressure is normally supplied to the system by two engine-driven pumps, one each on No. 3 and No. 4 engines. If system pressure becomes inadequate, pressure can be supplied to the right system by use of the right system auxiliary pump. The right system cannot be pressurized by the auxiliary pump unless the copilot's instrument power supply is shut off and the rudder power switch is OFF. The total capacity of the right system is 27.6 gallons: this includes 5.5 gallons in the reservoir.

LEFT SYSTEM AUXILIARY PUMP SWITCH

This switch (7, figure 1-38) on the hydraulic control panel has three positions and controls a three-way valve and an electric hydraulic pump. The three positions are AUTO, OFF, and RESERVE BRAKE. The switch is spring loaded from RESERVE BRAKE to the OFF position. In the AUTO position, the left system auxiliary hydraulic pump will automatically de-energize when the pressure reaches 2900 ± 150 psi, and energize when the pressure drops to between 200 psi below this value and 2400 psi. The pump will pressurize the system when no demand is on the system, but sufficient volume to operate the forward air refueling pumps or other services exceeding 0.7 gpm flow will be unavailable. Under this condition, equipment such as the spoilers will operate slowly. A filtered

HYDRAULIC POWER DISTRIBUTION



NOTE

1. When system pressure drops between 2900 to 2400 psi, the auxiliary hydraulic pump pressure switch energizes the auxiliary hydraulic pump if the auxiliary pump switch is in the AUTO position.
2. Dynamic cracking pressure 3500 ± 50 psi. Reseat pressure 3150 psi minimum.
3. The hydraulic pump supply switch or the fire switch controls the hydraulic supply shut-off valve; however, the fire switch has master control.
4. This pressure switch is energized when hydraulic pressure from the respective engine-driven hydraulic pump falls between 1200 and 700 psi.
5. The priority valve assures that powered rudder demand for hydraulic pressure will take precedence over demand from aft air refueling pumps.

Figure 1-37 (Sheet 1 of 2)

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RIGHT SYSTEM

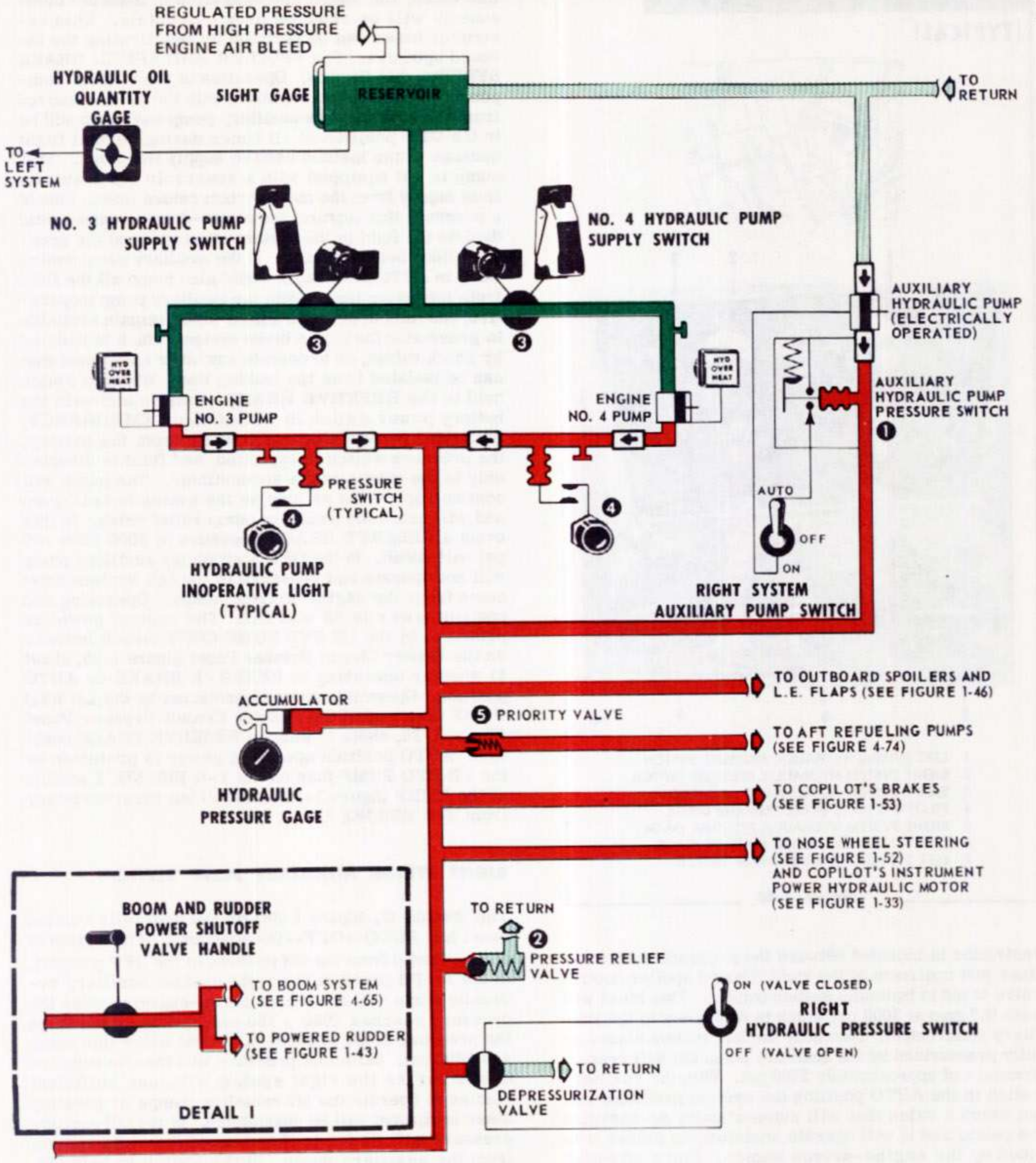
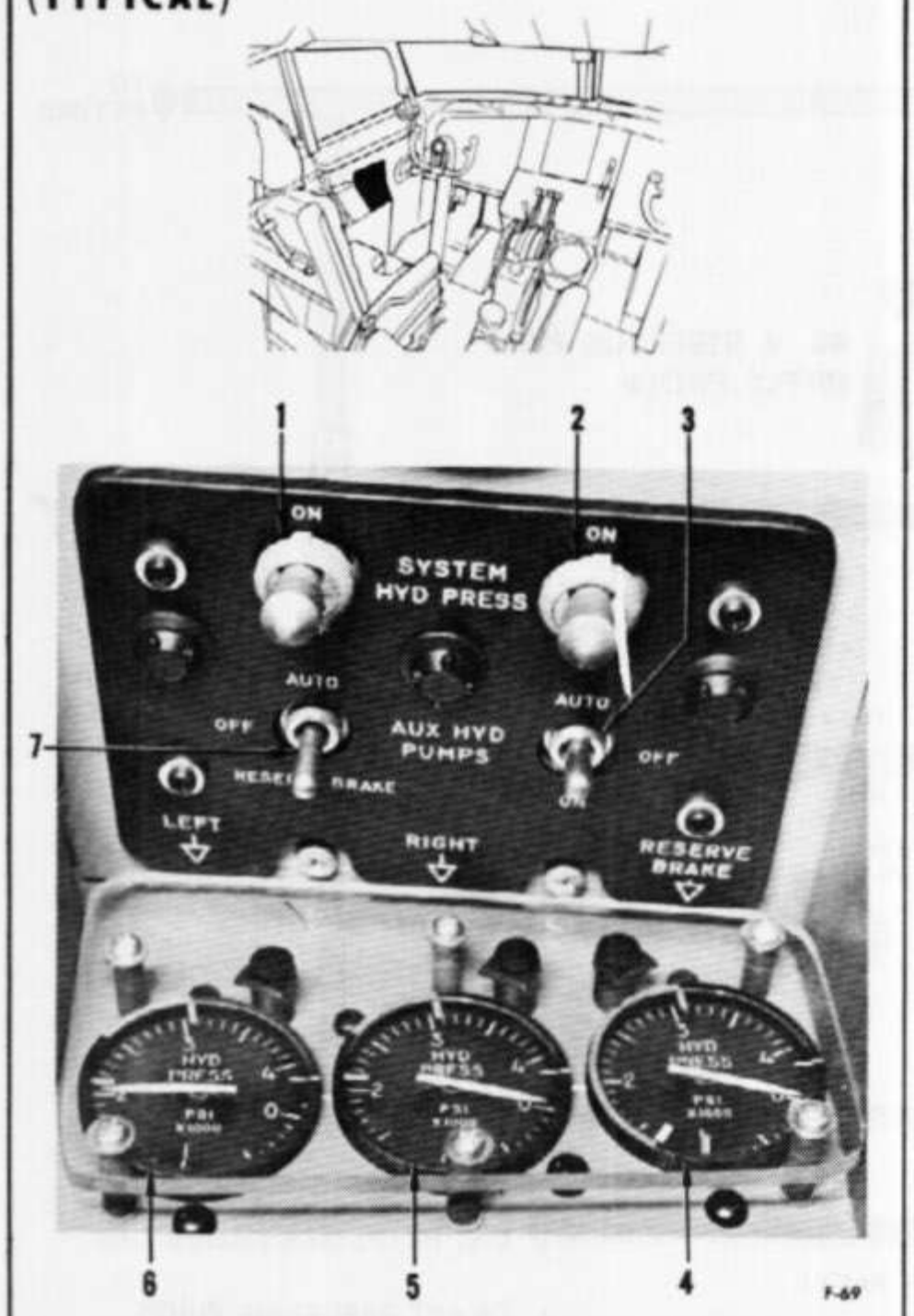


Figure 1-37 (Sheet 2 of 2)

HYDRAULIC CONTROL PANEL

(TYPICAL)



1 LEFT SYSTEM HYDRAULIC PRESSURE SWITCH
2 RIGHT SYSTEM HYDRAULIC PRESSURE SWITCH
3 RIGHT SYSTEM AUXILIARY PUMP SWITCH
4 PILOT'S RESERVE BRAKE PRESSURE GAGE
5 RIGHT SYSTEM HYDRAULIC PRESSURE GAGE
6 LEFT SYSTEM HYDRAULIC PRESSURE GAGE
7 LEFT SYSTEM AUXILIARY PUMP SWITCH

Figure 1-38

restrictor is included between the pressure and return lines just upstream of the right inboard spoiler control valve to aid in hydraulic system cooling. This bleed will pass 0.7 gpm at 3000 psi which is equivalent to the auxiliary pump output. Normally the left system cannot be fully pressurized by the auxiliary pump but will reach a pressure of approximately 2400 psi. With the auxiliary switch in the AUTO position the system pressure will not reach a value that will automatically de-energize the pump, and it will operate continuously unless it is aided by the engine-driven pumps. Since effective auxiliary system pressure and volume is reduced by this bleed, the speed and operation of affected components will be reduced proportionately. This restrictor bleed can be isolated by deactivating the inboard spoilers. See SPOILER AND SPEED BRAKE SYSTEM, this Section. Operation of the various components will be as stated above with the bleed removed from the system. The auxiliary pump switch should be in the OFF position at all times during normal flight because of the method used to supply the pump. This pump is not equipped with a reservoir but draws its fluid supply from the main system return lines. Should a pressure line rupture, the engine-driven pumps would deplete the fluid in the system reservoir and the pressure lines in a short time. If the auxiliary pump switch were in AUTO position, it would also pump all the fluid from the return lines. With the auxiliary pump inoperative, the fluid in the return lines would remain available to pressurize the pilot's brake system, which is isolated by check valves, or to operate any other component that can be isolated from the leaking line. With the switch held in the RESERVE BRAKE position and with the battery power switch in NORMAL or EMERGENCY, electrical power is drawn directly from the battery, the pressure switch is bypassed, and fluid is directed only to the pilot's brake accumulator. The pump will continue operation as long as the switch is held down and will crack the auxiliary pump relief valve. In this event a RESERVE BRAKE pressure of 3500 +200 -50 psi will result. In the OFF position the auxiliary pump will not operate and pressure to the left system must come from the engine-driven pumps. Operating and control power is 28 volt DC. The control power is protected by the LH HYD PUMP CONT circuit breaker on the Battery Circuit Breaker Panel (figure 1-35, sheet 1) whether operating in RESERVE BRAKE or AUTO position. Operating power is protected by the LH HYD PUMP fuse behind the Battery Circuit Breaker Panel (figure 1-35, sheet 1) when in RESERVE BRAKE position. AUTO position operating power is protected by the LH HYD PUMP fuse on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2) but receives power from T-R BUS NO. 1.

RIGHT SYSTEM AUXILIARY PUMP SWITCH

This switch (3, figure 1-38) on the hydraulic control panel has AUTO--OFF--ON positions. The switch is spring loaded from the ON position to the OFF position. In the AUTO position the right system auxiliary hydraulic pump will automatically de-energize when the pressure reaches 2900 ± 150 psi, and energize when the pressure drops to between 200 psi below this value and 2400 psi. Sufficient pressure will then be supplied to pressurize the right system although sufficient volume to operate the aft refueling pumps or possibly other equipment will be unavailable. In the ON position pressure will be fed to the units of the right system from the auxiliary pump. If the switch is held ON,

pressure should build up to approximately 3500 psi. This position should only be used at short intervals to supplement the normal system or for system checkout. In the OFF position the auxiliary pump will not operate and pressure to the right system must be from the engine-driven pumps. The auxiliary pump switch should be in the OFF position at all times during normal flight because of the method used to supply the pump. This pump is not equipped with a reservoir but draws its fluid supply from the main system return lines. Should a pressure line rupture, the engine-driven pumps would deplete the fluid in the system reservoir and the pressure lines in a short time. If the auxiliary pump switch were in the AUTO position, it would also pump all the fluid from the return lines. With the auxiliary pump inoperative, the fluid in the return lines will remain available to operate any component that can be isolated from the leaking line. Operating and control power is 28 volt DC. The operating power is protected by the RH HYD PUMP fuse on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2) and the control power is protected by the HYDRAULIC PUMP CONTROL circuit breaker on the T-R BUS NO. 2 section of the MCBP.

SYSTEM HYDRAULIC PRESSURE SWITCHES

Both hydraulic systems have a system hydraulic pressure switch (1 and 2, figure 1-38) marked ON--OFF, on the hydraulic control panel. If an engine-driven pump or an auxiliary pump is operating and the switch is ON, pressure will build up in the respective system. Placing the switch in the OFF position relieves the pressure on the system by opening the depressurizing valve. The open depressurizing valve connects the pressure line to the return line and results in a maximum flow circulation of fluid at reduced pressure (750 psi or less). Pressure is retained in the pilot's brakes by check valves and an accumulator so that depressurization of a system does not make the brakes inoperative. Pressure will also be retained in the boom accumulator, but the quantity of fluid available will not afford effective operation of the boom system. Power for the operation of the depressurizing valves is 28 volt DC protected by the HYD SYS PRESS circuit breaker on the SBCBP (figure 1-35, sheet 1).

HYDRAULIC PUMP SUPPLY SWITCHES

A guarded switch (21, figure 1-19), under each overheat warning light, controls the hydraulic supply shutoff valve for the corresponding pump. These switches have OPEN and CLOSED positions and are held in the OPEN position by the guard. In the OPEN position the pump is supplied with hydraulic fluid from the reservoir. When the guard is raised and the switch is moved to CLOSED, the fluid supply from the reservoir is cut off and the pump is isolated. The engine fire switches override these supply switches in that the supply valve cannot be opened by the pump supply switch when it is closed by the engine fire switch. Operating power is 28 volt DC protected by the four ENGINE HYDRAULIC OIL FIRE SHUTOFF circuit breakers on the SBCBP (figure 1-35, sheet 1).

CAUTION

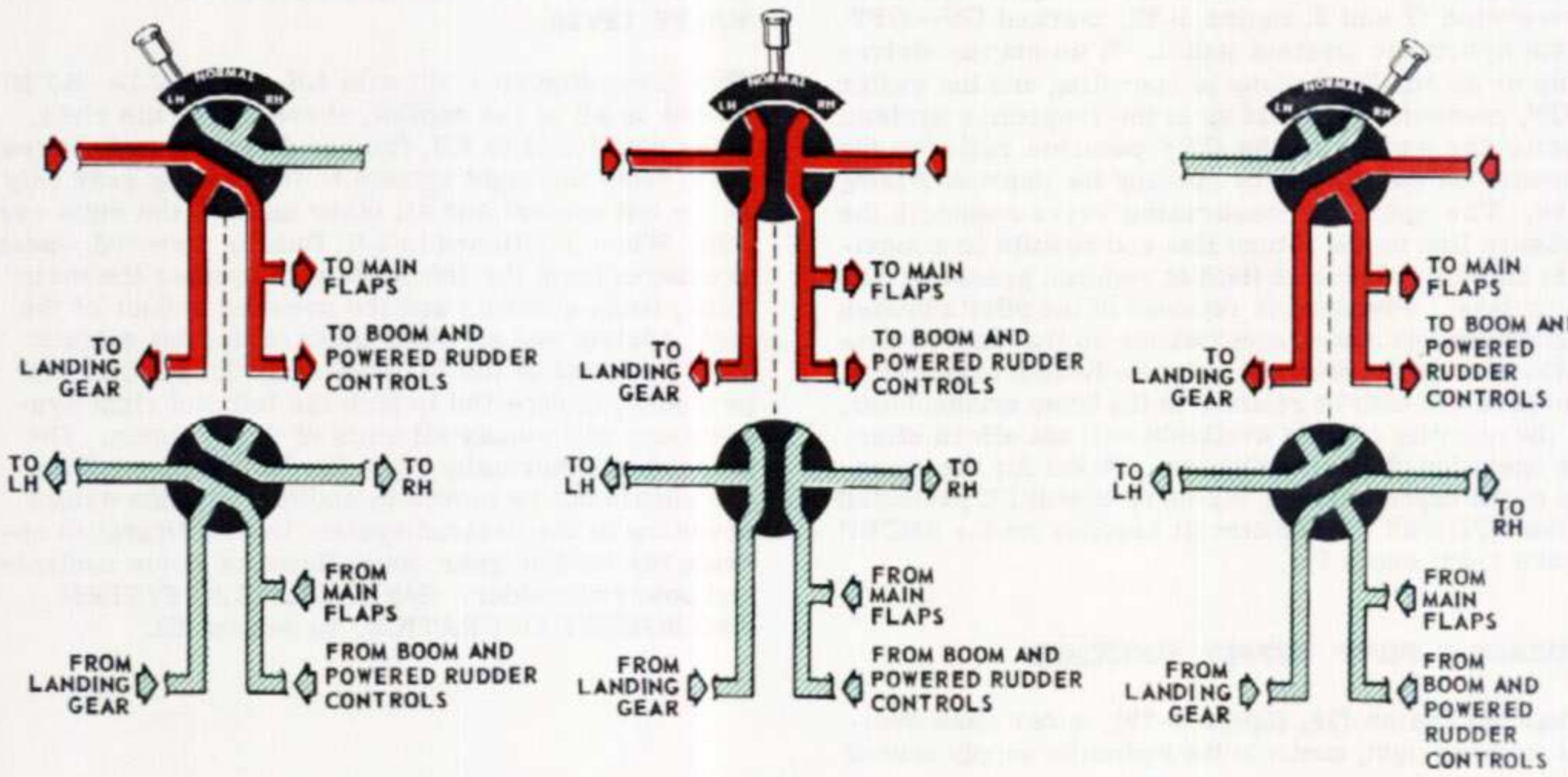
Pump isolation is an emergency operation only. Isolation of the pump for short periods (less than 5 minutes) results in wear which is cumulative and will result in premature failure of the pump. Isolation of a pump in excess of 5 minutes may result in self destruction of the unit. Enter pump isolation time in Form 781.

EMERGENCY HYDRAULIC CROSSOVER VALVE LEVER

This lever (figure 1-39) with LH--NORMAL--RH positions is aft of the copilot, above and to the right. When positioned to RH, fluid is directed, under pressure, from the right system to the landing gear only in the left system and all other units of the right system. When positioned to LH, fluid is directed, under pressure, from the left system to operate the main flaps, boom controls and the powered rudder of the right system and all other units of the left system. With the lever in the NORMAL position, fluid under pressure, is directed to both the left and right systems and will supply all units of the systems. The lever should normally be in the NORMAL position, and should not be moved to another position unless pressure to the desired system is insufficient to operate the landing gear, main flaps, or boom controls and powered rudder. See HYDRAULIC SYSTEM EMERGENCY OPERATION, in Section III.

EMERGENCY HYDRAULIC CROSSOVER VALVE





See figures 1-37, 1-43, 1-45 and 1-47

PRESSURE

RETURN

NOTE

The emergency hydraulic crossover valve is located on the keel beam in the right hand wheel well above the SPR receptacle. It is actuated by cable linkage connected to the emergency hydraulic crossover valve lever.

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Figure 1-39

HYDRAULIC SYSTEM PRESSURE GAGES

There are three gages on the hydraulic control panel. One gage (4, figure 1-38) indicates pilot's reserve brake system pressure, another (5, figure 1-38) indicates right system hydraulic pressure, and the third gage (6, figure 1-38) indicates left system hydraulic pressure. These are direct-reading air pressure gages and all three gages are read in psi. The pilot's reserve brake accumulator is preloaded to 1000 psi. Each system accumulator is preloaded to 2000 psi. These pressures will be indicated on the respective gages. This preload is based on a 70° F day and will vary with different temperatures. See figure 1-65. Under normal conditions, the gages should indicate system pressure when the systems are pressurized. If the systems are depressurized, the left and right system pressure gages will drop to preload pressure, whereas the pilot's reserve brake pressure gage indicates pressure available for braking. The latter gage remains at system pressure due to a check valve in the left hydraulic system which keeps the reserve brake accumulator fully charged when the system is depressurized. With the reserve brake accumulator fully charged, upon actuating the pilot's brakes approximately three times, the reserve brake pressure will drop to its preload pressure. Hydraulic pressure gages are also mounted on the air side of the left system accumulator, the right system accumulator, boom hydraulic accumulator, and the reserve brake accumulator. See figure 1-37. These gages have color markings which are identical to the markings on the hydraulic pressure gages on the hydraulic control panel.

HYDRAULIC OIL QUANTITY GAGE

This dual gage (17, figure 1-19), on the copilot's instrument panel, indicates the quantity of hydraulic fluid in both system reservoirs. Gage markings are from E (empty) through 5.5 gallons; however, the gage only indicates from 1 to 5.5 gallons because structural interference within the reservoir causes the transmitter float to stop at the one gallon level. Therefore, the reservoir should be considered empty when the pointer reads approximately one gallon. Operating power is 28 volt DC and circuit protection is through a circuit breaker marked HYDRAULIC OIL QUANTITY INDICATOR on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2).

NOTE

A drop of approximately one gallon will be indicated on the left system gage after landing gear retraction. This drop is normal and is accounted for by the displacement differential within the gear actuators.

HYDRAULIC PUMP INOPERATIVE LIGHTS

Four push-to-test amber lights (16, figure 1-19), on the copilot's instrument panel, indicate low pressure from the engine-driven hydraulic pumps. These lights are illuminated prior to engine start and at any time the systems are depressurized. As an engine-driven pump builds up pressure to 1200 ± 250 psi the corresponding light is extinguished. On decreasing pressure, the light illuminates at 100 psi below the build-up pressure or before the pressure drops to 700 psi. The light will remain illuminated until a pressure build-up extinguishes it. Operating power is 28 volt DC and circuit protection is through a circuit breaker marked HYD LOW PRESS WARN on the SBCBP (figure 1-35, sheet 1).

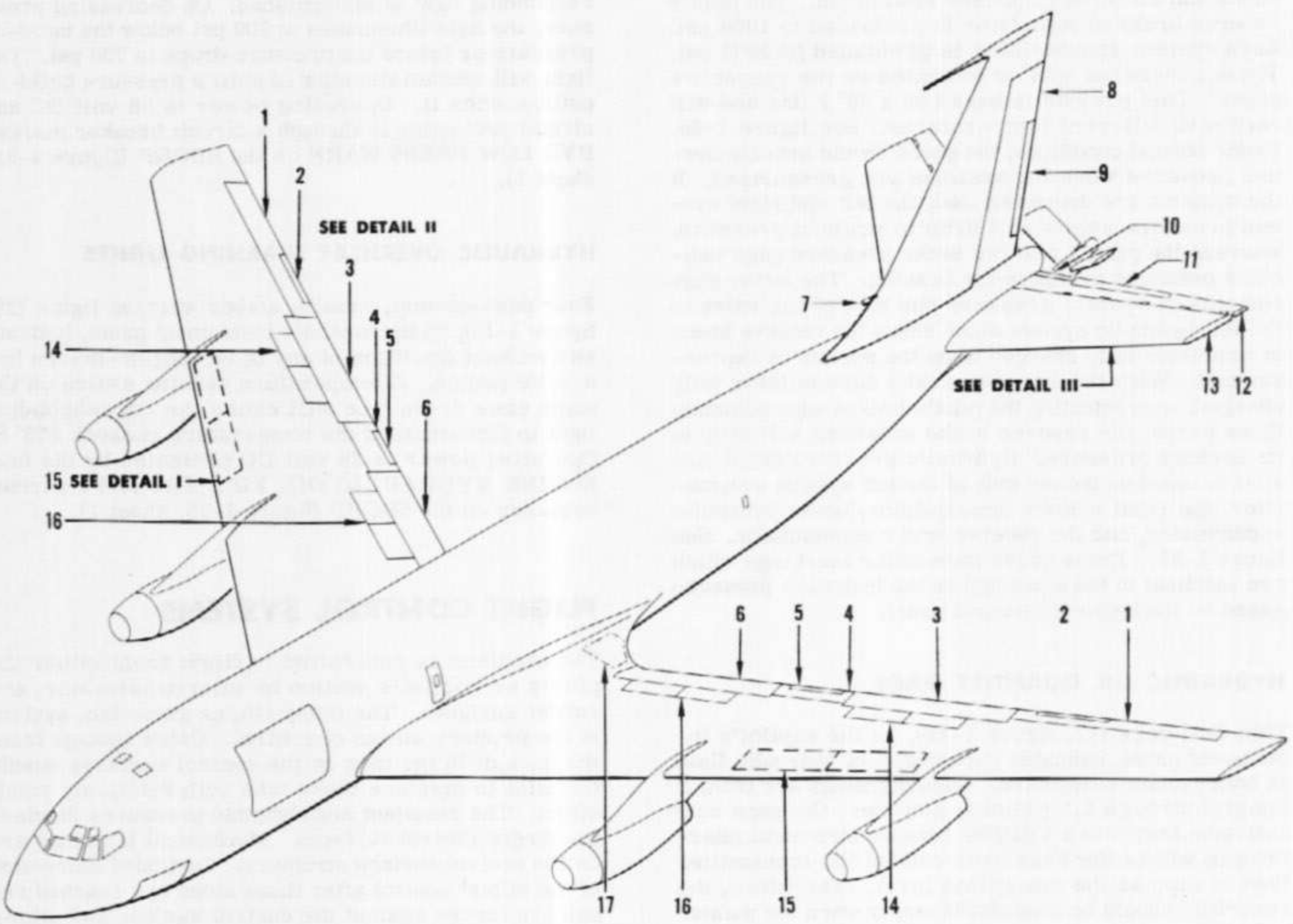
HYDRAULIC OVERHEAT WARNING LIGHTS

Four push-to-test, square, amber warning lights (22, figure 1-19), on the copilot's instrument panel, indicate an overheat condition of any of the engine-driven hydraulic pumps. A temperature sensing switch on the pump case drain line will cause the corresponding light to illuminate if the temperature exceeds 275° F. Operating power is 28 volt DC protected by the four ENGINE HYDRAULIC OIL FIRE SHUTOFF circuit breakers on the SBCBP (figure 1-35, sheet 1).

FLIGHT CONTROL SYSTEMS

The airplane is controlled in flight from either the pilot's or copilot's station by aileron, elevator, and rudder surfaces. The flying tab, or servo tab, system is the primary means of control. Cable linkage from the cockpit to the tabs on the control surfaces enable the pilot to displace these tabs with relatively small effort. The resultant aerodynamic pressures displace the larger control surfaces. Mechanical tab stops are on the control surface structure. Continued movement of the pilots' control after these stops are reached results in forces against the control surface and allows the pilot to physically position these surfaces. Additional lateral control is provided by hydraulically operated wing spoilers. These spoilers are also used as speed brakes. Longitudinal control is provided by means of elevators mounted on the adjustable horizontal stabilizer. Directional control is supplied by a hydraulically powered rudder mounted on a vertical fin. Refer to POWERED RUDDER SYSTEM in this Section. Two sets of ailerons and spoilers furnish lateral control. The inboard ailerons are used throughout the entire speed range while the outboard ailerons are locked out except during flaps down flight where they give additional control at slower

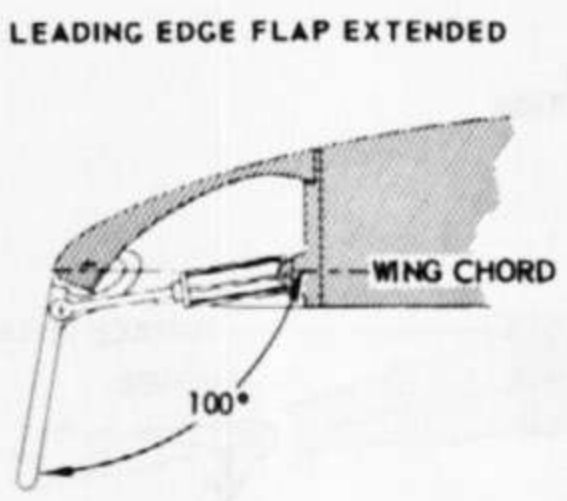
FLIGHT CONTROL SURFACES



1 OUTBOARD AILERON (3 PLACES)
2 OUTBOARD AILERON BALANCE TAB (3 PLACES)
3 OUTBOARD FLAP (3 PLACES)
4 INBOARD AILERON (3 PLACES)
5 INBOARD AILERON CONTROL TAB (2 PLACES)
6 INBOARD FLAP (3 PLACES)
7 Q-INLET
8 RUDDER
9 RUDDER CONTROL TAB
10 STABILIZER ACTUATED TAB
11 ELEVATOR CONTROL TAB
12 ELEVATOR
13 ADJUSTABLE HORIZONTAL STABILIZER
14 OUTBOARD SPOILERS (2 PLACES)
15 LEADING EDGE FLAP (2 PLACES)
16 INBOARD SPOILERS (3 PLACES)
17 FILLET FLAP
18 STABILIZER VORTEX GENERATORS
19 FOREFLAPS

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Figure 1-40 (Sheet 1 of 2)



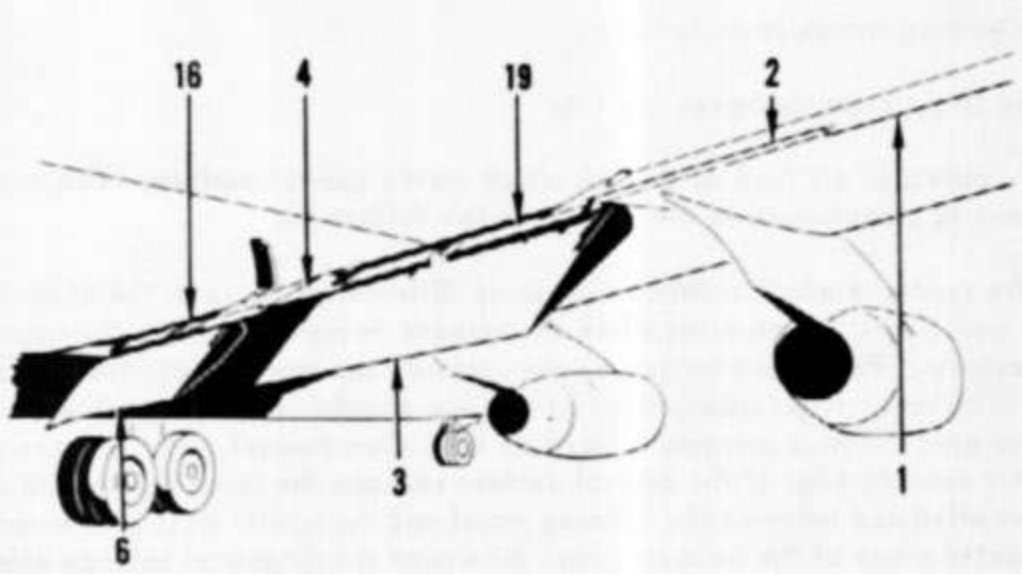
DETAIL I

F-73



DETAIL III

F-508



DETAIL II

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Figure 1-40 (Sheet 2 of 2)

speeds. Snubbers on each control surface, except the outboard ailerons, eliminate the need for ground surface locks and provide positive surface travel stops. See figure 1-40.

NOTE

- The following definition will clarify and differentiate the terms "spoilers" and "speed brakes." The structural parts are termed "spoilers." This term is applied to these surfaces when they are used in lateral control. When these surfaces are used across the wing symmetrically to increase drag and to decrease lift, they are referred to as "speed brakes" as indicated by the nomenclature on the speed brake control lever.

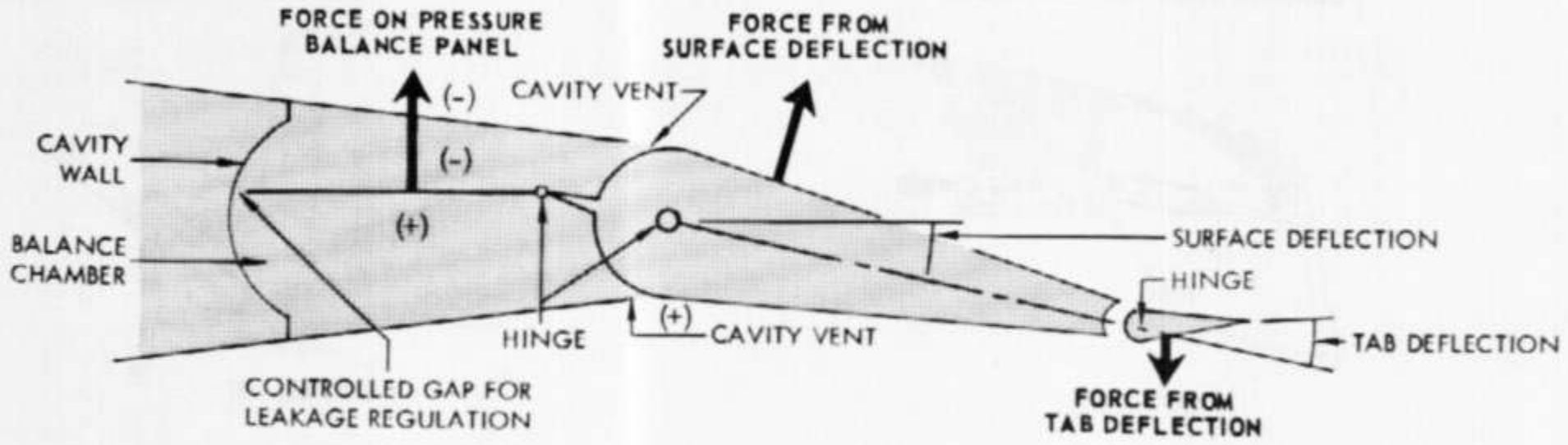
- Shear rivets or joints are installed in the flight control systems to ensure that an entire system will not be made inoperative due to jamming or seizing of one component. If an apparent jamming occurs during flight, the pilots should not hesitate to apply whatever force is necessary to restore free movement of the system and maintain control of the airplane.

PRESSURE BALANCE

Movement of the control surfaces is aided by the pressure balance panels located in the cavity ahead of the surfaces. See figure 1-41. This balancing effect is caused by the pressure differential between the upper and lower cavity vents acting upon the area of the balance plate and surface nose overhang. The difference in cavity vent pressure is a result of both control surface deflection and angle of attack and at all times acts to assist control motion. The balance panels have been factory set for proper control travel and feel characteristics.

AERODYNAMIC FORCES

(CONTROL BALANCE)



NOTE

Action of the aerodynamic forces is as follows:

1. Operation of the flight controls moves the tab.
2. Tab deflection causes an air load on the tab which moves control surface. The amount of control surface movement is proportional to the amount of tab deflection.
3. Deflection of the control surface creates a pressure differential between the opposite surfaces. (The side that moves into the air stream has an increase in pressure while the opposite side has a decrease in pressure.) Pressure changes on the surfaces are transmitted through the cavity vents into the balance chambers. High pressure air (+) in one chamber tends to push the balance panel into the low pressure area (–) thus creating a force on the balance panel. The balance panel, through its attachment to the leading edge of the control surface reduces the force required to deflect the control surface. A controlled gap between the balance panel and the cavity wall plus aerodynamic seals around the unvented areas of the balance panel determine the degree of balance effect in ratio to control surface deflection. At high angles of surface deflection when the loads are the greatest, the controlled gap is at its minimum and balance forces are at their maximum. Excessive leakage through the aerodynamic seals can reduce the balance effect to the point where abnormal control forces are required to deflect the main control surface and full control surface movement will not occur.

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Figure 1-41

AIRPLANE TRIM

Directional trim is obtained with the rudder control tab (figure 1-40). A combination of spoiler and aileron displacement is used for lateral trim. Rotating the aileron trim control wheel displaces the inboard aileron control tabs (the same tabs that are used for lateral control). Since the spoilers aid in lateral control and are operated by the ailerons, aileron movement due to trimming causes actuation of the spoilers. Lateral trimming also turns the pilots' control wheels. The horizontal stabilizer is pivoted about its aerodynamic center for purposes of pitch trim. The location of the pivot axis results in low trim screw loads during normal flight. The use of the horizontal stabilizer movement for trim is desirable because of the large speed range of the airplane. The horizontal stabilizer may be trimmed by either an electric motor drive unit actuated by the stabilizer trim control switch or manually by using the stabilizer trim control wheel.

CONTROL COLUMN AND WHEELS

The dual control columns and wheels (10, figure 1-13 and 2, figure 1-14) mechanically position the elevator and aileron tabs. Each control column wheel contains a stabilizer trim control switch, an interphone-mike switch, an RGA/AP pushbutton, and a heading slew switch (6, 8, 9, 10A, figure 1-13 and 1A, 3, 4, 5, figure 1-14).

WARNING HORN AND CUTOUT SWITCH

The warning horn (2, figure 4-9), just aft of the overhead panel, will sound if any of the following conditions exist:

A. Any gear is not down and locked when any throttle is retarded near the IDLE range.

B. Speed brake lever is pulled back more than 2 degrees while the airplane is on the ground and No. 3 throttle is advanced near full OPEN.

C. The No. 3 throttle is advanced near OPEN while the airplane is on the ground and the flap control lever is positioned at or near the 0, 40 or 50 degree detents. (Warning horn sounds when the flap control lever is forward of the 5 ± 3 degree position or aft of the 35 ± 3 degree position.)

D. The No. 3 throttle is advanced near OPEN while the airplane is on the ground and the outboard leading edge flaps are not fully extended.

A warning horn cutout switch (11, figure 1-22) on the control stand is available to the pilot or copilot. If the warning horn is sounding due to landing gear conditions, the horn can be silenced if either the pilot or copilot pulls the warning horn cutout switch. Any movement of the throttles near the IDLE range will re-energize the circuit and the horn will again sound. The warning horn will not be silenced by use of the cutout switch due to a flap or speed brake condition. Operating power is 28 volt DC through a circuit breaker marked WARNING HORN on the SBCBP (figure 1-35, sheet 1).

NOTE

On airplanes 1▶14, the warning horn will sound when the battery power switch is placed in EMERGENCY, the throttle is less than one-third open, and no external power is connected. Actuating the warning horn cutout switch will silence the horn until the throttle is moved.

HYDRAULIC SNUBBERS AND DAMPERS

There are no internal or external surface locks for the flight controls. To prevent damage to the control surfaces due to gusts, hydraulic snubbers or dampers are provided for each primary surface except the outboard ailerons. A snubber or damper is a unit which provides progressively increasing resistance to surface travel by means of a piston actuated mechanism. They prevent damage to the flight controls from gusts up to 65 knots even with the gust from directly behind the airplane. If gusts in excess of 65 knots are expected, the airplane should be positioned into the wind.

CAUTION

- Snubbers are installed on the inboard ailerons only in the lateral control system. To protect this control system from wind damage, the flaps should be retracted to lock out the outboard aileron whenever the airplane may be subjected to gusts of 35 knots or more.

- Snubbers will not protect the surfaces if the cockpit controls are restricted. Restraint of the control column or rudder pedals can result in damage to the control cables and linkages.

AILERON CONTROL SYSTEM

Each wing has two ailerons and four spoilers for lateral control of the airplane. The inboard ailerons (4, figure 1-40) are control tab operated and in turn operate the outboard ailerons through interconnecting cables and linkages. Servo tabs on the outboard ailerons act as additional aerodynamic balances to reduce control force requirements. Additional lateral control is provided by the use of hydraulically operated spoilers. Refer to SPOILER AND SPEED BRAKE SYSTEM in this Section. Rotation of the control wheel mechanically operates the control tabs and actuates the spoiler control valve to permit coordinated control of both components. With the flaps in the up position, the outboard ailerons are mechanically locked out of the control system and remain fixed in the neutral position. The outboard ailerons become effective as the flaps are extended and are fully effective with the flaps extended to 23 degrees or beyond. Control feel is provided by tab air-loading and control tab centering springs. Maximum control wheel travel for aileron control is approximately 108 degrees right or left from neutral. When engaged, the autopilot assumes lateral control through a servo motor connected to the aileron control system. A slip clutch allows the pilot to manually overpower the autopilot. Refer to AUTOPILOT SYSTEM in Section IV.

Aileron Trim Control Wheel And Indicator

An aileron trim control wheel and indicator (12, figure 1-22) are on the control stand. The trim control wheel is connected by cables to an aileron trim actuator for each inboard aileron control tab. Rotating the trim wheel drives the aileron tabs and spoilers through a spring cartridge in each aileron trim actuator. These spring cartridges can absorb as much as 12 units of trim wheel rotation before the aileron tabs begin to move, due to friction in the lateral control system. The airplane is trimmed laterally with the aileron control wheel and the force on the control wheel is relieved by rotating the aileron trim wheel.

Displacement of the aileron control system also causes the pilot's and copilot's control wheels to rotate to a new neutral position. A pointer, which is a component of the trim control wheel, is moved mechanically to indicate the amount of trim applied. There are 20 units of left and 20 units of right aileron trim available. The trim setting required to maintain straight and level flight at zero bank angle and zero rate of turn is between 2 units left and 2 units right. The setting will be in this area provided: (1) the airplane is flying at normal cruise conditions, (2) the rudder is properly trimmed (no turn indicated on directional indicators), (3) the lateral fuel weight is equalized, (4) all engines are operating at the same EPR (thrust) and fuel flow rate and (5) correct aileron trim procedures have been used.

NOTE

Lateral trim is accomplished by holding the desired trim with the control wheel and then relieving the control wheel force by rotating the aileron trim wheel. Otherwise, additional trim units are required to overcome friction in the lateral control system before the tabs will move.

POWERED RUDDER SYSTEM

A hydraulically powered rudder provides directional control of the airplane. The rudder can also be controlled manually through the operation of a control tab on the rudder trailing edge as shown in figure 1-43. The pilot's and copilot's rudder pedals control the rudder. With rudder power on, deflection of the pilots' rudder pedals (figure 1-43) deflects an input crank which positions a valve in the hydraulic power control unit. Hydraulic pressure then moves the power control unit which is attached to the rudder causing the rudder to deflect. Movement of the input crank also moves the control tab which aerodynamically assists rudder movement. When the rudder passes 17 degrees of travel a tab link arm in the rudder contacts a stop and reverses the tab movement. The tab then acts as a rudder antibalance tab. One rudder damper and two tab dampers restrict vibration and flutter. The hydraulic dampers offer little or no resistance to slow movement; however, they offer a high resistance to rapid or high frequency motion. When engaged, the autopilot assumes directional control through a servomotor connected to the rudder system. A slip clutch allows the pilot to overpower the autopilot. When hydraulic power is off, movement of the pilots' rudder pedals actuates the control tab which positions the rudder by aerodynamic forces as described in figure 1-41; however, rudder travel is restricted to approximately 12 degrees right or left when in this manual mode.

The rudder Q-spring (dynamic pressure sensor) assembly provides the pilot with an artificially produced sense of feel at rudder deflections greater than 17 degrees. The control tab provides these forces for rudder deflections of less than 17 degrees. The feel force introduced into the rudder control system by the Q-spring is proportional to the airplane airspeed and rudder deflection. Ram air from the fin leading edge is vented to a bellows which produces a force that is mechanically transmitted to the rudder control linkage. A Q-spring lockout assembly is mounted just below the bellows. The lockout assembly contains springs that are held compressed by hydraulic pressure. When the hydraulic system is depressurized, the springs hold the Q-spring assembly in a fixed position. Holding the Q-rod stationary provides a pivot that allows the control tab to be positioned manually. Aerodynamic forces caused by a change in position of the control tab will then deflect the rudder. The Q-inlet (ram air intake) contains an electrically operated heater to prevent icing of the intake. A warning light and a switch to control heater operation are on the pilots' center instrument panel. The warning light will be on when the switch is in the ON position and the heater is inoperative.

Rudder Hydraulic Pressure Control

Hydraulic power to operate the rudder system is received from the right hydraulic pressure supply system. A pressure reducer and pressure control valve reduce rudder sensitivity by reducing hydraulic system pressure from high range (2800 to 3050 psi) to low range (800 to 1175 psi). The control valve is actuated by a switch that is actuated by the inboard wing flaps. High range hydraulic pressure is selected to provide necessary rudder deflection whenever the inboard wing flaps are extended more than 5 degrees. With the inboard wing flaps retracted above 5 degrees, low range hydraulic pressure is selected to limit rudder deflections and eliminate the possiblity of damage to the vertical fin from large control inputs.

CAUTION

The rudder pressure control valve is a solenoid actuated valve and is electrically energized to the closed position for low range hydraulic pressure. When operating in low range and the RUDDER PRESS CONT circuit breaker is opened (tripped) or electrical power is lost, the rudder pressure control valve will open and increase rudder system pressure to the high range.

POWERED RUDDER SYSTEM COMPONENTS

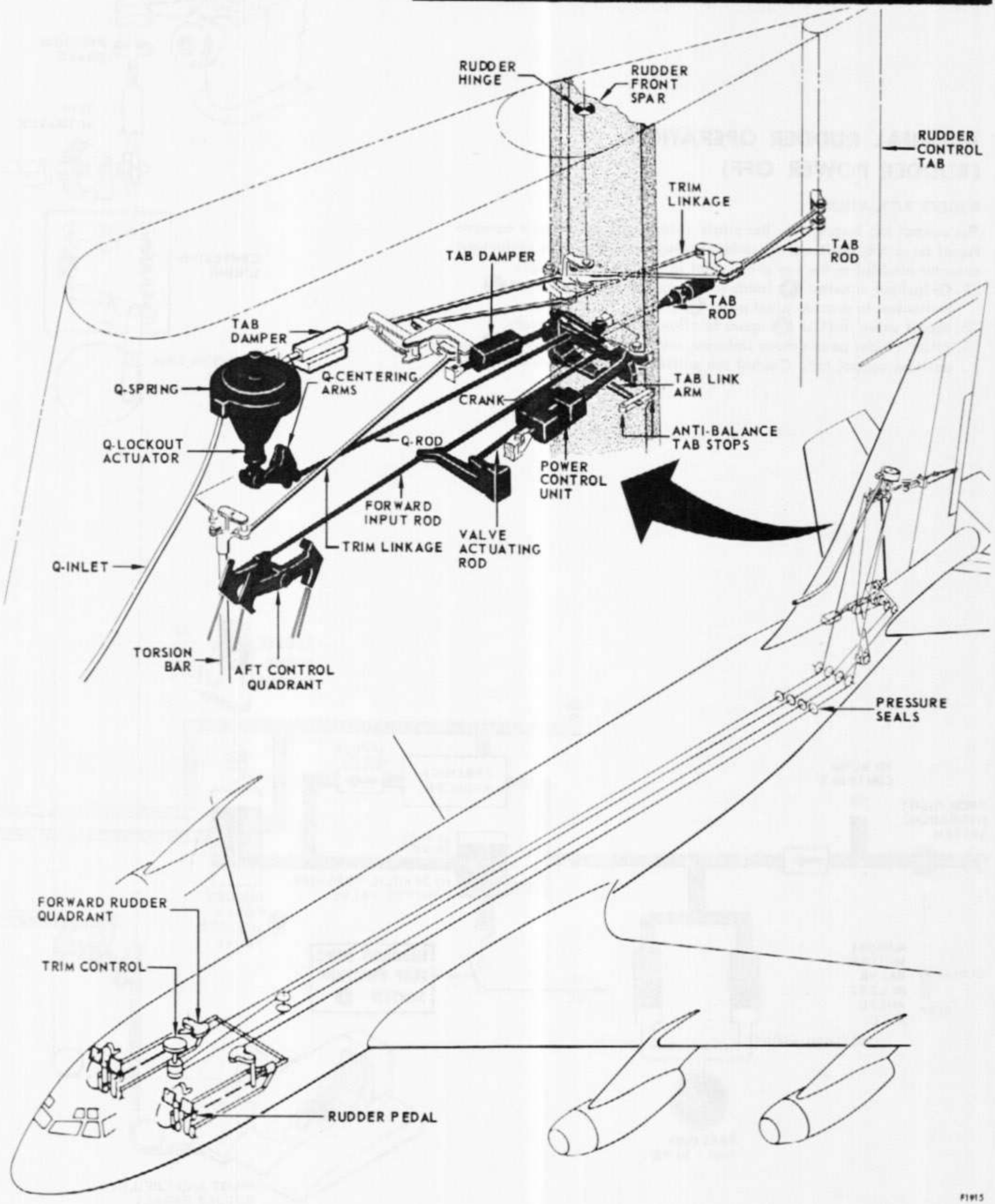


Figure 1-42

POWERED RUDDER SYSTEM

MANUAL RUDDER OPERATION (RUDDER POWER OFF)

RUDDER ACTUATION

The control tab is moved by the pilots' pedals and, acting as a conventional servo tab, positions the rudder aerodynamically. The Q-lockout actuator establishes the key pivot point in the control linkage.

1. Q-lockout actuator Ⓐ holds centering arm Ⓑ and Q-rod Ⓒ motionless to provide pivot point Ⓓ.
2. Bypass valve in PCU Ⓔ opens to allow PCU to move freely.
3. Pilots' rudder pedals move linkages, and crank around pivot Ⓓ to position control tab. Control tab positions rudder aerodynamically.

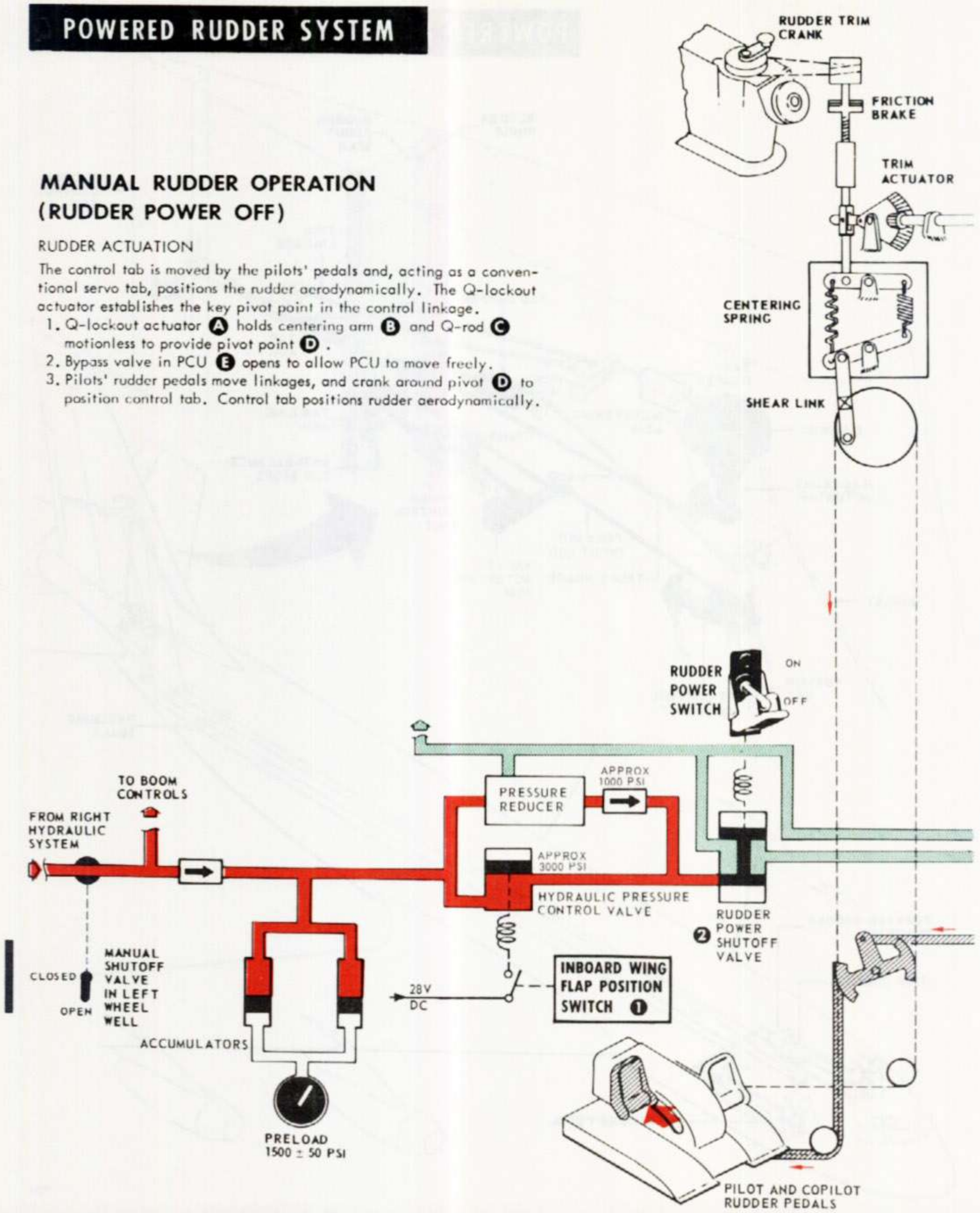
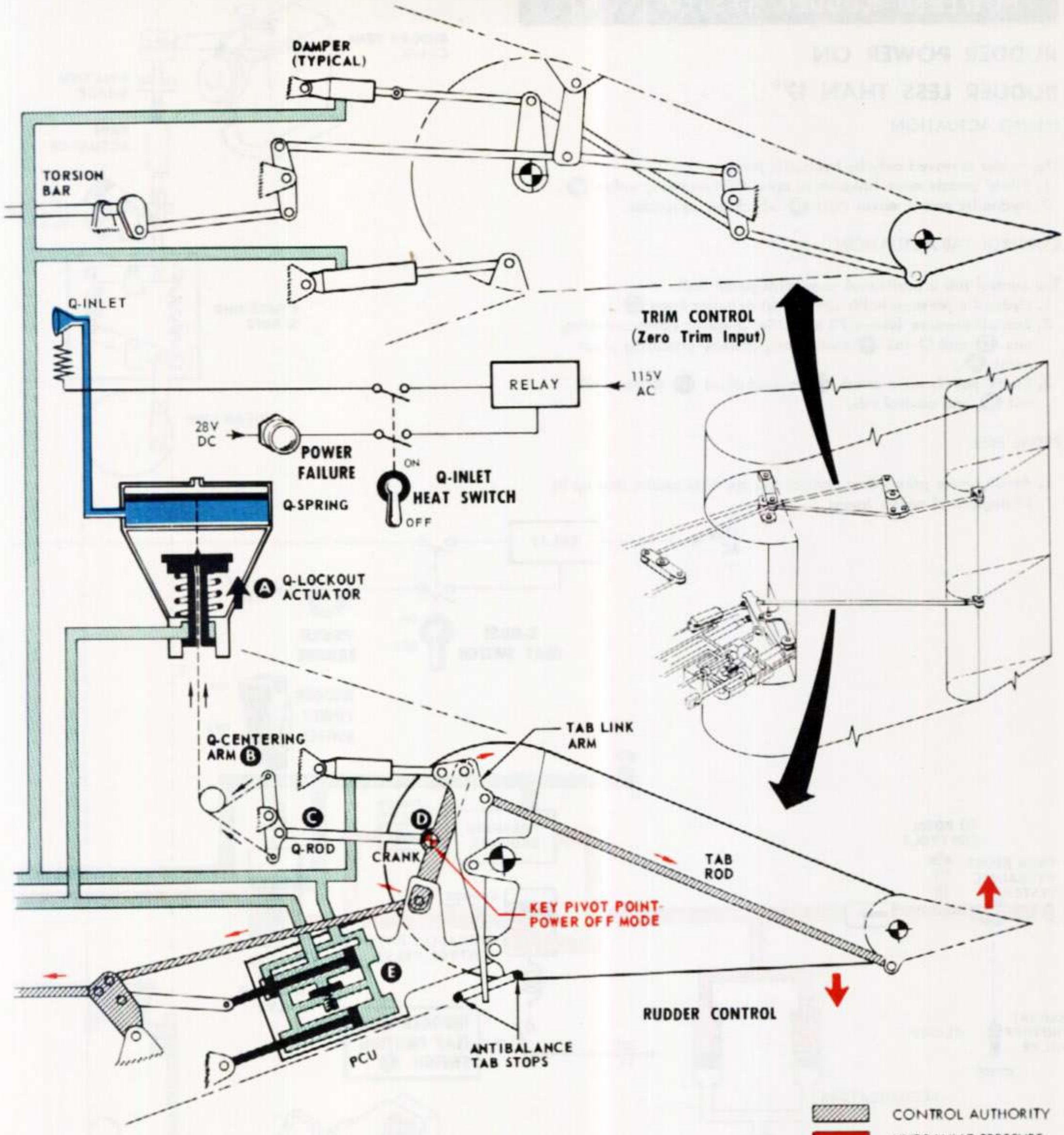


Figure 1-43 (Sheet 1 of 6)



❶ Switch opens when inboard main wing flaps are extended 5 degrees.

❷ Valve spring-loaded to rudder power ON, electrically energized to rudder power OFF.

Figure 1-43 (Sheet 2 of 6)

POWERED RUDDER SYSTEM (CONT)

RUDDER POWER ON

RUDDER LESS THAN 17°

RUDDER ACTUATION

The rudder is moved only by hydraulic power.

1. Pilots' pedals move linkages to open PCU metering valve (A).
2. Hydraulic power moves PCU (B) which moves rudder.

CONTROL TAB ACTUATION

The control tab is positioned to provide pedal feel.

1. Hydraulic pressure holds Q-lockout actuator open (C).
2. Ram air pressure (above 70 KIAS) in Q-spring holds centering arm (D) and Q-rod (E) motionless, thereby providing pivot point (F).
3. Pilots' pedals move crank (G) around pivot (F) to move tab rod (H) and control tab.

PEDAL FEEL

1. Aerodynamic pressure on control tab provides rudder feel up to 17 degrees of rudder travel.

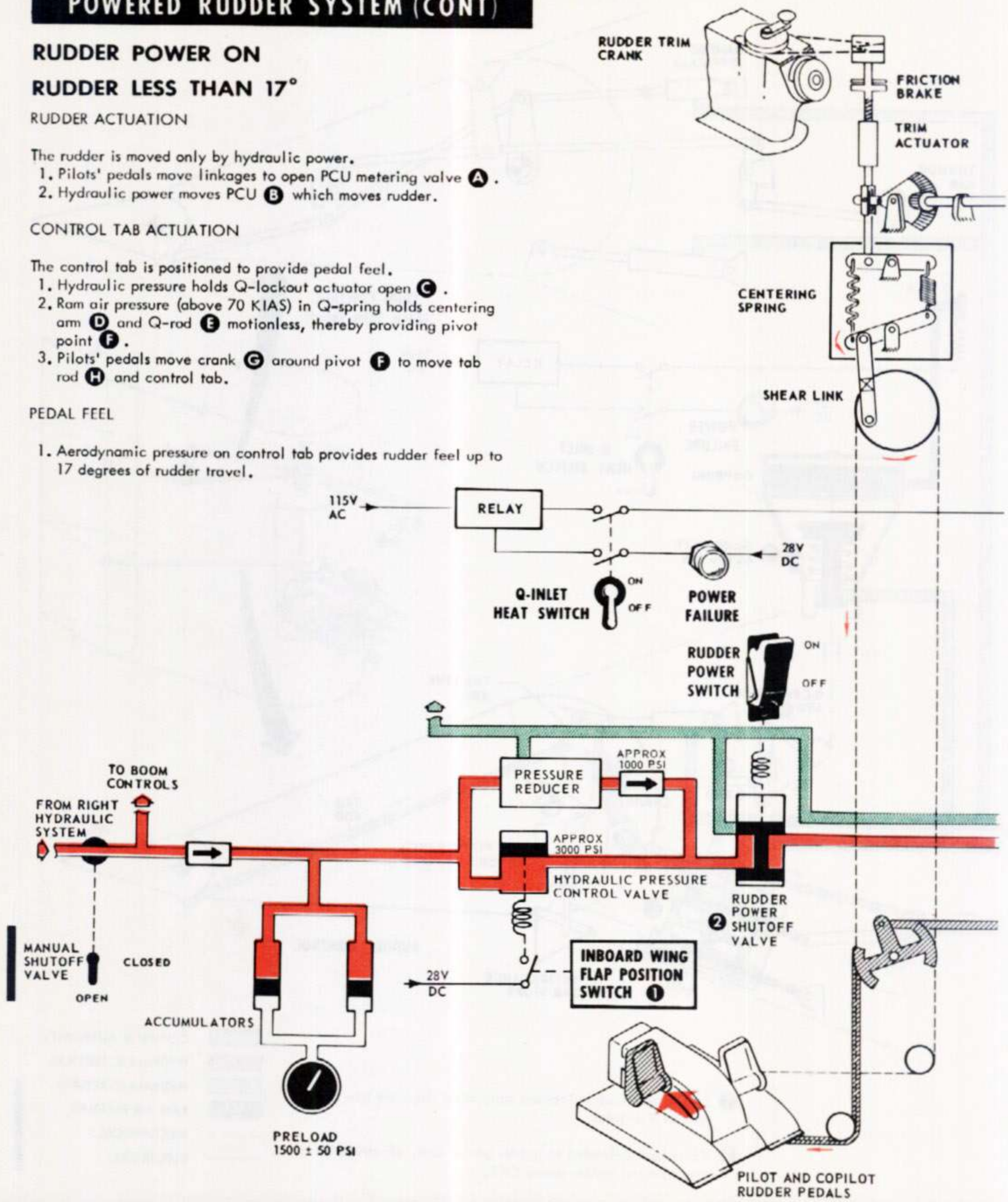
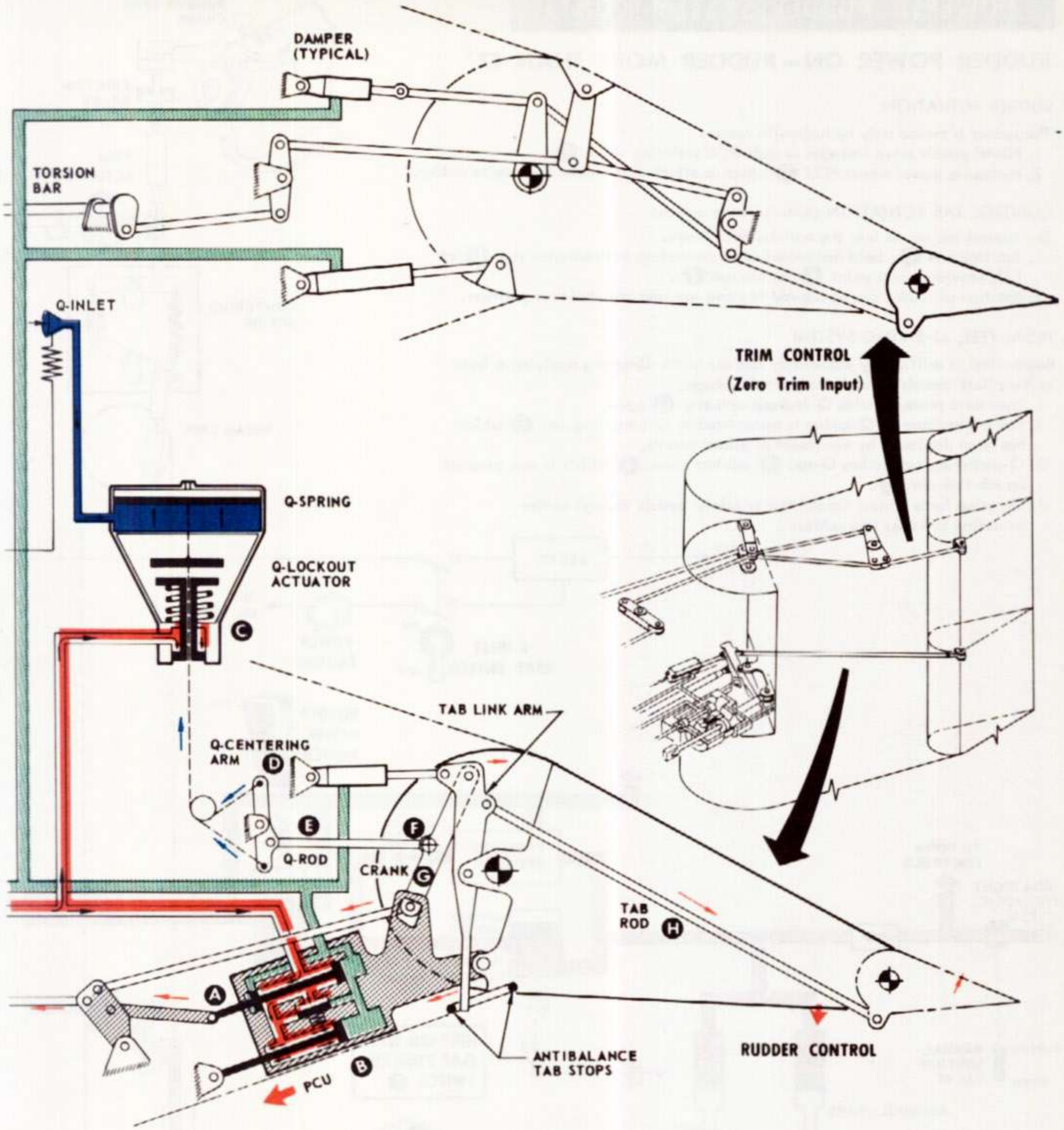


Figure 1-43 (Sheet 3 of 6)



❶ Switch opens when inboard main wing flaps are extended 5 degrees.

❷ Valve spring-loaded to rudder power ON, electrically energized to rudder power OFF.

Figure 1-43 (Sheet 4 of 6)

POWERED RUDDER SYSTEM (CONT)

RUDDER POWER ON—RUDDER MORE THAN 17°

RUDDER ACTUATION

The rudder is moved only by hydraulic power.

1. Pilots' pedals move linkages to open PCU metering valve Ⓐ.
2. Hydraulic power moves PCU Ⓑ which is attached to rudder and moves rudder.

CONTROL TAB ACTUATION (Anti-balance action)

The control tab moves into the anti-balance mode.

1. Tab link arm Ⓒ, held motionless after contacting anti-balance stop Ⓓ at 17°, provides pivot point Ⓔ for tab rod Ⓕ.
2. Rotation of rudder causes tab rod to move tab into anti-balance position.

PEDAL FEEL, Q-SPRING SYSTEM

Rudder feel is artificially induced by ram air in the Q-spring applying a force to the pilots' pedals through the control linkage.

1. Hydraulic pressure holds Q-lockout actuator Ⓖ open.
2. Ram air pressure in Q-spring is transmitted to Q-centering arm Ⓗ which has been displaced by movement of pilots' pedals.
3. Q-centering arm pushes Q-rod Ⓘ against crank Ⓙ which is now pivoted on tab link arm Ⓒ.
4. Q-spring force is now transmitted to pilots' pedals through rudder actuating linkages and cables.

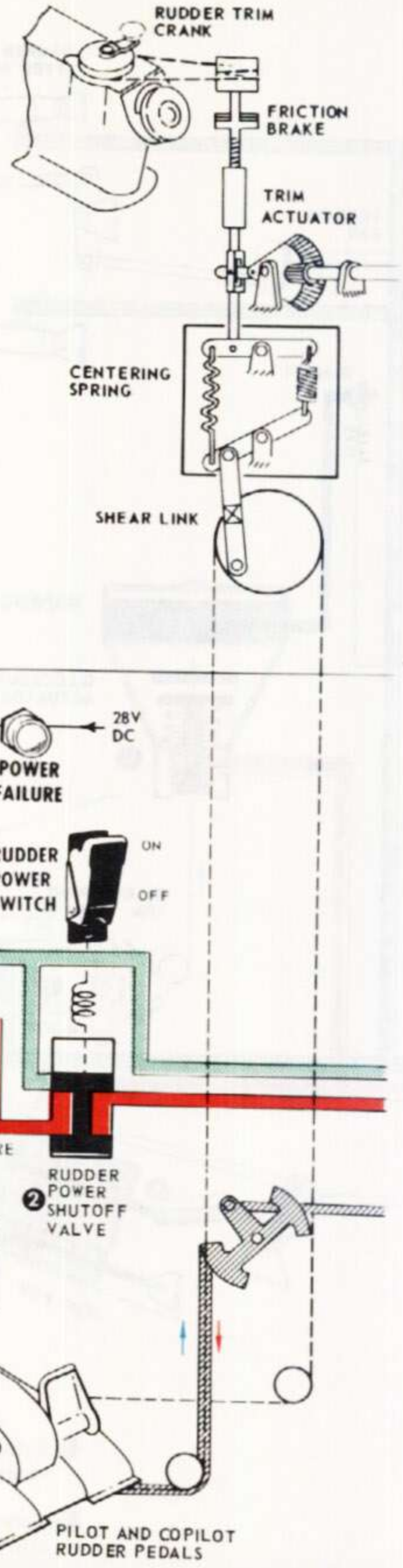
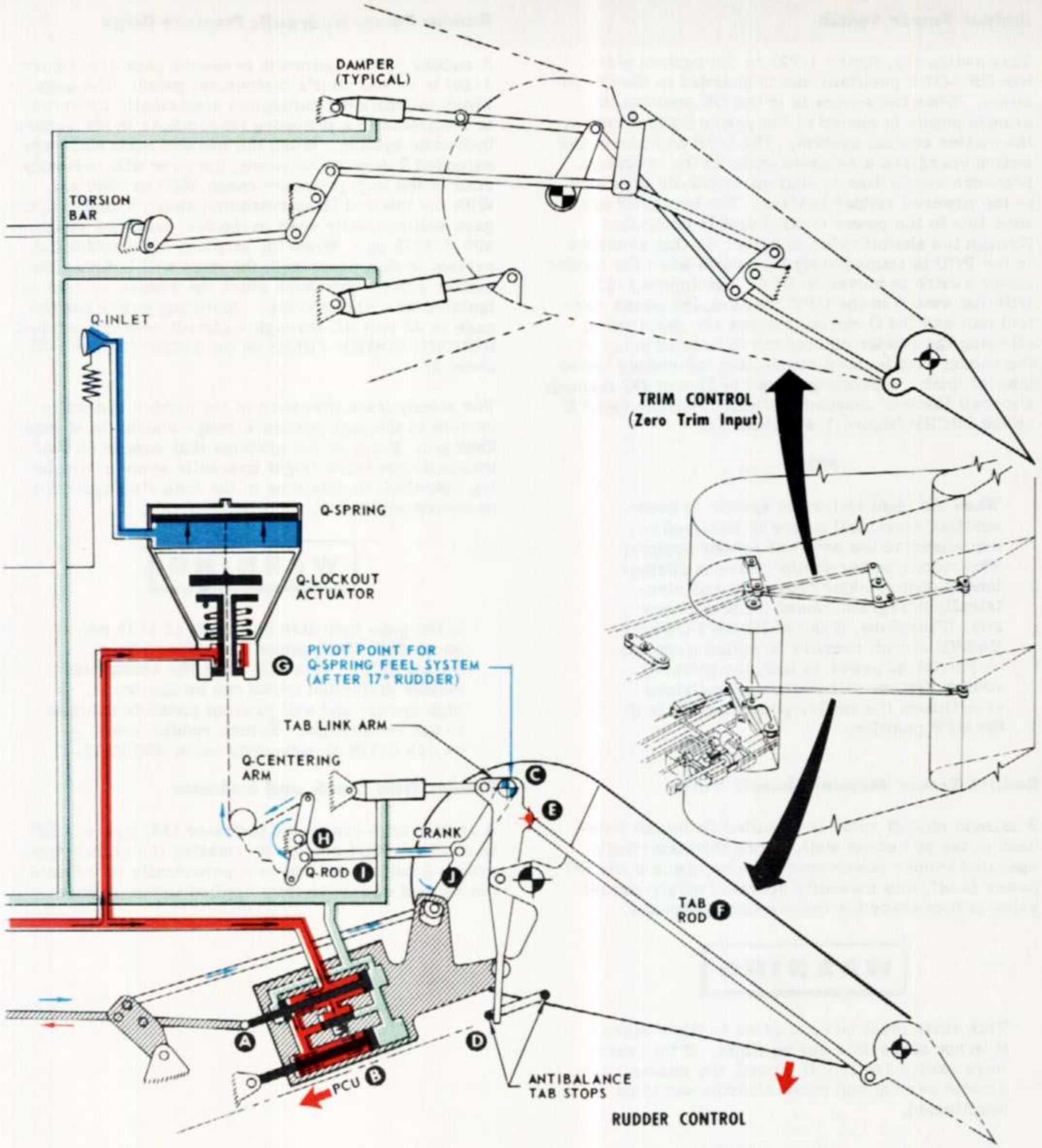


Figure 1-43 (Sheet 5 of 6)



1 Switch opens when inboard main wing flaps are extended 5 degrees.

2 Valve spring-loaded to rudder power ON, electrically energized to rudder power OFF.

Figure 3 (Sheet 6 of 6)

Rudder Power Switch

This switch (16, figure 1-22) on the control stand, has ON--OFF positions and is guarded to the ON position. When the switch is in the ON position, hydraulic power is routed to the power control unit in the rudder control system. The OFF position of the switch energizes a solenoid valve in the hydraulic pressure supply line to shut off hydraulic pressure to the powered rudder system. The hydraulic pressure line to the power control unit is connected through the shutoff valve to return so that pressure in the PCU is immediately bled down when the rudder power switch is moved to OFF. See figure 1-43. With the switch in the OFF position, the power control unit and the Q-spring lockout are deactivated allowing the rudder control tab to be positioned by the rudder pedals, thus controlling the rudder in the manual mode. Operating power is 28 volt DC through a circuit breaker marked RUDDER POWER VALVE on the SBCBP (figure 1-35, sheet 1).

NOTE

When the right hydraulic system is pressurized, electrical power is required to depressurize the powered rudder system. The rudder power shutoff valve is spring-loaded open (rudder power on) and electrically energized closed (rudder power off). Therefore, if the RUDDER POWER VALVE circuit breaker is pulled (tripped) or electrical power is lost, the powered rudder system will remain pressurized even though the rudder power switch is in the OFF position.

Rudder Power Manual Shutoff Valve

A manual shutoff valve is installed on the aft bulkhead in the left wheel well. Since the electrically operated rudder power shutoff valve opens if the DC power is off, this manually operated safety shutoff valve is necessary for maintenance purposes.

WARNING

This valve must be open prior to flight since it is not accessible during flight. If this valve were inadvertently left closed, the rudder hydraulic system and boom controls would be deactivated.

Rudder Power Hydraulic Pressure Gage

A rudder power hydraulic pressure gage (19, figure 1-18) is on the pilot's instrument panel. The gage, which is indirect reading and electrically operated, is connected to a pressure transmitter in the rudder hydraulic system. When the inboard main flaps are extended 5 degrees or more, the gage will normally read in the high pressure range,2800 to 3050 psi. With the inboard flaps retracted above 5 degrees, the gage will normally read in the low pressure range, 800 to 1175 psi. When the airplane right hydraulic system is depressurized, the gage will indicate the rudder system pressure since the rudder system is isolated by a check valve. Operating power for the gage is 28 volt AC through a circuit breaker marked RUDDER POWER PRESS on the MCBP (figure 1-35, sheet 3).

The steady state pressure of the rudder hydraulic system in the high pressure range should be at least 2800 psi. If any of the systems that depend on that hydraulic pressure (right hydraulic system) are being operated, fluctuations in the indicated hydraulic pressure will occur.

WARNING

If the gage indicates in excess of 1175 psi above 260 KIAS, place the rudder power switch OFF. This will limit the amount of rudder deflection which can be applied at high speeds and will prevent possible damage to the vertical fin. Return rudder power switch to ON at airspeeds below 250 KIAS.

Rudder Trim Crank and Indicator

A rudder trim crank and indicator (13, figure 1-22) is on the control stand. By rotating the rudder trim crank, a pointer will move mechanically to indicate the amount of rudder trim applied to the surface.

The trim crank is connected by a cable system to the rudder trim actuator in the vertical fin. The actuator positions the rudder control tab (and the power control unit through the tab linkage) to provide directional trim. See figure 1-43. In flight when the rudder hydraulic system is either pressurized or unpressurized, moving the rudder trim crank will move the rudder pedals proportionally. On the ground when the rudder hydraulic system is pressurized, there is no dynamic air pressure applied to the Q-spring to fix the control linkage pivot point. Cranking in rudder trim will then result in lost motion through the Q-spring linkage and less movement of the rudder pedals. When the rudder hydraulic system is depressurized on the ground, the Q-lockout actuator will relax and fix the linkage pivot point. Cranking in trim will now result in proportional movement of the pedals. The forces required to crank in rudder trim should be approximately the same for left and right trim but will normally be higher when returning trim to neutral. There are 10 units of left and 10 units of right rudder trim available; however, only 5 units are required for system checkout on the ground since this provides full tab travel. The trim setting to maintain straight and level flight at zero bank angle angle and zero rate of turn is between 1.5 units left and 1.5 units right. The setting will be within this area provided: (1) the airplane is flying at normal cruise conditions, (2) the ailerons are trimmed for straight and level flight, (3) the lateral fuel weight is equalized, and (4) all engines are operating at the same EPR and fuel rate. If rudder trim is between 1.5 and 3 units for several flights or more than 3 units for a single flight, the factors affecting airplane trim should be investigated.

Rudder Control Tab Dampers

Two rudder control tab dampers restrict vibration and flutter of the tabs. One damper is attached to the rudder control linkage and the other to the trim control linkage. The dampers offer little or no resistance to slow movement of the control tab; however, they offer a high resistance to rapid or high frequency motion. An oil reservoir in each damper is connected to the hydraulic system return line. See figure 1-43.

Rudder Pedals

The rudder pedals (13, figure 1-13) are conventional in appearance and operation. The pedals are hinged for toe operation of the hydraulic brakes. Fore and aft adjustment of the pedals is accomplished by rotation of a crank attached to the lower side of the flight instrument panel forward of both the pilot's and copilot's seats.

Rudder Pedal Adjustment Cranks And Indicators

Rudder pedal adjustment is provided for the pilot and copilot. A pilot's rudder pedal adjustment crank (12, figure 1-13) and rudder pedal adjustment indicator (14, figure 1-13) are near his rudder pedals. The copilot's rudder pedal adjustment crank (17, figure 1-14) and rudder pedal adjustment indicator (16, figure 1-14) are at the copilot's station. The pilot or copilot may adjust his pedals fore and aft by turning the rudder pedal adjustment crank in the desired direction. By rotating the crank clockwise the rudder pedal distance may be lengthened or by turning the crank counterclockwise the distance may be shortened.

ELEVATOR SYSTEM

Pitch control of the airplane is provided by the elevator system. The elevators (12, figure 1-40) are control tab-operated floating surfaces. The control tabs are cable operated from the pilots' control columns. Fore and aft pressure applied to the control column is transmitted to the elevator control tab which in turn aerodynamically positions the elevators. Elevator control force feel is obtained by air loads on the control tab and a centering spring. The airplane has a stabilizer actuated tab linkage which provides anti-balance tab action with up elevator motion when the stabilizer setting is in the normal cruise range. This tab action reduces the tendency for the elevator stick force to lighten at the higher elevator deflections. This linkage also affects the up elevator travel during ground check when the stabilizer is between 1/2 degree leading edge up to 9 degrees leading edge down. Therefore, it is necessary to position the stabilizer 9 to 14 degrees leading edge down (6 to 11 units airplane nose up trim)

to make a ground check of elevator travel. Elevator trimming is not provided since trimming is accomplished by positioning the adjustable horizontal stabilizer. For information concerning pitch trim, see STABILIZER TRIM SYSTEM, this Section. When engaged, the autopilot assumes pitch control through a servo motor connected to the elevator system. A slip clutch allows the pilot to manually overpower the autopilot. Refer to AUTOPILOT SYSTEM in Section IV.

CONTROL COLUMN DAMPER

A hydraulic control column damper is installed to control pitch axis damping for autopilot operation.

NOTE

- If the damper becomes clogged, an additional force on the control column of 25 pounds opens an internal relief valve to allow motion.
- If the damper should become jammed, an additional force on the control column of 100 to 160 pounds breaks a shear link and essentially removes the damper from the system.

STABILIZER TRIM SYSTEM

Longitudinal, or pitch, trim adjustments are made by varying the angle of incidence of the horizontal stabilizer. This method of trimming gives the wide range of control required to compensate for large variations in airspeed, cg location and drag due to gear and flap position. The angle of incidence is changed by rotating the horizontal stabilizer with a jackscrew. See figure 1-44. The horizontal stabilizer may be electrically controlled by the pilot or copilot and manually controlled by the pilot. The maximum available trim to the stabilizer with either method of operation is 3.5 units of airplane nose-down and 11 units of airplane nose-up. During normal operation, the stabilizer trim range will run between approximately 2.6 units airplane nose-down and 6.6 units airplane nose-up. For methods of relieving elevator control forces in the event that stabilizer trim is inoperable, see STABILIZER TRIM EMERGENCY OPERATION, Section III.

Stabilizer Trim Indicator

This indicator (5, figure 1-22 and figure 6-6) on the right side of the control stand, shows stabilizer position in trim units which are approximately equal to degrees of stabilizer travel. Each unit represents approximately 9 revolutions of the wheel. When the trim indicator reads zero the stabilizer angle of incidence is minus three degrees. A light is installed to improve indicator visibility. The external stabilizer position markings are not correlated to the trim indicator. However, these markings will assist ground personnel in reporting the position and movement of the stabilizer leading edge to the flight crew during checkouts. For specific trim settings see the Appendix, T.O. 1C-135(K)A-1-1.

Manual Stabilizer Trim

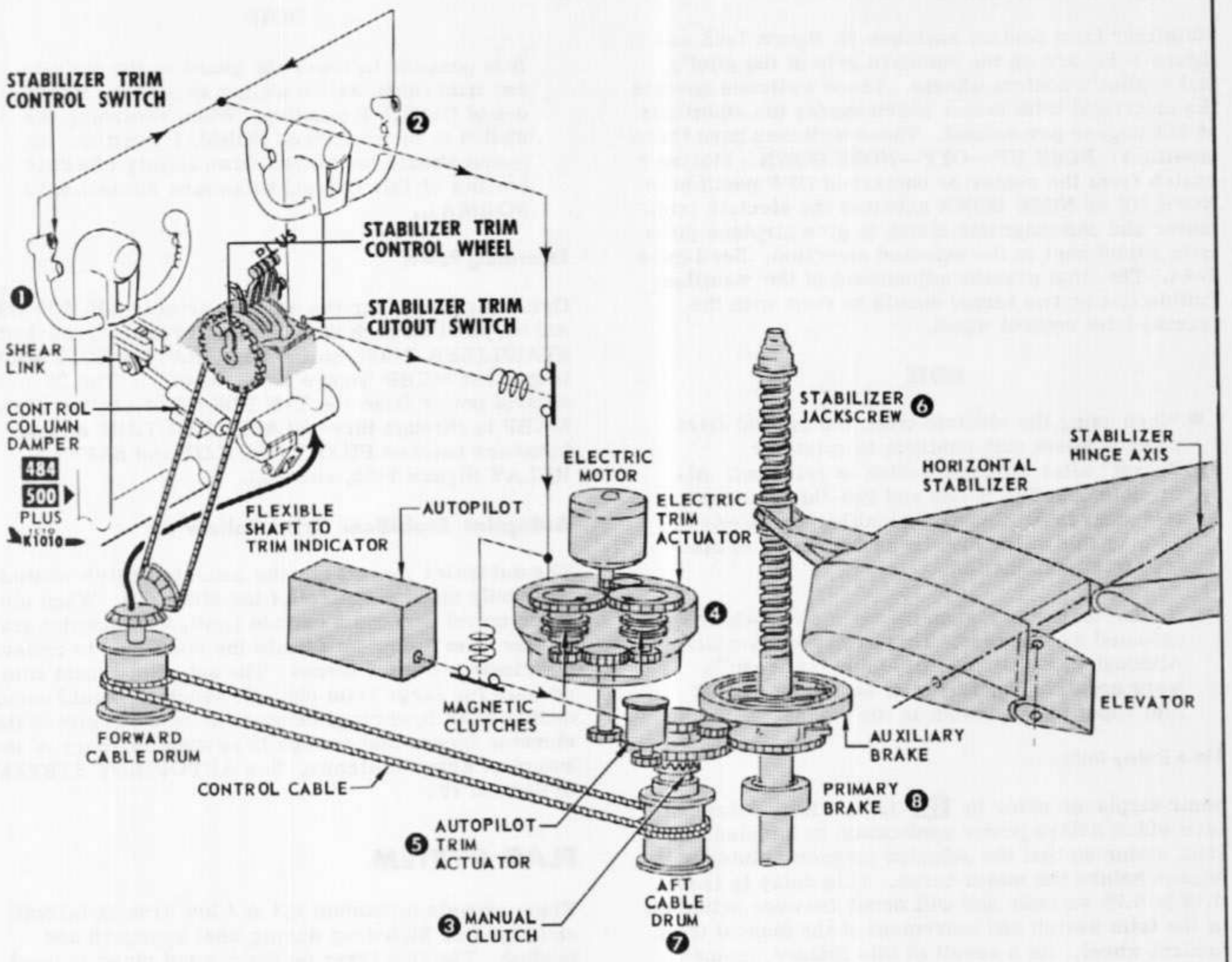
Stabilizer Trim Control Wheel

This wheel (15, figure 1-22) on the left side of the control stand, is connected by cables to the stabilizer jackscrew assembly. See figure 1-44. This wheel will rotate during all trim operations. Full travel of the stabilizer requires approximately 135 revolutions. A force of 16 pounds is required to overcome friction of the gear trains during normal manual operation. In the event that either the electric or autopilot drive malfunctions, a force of 20 to 30 pounds on the trim wheel will disengage the manual clutch and allow the airplane to be trimmed manually. See figure 1-44. The ratcheting of the clutch and the force required to make this disengagement are easily recognizable. Stopping the trim wheel by hand during electric or autopilot operation will also disengage this clutch and thus override the electrical and autopilot trim action.

NOTE

The operation of the stabilizer manual trim during preflight will acquaint pilots with the forces necessary to operate this system. Any abnormal feeling of roughness or binding is sufficient justification for investigation of the trim system.

STABILIZER TRIM SYSTEM



❶ When actuated, trim switch energizes motor and one magnetic clutch. The direction of stabilizer travel depends upon which magnetic clutch is energized. On some airplanes prior to 491 a time delay relay delays energizing of trim motor to insure positive clutch actuation before motor starts.

❷ Actuation of cutout switch removes power from electric trim motor.

❸ Both electric trim and autopilot pitch trim are isolated from manual system by a mechanical clutch so that a force of 20 to 30 pounds on the trim control wheel overrides both electric and autopilot trim.

❹ Electrical trim moves stabilizer at rate of 1/2 degree per second.

❺ Autopilot trim follow-up moves stabilizer at rate of 1/20 degree per second.

❻ Limit switches remove power from magnetic clutches to prevent jackscrew from jamming against mechanical stops in the extreme upper and lower positions.

❼ Cable drum is always mechanically connected to jackscrew.

❽ The primary brake is actuated by stabilizer loads, in either direction, acting on the jackscrew. The purpose of this brake is to prevent jackscrew rotation by stabilizer loads. This brake causes the increase in trim force required when control column pressure is applied.

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Figure 1-44

Electric Stabilizer Trim

Stabilizer Trim Control Switch

Stabilizer trim control switches (6, figure 1-13 and 5, figure 1-14) are on the outboard grip of the pilot's and copilot's control wheels. These switches operate the electrical trim motor which moves the stabilizer at 1/2 degree per second. These switches have three positions: NOSE UP--OFF--NOSE DOWN. Moving a switch from the center or unmarked OFF position to NOSE UP or NOSE DOWN actuates the electric trim motor and one magnetic clutch to give airplane pitch trim adjustment in the selected direction. See figure 1-44. The final precise adjustment of the stabilizer (within one or two turns) should be done with the manual trim control wheel.

NOTE

- When using the electric trim, the manual trim control wheel may continue to rotate or "coast" after the trim switch is released. Allowable coasting is one and two-thirds turns (600 degrees). Coasting significantly in excess of this value may be an indication of electric trim malfunction.

- Arcing may occur when the trim switches are actuated or released. This arcing is normal. Although gas chamber explosion test results were negative, manual trim should be used if fuel vapors are present in the cabin.

Time Delay Relay

Some airplanes prior to 491 have a time delay feature which delays power application to the electric trim motor so that the selected magnetic clutch will engage before the motor turns. This delay is from 0.15 to 0.25 seconds and will occur between actuation of the trim switch and movement of the manual trim control wheel. As a result of this feature, momentary or split second actuations of the trim control switch may not cause any movement of the manual trim control wheel and thus no change in the stabilizer angle of incidence.

Stabilizer Trim Cutout Switch

This switch marked STAB TRIM CUTOUT (7, figure 1-22) on the right side of the control stand, can be moved to the CUTOUT position to turn off electric trim power. This is the primary method of correcting a runaway trim motor; however, further mistrimming can also be prevented by manually stopping the trim control wheel. See STABILIZER TRIM EMERGENCY OPERATION, Section III.

NOTE

It is possible to lower the guard on the stabilizer trim cutout switch without moving the switch out of CUTOUT position. When returning the switch to the unmarked NORMAL position, the guard should be pushed down firmly (definite feeling of full travel) to assure actuation to NORMAL.

Operating Power

Operating power for the electric trim is 115/200 volt AC supplied through three circuit breakers, marked STABILIZER TRIM, on the GENERATOR NO. 2 section of the MCBP (figure 1-35, sheet 3). The 28 volt control power from the T-R BUS NO. 1 section of the MCBP is through three STABILIZER TRIM circuit breakers marked PILOT, COPILOT and SAFETY RELAY (figure 1-35, sheet 2).

Autopilot Stabilizer Trim Follow-up

The autopilot maintains the selected pitch attitude primarily through control of the elevators. When elevator travel exceeds a certain limit, the autopilot stabilizer trim follow-up adjusts the stabilizer to relieve the elevator control forces. The autopilot cannot compensate for large trim changes (such as would occur during gear lowering) because it cannot relieve the elevator forces fast enough to prevent slippage of the autopilot servo clutches. See AUTOPILOT SYSTEM in Section IV.

FLAP SYSTEM

Flaps provide maximum lift and low drag at takeoff, and high lift, high drag during final approach and landing. The flap lever on the control stand is used to select the desired flap position. The position of the flaps is indicated on the flap position indicators on the pilots' center instrument panel. Each wing has an outboard flap, an inboard flap, two leading edge flaps and a fillet flap (3, 6, 15 and 17, figure 1-40). The inboard and outboard flaps also have a fore flap ahead of their leading edges for improved air flow. For reference purposes, the flaps on the trailing edge of the wing are referred to as the main flaps. The main flaps are positioned by transmission assemblies that are turned by two hydraulic motors. One motor operates the inboard and fillet flaps while the second motor operates the outboard flaps. See

figure 1-45. The main flaps can also be positioned manually. See figure 1-51 and MAIN FLAP EMERGENCY OPERATION in Section III. Pressure to the flap drive motors is normally from the right hydraulic system; however, if pressure from that system becomes inadequate, the flap motors can receive pressure from the left hydraulic system by use of the emergency hydraulic crossover valve lever. See EMERGENCY HYDRAULIC CROSSOVER VALVE LEVER, this section.

Flow regulators limit the speed of flap operation so that the main flaps can be fully extended or retracted in approximately 30 seconds. Movement of the outboard flaps operates the outboard aileron lockout mechanism. This mechanism locks the outboard ailerons in a faired position when the flaps are up. Some outboard aileron travel is available as soon as the flaps leave the full up position. The amount of aileron travel available increases as the flaps are lowered until they are fully operable when the outboard flaps are down approximately 23 degrees. The outboard aileron lockout mechanism also actuates the control valves for positioning the leading edge flaps. See figure 1-45. The leading edge flaps extend when the outboard flaps are lowered below 9.5 degrees and retract when the flaps are raised above 6 degrees. The leading edge flaps are hydraulically operated with pressure from the right system through the outboard spoiler bypass valve and they have only two positions: fully extended or retracted. In the event of malfunction, the leading edge flaps can be deactivated by placing the outboard spoiler switch in CUT-OFF. Leading edge flaps improve the low speed performance of the airplane by modifying the wing stall characteristics. Refer to LEADING EDGE FLAPS in Section VI for information regarding the affect of L.E. flaps on flight characteristics. The warning horn will blow if the main flaps and leading edge flaps are not correctly positioned prior to takeoff. Refer to WARNING HORN AND CUT-OUT SWITCH in this Section.

NOTE

If the leading edge flaps are left in the retracted position when the airplane is parked, the flaps will gradually extend as the hydraulic pressure bleeds off.

FLAP LEVER AND LEVER POSITION INDICATOR

A flap lever and indicator (10, figure 1-22) is located on the control stand. The pilot may select the degree of flaps desired, by actuating the lever which mechanically operates a flap control valve. Fluid under pressure is then directed to flap drive mechanisms which lower or raise the flaps. A follow-up cable mechanism repositions the control valve to neutral when the desired flap position has been reached. The control lever must be positively seated in the UP detent to prevent inadvertant flap extension. The indicators with FLAPS UP--FLAPS DOWN positions will allow a range of flap settings of from 0 to 50 degrees. The fillet flaps (17, figure 1-40) are geared to the main flaps such that 50 degrees of main flaps will lower 45 degrees of fillet flaps.

FLAP POSITION INDICATORS

Two flap position indicators (11, figure 1-17) on the pilots' center instrument panel register the position of the main flaps in degrees. The indicators are accurate within two degrees. The range of flap operation is from 0 to 50 degrees. A failure in the main flap drive system will be indicated by a difference of more than four degrees in the instrument readings. Operating power for the outboard flap position indicator is 28 volt AC provided through the OUTBOARD FLAP POSITION INDICATOR circuit breaker under INSTRUMENT on the 28V AC section of the MCBP (figure 1-35, sheet 3). Power for the left hand pointer of the inboard flap position indicator is 28 volt AC provided through the INBOARD FLAP POSITION INDICATOR circuit breaker under INSTRUMENT on the 28V AC section of the MCBP (figure 1-35, sheet 3). Power for the right hand pointer of the inboard flap position indicator is 28 volt AC provided through the INSTR EXC fuse on the CIPP (figure 1-35, sheet 8A).

FLAP BYPASS VALVE HANDLES

Two flap bypass valve handles on the floor on the left side of the fuselage, when lifted and rotated 90 degrees, open flap bypass valves to allow free circulation of fluid between extend and retract lines for manual operation. These handles also act as covers for the manual crank receptacles. See figures 1-45, 1-51 (sheet 1), and figure 3-18.

NOTE

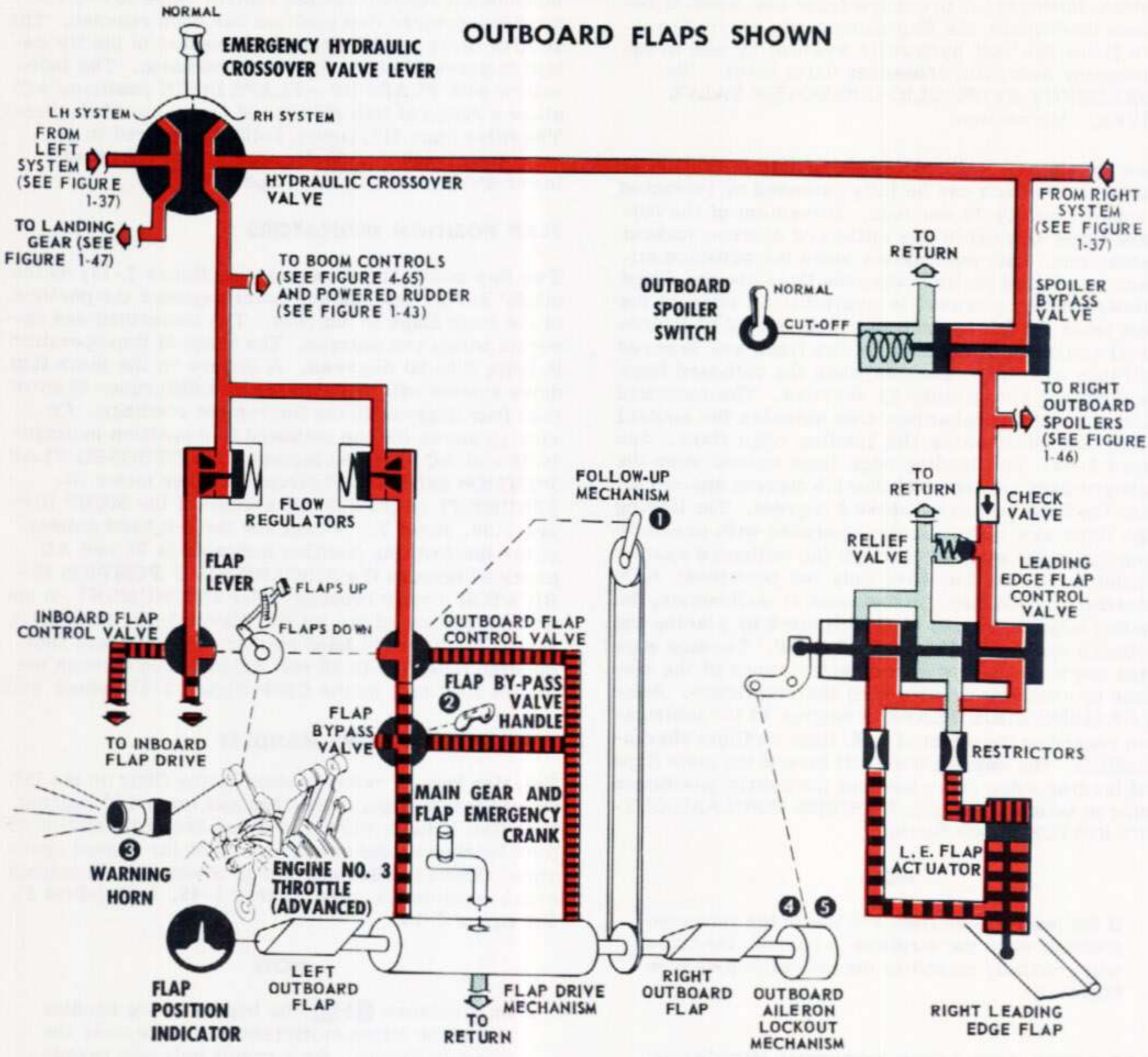
- On airplanes 1▶18 the bypass valve handles cannot be lifted sufficiently to pass over the opposite handle. As a result only one bypass valve can be positioned at a time. Airplanes 19▶ have redesigned handles which can be raised sufficiently to pass over one another allowing the inboard and outboard bypass valves to be positioned simultaneously.

- When the RH system is depressurized and the flap handle is down, inboard flap creepage may occur due to a slight pressurization of the return lines. If the creepage is considered undesirable it can be stopped by positioning both bypass valves to bypass on airplanes 19▶.

FLAP SYSTEM

SYSTEM SHOWS TYPICAL FLAP IN THE RETRACTED POSITION

OUTBOARD FLAPS SHOWN



NOTE

❶ Follow-up cable positions flap control valve after desired position has been reached.

❷ Pulling up and rotating flap bypass valve handle 90 degrees counterclockwise allows free circulation of fluid between extend and retract lines for manual operation.

❸ Warning horn sounds when the No. 3 throttle is advanced near OPEN while the airplane is on the ground and the flaps are not properly positioned for takeoff. Refer to WARNING HORN AND CUTOUT SWITCH in this Section.

❹ Movement of the outboard flaps operates the outboard aileron lockout mechanism. Some outboard aileron travel is available as soon as the flaps leave the full up position; however, these ailerons are not fully operable until the outboard flaps are down 23 degrees.

❺ The outboard aileron lockout mechanism causes the leading edge flaps to extend when the outboard flaps are lowered to 9.5 degrees and to retract when the outboard flaps are raised to 6 degrees.

Figure 1-45

FLAP AND MAIN GEAR EMERGENCY CRANK

The main flaps and main landing gear can be operated manually by use of a hand crank. The crank is stowed on the left side of the fuselage aft of the overwing emergency exit hatch. Both flap receptacles for the crank are uncovered when the flap bypass valve handles are rotated 90 degrees. Refer to FLAP BYPASS VALVE HANDLE in this Section. The inboard and outboard flaps are operated individually, and may be either extended or retracted by use of the crank; however, hand crank operation of the landing gear is limited to extension only. See figure 1-51. The manual operation of the nose gear uses a separate system. Refer to NOSE GEAR GROUND DOWN LOCK AND RELEASE HANDLE in this Section.

FLAP WARNING HORN

See WARNING HORN AND CUTOUT SWITCH, this Section.

SPOILER AND SPEED BRAKE SYSTEM

Lateral control of the airplane is augmented with four hydraulically operated spoilers (14 and 16, figure 1-40), installed in pairs, on the upper surface of each wing. Each spoiler has its own actuator although it is partially linked to the adjacent spoiler. The spoiler pairs have common follow-ups and metering valves, with pressure from the left hydraulic system to the inboard spoilers and pressure from the right hydraulic system to the outboard spoilers. The spoiler deflection limits are from 0 to 60 degrees with the stops being incorporated in the actuator. The spoilers deflect as a part of the lateral control system depending on control wheel movement. After an initial movement of 3 to 5 degrees, further wheel motion results in approximately a third of a degree of spoiler deflection, on the up aileron wing, per degree of control wheel movement. This rate progressively increases so that 40 degrees of spoilers can be obtained with 90 degrees of control wheel travel. This spoiler motion is used to insure that the increase in roll sensitivity during speed brake operation will not be excessive while still maintaining an acceptable initial roll response for normal flight. The spoilers can be used as speed brakes by positioning a lever on the control stand to the desired position. Pressure will be evenly distributed to all spoiler actuators automatically raising all spoilers to act as speed brakes. Any setting of the speed brake lever establishes a reference position for spoiler operation during control wheel movement. The control wheel can actuate the spoilers to a maximum of 40 degrees (up or down) from this reference position unless limited by structure or air loads. In the event of complete hydraulic failure, spoilers cannot extend further although they may retract. See figure 1-46.

NOTE

A restrictor bleed in the left hydraulic system aids in hydraulic system cooling but results in slower response of the inboard spoilers to either the control wheel or the speed brake lever when hydraulic pressure is supplied by the left system auxiliary pump. Response is normal when the left system is pressurized by the engine-driven pumps.

SPEED BRAKE LEVER

A speed brake lever (1, figure 1-22) is located on the control stand. Actuating this lever hydraulically raises the spoilers symmetrically so they act as speed brakes. Numbers near the lever show the degree of speed brake applied. Figure 6-7 shows the angle of spoilers that can be attained at various airspeeds.

NOTE

For positive down spoilers, the handle should be forward of the 0 degree mark. This is due to rigging tolerances and is necessary to insure that the lever is against the stop.

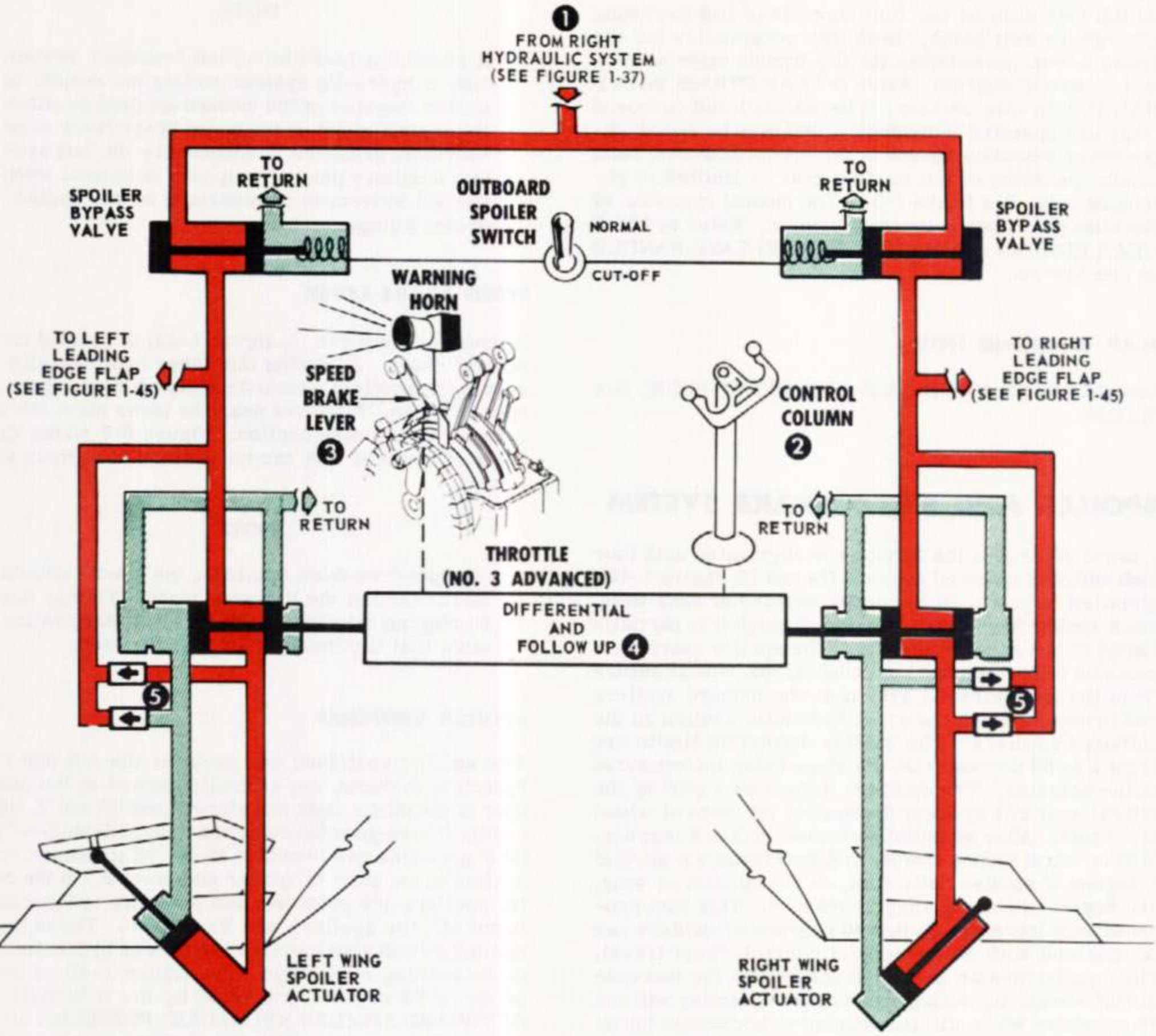
SPOILER SWITCHES

Two spoiler switches, one each for the left and right hydraulic systems, are centrally located on the underside of the pilots' light and glare shield (6 and 7, figure 1-16). These guarded switches with NORMAL--CUT-OFF positions are provided to cut off pressure to the system in the event of spoiler malfunction. In the event the spoilers are extended, and pressure to the system is cut off, the spoilers will blow down. The outboard spoiler switch also controls the flow of hydraulic fluid to the leading edge flaps. See figure 1-45. Control power is 28 volt DC protected by the INBOARD and OUTBOARD SPOILER HYDRAULIC PRESSURE circuit breakers on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2).

SPEED BRAKE WARNING HORN

See WARNING HORN AND CUTOUT SWITCH, this Section.

SPOILER AND SPEED BRAKE SYSTEM



PRESSURE
RETURN
ELECTRICAL
MECHANICAL

TYPICAL SYSTEM
OUTBOARD SPOILERS SHOWN
AIRPLANE TURNING LEFT

NOTE

1. Outboard spoilers receive pressure from right system. Inboard spoilers receive pressure from left system.
2. When control wheel is in neutral and speed brake lever is in the 0 degree position, pressure to both spoiler actuators is blocked off.
3. When speed brake lever is actuated pressure is distributed to both inboard and outboard spoiler actuators. Warning horn sounds when engine No. 3 throttle is advanced near full OPEN if speed brake lever is pulled back more than 2 degrees and airplane is on the ground.
4. Differential and follow-up mechanism coordinates spoilers when used for lateral control, prevents uncontrolled surface movement, and allows coordination of speed brake and spoiler application.
5. Check valves open to relieve excessive pressure due to spoiler blow down or thermal expansion.

Figure 1-46

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LANDING GEAR SYSTEM

The airplane has a tricycle landing gear consisting of two four-wheel truck main gears and a steerable dual-wheel nose gear. The landing gear is extended and retracted hydraulically and is operated from a single control lever on the pilots' center instrument panel. Pressure to the landing gear system is normally from the left system; however, if pressure from the left system becomes inadequate, the landing gear can receive pressure from the right system by use of the emergency hydraulic crossover valve lever. See figure 1-47. Also refer to EMERGENCY HYDRAULIC CROSSOVER VALVE LEVER in this Section.

The main gear retracts inboard into the wheel wells and the nose gear retracts forward into its wheel well. Normally, the time for extension or retraction is approximately 10 seconds: however, at extremely low temperatures, gear retraction time may be as long as 30 seconds. Each gear is mechanically and hydraulically locked in the up and down positions. Hydraulic pressure is automatically directed to the main gear brakes during the retraction cycle. A snubber in the nose wheel well stops rotation of the nose wheels when fully retracted. Oleo actuated safety switches on both main gear prevent accidental retraction of the gear while the airplane is on the ground. Other safety features in the landing gear system are truck leveling switches for the main gears and a centering switch on the nose gear. These switches are wired in series with the oleo safety switches and normal gear retraction will be prevented when the airplane is off the ground unless both main gear are level and the nose gear is centered. Operating power for this safety circuit is 28 volt DC through the LANDING GEAR LEVER LOCK circuit breaker on the T-R BUS NO. 1 section of the MCBP (figure 1-35, sheet 2). There are separate manual systems for emergency extension of the main gear and the nose gear. The control for the nose gear manual extension is on the floor adjacent to the boom operator's seat. The main gear manual extension control is on the floor of the cargo compartment over the left wheel well. Refer to FLAP AND MAIN GEAR EMERGENCY CRANK in this Section. See figures 3-19 and 3-20. Windows in the floor allow visual inspection of both nose and main gear locks. It is not possible to manually retract any gear.

LANDING GEAR LEVER

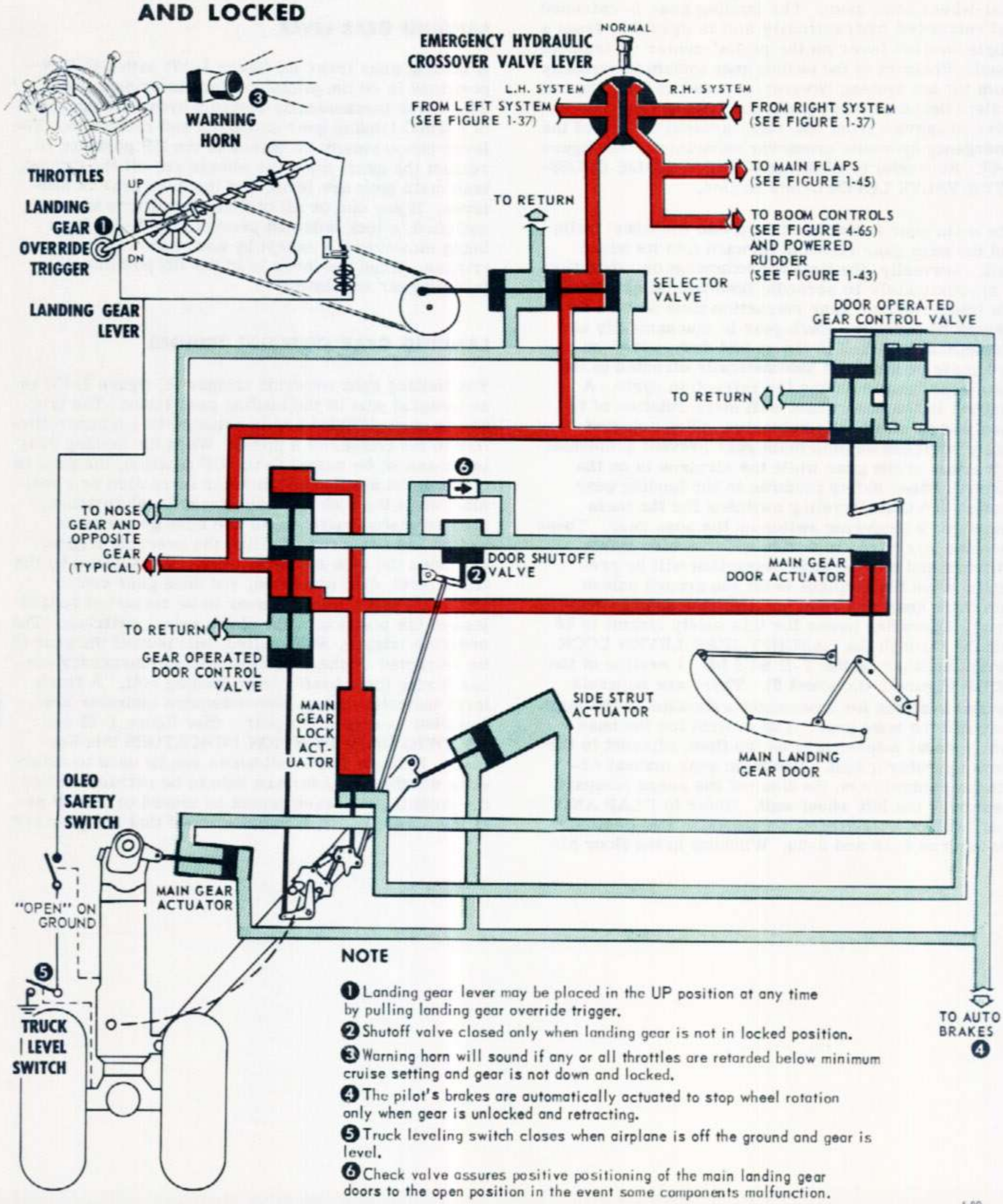
A landing gear lever (9, figure 1-17) with UP--DN positions is on the pilots' center instrument panel. This lever mechanically controls hydraulic operation of normal landing gear extension and retraction. The lever can normally be moved to the UP position, to retract the gear, when the wheels are off the ground, both main gear are level, and the nose gear is centered. If any one or all of these conditions are not satisfied, a lock solenoid prevents the lever from being moved to UP except by use of the override trigger. When the lever is in the DN position, the landing gear will extend.

LANDING GEAR OVERRIDE TRIGGER

The landing gear override trigger (8, figure 1-17) is an integral part of the landing gear lever. The trigger is spring loaded and is actuated in a manner similar to the trigger of a pistol. When the landing gear lever cannot be moved to the UP position, the gear is either in an unsafe condition for retraction or a malfunction of the lock solenoid, truck level switches, oleo extension switches, or the nose gear center switch has occurred. Pulling the override trigger bypasses the lock solenoid, which is energized by the truck level, oleo extension, and nose gear center switches, and allows the gear to be retracted regardless of the position of the above safety switches. The override trigger, when pulled, will permit the gear to be retracted on the ground should an emergency occur during the takeoff run or landing roll. A truck level indicator and an oleo extension indicator are installed on each main gear. (See figure 1-49 and LANDING GEAR POSITION INDICATORS this Section.) In flight these indicators can be used to determine whether the gear are safe to be retracted when the landing gear lever cannot be moved to the UP position normally. If it is determined that the gear are

LANDING GEAR SYSTEM

LANDING GEAR DOWN AND LOCKED



NOTE

❶ Landing gear lever may be placed in the UP position at any time by pulling landing gear override trigger.

❷ Shutoff valve closed only when landing gear is not in locked position.

❸ Warning horn will sound if any or all throttles are retarded below minimum cruise setting and gear is not down and locked.

❹ The pilot's brakes are automatically actuated to stop wheel rotation only when gear is unlocked and retracting.

❺ Truck leveling switch closes when airplane is off the ground and gear is level.

❻ Check valve assures positive positioning of the main landing gear doors to the open position in the event some components malfunction.

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Figure 1-47 (Sheet 1 of 2)

LANDING GEAR IN TRANSIT UP

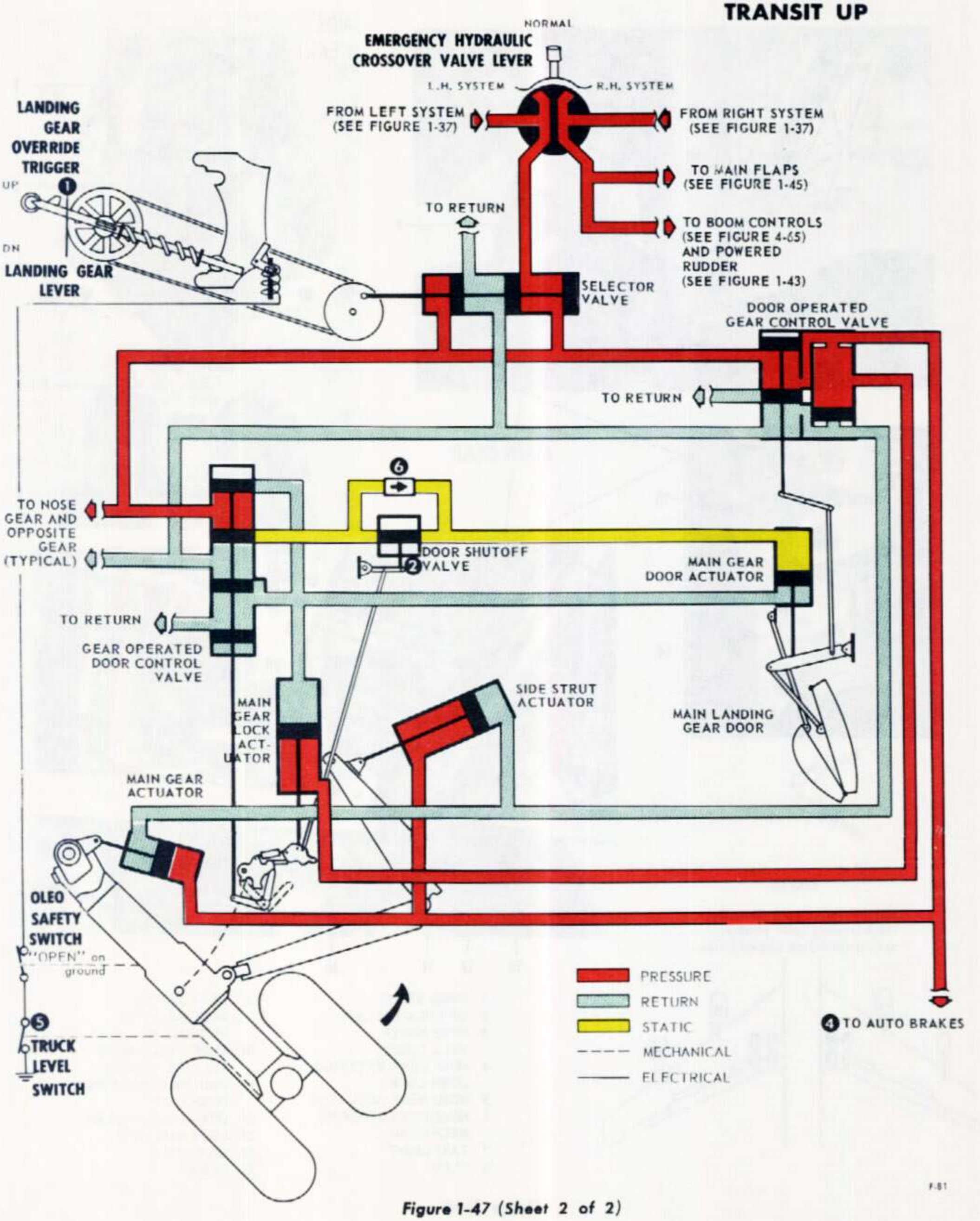
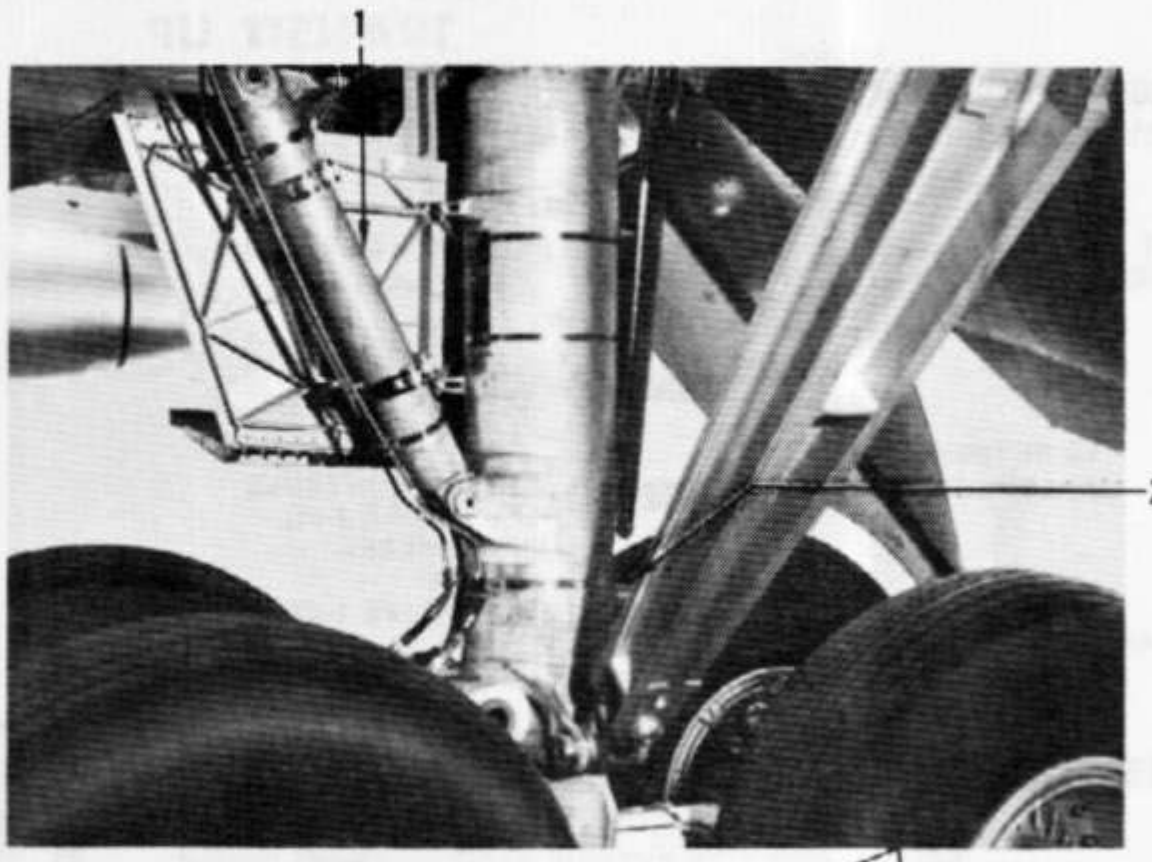
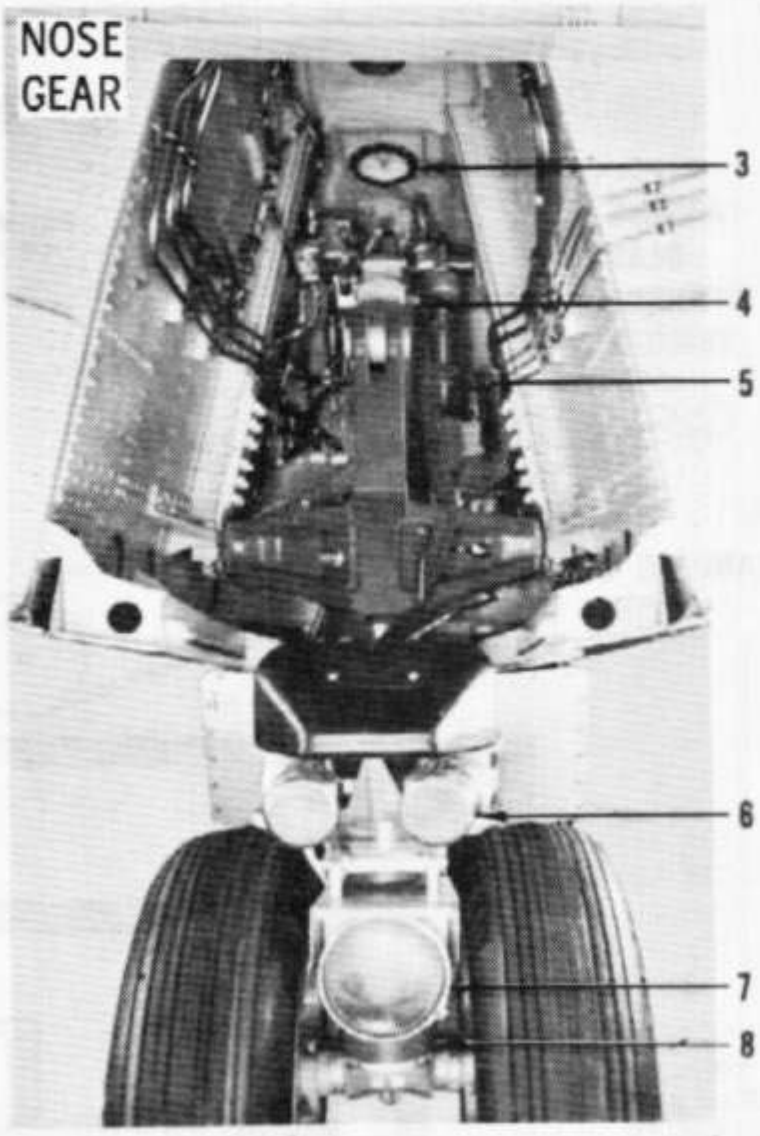


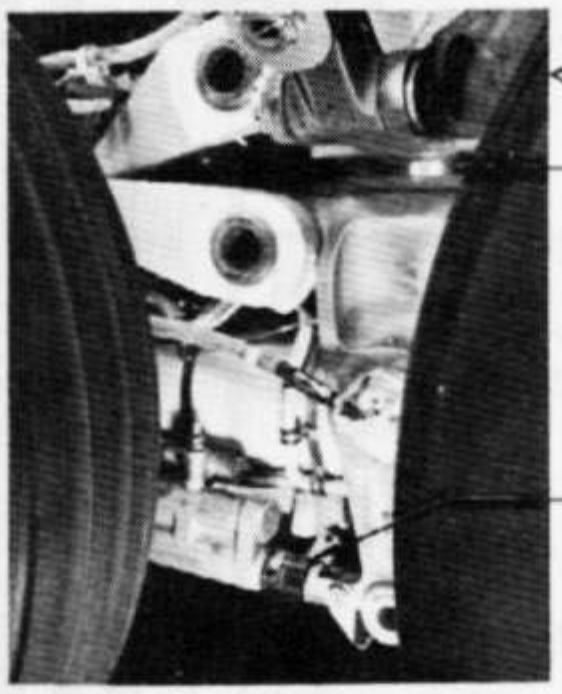
Figure 1-47 (Sheet 2 of 2)

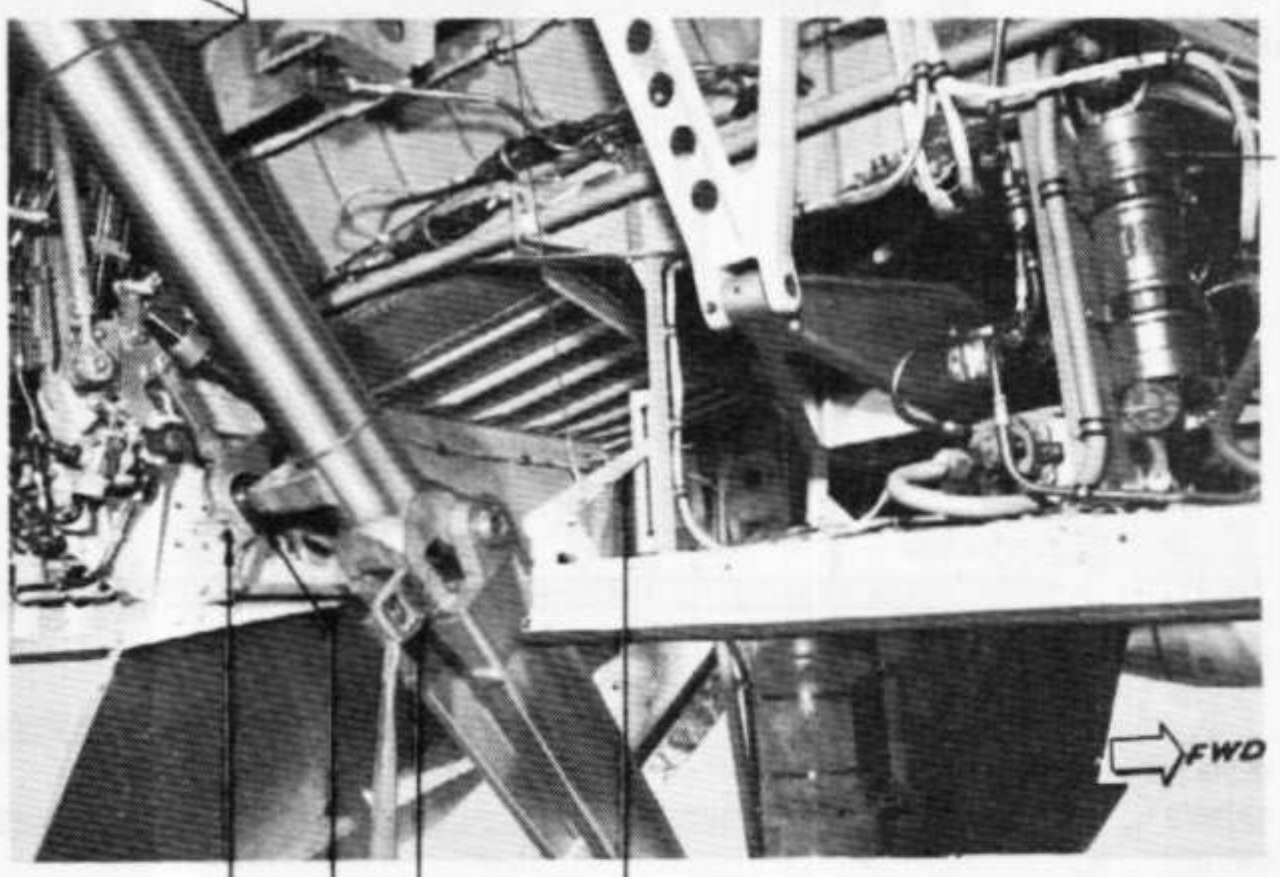
LANDING GEAR COMPONENTS





MAIN GEAR

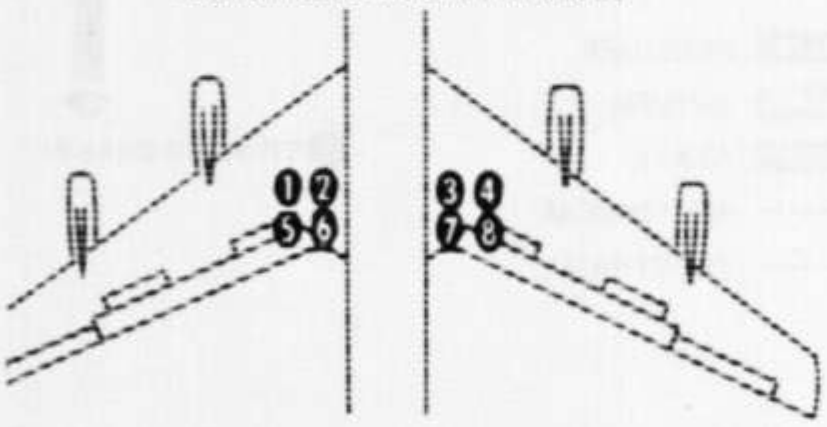






NOTE

For reference purposes, the main landing gear wheels are numbered as shown below.



1 DRAG STRUT
2 UP LOCK ROLLER
3 NOSE WHEEL WELL LIGHT
4 NOSE GEAR EXTERNAL DOWN LOCK
5 NOSE GEAR ACTUATOR
6 NOSE GEAR STEERING MECHANISM
7 TAXI LIGHT
8 OLEO
9 LEFT SYSTEM ACCUMULATOR (HYDRAULIC)
10 WHEEL WELL DOOR RELEASE HANDLE
11 MAIN GEAR EXTERNAL DOWN LOCK
12 DOWN LOCK ROLLER
13 LOCK ASSEMBLY
14 SNUBBER
15 OLEO

Figure 1-48

in the required position for retraction, the override trigger can be pulled and the subsequent gear retraction accomplished safely. See EMERGENCY RETRACTION OF LANDING GEAR, Section III.

CAUTION

Wheel well damage may result from emergency retraction if the main gear trucks are not level, the oleos are not sufficiently extended, or the nose gear is not centered.

LANDING GEAR POSITION INDICATORS

Three electrically operated, tab-window type, landing gear position indicators, (4 and 5, figure 1-17) one for each gear, are on the pilots' center instrument panel. These tabs indicate the position of the nose and main gear. With the gear in the intermediate position, alternate colored slanting marks appear in the window: in the gear up and locked position, the word UP appears: in the gear down and locked position, a strut supported wheel appears. With no power on the airplane, the alternate colored slanting marks appear. Operating power is 28 volt DC through the LH, NOSE and RH LANDING GEAR POSITION circuit breakers on the T-R BUS NO. 1 section of the MCBP (figure 1-35, sheet 2) on airplanes 1▶14. Power is through the LH, NOSE and RH LANDING GEAR POS & WARN circuit breakers on the SBCBP (figure 1-35, sheet 1) on airplanes 15▶.

LANDING GEAR LOCK ALIGNMENT STRIPES

Alignment stripes (figure 1-49) indicate when the landing gear is locked. The stripes may be observed by uncovering the gear inspection windows and turning on the wheel well lights. The main gear alignment stripes consist of a red stripe on the lock support assembly and a similar red stripe on the adjacent spacer. When the stripes are aligned, the main gear is locked in either the up or down position. The nose gear stripes are located on the drag strut knuckle and on the lock rod 1▶232 or on a sheet metal plate attached to the lock rod 233▶. When the nose gear is down, the stripes may be seen through the inspection window on the flight deck. If the stripes are aligned, the nose gear is down and locked. When the nose gear is up, the stripes must be viewed through the inspection window in the lower nose compartment. On airplanes 1▶232 the nose gear stripes will appear to be misaligned in both the locked and unlocked condition. On airplanes 233▶ when the stripes are aligned, the nose gear is up and locked.

TRUCK LEVEL AND OLEO EXTENSION INDICATORS

Truck level and oleo extension indicators are installed on both main gear. (See figure 1-49.) The truck level indicator is clamped on the inner brake equalizer rod and pivots at the oleo inner cylinder fork. The pointer of the indicator is tipped with yellow with red and yellow markings on the inner cylinder fork. When the entire yellow tip of the pointer falls within the yellow zone on the oleo fork, the truck is level within 2 degrees and the gear is safe to be retracted. The oleo extension indicator consists of red and yellow markings on the inside of the lower torsion link and a yellow mark on the torsion link bolt. When the yellow mark on the torsion link bolt falls entirely within the yellow zone on the torsion link, the oleo is fully or near fully extended and the gear is safe to be retracted. Both the truck level and oleo extension indicators must be within limits before the gear is safe to be retracted. The truck level and oleo extension indicators on both main gear are observed through the main gear inspection windows. The indicators are used in conjunction with a check of the nose gear for center position when the gear retraction is to be accomplished by using the override trigger. If the gear are determined to be in the required position for retraction, a malfunction of a landing gear safety device has most likely occurred and gear retraction may be safely accomplished by use of the override trigger. See EMERGENCY RETRACTION OF LANDING GEAR, Section III.

CAUTION

The two truck level and two oleo extension indicators must be read carefully. A misread indicator could lead to wheel well damage.

LANDING GEAR WARNING LIGHT KNOB

A landing gear warning light knob (10, figure 1-17) is an integral part of the landing gear lever. The light in the knob can be tested by placing the landing gear lever in the DN or UP position and pulling the lever. This red light knob will illuminate if any of the following conditions exist.

A. Lever not in the full UP or DN position.

B. Any landing gear not up and locked or not down and locked.

C. Lever in the UP position, and any gear is down and locked.

D. Lever is in the DN position and any gear is not down and locked.

E. Any landing gear doors not closed.

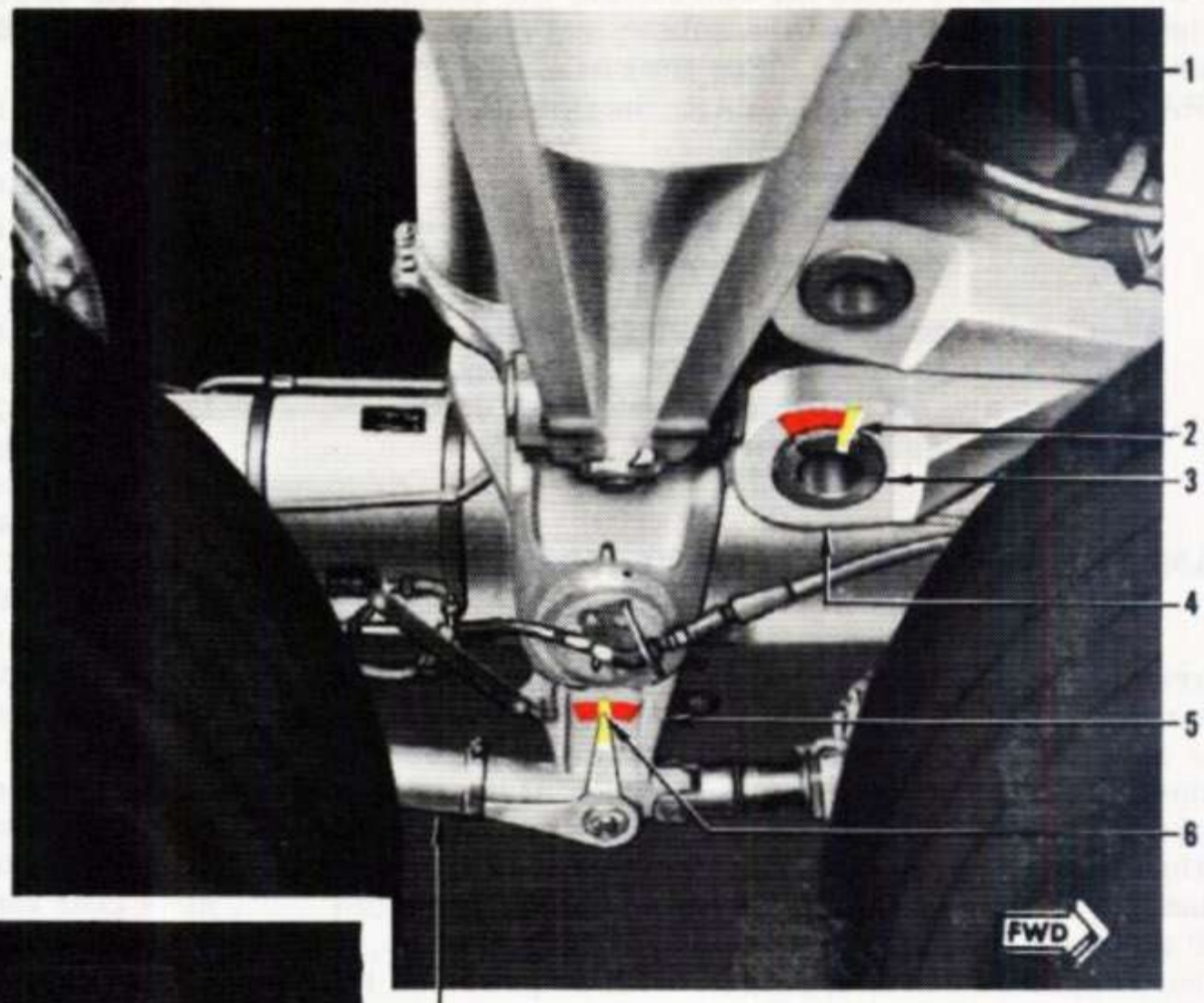
GEAR INDICATORS

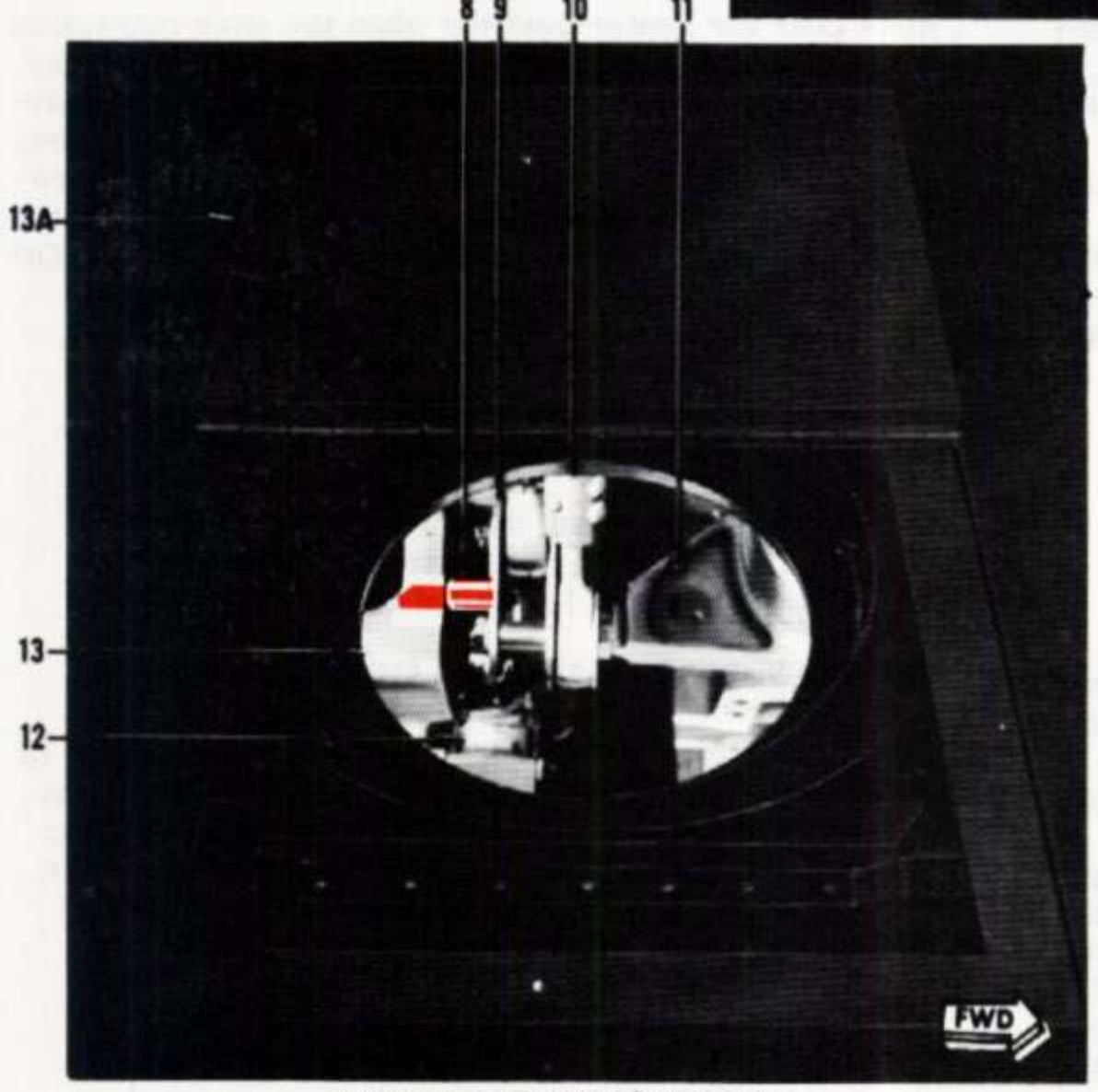
CAUTION

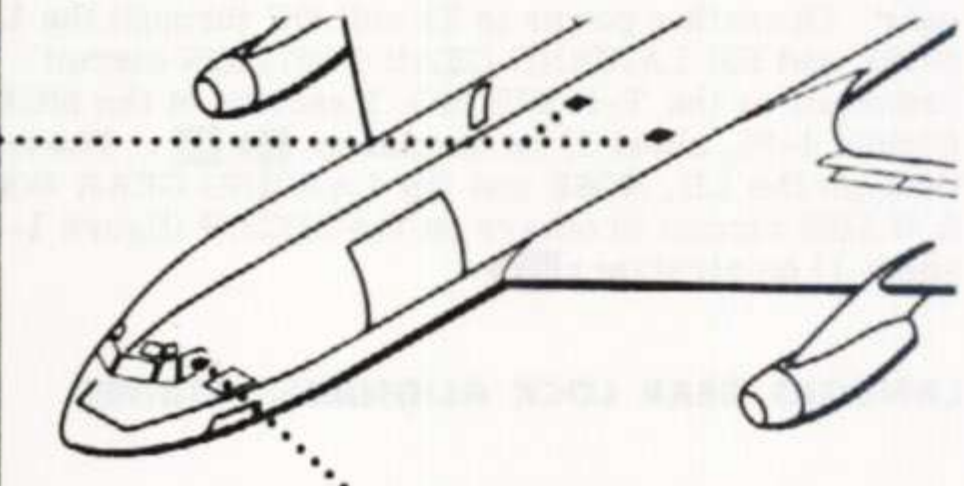
The truck level and oleo extension indicators must be read carefully. A misread indicator could lead to wheel well damage.

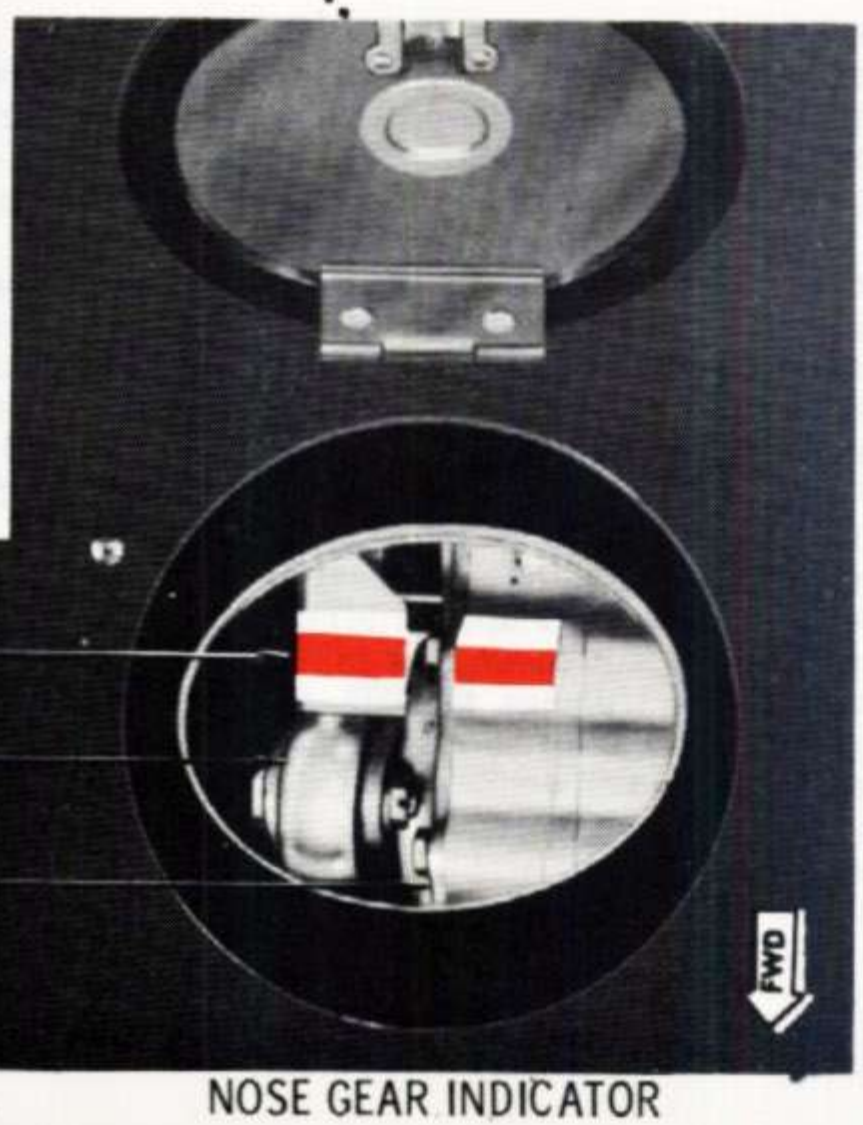
NOTE

Left main landing gear shown; truck level, oleo extended.









F 835
F1349
F1350

MAIN GEAR INDICATORS

1 DRAG STRUT
2 OLEO EXTENSION INDICATOR
3 TORSION LINK BOLT
4 LOWER TORSION LINK
5 OLEO INNER CYLINDER FORK
6 TRUCK LEVEL INDICATOR
7 BRAKE EQUALIZER ROD
8 MAIN GEAR LOCK ALIGNMENT STRIPES
9 LOCK CRANK
10 EMERGENCY UNLOCK ROD
11 UPPER SIDE STRUT
12 DOOR SHUTOFF VALVE
13 LOCK SUPPORT ASSEMBLY
13A LANDING GEAR LOCK INSPECTION DOOR
14 NOSE GEAR LOCK ALIGNMENT STRIPES
15 LOCK ROD
16 DRAG STRUT KNUCKLE

NOSE GEAR INDICATOR

Figure 1-49

F. One or more throttles retarded and any gear not down and locked.

Operating power is 28 volts DC through a circuit breaker marked LANDING GEAR WARNING LIGHT on the SBCBP (figure 1-35, sheet 1).

LANDING GEAR WARNING HORN

See WARNING HORN AND CUTOUT SWITCH, this Section.

EMERGENCY WHEEL WELL DOOR RELEASE ACCESS

This access (figure 1-51) is in the center of the cargo compartment floor near the main gear manual extension controls on airplanes 406▶. This serves as an auxiliary wheel well door release in case the doors fail to open during the main landing gear emergency extension operation. Refer to MAIN LANDING GEAR EMERGENCY EXTENSION in Section III.

NOSE GEAR DOOR RELEASE AND ACCESS COVER

This release and access cover (15, figure 1-26) is on the floor of the aisleway in the control cabin, just inboard of the main AC power panel. The cover serves to open the nose gear doors when the nose gear doors cannot be normally opened. The double hinged cover, when pulled up, uncovers a nose gear extension release assembly and releases the nose gear doors if the left hydraulic system has been depressurized. Refer to NOSE GEAR EMERGENCY EXTENSION in Section III.

NOSE GEAR GROUND DOWN LOCK AND RELEASE HANDLE

This handle (figure 1-51) serves a twofold purpose. The primary purpose of the handle is to lower the nose gear when the nose gear cannot be normally extended. This is achieved by placing the handle in a slot, located in a recess below the nose gear door release and access cover. The handle is then moved forward, unlocking the nose gear permitting the gear to free fall. The second purpose of the handle is to lock the nose gear down. This is achieved by moving the handle aft after the gear has been extended. The handle is then mechanically locked and will remain in this position until unlocked mechanically by depressing a button beneath the nose gear door release and access cover. The handle should serve as a down lock whenever the airplane is on the ground to prevent inadvertent retraction while the airplane is not in flight. This handle should be removed before takeoff, or the nose gear cannot be retracted. The handle is stowed just forward of the main AC power panel on airplanes 1▶97 and on the aft inboard side of the electrical equipment rack on airplanes 98▶. See figure 1-51. Two clips are provided to secure the handle when stowed. For operation, refer to NOSE GEAR EMERGENCY EXTENSION in Section III.

WHEEL WELL DOOR RELEASE HANDLE

An external release handle for opening the wheel well doors is just aft of the main gear actuator. Before this handle is actuated, the hydraulic system must be depressurized and the system hydraulic pressure and auxiliary hydraulic pressure switches positioned OFF. After the wheel well door release handle is actuated, the wheel well doors may be pushed open and the landing gear door external down locks installed to hold doors open.

CAUTION

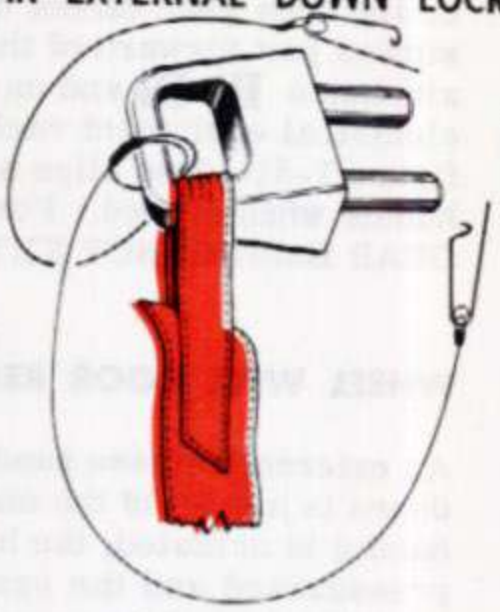
Check that door opening area is clear of personnel and equipment before opening door.

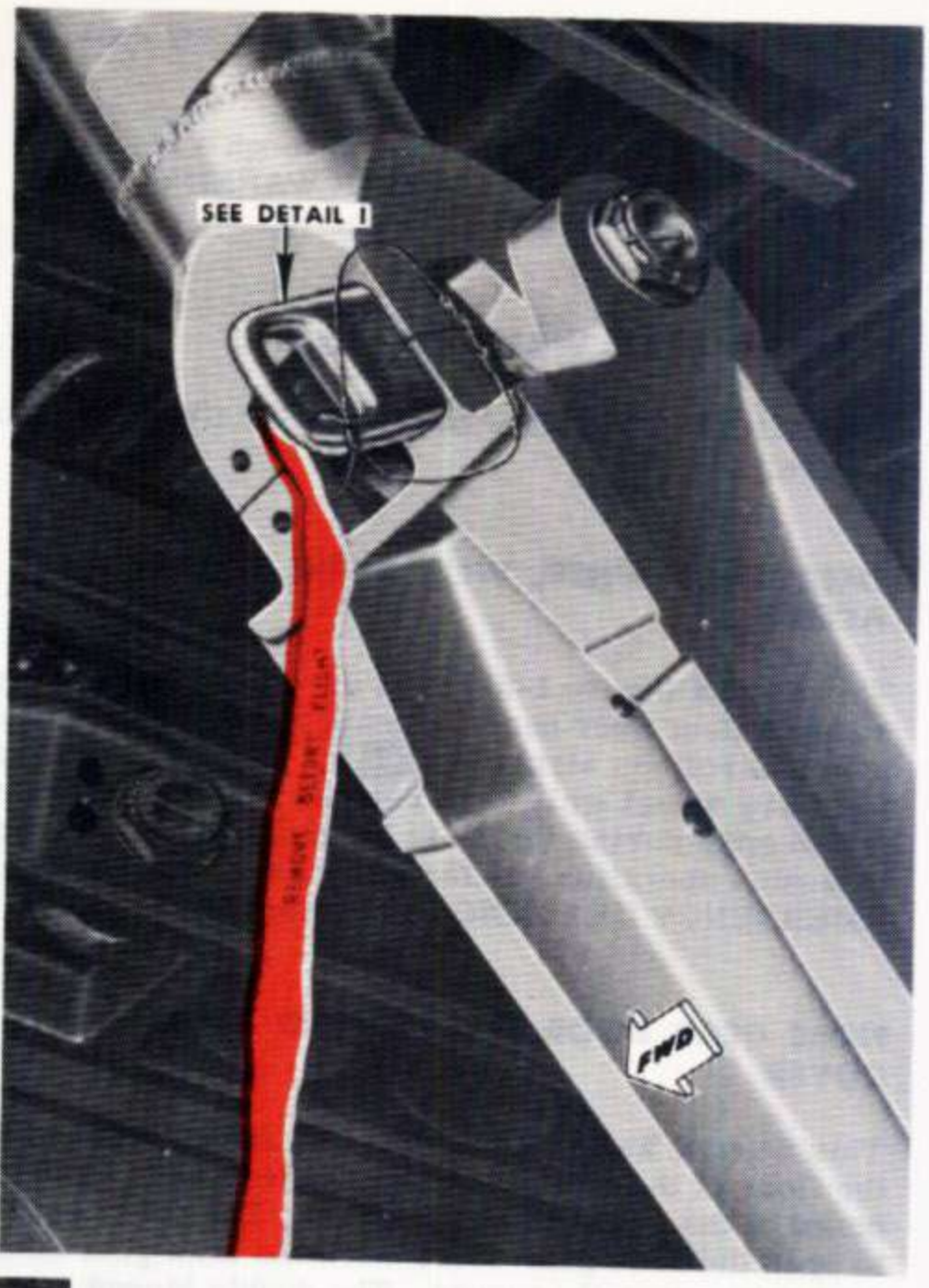
EXTERNAL GROUND SAFETY LOCKS

Three external ground safety locks (figure 1-50), one for each landing gear, prevent accidental collapse of the landing gear while the airplane is on the ground. Red warning streamers are attached to the locks for easy recognition. The locks must be removed before flight or landing gear retraction will be impossible. Stowage containers for these locks are on a wall near the cargo door (3 and 4, figure 1-63). Two main landing gear door down locks assure positive locking of the main landing gear doors when the airplane is on the ground. See figure 1-50. These down locks are installed by seating the lower end of the lock on the actuator rod at an angle of approximately 55 degrees and swinging the top end in place below the actuator. A brass retaining pin is inserted through a lock, located near the top of the down lock, holding it in position. No down locks are provided for the nose gear doors. The main landing gear door down locks are stowed by strapping to the floor at the forward end of the cargo compartment.

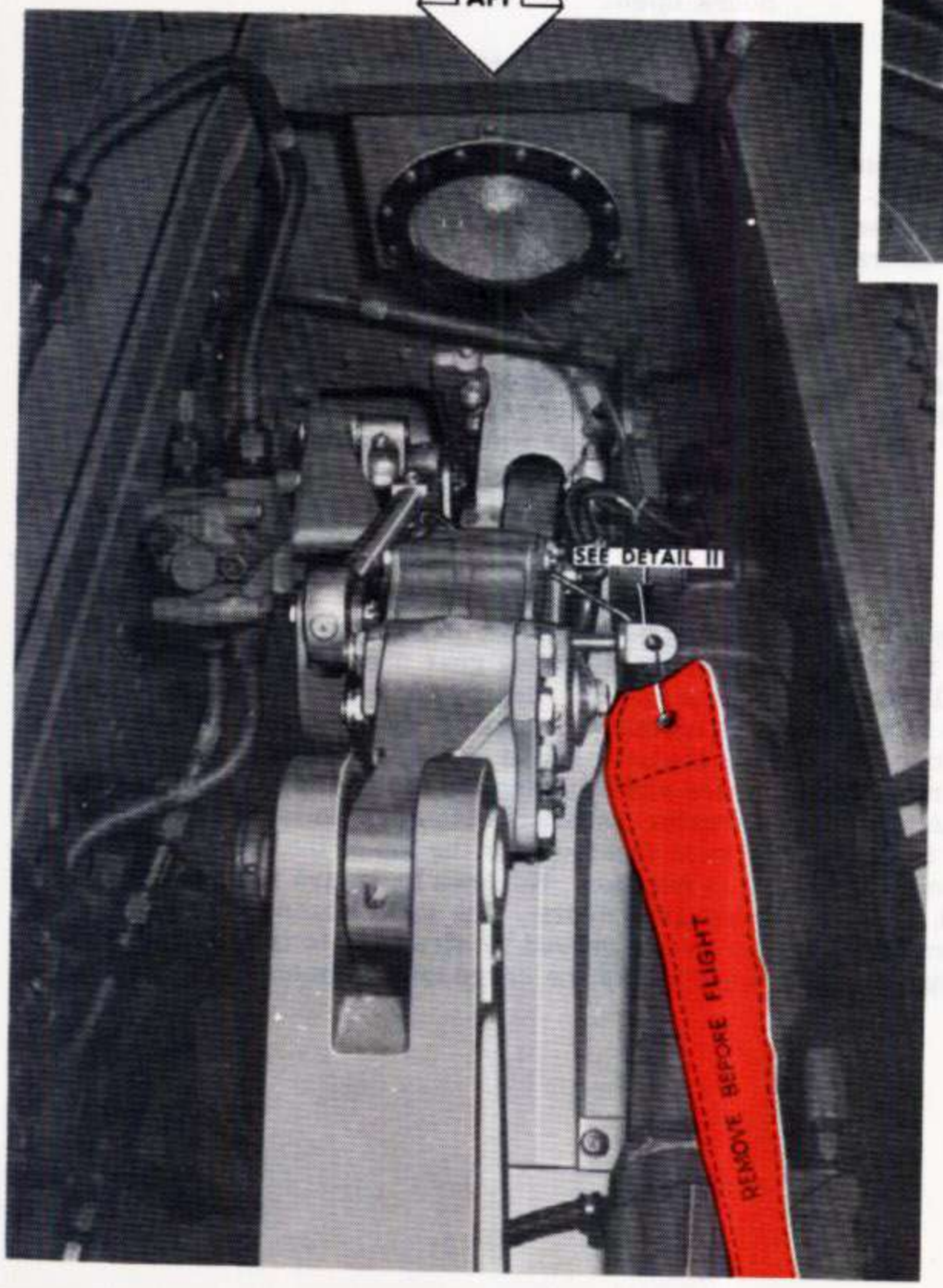
EXTERNAL GROUND SAFETY LOCKS

DETAIL I
MAIN GEAR EXTERNAL DOWN LOCK

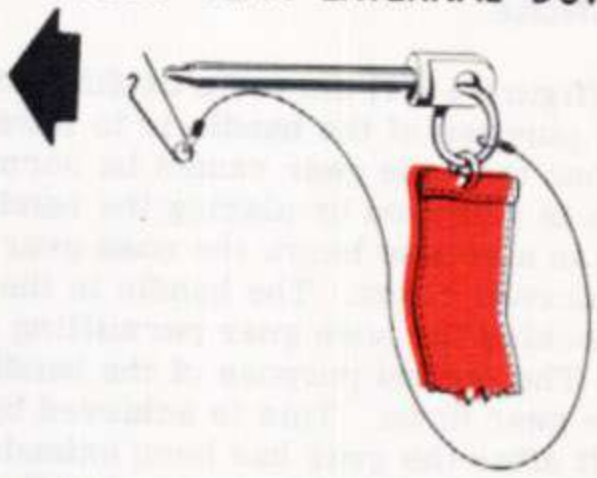




AFT



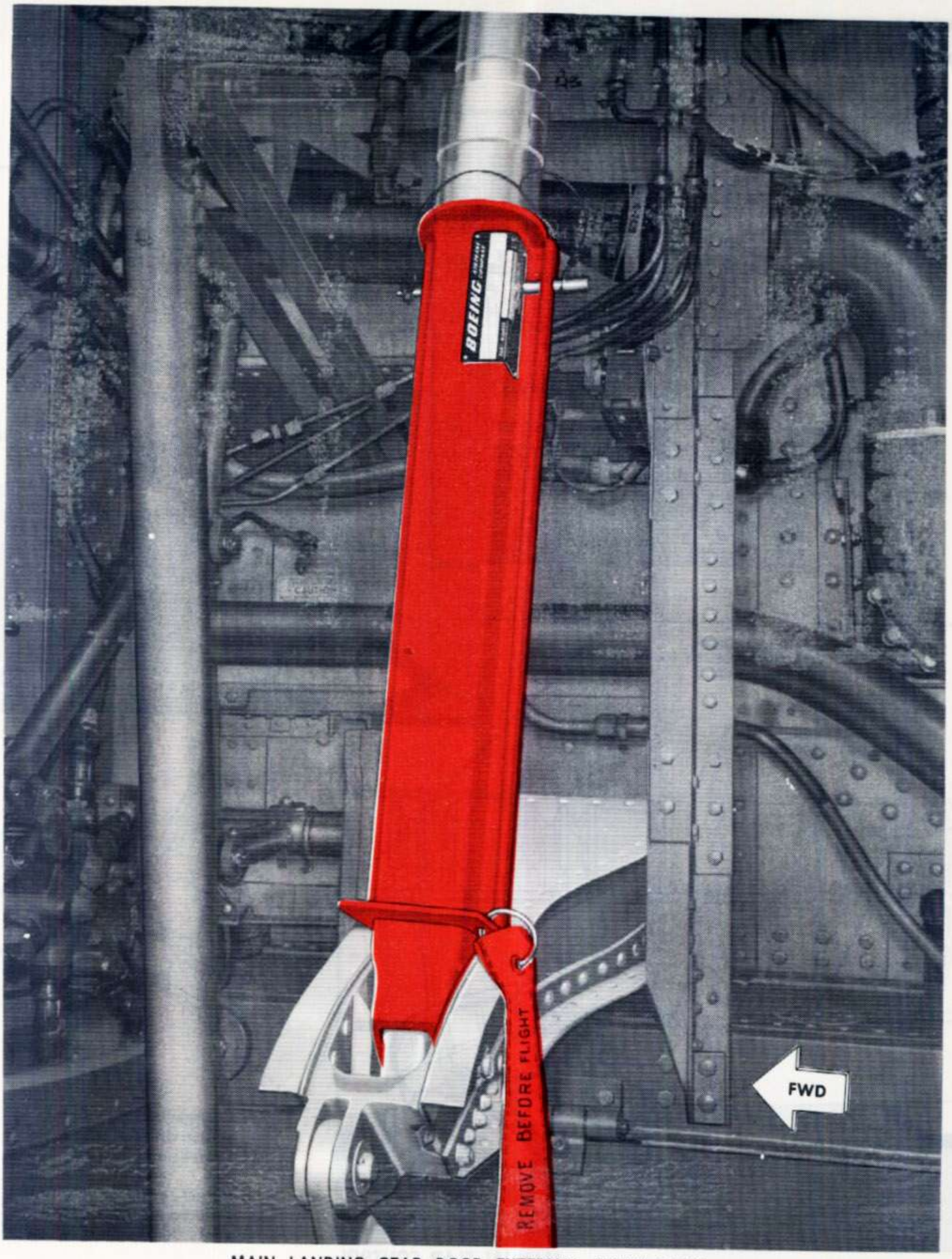
DETAIL II
NOSE GEAR EXTERNAL DOWN LOCK



(USED WHEN TOWING OR DURING INSPECTION AND MAINTENANCE)

F-86
F-87

Figure 1-50 (Sheet 1 of 2)



MAIN LANDING GEAR DOOR EXTERNAL DOWN LOCK

Figure 1-50 (Sheet 2 of 2)

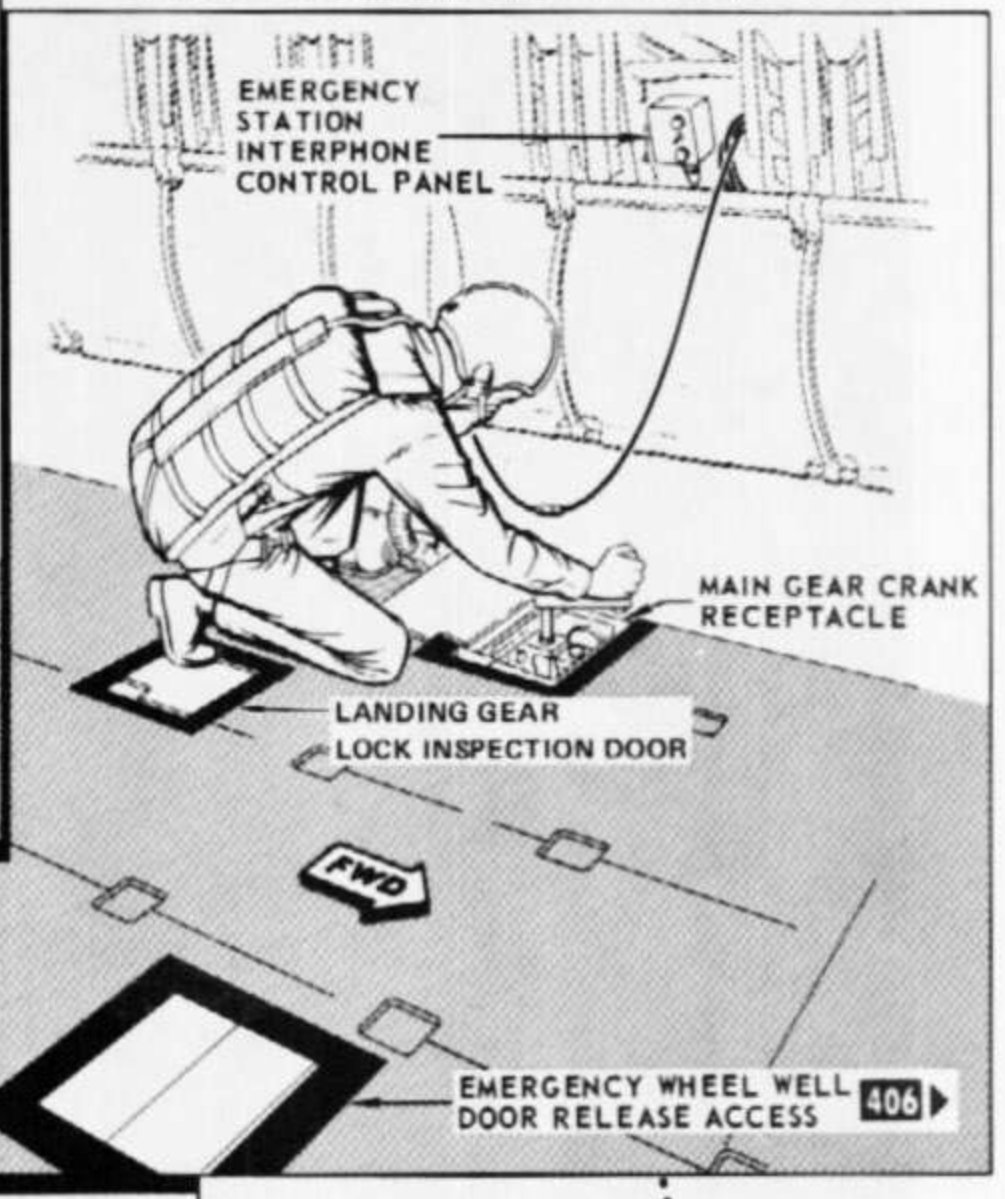
F 88

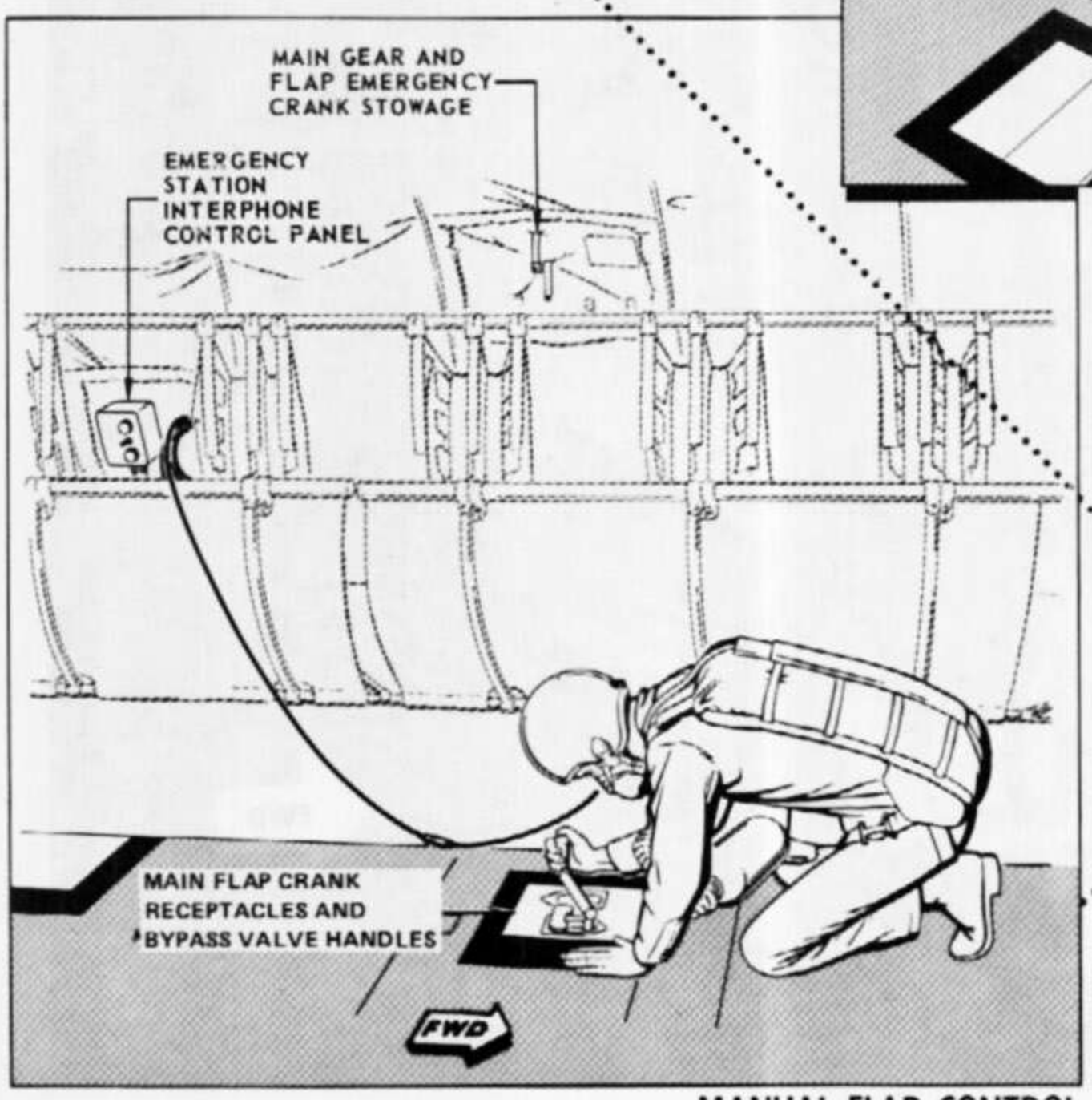
LANDING GEAR AND MAIN FLAP EMERGENCY CONTROLS

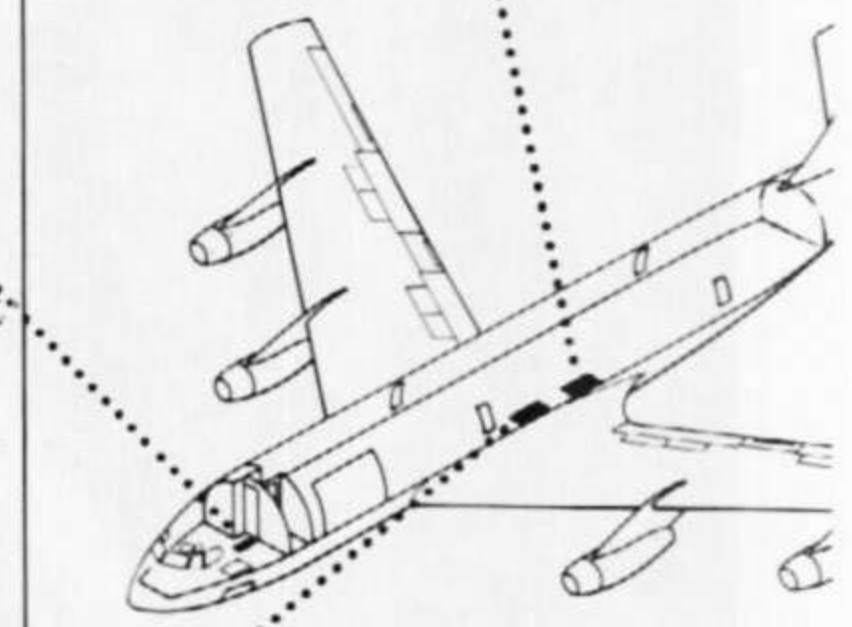
NOSE GEAR MANUAL CONTROL



MAIN GEAR MANUAL CONTROL







MANUAL FLAP CONTROL

NOTE

- Crewmember will maintain liaison with the pilot on interphone.
- Helmet, mask and parachute required only on direction of pilot. Headset may be used.

F-89

Figure 1-51 (Sheet 1 of 2)

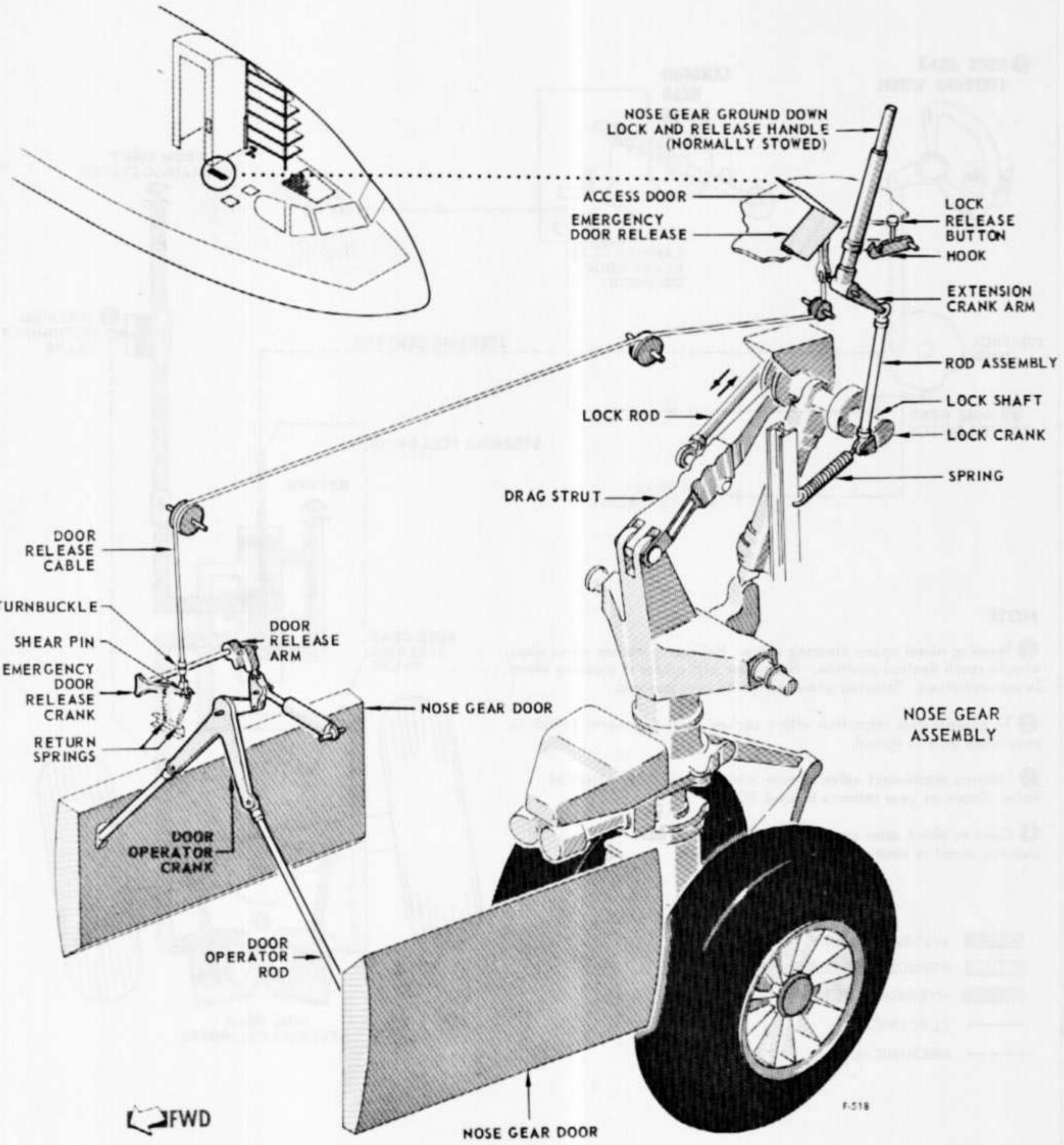
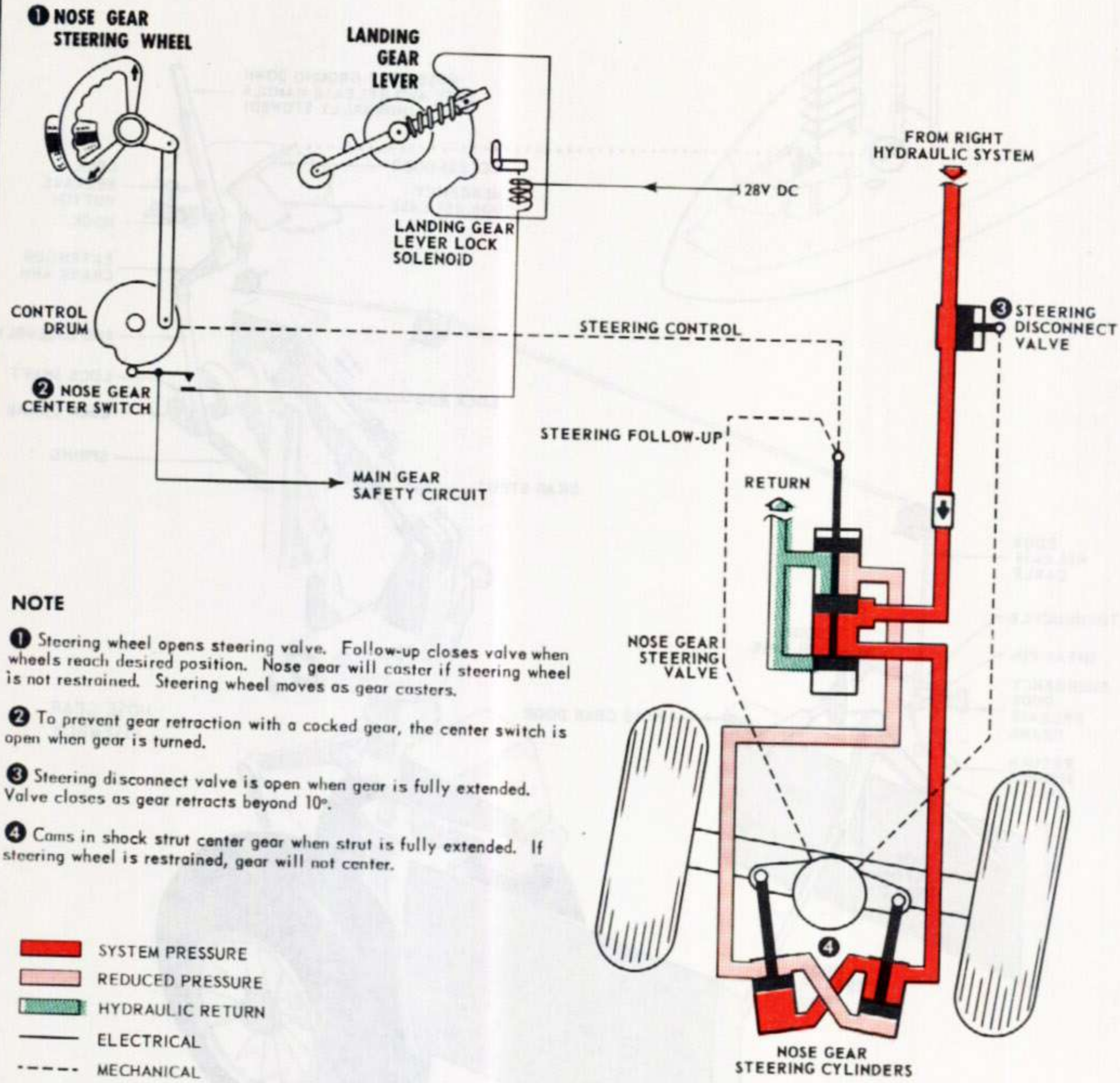


Figure 1-51 (Sheet 2 of 2)

NOSE GEAR STEERING SYSTEM



NOTE

❶ Steering wheel opens steering valve. Follow-up closes valve when wheels reach desired position. Nose gear will caster if steering wheel is not restrained. Steering wheel moves as gear casters.

❷ To prevent gear retraction with a cocked gear, the center switch is open when gear is turned.

❸ Steering disconnect valve is open when gear is fully extended. Valve closes as gear retracts beyond 10°.

❹ Cams in shock strut center gear when strut is fully extended. If steering wheel is restrained, gear will not center.

F-90

Figure 1-52

NOSE GEAR STEERING SYSTEM

The nose gear is steerable through approximately 55 degrees each side of center, but is normally limited to 45 degrees each side of center. The nose gear is turned by two hydraulically operated cylinders while the gear is down and locked. When the nose landing gear retracts, hydraulic steering pressure is shut off by a nose gear operated steering disconnect valve. With the airplane airborne the nose wheels automatically center by means of a centering mechanism. When the nose landing gear is extended the steering disconnect lever actuates the hydraulic steering disconnect valve to the open position directing hydraulic pressure to the nose gear for steering. In the event of hydraulic pressure failure, or if the nose gear steering wheel is not restrained or turned, the nose gear will caster allowing directional control of the airplane by engine and brake operation. See figure 1-52.

NOSE GEAR STEERING WHEEL

Nose gear steering is accomplished by a steering wheel (5, figure 1-13) mounted forward and to the left of the pilot's control column. An arrow on the wheel and a mark on a caution plate aft of the wheel align to indicate the nose gear is centered. Visual markings are provided to indicate when the nose wheel is at 45 degrees either side of center. The nose gear turns in the direction selected by the steering wheel and remains in that position until the steering wheel is turned to a new position or released. A cable follow-up system will return the nose gear to its set course should the wheel be deflected momentarily by some obstacle.

WARNING

When the airplane is being towed, depressurize the right hydraulic system and do not turn or hold steering wheel as this action may result in injury to personnel and damage to the steering mechanism.

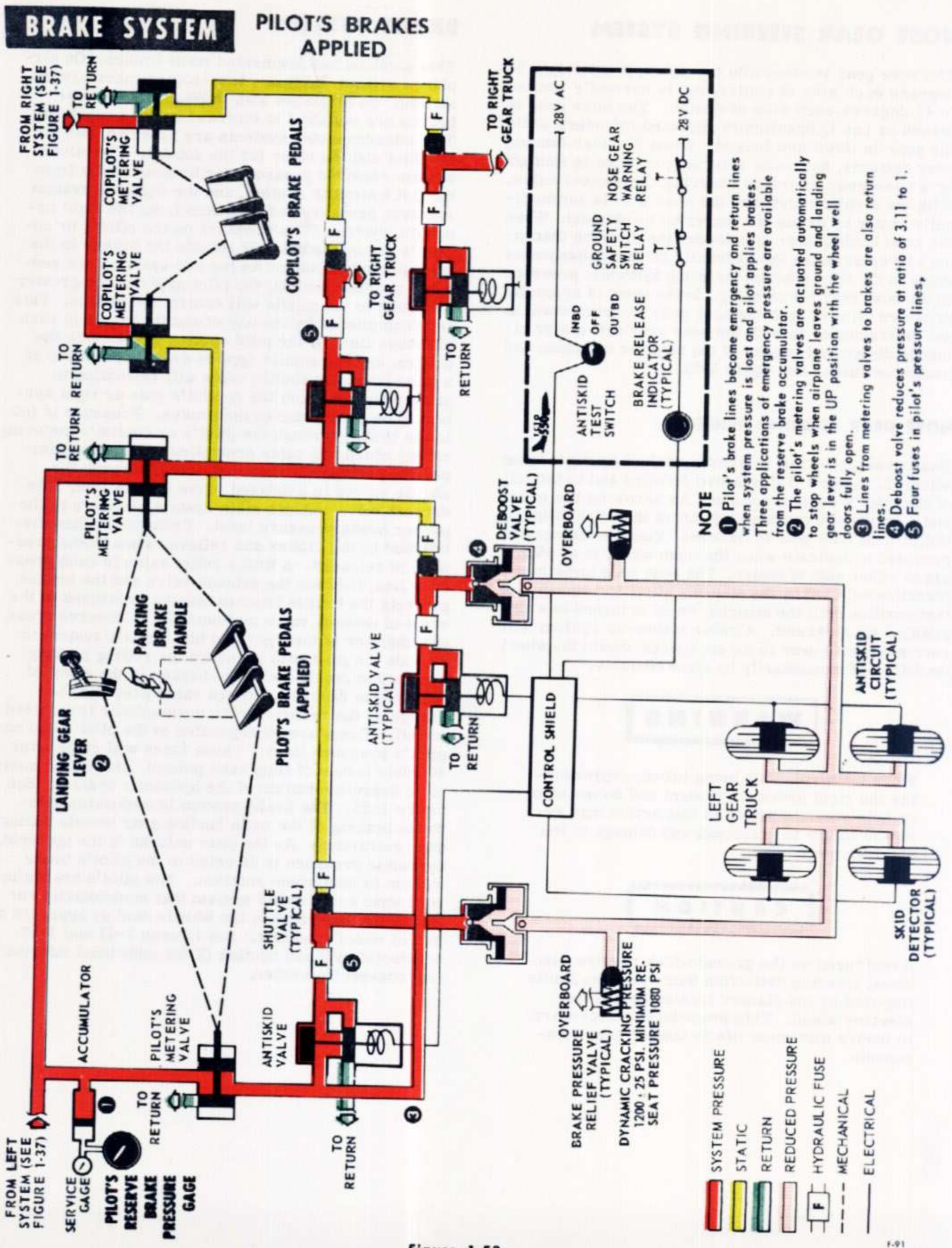
CAUTION

Avoid turns on the ground which require nose wheel steering deflection more than the limits imposed by the placard located behind the steering wheel. This procedure is necessary to insure maximum life to landing gear components.

BRAKE SYSTEM

This airplane has segmented rotor brakes. On airplanes without 1518 622, four-rotor brakes are installed. On airplanes with 1518 622, five-rotor brakes are installed to increase braking capability. Two interconnected systems are provided, one for the pilot and the other for the copilot. The pilot's system receives pressure for braking action from the left hydraulic system, and the copilot's system receives pressure to his brakes from the right hydraulic system. Toe pressure on the pilot's or copilot's rudder pedals will actuate the brakes in the conventional manner. As the two systems are separate and independent, the pilot applying the greater pressure to the pedals will control the brakes. This is accomplished by the use of shuttle valves in each pressure line. If the pilot applies pressure to the brakes, and the copilot applies greater pressure at a later time, the shuttle valve will reposition to allow pressure from the copilot's side or right system to be distributed to the brakes. Pressure is fed to the brakes through the pilot's or copilot's metering valves which are cable controlled from the rudder pedals; pressure is then distributed through the shuttle valves to a deboost valve in each line. The deboost valve reduces main system pressure to the proper brake pressure level. Pressure is then distributed to the brakes and relieved when brake pressure is released. A brake relief valve in each pressure line, between the deboost valve and the brakes, protects the brakes from excessive pressures in the event of deboost valve malfunction. A reserve brake accumulator is incorporated into the left system to provide the pilot with pressure for setting parking brakes and pressurizing the brakes in the event of left system failure. A check valve prevents the charge on the reserve brake accumulator from bleeding off. Fuses are incorporated in the pilot's and copilot's pressure lines. These fuses will close after 40 cubic inches of fluid have passed, preventing complete depressurization of the hydraulic system. See figure 1-53. The brake system incorporates automatic braking of the main landing gear wheels during gear retraction. As the gear unlocks in the up cycle, hydraulic pressure is directed to the pilot's brake system to stop wheel rotation. The pilot's brakes incorporate an anti-skid system that momentarily releases the brakes when the wheels skid or approach a locked wheel condition. See figures 1-47 and 1-53. See Section VII and Section IX for additional information concerning brakes.

BRAKE SYSTEM



NOTE

❶ Pilot's brake lines become emergency and return lines when system pressure is lost and pilot applies brakes. Three applications of emergency pressure are available from the reserve brake accumulator.

❷ The pilot's metering valves are actuated automatically to stop wheels when airplane leaves ground and landing gear lever is in the UP position with the wheel well doors fully open.

❸ Lines from metering valves to brakes are also return lines.

❹ Deboost valve reduces pressure at ratio of 3.11 to 1.

❺ Four fuses in pilot's pressure lines,

Figure 1-53

NOSE GEAR WHEEL SNUBBER BRAKE

To eliminate noise and vibration, a nose wheel snubber has been placed in the nose gear wheel well. This snubber consists of two lined brake shoes on spring arms. As the gear is retracted the tread surface of the tires contact the brake shoes, stopping rotation.

ANTI-SKID BRAKE SYSTEM (Less 707-320B/C)

The pilot's brakes have an anti-skid system (figure 1-53) that automatically prevents prolonged wheel skidding. Skid prevention minimizes tire wear, prevents blowouts and permits maximum brake efficiency to be achieved safely. This system, which affects only the pilot's brakes, can be overridden by the copilot's brakes. The system consists of a skid and locked wheel detector unit in the axle of each wheel of the main landing gear, four brake release valves (one for each pair of tandem wheels), and two control shields. The control shields, one for each main gear, house the relays that control the brake release valves. When the pilot's brakes are applied and conditions are such that one or more tires approaches a skid, the skid detector senses that the rpm of the wheel is dropping too rapidly and actuates the brake release valve. The brake release valve removes the pressure from the brakes on the skidding wheel and its tandem. With the brake pressure relieved, the wheel accelerates and the skid detector de-energizes the brake release valve to restore effective braking. The skid detector is operative at all times but locked wheel detector operation depends upon the velocity of the airplane. The locked wheel detector causes the brake release valve to interrupt braking when a wheel or wheels rotates less than 28 rpm (4 knots) while the other wheels are rotating at higher speeds. On airplanes 1 ▶ 70, locked wheel protection becomes operative when the airplane accelerates above either 12 or 17.5 knots (approximate) and restores conventional braking when the airplane decelerates below either 3 or 8 knots (approximate) depending upon the type of control shield in use. For airplanes 71 ▶, locked wheel protection cuts-in at 17.5 knots and cuts-out at 8 knots. The anti-skid system requires 28 volts DC and is operative when:

A. The nose gear is down and locked.

B. The ANTI-SKID circuit breaker on T-R BUS NO. 2 section of the MCBP is closed (figure 1-35, sheet 2).

C. The NOSE LANDING GEAR WARNING circuit breaker on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2) is closed for airplanes 1 ▶ 14 or the NOSE LANDING GEAR POS & WARN circuit breaker on the SBCBP (figure 1-35, sheet 1) is closed on airplanes 15 ▶

WARNING

Pull the ANTI-SKID circuit breaker if there is only reserve brake pressure available for braking. Three cycles of the anti-skid system will deplete the pressure in the brake accumulator and result in a loss of brakes. Loss of accumulator pressure could be experienced in a very short time since the anti-skid system can cycle as fast as 3 cycles per second.

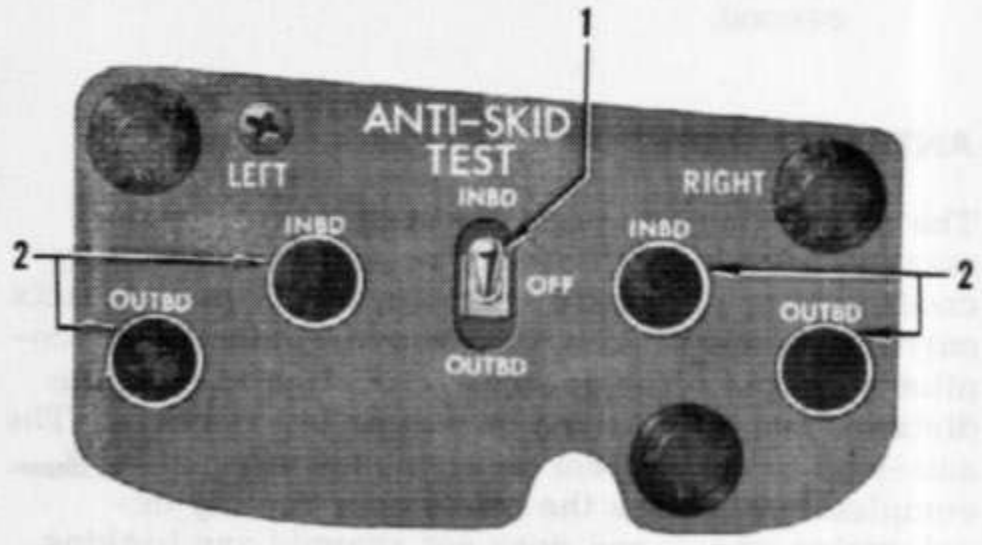
ANTI-SKID BRAKE SYSTEM (With 707-320B/C)

The modulating anti-skid brake system provides maximum braking efficiency regardless of runway conditions or pilot skill. This system, which affects only the pilot's brakes, can be overridden by the co-pilot's brakes. The greatest reduction in stopping distance can be realized on wet or icy runways. The anti-skid brake system on airplanes without 707-320B/C completely releases the brake on a rapidly decelerating wheel, and does not reapply any braking force until the wheel has accelerated to free rolling speed. The pilot thus must constantly regulate the braking force to produce maximum braking, without going into full release anti-skid. The modulating anti-skid system, however, anticipates the impending skid by monitoring rate of change of wheel speed and immediately reduces braking force only enough to allow the wheel to resume speed. The modulating control then reapplies a braking force slightly less than that which resulted in the skid. The modulating system thus will adjust the pressure selected by the pilot to give the best possible stopping performance under existing airplane and runway conditions. The system consists of three main elements, an axle-mounted skid detector for each wheel, one control shield which computes wheel speed information, and a solenoid-operated, modulating anti-skid valve for each pair of wheels. The control panel (figure 1-54) for the system is located on the pilot's side panel and contains a test switch and four anti-skid indicators. The test circuit and indicators provide a system check for proper operation either in flight (gear down and locked) or on the ground. The indicators also operate when the anti-skid system is operating normally. The landing gear must be down and locked before the anti-skid system is operative. The anti-skid system is inoperative at wheel speeds below 160 rpm

ANTISKID PANEL

TCTO 550





F1912

1. ANTISKID TEST SWITCH
2. ANTISKID INDICATORS (2 PLACES)

Figure 1-54

(20 knots). Operating power is 28 volt DC through two circuit breakers marked ANTI-SKID INBOARD and ANTI-SKID OUTBOARD on the T-R BUS NO. 2 section and a circuit breaker marked ANTI-SKID SAFETY RELAY on the T-R BUS NO. 1 section of the MCBP (figure 1-35)

CAUTION

On airplanes with TCTO 550 (Mark II modulated antiskid brake system), all HF radio transmissions should be avoided during taxi, takeoff, and landing roll. Simultaneous keying of an HF radio and the application of the pilot's brakes may generate electronic interference in the antiskid system and result in the brakes "releasing" with temporary loss of the pilot's brakes. Momentary interruption of electrical power by operation of the battery switch from NORMAL to EMERGENCY or EMERGENCY to NORMAL and by actuation of the water injection system may also result in momentary release.

WARNING

If there is only reserve brake pressure available for braking, excessive cycling of the antiskid system will deplete the pressure in the brake accumulator rapidly and may result in loss of brakes. Pull ANTI-SKID INBOARD and OUTBOARD circuit breakers for maximum braking capability when the left hydraulic system is depleted. Use light braking as far as possible and do not "pump" brake pedals.

NOTE

When the parking brake is set, the anti-skid valves will be deactivated. In this case a REL (release) indication will not result in a release of the corresponding brakes.

Anti Skid Test Switch and Indicators

The antiskid test switch (1, figure 1-54) is on the antiskid panel, and is used with the antiskid indicators (2, figure 1-54) to test the antiskid system before taxiing and before landing. The switch has INBD--OFF-OUTBD positions and is spring-loaded to OFF. When the airplane is on the ground, all four antiskid indicators will be blank. Movement of the antiskid test switch to the OUTBD position electrically simulates rotation of the outboard wheels. The system will interpret this as locked inboard wheels and thus show REL (release) on the inboard indicators. Movement of the test switch to INBD will have the opposite effect.

NOTE

When the antiskid test switch is released, the blank indicators may show REL momentarily.

When the airplane is in flight and the gear is down and locked, all indicators will show REL. Movement of the test switch to OUTBD will then cause the outboard indicators to be blank. Movement of the switch to INBD will cause the inboard indicators to be blank. Operating power for the test switch is 28V AC through a circuit breaker marked ANTI-SKID TEST on the MCBP (figure 1-35).

CAUTION

Do not operate the test switch during taxi, takeoff and landing.

PILOT'S RESERVE BRAKE PRESSURE GAGE

A reserve brake pressure gage (4, figure 1-38) is on the hydraulic control panel. This gage reads directly from a brake accumulator in the left hydraulic system. Under normal conditions, system pressure will be read on the gage. In the event of engine-driven hydraulic pump failure of the left system, the left system hydraulic pressure gage will drop to preload pressure and the pilot's reserve brake pressure gage will remain at system pressure. If brakes are actuated, the pilot's reserve brake pressure gage will drop to preload pressure of the accumulator. If the left system auxiliary pump switch is positioned to RESERVE BRAKE when left system pressure is low, the left system auxiliary pump will energize, and bring the pilot's brake system pressure to normal.

PARKING BRAKE HANDLE

The parking brake handle (3, figure 1-22) is on the control stand. Parking brakes are set by applying toe pressure to the pilot's rudder pedals only (13, figure 1-13) and pulling the parking brake handle upward. This action locks the rudder pedals in the depressed position to retain pressure in the brake lines. The parking brakes are released when both pilot's rudder pedals are depressed. Pressure will be maintained on the parking brakes for a minimum period of five hours with a temperature change of 40° F above or below the original parking temperature.

CAUTION

To insure correct parking brake application on both trucks, the angular relationship of the pilot's brake pedals must be checked after actuating the parking brake handle. Both pedals must remain depressed at the same angle. If one pedal does not remain depressed, release parking brakes and reapply correctly.

BRAKE PEDALS

Refer to RUDDER PEDALS in this Section.

INSTRUMENTS

NOTE

For information concerning the pilot's and copilot's attitude indicators and slip indicators, refer to ATTITUDE DIRECTOR INDICATOR (ADI) under INTEGRATED DUAL FLIGHT DIRECTOR/ROTATION GO-AROUND SYSTEM, Section IV.

Only those instruments which are not properly a part of a complete system are listed in figure 1-56. These instruments include pitot-static operated instruments (see figure 1-55), alternating-current operated instruments, direct-current operated instruments, magnetic instruments, and mechanical instruments.

ACCELEROMETER

An accelerometer (1, figure 1-17) in on the pilots' center instrument panel. This self contained instrument, graduated in g units, indicates loads imposed on the airplane. The instrument contains a dial and a main pointer for continuous indications, and two auxiliary pointers which show maximum plus and minus readings. In straight and level unaccelerated flight, the main pointer will indicate 1g, the normal force of gravity.

NOTE

All of the accelerometer "G" indications that exceed the instrument limits do not necessarily represent an overloading of the airplane structure. They may be local accelerations due to structural flexing and high acceleration of the instrument itself rather than actual change of lift over the wings. The 135 fuselage and wings are flexible and have a natural tendency to react in bending at a certain frequency in rough air (vertical gusts). The small accelerometer is influenced by this structural flexing since it is mounted near the end of the long flexible fuselage, and it is also influenced by the instrument panel shock mounting. For these reasons it will show very high readings at high vertical gust frequencies, rapid fore and aft control column movement, hard landings, or even taxiing on rough surfaces. Such readings represent high accelerations of the instrument itself and not true loads imposed on the airplane structure. The accelerometer will give reliable steady readings during maneuvers such as in a bank, a smooth steady pullout from a nose down attitude or a smooth negative "G" pushover. The factors of speed, altitude, weight and fuel loading make it very difficult to correlate actual loading of the structure with the cockpit accelerometer. However, if any doubt exists as to exceeding "G" limits in flight, make a Form 781 entry.

FREE AIR TEMPERATURE GAGE (OAT)

The pilots' free air temperature gage (24, figure 1-19) and the navigator's free air temperature gage (16, figure 4-43) are calibrated in degrees Centigrade ranging from +50°C to -70°C. Temperature bulbs for the gages are on the lower surface of the fuselage approximately 20 inches aft of the radome, 5 inches each side of the airplane centerline. Operating power is 28 volt DC through a circuit breaker marked FREE AIR TEMPERATURE INDICATOR on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2). The gages will indicate free air temperature (ram air temperature in flight) whenever airplane power is available.

PITOT-STATIC SYSTEM (TYPICAL)

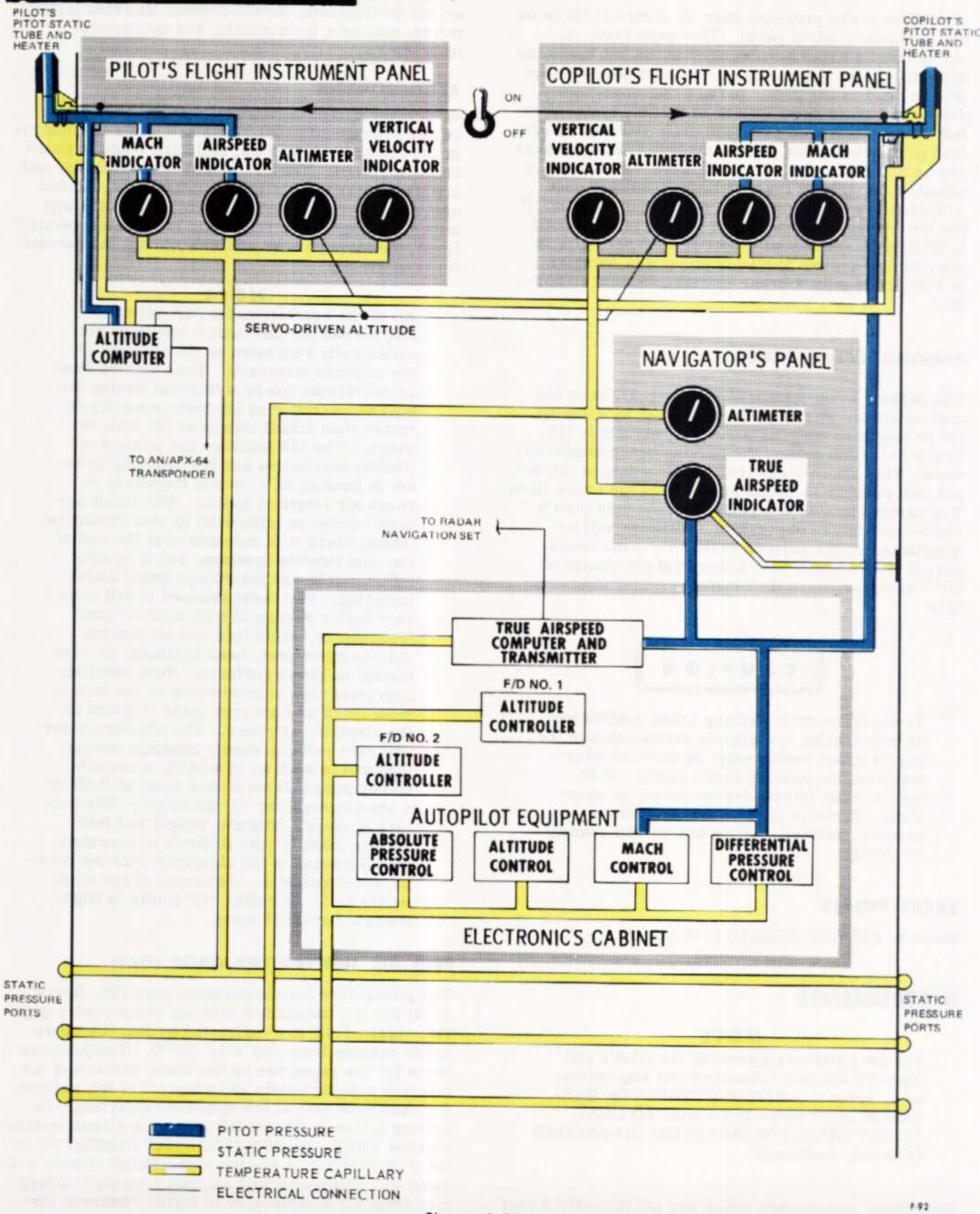


Figure 1-55

MISCELLANEOUS INSTRUMENTS

INSTRUMENT	OPERATING POWER	POWER SOURCE	CIRCUIT PROTECTION LOCATION
MACH INDICATORS	Pitot-Static System	Pitot-Static System	None
AIRSPEED INDICATORS	Pitot-Static System	Pitot-Static System	None
VERTICAL VELOCITY INDICATORS	Pitot-Static System	Pitot-Static System	None
ALTIMETERS ❶	115 Volt AC	See Fig. 1-28	MCBP
HEADING INDICATORS			
N-1 COMPASS (See Sect IV)	115 Volt AC (28 Volt DC Control)	See Fig. 1-36	See Fig. 1-36
J-4 COMPASS (See Sect IV)	115 Volt AC	See Fig. 1-36	See Fig. 1-36
MAGNETIC COMPASS	Earth's Magnetic Field	Earth's Magnetic Field	None
ATTITUDE INDICATORS (See ADI, Section IV)			
SLIP INDICATORS (See ADI, Section IV)			
RATE OF TURN INDICATORS (See ADI, Section IV)			
FREE AIR TEMPERATURE GAGE	28 Volt DC	See Fig. 1-36	See Fig. 1-36
ACCELEROMETER	Mechanical	None	None
CLOCK	Mechanical	Winding	None
DESTINATION INDICATOR 98	28 Volt DC	ASN-7 System	None

❶ REMOTELY OPERATED FROM THE ALTITUDE COMPUTER

Figure 1-56

Figures 1-57 and 1-58 (Deleted)

ALTIMETERS

Altimeter (Navigator's)

A Type AAU-8/A or MA-1 altimeter is installed on the navigator's instrument panel (15, figure 4-43). 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 1-60) indicates hundreds of feet altitude, the broad pointer (2, figure 1-60) indicates thousands of feet, and the small pointer with the triangular index marker on the outer edge of the dial (1, figure 1-60) indicates tens of thousands of feet. The barometric scale (3, figure 1-60) and the barometric pressure set knob (6, figure 1-60) are interconnected to allow the altimeter to be set to station barometric pressure corrected to sea level pressure. The low altitude warning symbol (5, figure 1-60) 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 barometric scale. Check all three pointers to be sure the altimeter indicates the proper field elevation before takeoff. The altimeter correction card or the position correction charts must be used to fly corrected altitude for traffic separation.

Altimeters (Pilot's and Copilot's)

A type AAU-19/A altimeter (figure 1-59) is on the pilot's and copilot's instrument panels. The altimeter has a counter-drum-pointer display. The counters (5, 7 and 8, figure 1-59) and drum provide a direct digital readout in hundreds and thousands of feet. The single pointer (2, figure 1-59) repeats the 100-foot indications of the drum, serving both as a vernier for the drum and as a quick indication of the rate and direction of altitude change. The altimeter can be operated in either the servo (computer controlled) mode or the standby (static pressure) mode as selected by the reset-stby lever (4, figure 1-59). The reset-stby lever is spring loaded to an unmarked neutral position between RESET and STBY positions. When in the standby mode, a STBY flag (1, figure 1-59) will be in sight on the instrument face. A barometric pressure set knob (6, figure 1-59) and barometric scale (3, figure 1-59) are provided for adjusting the altimeter setting. A field elevation check will be made in both modes using +75 feet as the maximum altimeter error allowable in either case. In addition, readings between the two modes should correspond within 75 feet.

SERVO MODE. Servo mode is designed to be the primary mode of operation and should be used unless failure prohibits. In the servo mode, the basic pressure altitude indication of the instrument is servo-corrected for position error by the "compensated cam" of the CPU-66/A-1 altitude computer.

NOTE

- In the servo mode, the altitude indication on the AAU-19/A altimeter is accurate within a tolerance considered acceptable without an additional position error correction.
- The allowable difference between two AAU -19/A altimeters, both in SERVO MODE, is 75 feet at all altitudes and speeds throughout the operating range.

The altimeter is placed in servo mode by momentarily positioning the reset-stby lever to RESET. It may be necessary to hold the lever in the RESET position up to three seconds. The STBY flag will disappear. A failure monitor circuit will automatically return the system to standby mode and the STBY flag will appear for any of the following malfunctions:

- Primary power failure or interruption
- Servo amplifier or motor failure
- Switch failure
- Relay failure
- Monitor failure

The CPU-66/A-1 computer error sensing system senses error in a servo loop that takes its input from a pneumatic sensor within the computer. All error sensing is downstream of the sensor and as a result there is no monitor function applied to the sensor itself. The AAU-19/A altimeter also has a means of monitoring internal failures which will revert the altimeter to STBY. In addition, it is designed so as to be capable of accepting electrical signals from the computer which differ from the uncorrected pneumatic altitude (standby mode) by as much as ±4500 feet or more without the altimeter monitor inadvertently switching the altimeter to the standby mode. This is to compensate for large altitude position errors in some airplanes. Since a single CPU-66/A-1 computer drives both altimeters in the SERVO mode, no means of comparison between AAU-19/A altimeters is available if both are in RESET. This condition can be circumvented by operating one altimeter in RESET and the other altimeter in STANDBY. Both altimeters will then display data derived from separate sources and provide a means of comparison and independent backup.

WARNING

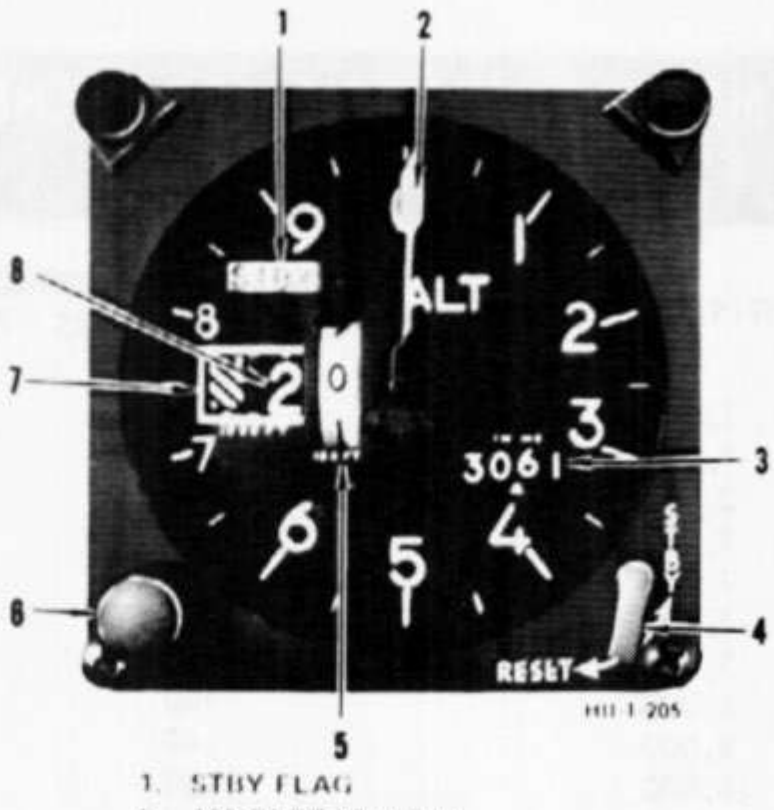
- If the computer pneumatic sensor were to fail or become locked in a particular position, or system failures - such as pitot or static source icing, ice or water blockage in static lines, leaks, or pitot head damage - were to occur, the computer could deliver erroneous data to the altimeters. The airplane could experience a large change in altitude before the AAU-19/A error detection circuit would react and switch the system to standby. Erroneous data would also be delivered to the transponder and relayed, on interrogation, to the ground radar agency.
- If it is determined that the altitude computer (CPU-66/A-1) has failed or is delivering erroneous data, place the mode C enabling switch to the OUT position and advise the ARTC center.

If the altimeter reverts to standby mode automatically, attempt should be made to reset to the servo mode. If the malfunction was transient, the altimeter will reset. If the fault remains, the altimeter will not reset but will operate normally in the standby mode.

NOTE

The altimeter correction card is not used in servo mode.

ALTIMETER (AAU-19/A)



1. STBY FLAG
2. 100 FOOT POINTER
3. BAROMETRIC SCALE
4. RESET STBY LEVER
5. 100 FOOT COUNTER
6. BAROMETRIC PRESSURE SET KNOB
7. 10,000-FOOT COUNTER
8. 1000-FOOT COUNTER

NOTE

INDICATED ALTITUDE IS 2000 FEET.

Figure 1-59

STANDBY MODE. In the standby mode, the altimeter operates solely from the static pressure system. A black-on-red STBY flag will be in view, indicating that the instrument is providing a normal static pressure reading and that the displayed altitude is not corrected for position error. The instrument will be in standby mode when aircraft power is first applied and will remain in standby mode until the reset-stby lever is momentarily placed to RESET. The altimeter may be shifted from servo to standby mode by holding the reset-stby lever in the STBY position until the STBY flag appears. Normally 1 to 3 seconds are required for this to happen due to the time delay built into the instrument to prevent nuisance tripoffs. When the altimeter is in the standby mode, an internal vibrator will operate continuously. The vibrator minimizes mechanical friction, enabling the instrument to provide a smoother display during altitude changes. Should vibrator failure occur, the altimeter will continue to function but a less smooth movement of the instrument display will be evident with changes in altitude. The copilot's and pilot's altimeter vibrators receive dc power from circuit breakers marked "ALT VIBRATOR" on the (CIPP) panel and "PILOT ALTM VIBRATOR" on the (SBCBP) panel respectively.

WARNING

- When the altimeter is operating in standby mode, the altimeter correction card or the position correction charts must be used to fly corrected altitude for traffic separation. Airplane position error only is indicated on the card.
- If the altimeter's internal vibrator is inoperative, the 100-foot pointer may momentarily hang up when passing through "0" or 12 o'clock position. The pointer hangup can be minimized by tapping the altimeter case. Pilots should be especially watchful for this failure when their minimum approach altitude lies within the 800 to 1000 foot part of the scale, such as 1800 to 2000 feet or 2800 to 3000 feet, and should use any appropriate altitude backup information available.

CAUTION

During normal use of the barometric setting system, momentary locking of the barocounters may be experienced. If this occurs, do not force the setting. Application of force may cause internal gear disengagement and result in excessive altitude errors in both standby (STBY) and servo (RESET) modes. If locking occurs, the required setting may sometimes be established by rotating the knob a full turn in the opposite direction and approaching the setting carefully.

ALTITUDE COMPUTER (CPU-66/A-1). The CPU-66/A-1 altitude computer provides the same inputs to both the AAU-19/A altimeter and the AN/APX-64 IFF. The operating mode of the AAU-19/A altimeter (RESET or STBY) has no effect on the CPU-66/A-1 computer inputs to the IFF transponder. The computer measures pressure altitude referenced to standard sea level pressure of 29.92 and corrects for position error. For IFF functions, this corrected altitude is encoded to the nearest 100-foot level and is furnished to the IFF transponder, which in turn automatically relays the corrected altitude as a pulse train to the Ground Control Center, upon interrogation, provided the mode C enabling switch on the control panel is in the ON position. For altimeter functions, this corrected altitude is used to drive the altimeter display when the altimeter is in servo mode. With an altimeter setting of 29.92, the altimeter altitude displayed will correspond to the

computer altitude. Altimeter settings other than 29.92 introduce a corresponding difference between the altimeter altitude displayed and the computer altitude. If either the pilot's, copilot's, or both altimeters fail (STBY flag showing), the computer may still operate properly and transmit correct altitude data to the transponder. With both altimeter flags showing simultaneously, it may be determined if the altimeters or computer failed by using the IFF self-test feature for mode C. With both flags showing, and the system does not self test in mode C, the computer may be assumed to have failed. If both altimeter flags are showing and the system self tests in mode C properly, the two altimeters have failed in the SERVO mode or have been placed in STBY. In this case, a subsequent failure of the computer would not be indicated to the pilots since the same AAU-19/A STBY flag is used to indicate a failure in the altimeter or the computer. Periodic mode C checks while cruising and a check prior to a change of altitude should be made to assure correct computer operation. The mode C self-test check will not detect blockage of static lines to the computer, only a failure within the computer. The computer receives ac power from a circuit breaker marked "ALTITUDE COMPUTER" on the (MCBP) panel.

Altimeter Correction Card Holders

A pilot's and copilot's altimeter correction card holder is installed on the hinged plate adjacent to the magnetic standby compass. A third card holder is installed on the navigator's instrument panel. The holders contain copies of AFTO Form 146 (figure 1-60), which is a correction card for off-setting the position error of the airplane static pressure system. Position error information for altitude correction is contained in Part 1 of the Appendix, T.O. 1C-135(K)A-1-1, and is used when AFTO Form 146 is not installed.

ALTIMETER ERROR CROSS-CHECK

Pneumatic Cross-Check Table

The altimeter pneumatic cross-check table (figure 1-59A) presents the allowable INFLIGHT difference between standby mode readings of two AAU-19/A altimeters, or between the standby mode of an AAU-19/A and the readings of an AAU-8/A or MA-1 altimeter, or between two AAU-8/A or MA-1 altimeters.

ALTIMETER PNEUMATIC CROSS-CHECK TABLE (INFLIGHT)

ALTITUDE - FEET	ALLOWABLE DIFFERENCE BETWEEN INDICATORS - FEET
1,000	70
1,500	80
2,000	80
2,500	90
3,000	90
4,000	100
5,000	110
6,000	120
8,000	140
10,000	160
12,000	180
14,000	20
15,000	21
16,000	220
18,000	24
20,000	26
22,000	28
25,000	31
30,000	360
35,000	410
40,000	460
45,000	510
50,000	560
55,000	1200

EXAMPLE:

The indications between the readings of the copilot's AAU-19/A altimeter in STBY mode and the navigator's AAU-8/A or MA-1 altimeter at 35,000 feet should agree within 410 feet of each other.

NOTE

This table is common to all airplanes and does not depend on speed and airplane configuration.

Figure 1-59A

Servo-To-Pneumatic Cross-Check Table

During normal operations, a difference in altitude readings may be observed between the SERVO and PNEUMATIC modes of AAU-19/A altimeters or between the servo mode of an AAU-19/A altimeter and the reading of a pneumatic altimeter (AAU-8 or MA-1). This SERVO-TO-PNEUMATIC CROSS-CHECK TABLE presents a ± TOLERANCE acceptable after airplane position error has been applied to the STBY mode of the AAU-19/A or to the reading of a pneumatic altimeter. The ± TOLERANCE consists of averages of cumulative inherent instrument error (Specification Allowable Scale Error) of the CPU-66/A computer and the altimeters (servo and pneumatic).

ALTIMETER SERVO-TO-PNEUMATIC CROSS-CHECK TABLE

PRESSURE ALTITUDE - FEET	TOLERANCE - FEET
0	± 75 Zero Speed
5,000	± 100 Inflight
10,000	± 100 Inflight
20,000	± 150 Inflight
30,000	± 200 Inflight
40,000	± 250 Inflight

NOTE

- If the difference between the SERVO (RESET) and PNEUMATIC (STBY) mode indications of a single altimeter (or altimeters) exceeds the ± TOLERANCE in the cross-check table after airplane position correction is applied to the STBY mode, determine the faulty mode and switch that altimeter to the other mode. If the fault cannot be isolated to a single mode (Reset or STBY) both modes of one of the altimeters may be malfunctioning and a comparison with the Navigator's pneumatic altimeter (AAU-8 or MA-1) should be made. Enter readings in excess of the CROSS-CHECK TABLE ± TOLERANCE in the Form 781.

- Cross-checks at the elevations shown on the chart are not mandatory. In-flight altimeter checks are suggested at the discretion of the pilot when excessive errors are suspected.

Figure 1-59B

ALTIMETER SETTINGS

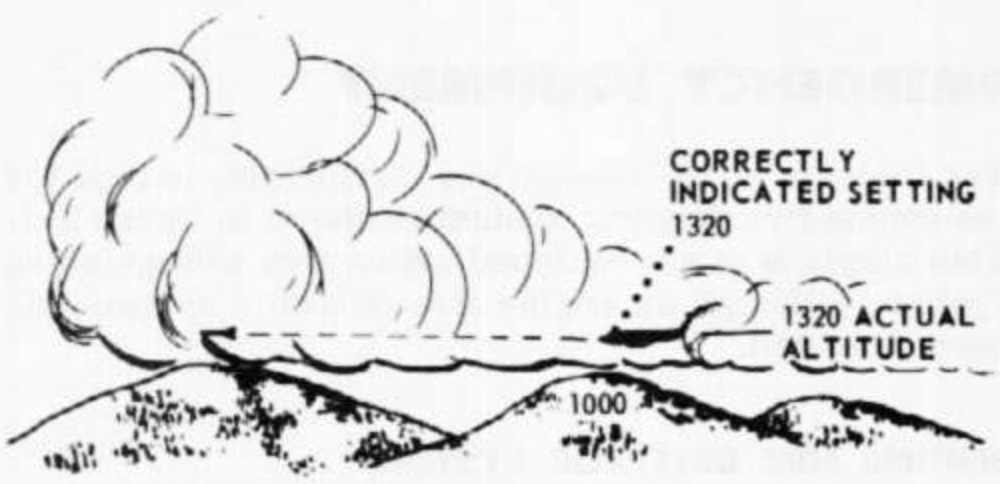
AAU-8/A OR MA-1

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

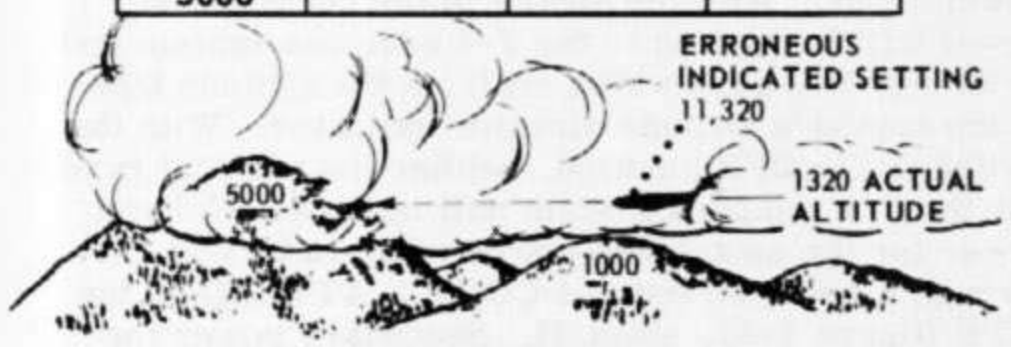
TYPE		EXT CONFIG	
ALTIMETER SERIAL NO.			
ASSIGNED ALTITUDE	INDICATED ALTITUDE HOLD AIRSPEED	CRUISE AIRSPEED	MAX AIRSPEED
50,000			
45,000			
40,000			
35,000			
30,000			
25,000			
20,000			
CHANGE TO 29.92 AT 18,000			
15,000			
10,000			
5000			

(SAMPLE ONLY) ALTIMETER CORRECTION CARD

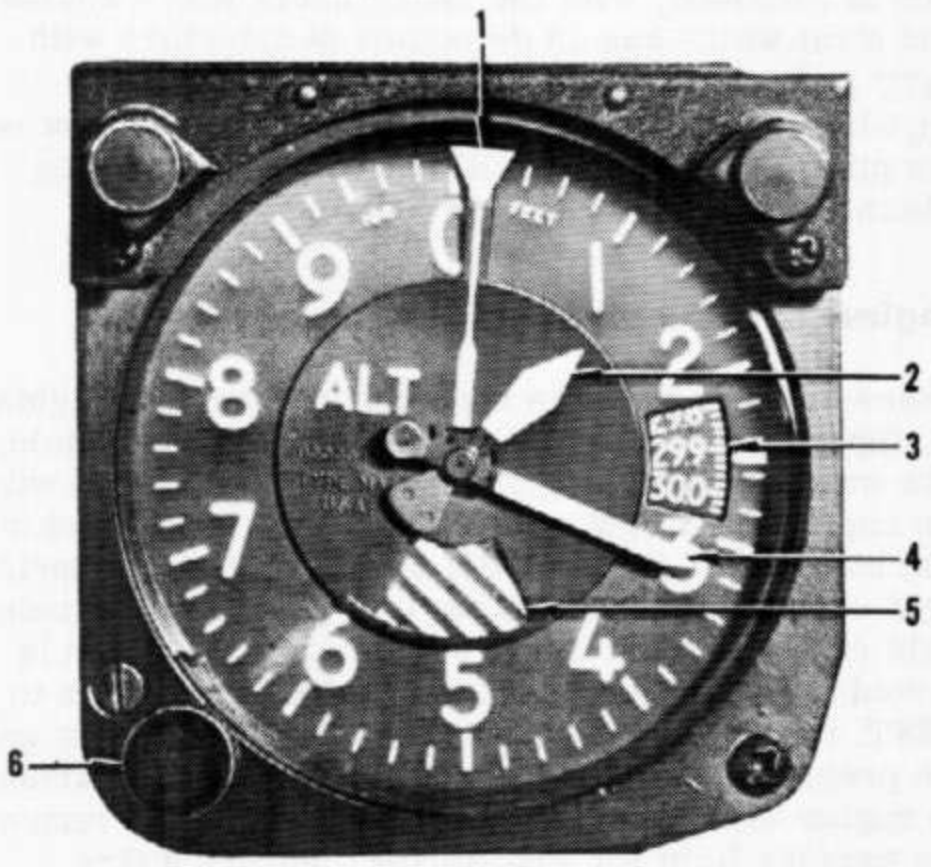
AFTO FORM 146, AUG 67 — ALTIMETER CORRECTION



CORRECTLY INDICATING ALTIMETER

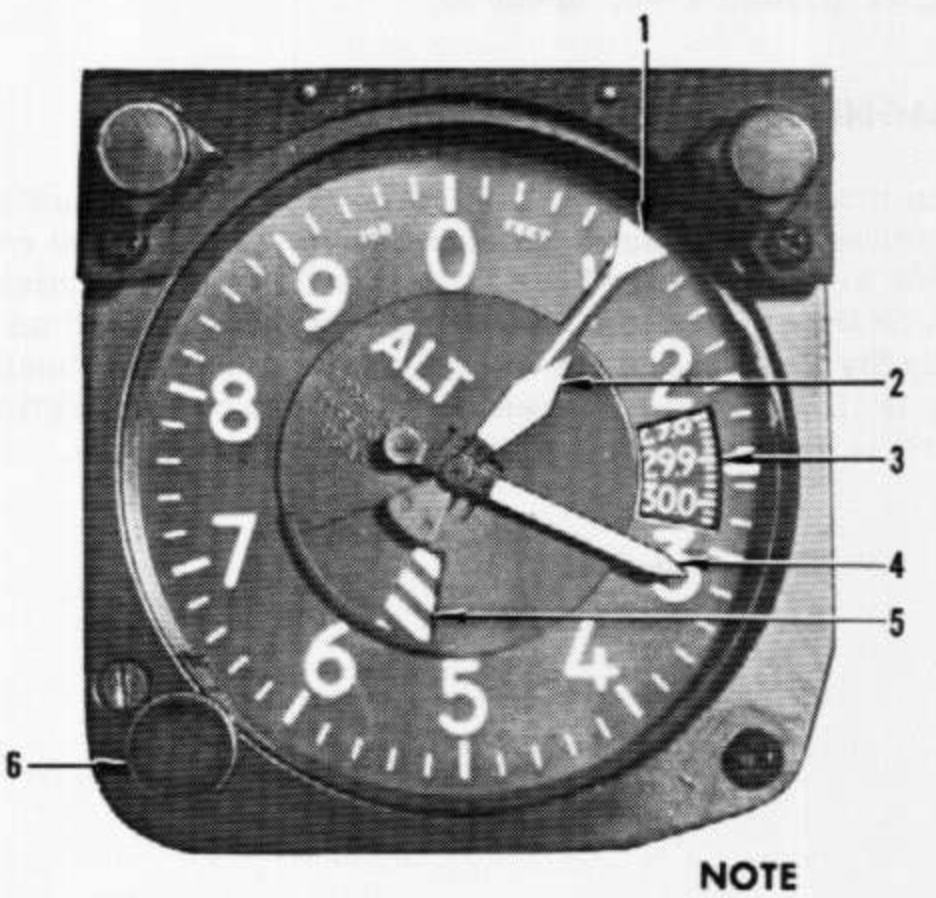


ERRONEOUSLY INDICATING ALTIMETER



INDICATED

SETTING – 29.92 IN. HG
ALTITUDE – 1320 FEET



INDICATED

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

NOTE

Altimeter setting is 10,000 feet high

F-96

Figure 1-60

PILOT'S INSTRUMENT GYROS SWITCH

This switch (17, figure 1-18) on the pilot's flight instrument panel has ON--OFF positions and controls the N-1 compass and pilot's attitude indicator power relay. With the switch in the ON position, power will be applied to the N-1 compass system and to the vertical gyro which controls the attitude tape in the pilot's attitude director indicator. With the switch in the OFF position, neither the vertical gyro nor the N-1 compass system will operate. Operating power for the switch and power relay is 28 volt DC through a circuit breaker marked N-1 COMPASS & PILOT ATTITUDE IND on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2).

COPILOT'S INSTRUMENT GYROS SWITCH

This switch (20, figure 1-19) on the copilot's flight instrument panel has ON--OFF positions and controls the J-4 compass and the copilot's attitude indicator power relay. With the switch in the ON position, power will be applied to the J-4 compass system and to the vertical gyro which controls the attitude tape in the copilot's attitude director indicator. With the switch in the OFF position, neither the vertical gyro nor the J-4 compass system will operate. Normal power for the switch and power relay is 28 volt DC through a fuse marked J-4 COMP & ATT IND on the CIPP (figure 1-35, sheet 1). Secondary power for the switch and power relay is 28 volt DC through a circuit breaker marked COPILOT'S FLIGHT INSTRUMENTS on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2).

MAGNETIC COMPASS

The magnetic compass (7, figure 1-5) is mounted beneath the overhead panel between the pilot and copilot windshields. This compass is used to cross-check other heading indicating instruments and as a standby compass in the event of failure of other heading indicating instruments. A compass correction card is mounted below the magnetic compass.

NOTE

An error up to 5° may exist in the magnetic compass when the landing gear lever latch solenoid is energized. This solenoid is energized anytime the gear is up and T-R BUS NO. 1 is energized. When accurate inflight magnetic compass readings are desired, pull the landing gear lever latch circuit breaker marked LANDING GEAR LEVER LOCK on T-R BUS NO. 1.

Lighting for the compass is controlled through a rheostat (5, figure 4-34) on the copilot's overhead light control panel. Operating power for the light is 28 volt DC through a circuit breaker marked MAGNETIC COMPASS LIGHT on the SBCBP (figure 1-35, sheet 1).

EMERGENCY EQUIPMENT

The location of the emergency equipment, except for the engine fire detector system is shown in figure 3-1. This airplane is not equipped with a fire extinguishing system, although an engine fire detector system has been provided.

ENGINE FIRE DETECTOR SYSTEM

A fire detector system with 14 detectors (10 detectors with 5/16 in.) for each pod and strut combination is provided, with the exception of No. 4 engine and strut which has 13 detectors (9 detectors with 5/16 in.). In the event of an overheat condition anywhere within the pod or strut, a warning light on the pilot's glare shield will illuminate, indicating which engine is overheating.

Engine Fire Switches and Warning Lights

There are 4 engine fire switches and warning lights (2, figure 1-16) on the pilots' light and glare shield. The warning lights are numbered to correspond with the engine each light represents. The fire detector test switch (10, figure 4-34) on the copilot's exterior light control panel is used to test part of the warning light circuit. When the fire detector test switch is moved from the spring loaded NORMAL position to TEST, the warning lights illuminate. The lights are the press-to-test type. An overheat condition around an engine causes thermostat type switches to turn on the warning light for that engine. Pulling a fire switch isolates the engine by: (1) deactivating the generator, (2) stopping hydraulic fluid and fuel flow to the engine. (3) closing the air bleed valve on airplanes 1 ▶ 3 , and (4) deactivates the ignition. (The

generator failure light will not indicate that the generator has tripped.) When the fire switch is returned to its normal position, the respective fire valves and control circuits return to their normal positions except the generator remains tripped. The generator control switch must be actuated to place the generator in operation again.

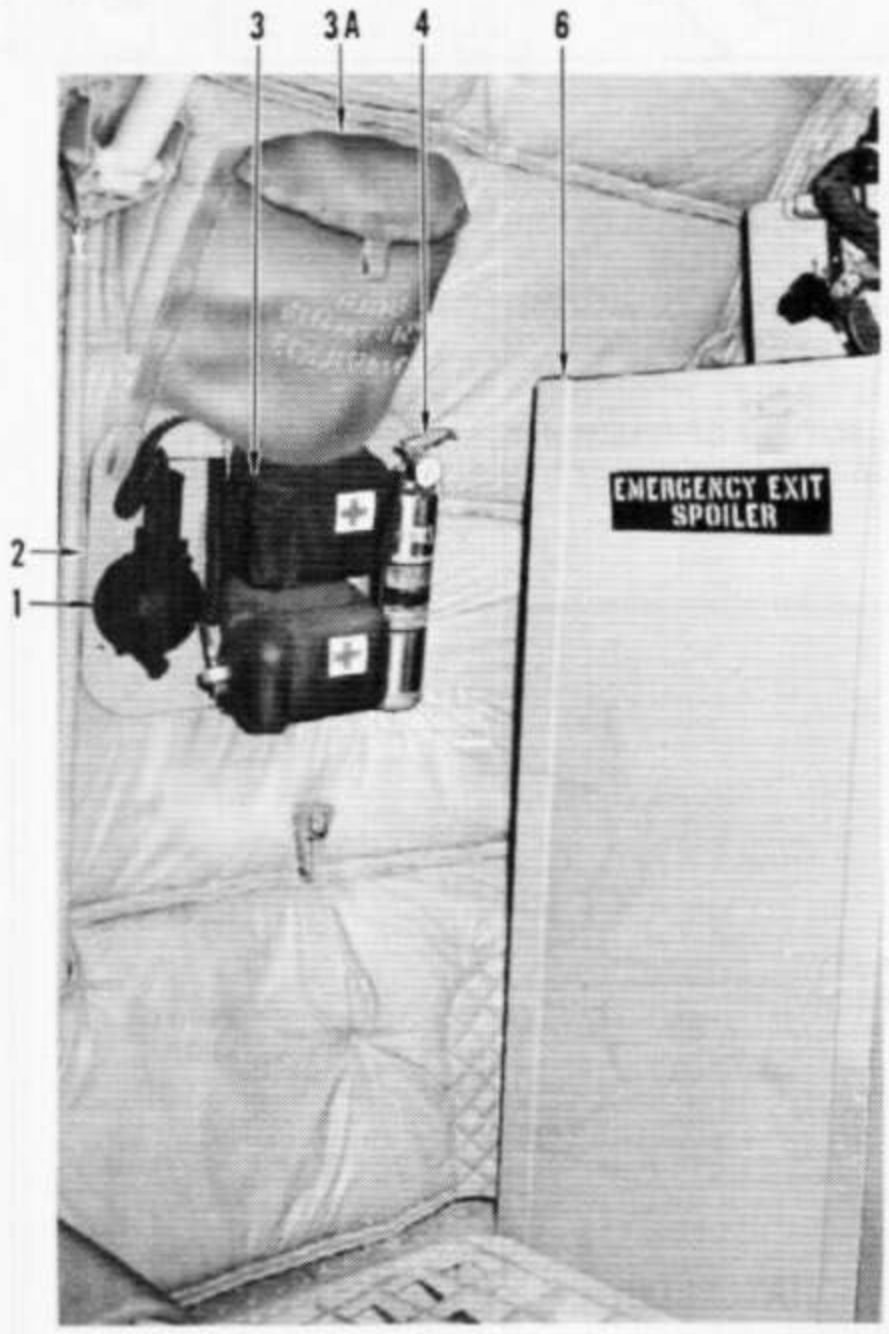
Engine Fire Detector Test Switch

A fire detector test switch (10, figure 4-34), with NORMAL--TEST positions, is on the copilot's exterior light panel. The fire detector system may be tested by positioning the switch to TEST. If the circuit is operative, the engine fire warning lights on the pilots' light and glare shield will illuminate. The switch should be left in the NORMAL position when not testing the system. Operating power is 28 volt DC through circuit breakers marked ENGINE FIRE DETECTOR 1, 2, 3 and 4 on the SBCBP (figure 1-35, sheet 1).

EMERGENCY ALARM BELL

The emergency alarm bells in the airplane are controlled by a single ON--OFF WARNING BELL SWITCH (12, figure 1-20) on the warning bell control panel. One alarm bell is on the ceiling just aft of the overhead panel in the control cabin; another is on the wall in the toilet compartment and the third is over the boom operator's station. When the switch is ON, power is supplied from the hot battery bus on the battery circuit breaker panel causing the bells to ring simultaneously. Operating power is 28 volt DC through the ALARM BELL circuit breaker on the battery circuit breaker panel (figure 1-35, sheet 1). There are 2 klaxon warning horns in the cargo compartment, one at the forward end and one at the aft end. These operate simultaneously with the alarm bells. Operating power is 28 volt DC through the CARGO COMPT WARNING HORN circuit breaker on the battery CBP (figure 1-35, sheet 1).

CONTROL CABIN EMERGENCY EQUIPMENT





1 SIGNAL LAMP
2 FORWARD EMERGENCY EQUIPMENT PANEL
3 FIRST AID KITS
3A FIREFIGHTER'S EQUIPMENT
4 FIRE EXTINGUISHER
5 (DELETED)
6 EMERGENCY EXIT SPOILER
7 (DELETED)
8 EMERGENCY EXIT SPOILER AIR BOTTLE
9 EMERGENCY EXIT SPOILER PRESSURE GAGE

F.97
F.98

Figure 1-61

GROUND INSTALLATION OF EMERGENCY EXIT HATCHES



1 MAKE SURE THAT EXTERNAL HANDLE IS FLUSH AND LATCHED.

2 GRASP UPPER FIXED HATCH HANDLE WITH THE LEFT HAND. SUPPORT LOCK HANDLE WITH RIGHT SHOULDER OR ARM TO PREVENT HANDLE DROPPING TO FULL DOWN POSITION.

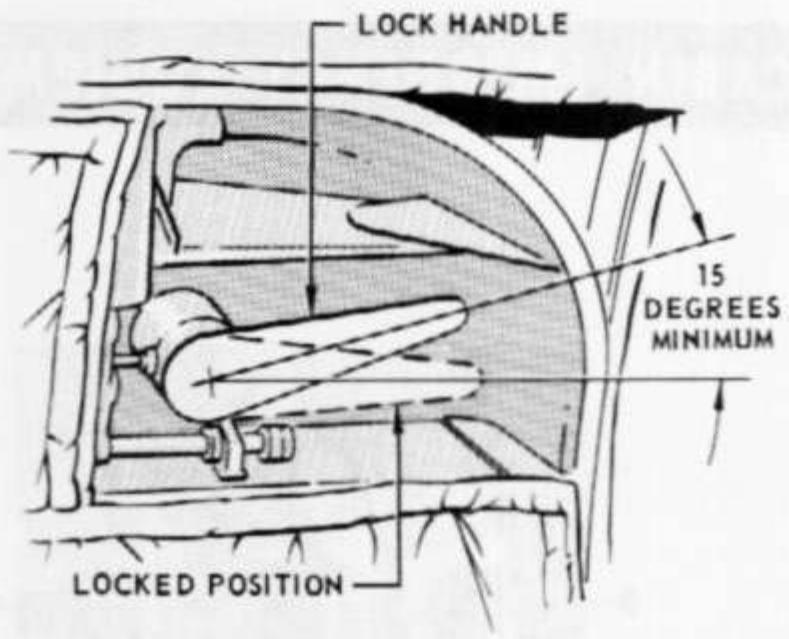
3 GRASP LOWER FIXED HANDLE WITH THE RIGHT HAND AND LIFT THE HATCH INTO POSITION.

4 INSERT BOTTOM OF HATCH FIRST AND GUIDE PIVOT HOOK INTO PIVOT STOP.

5 PULL BOTTOM OF HATCH INBOARD TO FULLY ENGAGE PIVOT HOOK TO PIVOT STOP.

NOTE

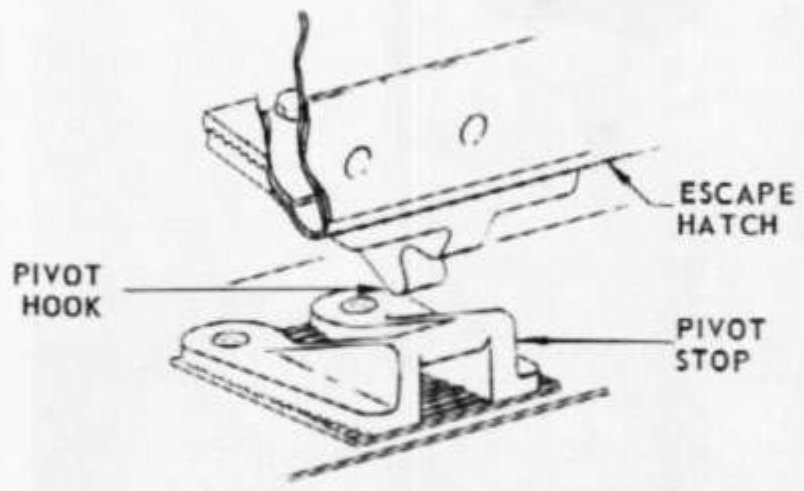
- LOCK HANDLE ON REAR HATCH MUST BE APPROXIMATELY 15 DEGREES ABOVE HORIZONTAL BEFORE INSTALLING HATCH. NO RETENTION IS REQUIRED TO KEEP IT IN THIS POSITION.



REAR HATCH LOCK

NOTE

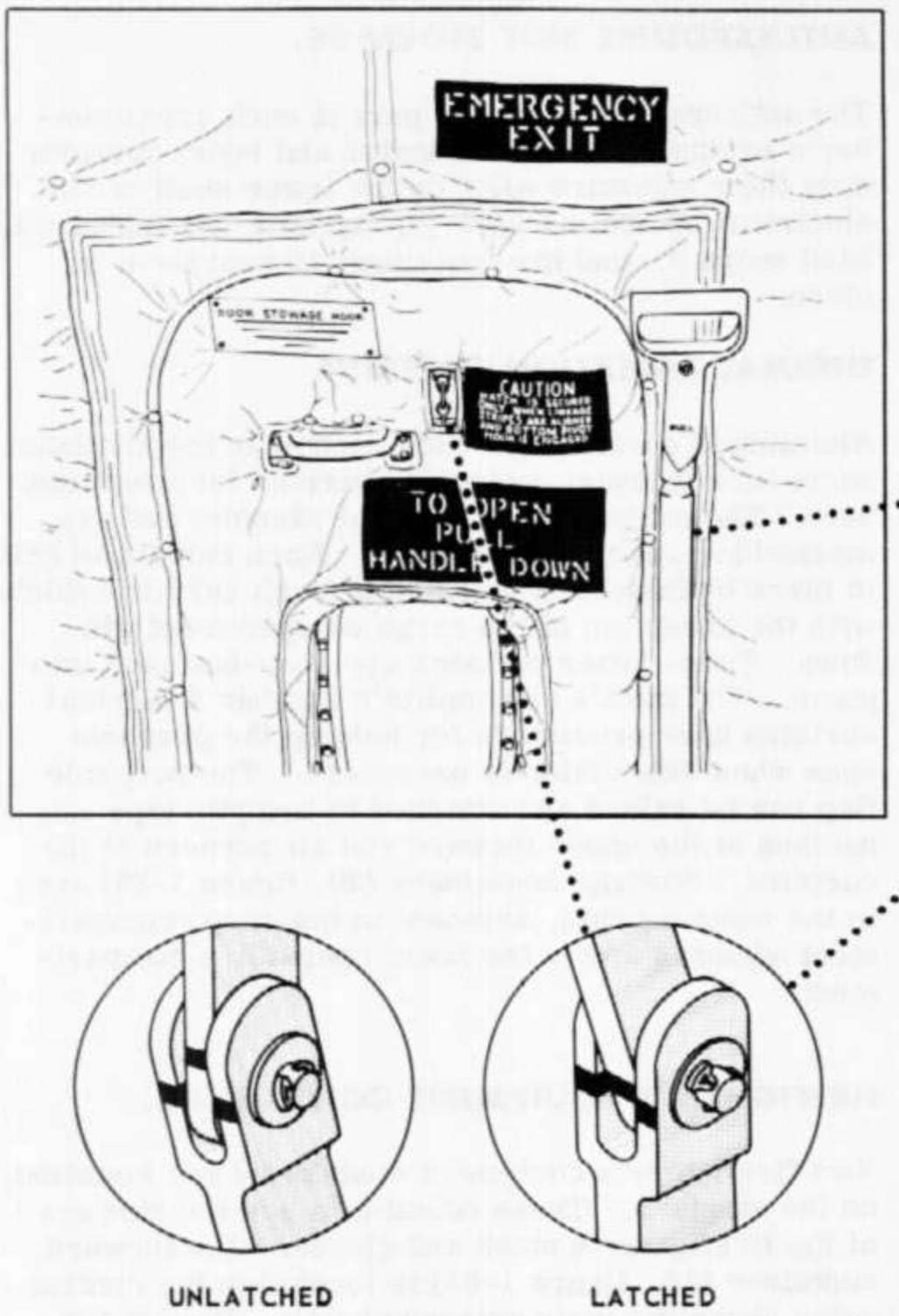
- WHEN LOCKING THE REAR HATCH, ROTATE THE LOCK HANDLE CLOCKWISE UNTIL FULLY LOCKED. HANDLE SHOULD BE HORIZONTAL.
- AS THE HANDLE IS PUSHED INTO POSITION, THE FORCE REQUIRED WILL GRADUALLY INCREASE AND THEN DROP OFF ABRUPTLY AS LINKAGE GOES OVER CENTER. THERE WILL ALSO BE A DEFINITE SOUND WHEN CORRECT LOCKING OCCURS.



HATCH LOWER SILL PIVOT HOOK

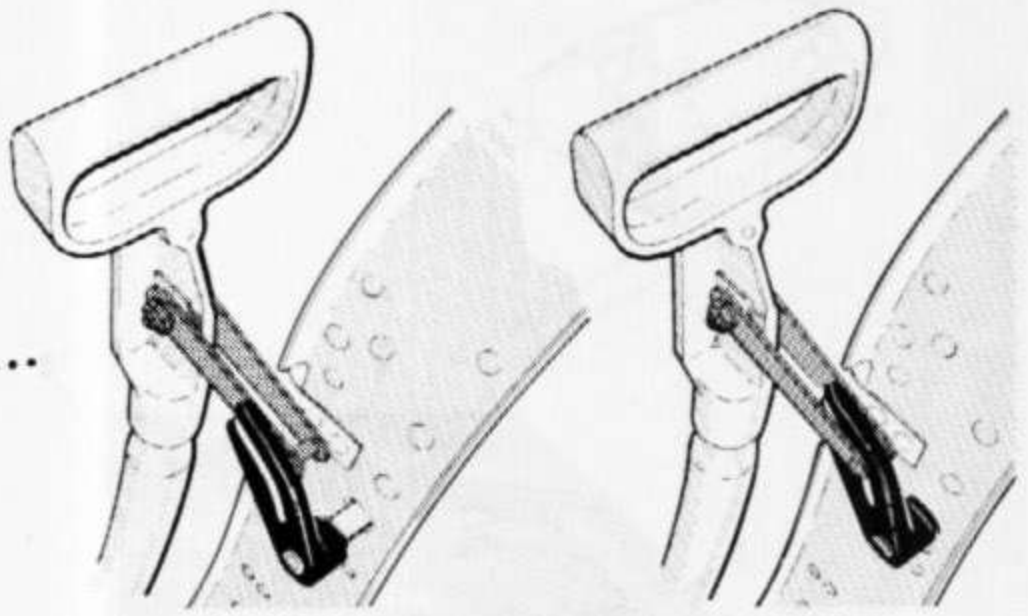
F-99
F-101
F-1353

Figure 1-62 (Sheet 1 of 2)



OVER-CENTER MECHANISM

6 ROTATE HATCH INTO POSITION AND PUSH LOCK HANDLE ALL THE WAY UP, MAKING CERTAIN THAT THE LOCK HANDLE ROLLER IS ENGAGED IN THE ACTUATOR ARM AS SHOWN.



7 INSPECT THE OVER-CENTER LOCK MECHANISM. LINKAGE MUST BE IN A DEFINITE OUTBOARD OVER-CENTER POSITION.

NOTE

IF VISUAL ACCESS HAS NOT BEEN PROVIDED IN THE HATCH LINING, FOLD BACK THE LINING AT THE UPPER RIGHT-HAND CORNER TO OBSERVE THE OVER-CENTER POSITION OF THE LINKAGE. IF ALIGNMENT MARKS ARE PROVIDED, DETERMINE THAT THEY ARE CORRECTLY ALIGNED AND THAT THE BOTTOM PIVOT HOOK IS ENGAGED.

8 AFTER SECURING LOCK, INSPECT PIVOT HOOK AND PIVOT STOP AT CENTER OF LOWER SILL FOR PROPER ENGAGEMENT. IT IS POSSIBLE FOR THE PIVOT HOOK AND PIVOT STOP TO BE OUT OF ENGAGEMENT EVEN THOUGH THE LOCK IS SET AND THE HATCH FEELS SECURE.

9 INSPECT THE HATCH LATCH PIN AND STRIKER PLATE ON TOP OF THE HATCH FRAME, FOR PROPER ENGAGEMENT.

F-100 F-1352

Figure 1-62 (Sheet 2 of 2)

CRASH AXES

Two crash axes are on the airplane. One axe (7, figure 3-1) is on the wall near the navigator's station. The second axe is stowed on the aft emergency equipment panel (12, figure 3-1).

EMERGENCY EXIT HATCHES

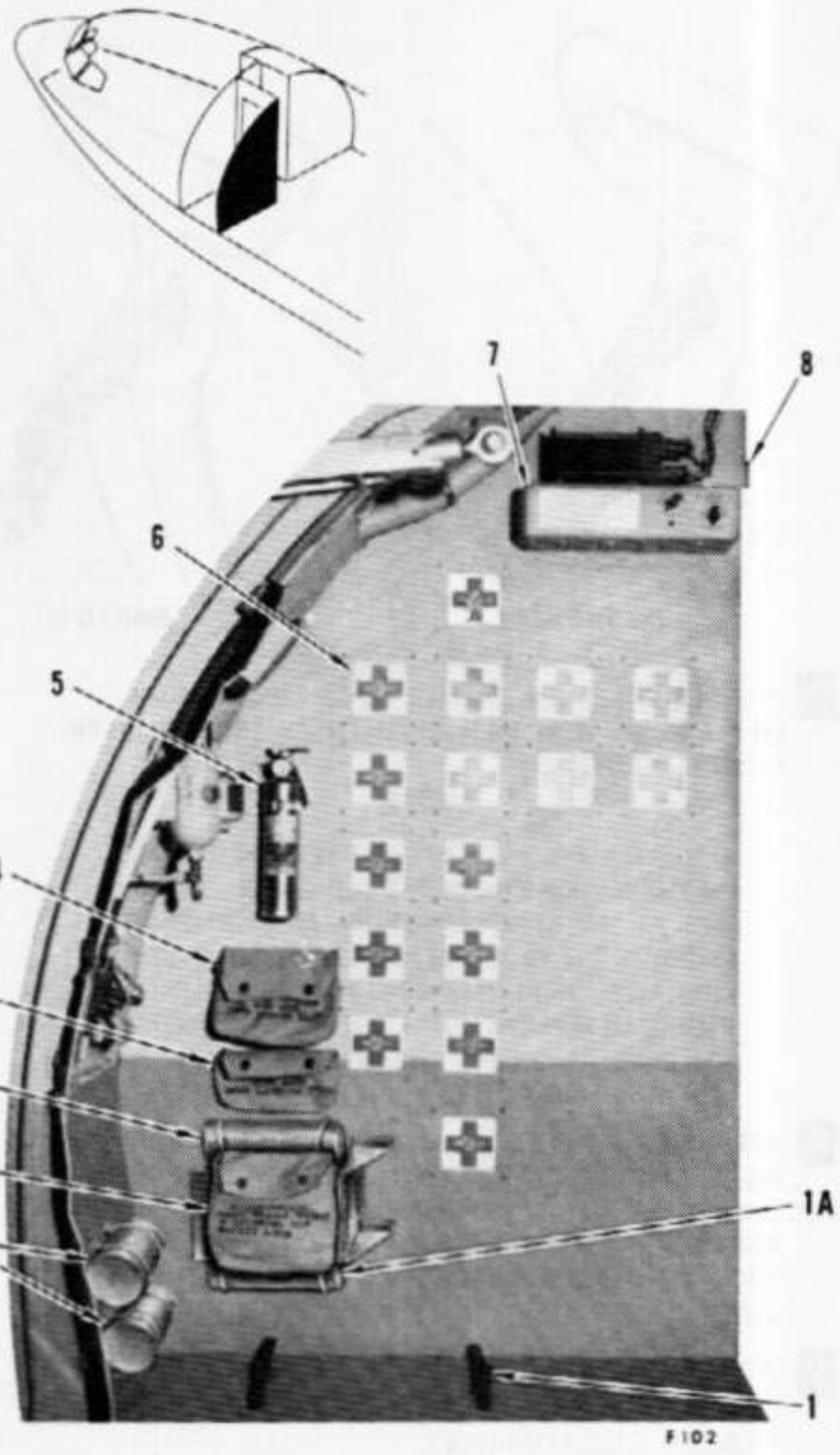
The crew entry hatch is the primary emergency escape hatch; however, there are three additional emergency exit hatches (figure 3-7) on the airplane. Two exit hatches, one on each side of the fuselage, are over the wing. The third is on the right side of the fuselage just forward of the boom operator's compartment. The overwing hatches are opened from the interior by grasping a fixed handle on the upper center of the hatch and pulling downward on a lock handle on the right side. They may be opened from the exterior by depressing a button and turning a flush handle on the door upward and then pushing the door. The flush handle on the outside of each hatch will extend from a recessed position after a trigger near the handle has been depressed. The door may then be easily pulled or pushed into the airplane. The hatch located forward of the boom operator's compartment is opened from the interior by grasping the fixed handle near the upper center and rotating a lock handle near it. Personnel handling these hatches should avoid laying them down on the exposed seals as damage to the seals may occur. The emergency exit hatches on airplanes 376 ▶have seal strips around the edges to reduce the heat losses and noise near the doors. The seal strips are hook and pile tapes that are jointed together by running a hand around the edge of the insulating blanket. The seal strips separate easily when the doors are opened.

ESCAPE SLIDE

With 10-10 886

An escape slide, located at the aft emergency exit hatch, is provided for rapid emergency exit of personnel from the airplane. See figure 3-7, sheet 6A for escape slide operations.

MISCELLANEOUS AND EMERGENCY EQUIPMENT (FORWARD WALL)



1. MAIN LANDING GEAR DOOR EXTERNAL DOWN LOCK STOWAGE
1A. STARTER CARTRIDGE/BREECH CAP STOWAGE
2. STOWAGE BAG (PITOT COVERS AND BOOM NOZZLE COVER)
3. STOWAGE BAG (NOSE LANDING GEAR DOWN LOCK)
4. STOWAGE BAG (MAIN LANDING GEAR DOWN LOCK)
5. HAND FIRE EXTINGUISHER
6. FIRST AID KIT STOWAGE
7. CARGO COMPARTMENT A/C PANEL (SEE FIGURE 4 7)
8. FOUR FIRST AID KITS 1▶345

Figure 1-63

FIRST AID KITS

There are provisions for carrying 19 first aid kits in the airplane. Two kits are on the forward emergency equipment panel (3, figure 1-61) just aft of the pilot's seat. Four other kits (2, figure 3-1) are above the entrance to the toilet compartment. Twelve kits (6, figure 1-63) are on the wall just forward of the cargo door. On later airplanes 16 kits are on the wall just forward of the cargo door. The other kit is on the aft emergency equipment panel (12, figure 3-1).

ANTI-EXPOSURE SUIT STOWAGE

The antiexposure suits are part of each crewmember's equipment. The navigator and boom operator stow their exposure suits on the lower shelf of the electrical equipment rack (8, figure 1-26). A canvas band snaps around the containers to hold them in place.

THERMAL RADIATION CURTAINS

Aluminized curtains for each window in the airplane serve as a thermal protective barrier for crewmembers. The curtains fit individual windows and are marked for ready identification. Each curtain is held in place by fasteners inserted through curtain eyelets with the exception of the cargo compartment windows. These latter curtains are snap-fastened into place. The pilot's and copilot's number 2 thermal curtains have provisions for holding the peephole open when side vision is necessary. The peephole flap can be raised and attached to two pile tape patches at the upper forward and aft corners of the curtains. Stowage containers (20, figure 1-26) are in the control cabin, adjacent to the cargo compartment windows and in the boom operator's compartment.

FIREFIGHTER'S EQUIPMENT CONTAINERS

Two firefighter's equipment containers are installed on the airplane. These containers are for stowage of the firefighter's mask and gloves. The forward container (3A, figure 1-61) is located in the control cabin above the main entrance hatch. The aft container (13, figure 3-1) is located in the cargo compartment aft of the aft emergency exit hatch.

HAND FIRE EXTINGUISHERS

Three hand operated fire extinguishers are provided in this airplane. The extinguishers are charged with bromochloromethane which is effective in combating all types of fire. The effective range of the extinguishers is 25 feet, when operated vertically to within 15 degrees from horizontal. One extinguisher is stowed on the forward emergency equipment panel (4, figure 1-61). A second extinguisher (5, figure 1-63) is on the

wall just inside the cargo door. The third fire extinguisher is stowed on the aft emergency equipment panel (12, figure 3-1).

WARNING

- Heavy, dense, black, suffocative, toxic smoke occurs when bromochloromethane (CB) is used on hot metal or open fire. Bromochloromethane (CB) is an anesthetic agent of moderate intensity and exposure may cause pronounced irritation of eyes and nose. Prolonged exposure (5 minutes or more) to high concentrations of CB or its decomposition products should be avoided. Adequate respiratory and eye protection from excessive exposure should be sought as soon as the primary fire emergency will permit. The use of 100% oxygen will provide respiratory protection.

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

NOTE

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

ESCAPE ROPES

Four escape ropes (6 and 11, figure 3-1) enable the crew members to lower themselves from the airplane in an emergency. Two are at the pilot's sliding window, one at the copilot's sliding window, and another over the aft emergency exit hatch on the right side of the fuselage. These ropes are retained in a ready position behind quick-release type cover. A hook is installed by the chinning bar latch above the crew entry chute. For emergency egress on the ground, one of the pilot's escape ropes can be placed over the hook to enable personnel to lower themselves through the crew entry chute. See figure 3-7.

SIGNAL LAMP

There is a portable signal lamp (1, figure 1-61) on the forward emergency equipment panel. The lamp may be plugged into special signal lamp receptacles. One receptacle (9, figure 1-14) is on the copilot's side panel and another is on the pilot's side panel. Two portable signal lamp receptacles are adjacent to the aft emergency exit hatch and two others are on the opposite side of the fuselage. Operating power for the receptacles is 28 volt AC. This power is obtained through the circuit breaker marked PORTABLE SIGNAL on airplanes 1 ▶ 117 ◀ and marked PORTABLE SIGNAL & AUX CREW OXY PANEL LIGHTS on airplanes 118 ▶ located on the 28V AC section of the MCBP (figure 1-35, sheet 3).

LIFE RAFT

One life raft (8, figure 3-1) is located just aft of the left overwing emergency exit hatch. The raft is held in place by two straps. There are no provisions for automatic launching of the raft. Therefore, in order to launch the raft, the straps must be unfastened and the raft removed from the airplane through one of the escape exits. After the raft has been removed from the airplane, it can be inflated by pulling the CO_2 release cable.

SURVIVAL KIT STOWAGE

A rack (9, figure 3-1) is provided for stowage of crew survival kits and is located on the floor at the right side of the forward end of the cargo compartment, opposite the cargo door.

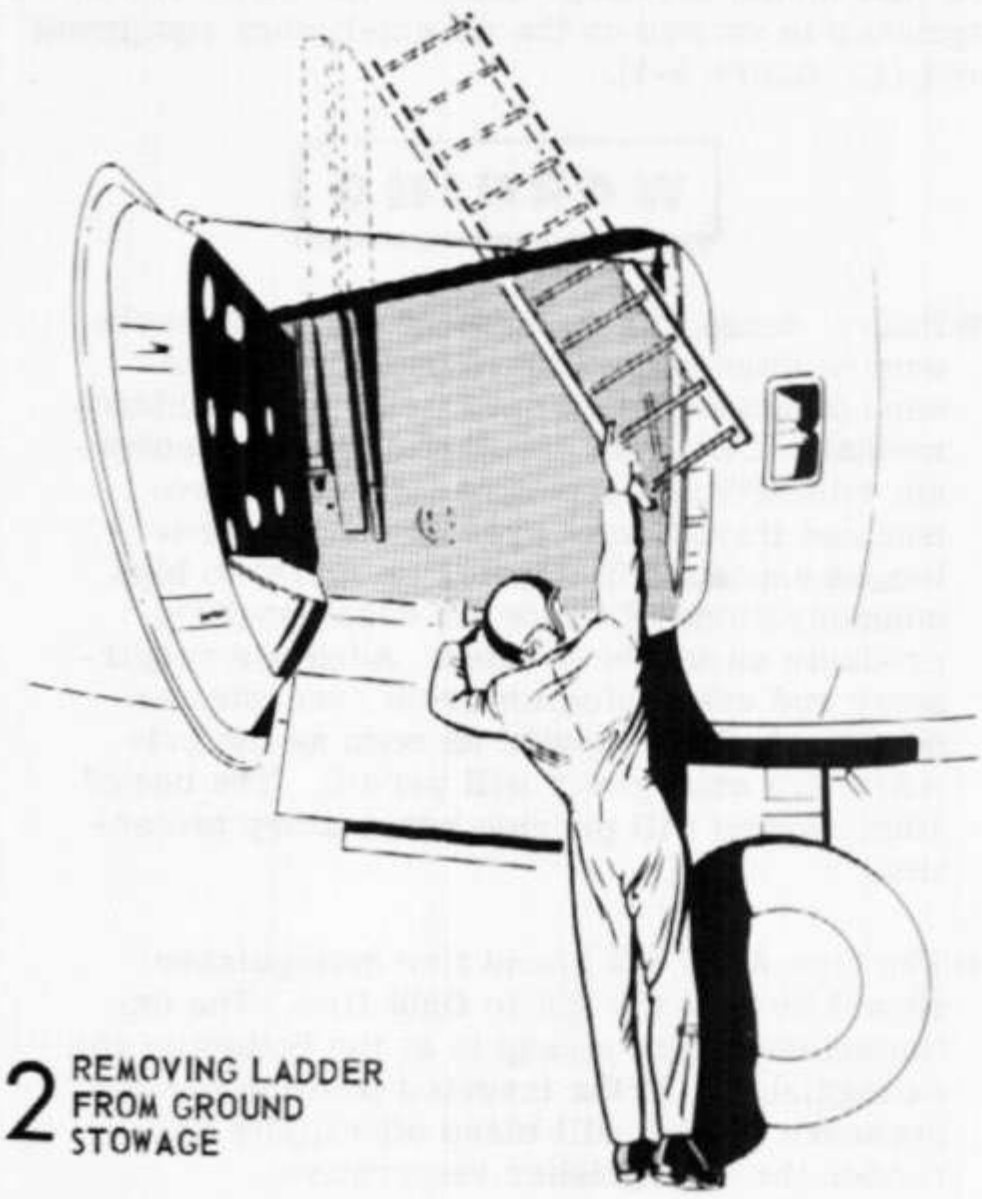
ENTRANCE DOOR

The crew entry door (figure 1-64) is on the left side of the airplane near the nose wheel, and is the primary entrance to the airplane. It is hinged along the forward edge and can be opened from either inside or outside the airplane. A folding strut on the inner side of the door holds the door open. When the door is opened, access to the control cabin is by means of a ladder stowed in the crew entry chute. The upper end of the chute is covered by a grille hinged along the outboard edge. During entry, the grille is held open by a spring-loaded latch on the sidewall of the control cabin. The outer door latch handle is under a cover at the aft edge of the door. See figure 1-64. The crew entry door interior latch handle (6, figure 1-26) is on the control cabin wall above the crew entry chute. These two handles are interconnected so that operation of either will latch or unlatch the door. When the door is unlatched during ground operation, it will tend to fall open due to gravity. The speed of opening is controlled by a friction brake in the crew entry door winch, which is connected to the door by a cable. The crew entry door winch (2, figure 1-26) is inside the control cabin and is used to close the door from that position. The crew entry door is jettisoned for emergency escape in flight. Jettisoning is accomplished by operating a chinning bar. Refer to CHINNING BAR in this Section.

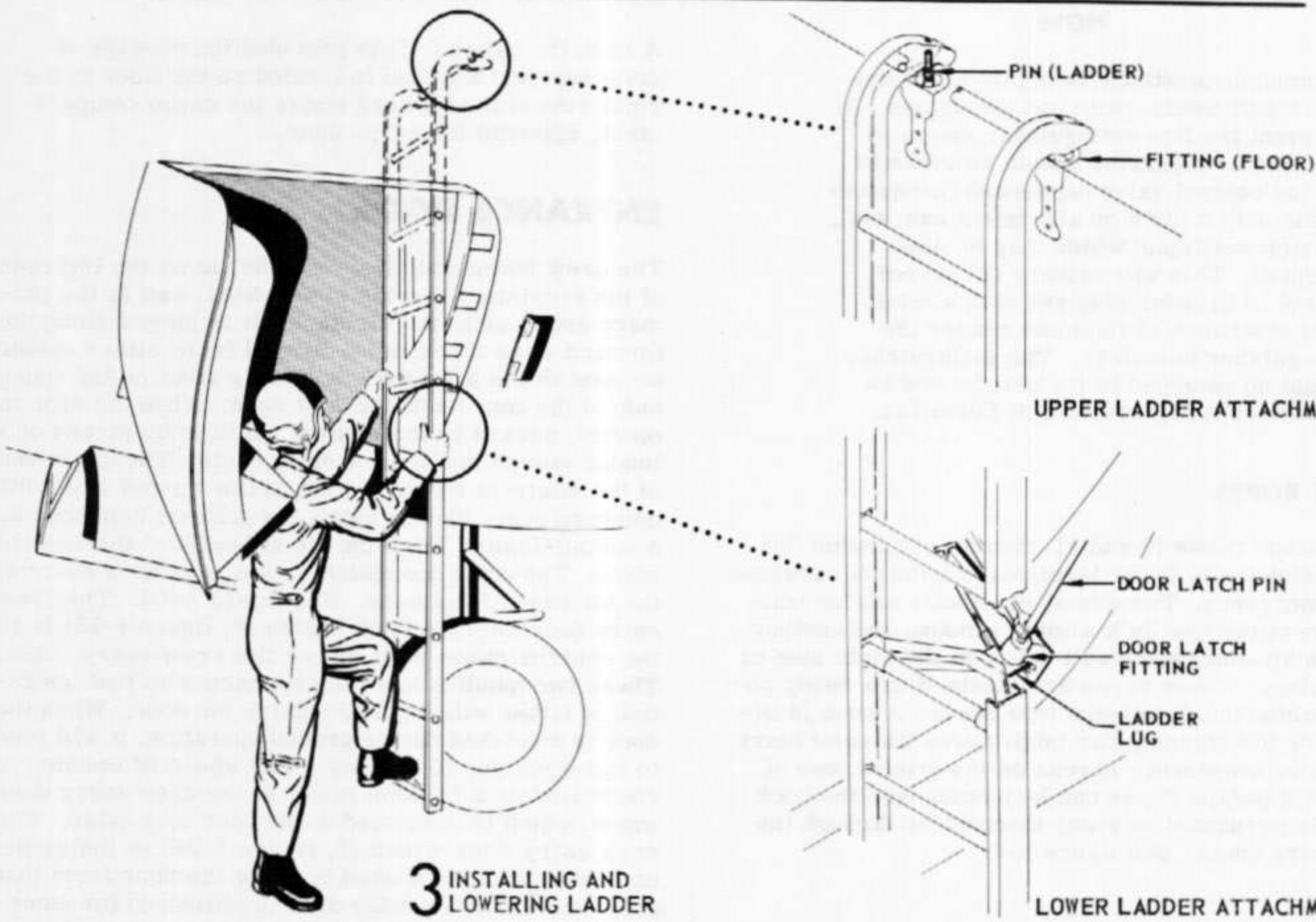
ENTRANCE TO AIRPLANE



1 OPENING CREW ENTRY DOOR



2 REMOVING LADDER FROM GROUND STOWAGE



3 INSTALLING AND LOWERING LADDER

F 103
F 103
F 104
F 103

Figure 1-64

DOOR WARNING LIGHT AND INDICATOR ROD

A door warning system indicates when either the crew entry door or the cargo door is not closed and latched. A warning light (9, figure 1-19) on the copilot's flight instrument panel will be illuminated if either the cargo door or crew entry door is not closed and latched. See DOOR WARNING SYSTEM, Section IV for further details. An indicator rod (9, figure 1-26) beneath the forward outboard end of the electrical equipment rack indicates that the crew entry door is closed and latched. Approximately one inch of the rod, which is luminous green, is visible above the floor when the entry door is closed and latched. The rod is not visible when the door is not latched. This rod is mechanically operated by the latching mechanism.

CREW ENTRY CHUTE AND FLOOR GRILLE

A crew entry chute is provided for crew members to enter or exit the airplane. Personnel also use this chute to exit the airplane in flight during emergencies. See figure 3-7. The crew entry chute floor grille (13, figure 1-26), covers the crew entry chute.

WARNING

The crew entry chute floor grille shall remain closed at all times, except when opened for entry or exit.

CHINNING BAR

The crew entry door can be jettisoned for emergency exit by pulling the chinning bar (3, figure 1-26) to a horizontal position. The chinning bar is held in place by a spring loaded plunger in the end of the bar. A safety lock can be inserted in the plunger to prevent accidental actuation of the door release mechanism when the airplane is on the ground. This lock must be removed prior to pulling the chinning bar to the horizontal position. Pulling the chinning bar down pulls the hinge pins out of the forward end of the door and actuates a pneumatic-hydraulic operated spoiler. The spoiler extends and pushes the leading edge of the door into the air stream. The door swings out and back on the latch pins and then falls free. Rotation of the door on the latch pins also releases the door winch cable. The extended spoiler creates turbulence that allows the crew members to drop free of the airplane during escape without being carried along the fuselage by the air stream. Crew members also use the chinning bar as a hand hold while bailing out through the escape chute. See figure 3-7. On later airplanes, there are two black bands marked GRIP HERE, that indicate the proper hand location on the chinning bar for best emergency egress.

WARNING

- Depressurize the cabin before actuating the chinning bar. Pulling the chinning bar when the cabin is pressurized requires greater force and the subsequent air flow through the escape chute during decompression may cause injury to the person pulling the bar.

- Do not actuate the chinning bar on the ground or any other time except during emergencies, as injury to personnel or damage to equipment may occur. To prevent actuation of the chinning bar on the ground, except during ground emergencies, the chinning bar safety lock will be installed prior to opening the crew entry door.

ENTRANCE LADDER

A one piece ladder is normally used in the crew entry chute to enter or leave the airplane when the airplane is on the ground. See figure 1-64. The inflight stowage of the ladder is in the cargo compartment strapped to the floor on the right side of the airplane (33, figure 1-3).

SEATS

CREW SEATS AND SAFETY BELTS

The seats for the pilot and copilot are identical except for the location of the seat controls. See figure 1-66. All the seat controls for the copilot are on the left side and all the seat controls for the pilot are on the right side with the exception of the shoulder harness inertia reel lock handle. These seats are fully adjustable for height, back tilting and fore-and-aft movement. Each seat has a safety belt and shoulder harness. See MISCELLANEOUS EQUIPMENT in Section IV for other seats.

WARNING

The pilot will insure that the occupants of the pilot and copilot positions have their safety belts and shoulder harnesses adjusted and fastened at all times that the airplane is in flight.

SERVICING

ITEM	LOCATION
FUEL ❶ USAF SPECIFICATION MIL-T-5624 (JP-4) NATO SYMBOL F-40 COMMERCIAL DESIGNATION JET B FREEZING POINT -60°F	5 Wing Tanks 2 Reserve Wing Tanks 1 Forward Body Tank 1 Aft Body Tank 1 Upper Deck Tank (Tanks can be filled through single point system)
ENGINE OIL ❷ USAF SPECIFICATION MIL-L-7808F (USAF)	4 Engine Oil Tanks 3 Generator Drive Oil Tanks 1 Auxiliary Power Unit
HYDRAULIC FLUID USAF SPECIFICATION MIL-H-5606 NATO SYMBOL H-515	2 Main Hydraulic Reservoirs 1 Cargo Door Hydraulic Reservoir 1 Boom Hoist Hand Pump Reservoir
CARTRIDGE STARTER SOLID PROPELLANT CARTRIDGE MXU-4/A	1 on No. 4 engine 1 on No. 1, 2, 3 and 4 engines (With 1610 920)

ITEM	LOCATION
OXYGEN USAF SPECIFICATION MIL-O-27210 NATO SYMBOL NONE AVAILABLE	1 Liquid Oxygen Converter Tank 6 G1 Gaseous Cylinders
WATER INJECTION CLEAN DISTILLED WATER OR WATER WITH LESS THAN 10 PARTS SOLID PER MILLION PARTS WATER (NOT TO EXCEED 130°F)	1 Tank. Filler port in right wheel well. See WATER FOR THRUST AUGMENTATION, Section V.
PORTABLE COMPRESSOR, AIR CYCLE MACHINE (ACM) BMS 3-7	1 Tank on portable compressor 1 Tank on ACM
RAIN REPELLENT CONTAINERS Type 3 Repellent	2 Containers under navigator's table (Pressurized, not to be refilled)
POWER CARTS STARTING COMPRESSOR - TYPE MA-1A (OR EQUIVALENT)	External Electrical Power - Type MD-3 (or equivalent) External Ground Blower - Type A-2 (or equivalent)

ACCUMULATOR PRELOAD

MAIN SYSTEM 2000 PSI EQUIVALENT PRELOAD PRESSURES FOR VARYING TEMPERATURES			RUDDER POWER 1500 PSI EQUIVALENT PRELOAD PRESSURES FOR VARYING TEMPERATURES			RESERVE BRAKE 1000 PSI EQUIVALENT PRELOAD PRESSURES FOR VARYING TEMPERATURES		
°C	°F	PSI	°C	°F	PSI	°C	°F	PSI
71	160	2450	71	160	1860	71	160	1200
60	140	2350	60	140	1780	60	140	1150
49	120	2250	49	120	1700	49	120	1120
38	100	2150	38	100	1620	38	100	1075
26	80	2050	26	80	1540	26	80	1025
21	70	2000 ◇	21	70	1500 ◇	21	70	1000 ◇
16	60	1950	16	60	1460	16	60	980
5	40	1850	5	40	1380	5	40	950
- 7	20	1750	- 7	20	1300	- 7	20	900
-18	0	1650	-18	0	1220	-18	0	850
-29	-20	1550	-29	-20	1140	-29	-20	820
-40	-40	1450	-40	-40	1060	-40	-40	770
-51	-60	1350	-51	-60	980	-51	-60	750

❶ See Section V for alternate fuels.

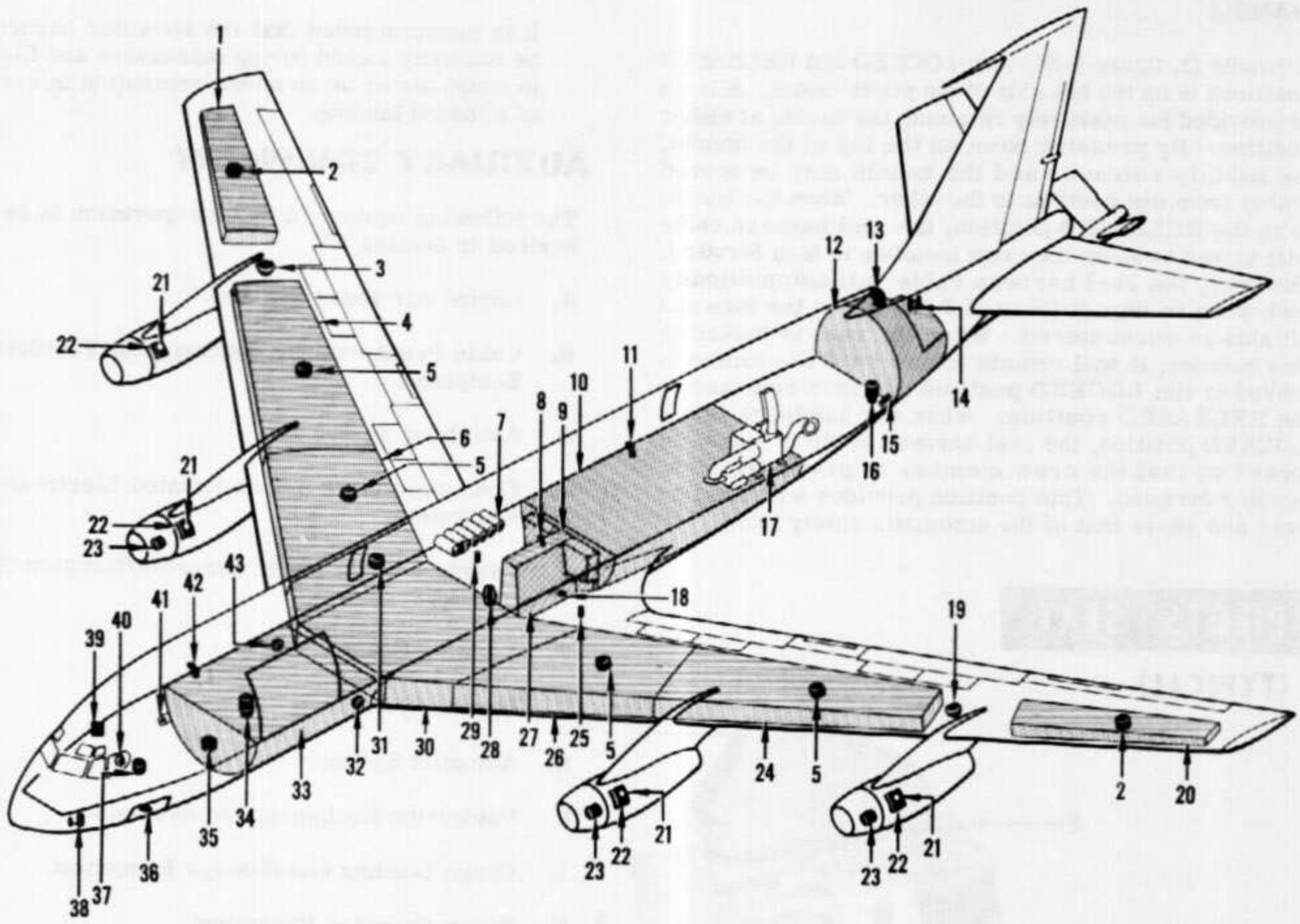
❷ See Section V for engine oil limitations.

◇ DENOTES NORMAL ACCUMULATOR PRELOAD FOR 70°F DAY

NOTE

- For complete servicing information refer to T.O. 1C-135(K)A-2-2.
- Nickel-cadmium batteries which appear to have dry plates do not necessarily require the addition of distilled water. Refer to T.O. 1C-135(K)A-2-2 for detailed servicing instructions.

Figure 1-65 (Sheet 1 of 2)



1 NO. 4 RESERVE TANK
2 RESERVE TANK EXTERIOR FUEL FILLER PORT (2 PLACES)
3 RIGHT SYSTEM HYDRAULIC RESERVOIR
4 NO. 4 MAIN TANK
5 MAIN TANK EXTERIOR FUEL FILL PORT (4 PLACES)
6 NO. 3 MAIN TANK
7 OXYGEN CYLINDERS AND PANEL
8 WATER INJECTION TANK FILLER PORT
9 WATER INJECTION TANK
10 AFT BODY TANK
11 AFT TANK EXTERIOR FUEL FILLER PORT
12 UPPER DECK TANK 10 ▶
13 UPPER DECK TANK EXTERIOR FUEL FILLER PORT 10 ▶
14 RUDDER POWER ACCUMULATORS
15 BOOM SYSTEM ACCUMULATOR (SIGHTING DOOR CAVITY)
16 BOOM HOIST HAND PUMP RESERVOIR
17 APU
18 WATER INJECTION TANK DRAIN VALVE
19 LEFT SYSTEM HYDRAULIC RESERVOIR
20 NO. 1 RESERVE TANK
21 ENGINE OIL TANK FILLER PORT (4 PLACES)
22 ENGINE OIL TANK (4 PLACES)
23 AC GENERATOR DRIVE OIL TANK (3 PLACES)
24 NO. 1 MAIN TANK
25 LEFT SYSTEM ACCUMULATOR (WHEEL WELL)
26 NO. 2 MAIN TANK
27 PILOT'S RESERVE BRAKE ACCUMULATOR (FWD WALL WHEEL WELL)
28 SINGLE POINT REFUELING AND DEFUELING RECEPTACLE
29 RIGHT SYSTEM ACCUMULATOR (WHEEL WELL)
30 CENTER WING TANK
31 CENTER WING TANK EXTERIOR FUEL FILLER PORT
32 GROUND AIR SERVICING CONNECTION 98 ▶
33 FORWARD BODY TANK
34 CARGO DOOR HAND PUMP RESERVOIR
35 BATTERY
36 CONDITIONED AIR CONNECTION
37 OXYGEN CONVERTER
38 EMERGENCY EXIT SPOILER AIR BOTTLE
39 RAIN REPELLENT CONTAINERS
40 LIQUID OXYGEN FILLER VALVE
41 EXTERNAL POWER RECEPTACLE
42 FORWARD BODY TANK EXTERIOR FUEL FILLER PORT
43 GROUND AIR SERVICING CONNECTION 1 ▶ 97

Figure 1-65 (Sheet 2 of 2)

SHOULDER HARNESS INERTIA REEL LOCK HANDLE

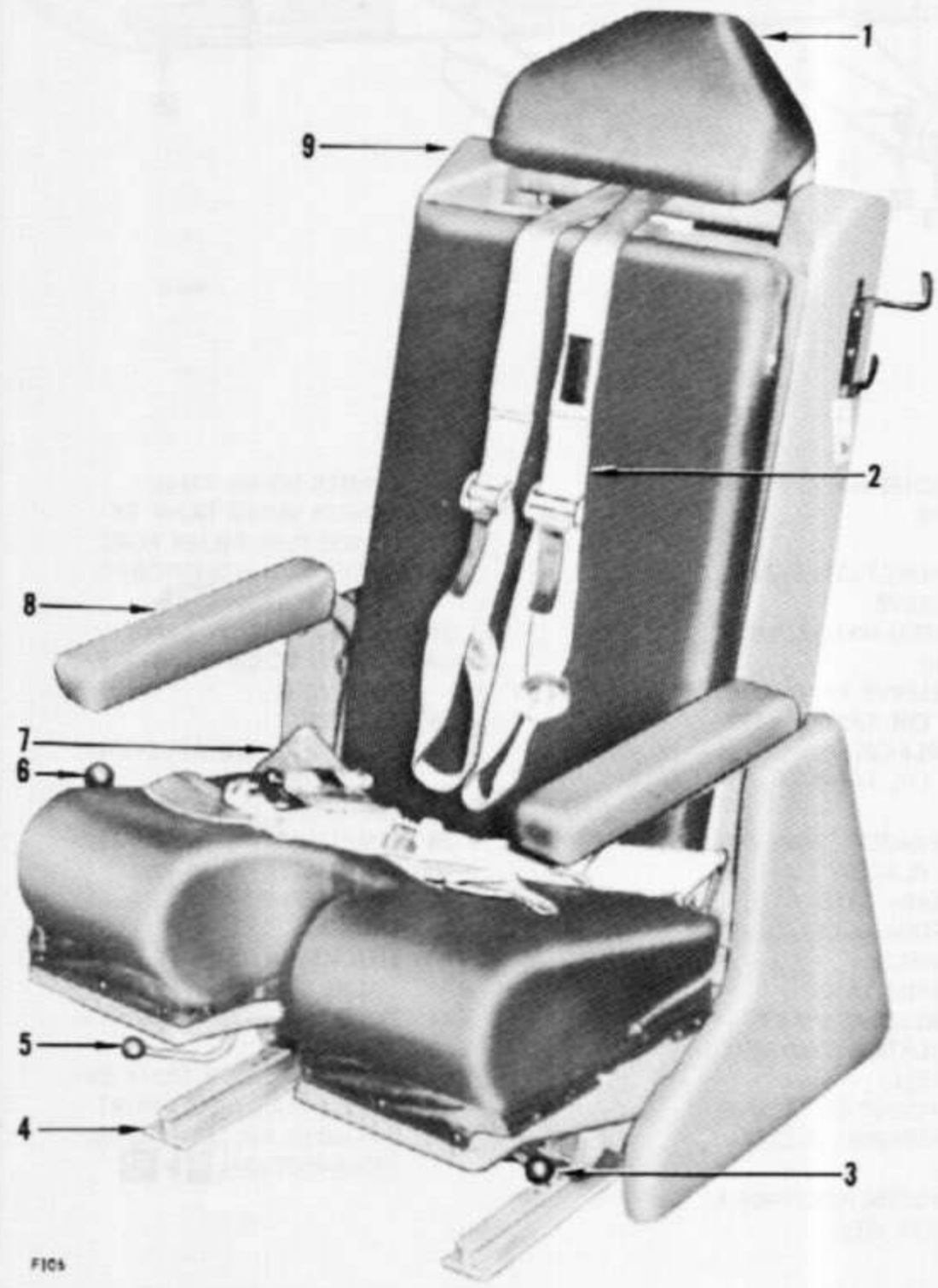
A handle (3, figure 1-66) with LOCKED and RELEASED positions is on the left side of the pilots' seats. A latch is provided for positively retaining the handle at either position. By pressing down on the top of the handle, the latch is released and the handle may be moved freely from one position to the 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 in the fore and aft axis 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 added safety 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.

PILOTS' SEAT

(TYPICAL)



1 HEAD REST
2 SHOULDER HARNESS
3 SHOULDER HARNESS INERTIA REEL LOCK HANDLE
4 SEAT TRACKS
5 HORIZONTAL ADJUSTMENT LEVER
6 VERTICAL-RECLINE ADJUSTMENT LEVER
7 SAFETY BELT
8 ARM REST
9 HEAD REST ADJUSTMENT BUTTON

NOTE

Pilot's seat shown. Copilot's seat same as pilot's except that all seat controls are on left side of seat.

Figure 1-66

AUXILIARY EQUIPMENT

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

A. Engine Air Bleed System

B. Cabin Pressurizing, Heating, and Ventilating Equipment

C. Anti-Icing Systems

D. Communications and Associated Electronic Equipment

E. Integrated Dual Flight Director/Rotation Go-Around System

F. Lighting Equipment

G. Oxygen System

H. Autopilot System

I. Navigation Equipment and Systems

J. Cargo Loading and Stowage Equipment

K. Troop Carrying Equipment

L. Arctic Capability Kit

M. Air Refueling System

N. Single Point Refueling and Defueling

P. Miscellaneous Equipment



FIG/

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SCOPE

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 airplane is left parked on the ramp. This provides a comprehensive picture of the requirements of a typical mission.

NOTE

- This Section contains text and the pilots' 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 the 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. To show which crew member is normally responsible for each step, code letters appear after the response as follows: (P) Pilot, (CP) Copilot, (N) Navigator, (BO) Boom Operator and (GC) Ground Crew. When more than one code letter appears after the response, coordination is required between those crew members to accomplish that step. At times it may be advantageous for the copilot to accomplish certain items designated for the pilot and vice versa. The terms "As Required" or "As Desired" as used in the checklist indicates equipment operation or settings which may vary according to prevailing conditions. In practice, the response to these items will be the required switch or control position. The Thru-Flight checklist is integrated into the Pilot's Normal checklist. The thru-flight items to be accomplished when using the checklist are indicated by an asterisk (*) preceding the item. The Thru-Flight checklist has been designed to work in conjunction with the T.O. 1C-135(K)A-6 maintenance work cards, and can be used for short time stopovers away from the home base, as well

as turn-around flights. When a different flight crew is to be used for the succeeding flight, the present crew will brief them on the status of the airplane.

- If a checklist is interrupted by maintenance or circumstances require action from another checklist, all appropriate checklists must be reviewed and the applicable items accomplished.

To prevent undue complication this Section only includes normal operating procedures applicable to the pilot and copilot. Procedures for other crew members are given only when coordination is required to properly execute a particular function. Other Sections in this publication deal with various aspects of the airplane and equipment from the standpoint of basic operation and peculiarities characteristic of the equipment under various conditions. A separate abbreviated checklist, T.O. 1C-135(K)A-1CL-1, is provided for the pilots. This checklist repeats the numbered line items of the amplified checklists but does not repeat the amplification.

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

All limitations imposed on the airplane are described in Section V, OPERATING LIMITATIONS.

BRIEFING

All crewmembers will be thoroughly briefed on all phases of the mission. The pilot and crew shall review the mission profile, with particular emphasis on normal and emergency procedures during the takeoff phase. This review may be accomplished at any time prior to starting engines but takeoff procedures and emergency considerations will again be reviewed with the copilot just prior to takeoff. Refer to Section VIII for detailed mission planning.

MISSION PREPARATION

The necessary fuel, airspeed, and thrust settings required to complete a proposed mission should be determined by using the operating data from the Appendix, T.O. 1C-135(K)A-1-1. Takeoff performance data shall be determined from appropriate charts. Stopping distance may be computed for estimated gross weight and conditions of first intended landing and entered on the landing data card. If gross weight or any condition changes that would increase distance, it must be recomputed. A mission problem in Section VIII contains complete information on fuel consumption during various phases of a long mission. Personal and professional equipment shall be checked and inspected at any convenient time prior to flight.

WEIGHT AND BALANCE

Check DD Form 365F for specific weights and center of gravity information for each flight. Refer to Section V, OPERATING LIMITATIONS, for weight and cg limitations. Do not attempt takeoff or landing with the cg outside the specified limits. Refer to T.O. 1-1B-40, Handbook of Weight and Balance Data, for weight and balance information.

ENTRANCE

Refer to Section I.

TYPICAL TIME SCHEDULE (To be used as a guide)

A. Arrive at Airplane - 1:10 before takeoff time

B. Start Engines - 0:30 before takeoff time

C. Taxi - 0:25 before takeoff time

PREFLIGHT

PREFLIGHT INSPECTION

The aircrew visual inspection procedures outlined in this Section are predicated on the fact that maintenance personnel have completed all the requirements of the Handbook of Inspection Requirements, T.O. 1C-135(K)A-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 flight safety. 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 above is recommended. However, unit commanders may, in some instances, find it necessary to deviate from the recommended time schedule.

INTERIOR INSPECTION (Cont)

3. Instructor's Oxygen Panel - Regulator OFF and 100% OXYGEN (CP)

4. Emergency Hydraulic Crossover Valve Lever - NORMAL (CP)

* 5. Pressurization and Air Conditioning Panel - Set (CP)

*a. Cabin Pressure Test Valve Handle - NORMAL, cover closed (CP)

Door must be closed and flush to insure that the cabin pressure test valve handle is in NORMAL.

*b. Cabin Manual Pressure Control - OFF (full clockwise) (CP)

*c. Cabin Pressure Controller - Set (CP)

Rotate cabin altitude selector full CCW before setting cabin altitude.

*d. Cabin Pressure Rate of Change Knob - Set (CP)

*e. Engine Bleed Switches - OPEN (CP)

*f. Air Conditioning Crossover Switch - OPEN (CP)

*g. Cabin Temperature Control - Set (CP)

*h. Air Conditioning Master Switch - RAM AIR (CP)

6. Overhead Panel - Checked (CP)

All switches OFF or in proper position. Check ciphony control panel in proper mode for mission. Check FD mode selectors in GYRO.

* 7. Fire Switches - Checked IN (CP)

* 8. Inboard Spoiler Switch - CUT-OFF (CP)

* 9. Landing Gear Lever - DN, in detent (CP)

*10. Fuel Panel - Checked (CP)

All fuel valves CLOSED and all switches OFF.

*11. Pilot's Radar Intensity Control - Full CCW (CP)

*12. Throttles - CUT-OFF (CP)

13. Rudder Power Switch - OFF (CP)

*14. All Starter Switches - OFF (CP)

*15. Hydraulic Pressure Switches - OFF (CP)

*16. Main External Power Switch - TRIP (CP)

Insure that external power is tripped and check all warning flags in view.

*17. Battery Power Switch - EMERGENCY (CP)

Check battery voltage and bus tie circuit open lights extinguished. See Section VII, ELECTRICAL SYSTEM OPERATION.

*18. Alarm Bell - Checked (CP, GC, or BO)

This is signal for ground crew to connect external power or boom operator to start APU, as applicable.

*19. External Power - Checked, switch CLOSED (CP)

Copilot checks voltage and frequency before closing the switch.

NOTE

- If external power or auxiliary power unit is not available, it will be necessary to start an engine to obtain electrical power. The battery switch must be placed in the EMERGENCY position in order to start an engine for the following checks.
- On airplanes ▌1▶▌▌ , the warning horn will sound with no external power and the battery switch in EMERGENCY and any throttle less than one-third open. Actuating the warning horn cutout switch will silence the horn until the throttle is moved.

*20. T-R Voltage - Checked (CP)

*21. Battery Power Switch - NORMAL (CP)

*21A. FD No. 1 and No. 2 Master Power Switches (With ▌ITO 879▌) - ON (CP)

Prior to placing switches ON, check both pilot and copilot FD-109/RGA power-off lights illuminated. Lights should go out when switches are placed ON.

*22. Instrument Power Gyro Switches, VOR, TACAN, UHF COMM Radios, and Autopilot - ON (CP)

*23. RGA Power Switches - ON (CP)

*24. Required Publications - Complete (CP)

*25. Assemble Crew - Assembled (P, CP, N, BO, GC)

*a. Ground Safety Locks - Stowed

(Boom Operator reports "6 ground safety locks stowed.")

*b. Form 781 - Read (as applicable)

Aircrew and ground crew will discuss applicable Form 781 discrepancies.

*c. Mission and Weather Briefing - Complete

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

*d. Start Engines Time - Announced

*e. Instructions, Questions, and Briefing - As required

Insure extra crewmembers are briefed, commensurate with their experience.

*f. Interior Inspection - Accomplish (All)

Instruct the crew to complete Interior Inspection.

*26. Oxygen System - Checked (P, CP)

See Section IV for Oxygen Check.

*27. Crew Report - Completed (BO, N, CP, P)

a. Copilot switches interphone to CALL position and announces "Crew Report."

b. Sequence will be boom operator, navigator, copilot, and pilot. Each crewmember switches to CALL position and reports, "Interphone and oxygen checked."

c. If desired, headsets may be worn after this point.

INTERIOR INSPECTION (Cont)

*28. Interior Lights - Set, as required (P, CP)

a. Press-to-test TEST RESET switch and check COMPAR WARNING lights, comparator monitor warning lights, and red attitude warning indicators.

b. Press-to-test FD annunciator TEST button and check all annunciators and attitude warning indicators.

c. T/O ARM annunciators should remain illuminated.

d. Copilot checks continuity of fire warning circuit with the engine fire detector test switch.

e. Copilot moves paralleling selector to GEN 3 position and checks synchronizing lights illuminated.

f. Check all press-to-test warning and indicator lights which have not been previously checked and are not illuminated. The following lights should be illuminated: hydraulic pump inoperative lights, cargo door or hatch not latched warning light, copilot's instrument power off light, water boost pumps low pressure warning lights (if a wet takeoff is to be made), landing gear warning light knob, engine manifold low pressure warning light, engine oil low pressure warning light(s) (No. 4 without ▙ 1510/738 ▬ , No. 1, 2, 3, and 4 with ▙ 1510/738 ▬), green attitude indicator monitor lights, and generator circuit open lights.

NOTE

Due to the possibility of the press-to-test lights sticking in the intermediate (OFF) or the press-to-test position during the press-to-test cycle, the individual accomplishing the check will press-to-test, then pull each light to preclude sticking.

g. When cocking the airplane for alert, turn the thunderstorm lights OFF and adjust all other cockpit light rheostats to the minimum position that will provide illumination of all necessary controls/panels and allow for optimum outside visibility at night.

NOTE

Positioning the rheostats between 12:00 and 2:00 o'clock positions will normally result in an intensity for optimum outside visibility.

*29. Battery Charging Current - Checked (P)

*30. Wheel Well Doors - Clear (CP, GC)

WARNING

The pilot will ensure that no personnel are standing near wheel well doors when pressurizing the left hydraulic system. Sudden closing of these doors could cause serious injury to personnel who may be in the path of the doors.

*31. Hydraulic Systems - Pressurize (P, CP)

a. Hydraulic Quantity and Pump Supply Guards - Checked, guards closed (CP)

b. System Pressure Switches - ON (P)

c. Right System Auxiliary Pump Switch - AUTO (P)

d. Left System Auxiliary Pump Switch - RESERVE BRAKE (P)

Check for increase in reserve brake pressure.

e. Left System Auxiliary Pump Switch - AUTO (P)

*32. Antiskid System (With [redacted]) - Checked (P)

a. Antiskid Indicators - 4 blanks

b. Antiskid Test Switch - INBD

With test switch in INBD position, the inboard indicators should be blank and the outboard indicators should show REL (release).

c. Antiskid Test Switch - OUTBD

With test switch in OUTBD position, the outboard indicators should be blank and the inboard indicators should show REL (release).

WARNING

Do not take off on a normal or training mission if the antiskid test indicates a system malfunction. Asymmetric brake effectiveness or blown tires could result during subsequent braking.

NOTE

A momentary REL indication, when the test switch is released, is normal.

*33. Anti-Icing and J-4 Panels - Checked (CP)

Check anti-icing panel switches as required and J-4 compass function selector switch in MAG.

*34. Fuel Quantity Readings - Checked (P, CP)

Press-to-test all gages and record actual readings on Form 7 and Form 365F, and flight progress section of SAC Form 200, if used.

WARNING

If a fuel quantity indicator is inoperative, open the associated 115-volt AC fuel quantity indicator circuit breaker on generator No. 1 MCBP. The circuit breaker will not be reclosed until proper inspection and repairs have been made.

*35. Hydraulic Pressure - Checked (P, CP)

Left system, right system, and pilot's reserve brake pressure gages should read approximately 2900 psi.

*36. Gear Warning Light - Extinguished (CP)

*37. Fuel Dump Actuator - Checked (CP, GC)

Ground crew will report boom fully retracted. The copilot will actuate the fuel dump switch to FUEL DUMP and return to OFF. Ground crew will report movement.

CP - "Dump Switch - Fuel Dump"
GC - "Poppet Valve - Open"
GC - "Dump Actuator - Reset, Poppet Valve Closed"

*38. Inboard Spoiler Switch - NORMAL (P)

INTERIOR INSPECTION (Cont)

39. Speed Brakes - Checked (P, GC)

NOTE

- What appears to be jammed controls can result when the airplane is parked in a strong tailwind or crosswind. A 12 knot tailwind, for example, can prevent movement of the aileron control wheel in one direction, while movement in the other direction is unrestricted. A tailwind of 17 knots or more may appear to lock the control column against either forward or aft movement. It is not advisable to ignore any indication of malfunction.

- A restrictor bleed added to the left hydraulic system results in slower response of the inboard spoilers to either the control wheel or the speed brake lever when hydraulic pressure is supplied by the left system auxiliary pump. Response is normal when the left system is pressurized by the engine-driven pumps.

a. Speed Brake Lever - 60 degrees (P)

"All spoilers up 60 degrees" (GC)

b. Control Wheel - Rotate full left (P)

"Left spoilers 60 degrees, right spoilers 20 degrees" (GC)

c. Control Wheel - Rotate full right (P)

"Left spoilers 20 degrees, right spoilers 60 degrees" (GC)

d. Control Wheel - Neutral (P)

"All spoilers up 60 degrees" (GC)

e. Inboard Spoilers Switch - CUT-OFF (P)

"Inboard spoilers moving down" (GC)

f. Outboard Spoiler Switch - CUT-OFF (P)

"Outboard spoilers moving down" (GC)

g. Speed Brake Lever - 0 Degrees (P)

h. Inboard and Outboard Spoiler Switches - NORMAL (P)

"All spoilers down" (GC)

40. Control and Trim Check - Completed (P, CP, GC)

Control check will be accomplished in the following sequence: ailerons, elevators, and rudder.

a. Control Wheel - Rotate to left (P)

"Left ailerons up, tabs down, left spoilers 40 degrees, right spoilers down, right ailerons down, tabs up" (GC)

b. Control Wheel - Rotate to right (P)

"Left ailerons down, tabs up, left spoilers down, right spoilers 40 degrees, right ailerons up, tabs down" (GC)

c. Control Wheel - Neutral (P)

d. Aileron Trim - Checked and set (P)

Check freedom of movement of aileron trim wheel, control wheel for movement in same direction as trim wheel and center aileron trim wheel.

NOTE

The up elevator travel available during ground check, by moving the control column, is restricted by the preload spring in the stabilizer actuated elevator tab linkage at stabilizer angles between 1/2 degree stabilizer leading edge up to 9 degrees stabilizer leading edge down. For this reason, the stabilizer should be positioned between 9 and 14 degrees stabilizer leading edge down (6 to 11 units airplane nose up trim) during the ground check of the elevator travel.

e. Control Column - Forward (P)

"Elevator down, outboard tabs up" (GC)

f. Control Column - Aft (P)

"Elevator up, outboard tabs down" (GC)

g. Stabilizer Trim Control Wheel - Check (P)

Rotate trim control wheel manually 4 to 5 turns in each direction. Observe stabilizer trim indicator for proper movement, and be alert for any abnormal feeling of roughness or binding in the wheel movement.

NOTE

Any roughness or binding in the trim wheel action is sufficient reason to have the trim actuator system inspected. Do not confuse roughness and binding with trim system chatter. This chatter can occur on a normal trim system only while trimming manually in the nose down direction; however, electrical trim will be normal. See also T.O. 1C-135(K)A-2-8.

h. Stabilizer Trim Control Switch - NOSE DOWN (P)

Check for forward movement of trim control wheel and trim indicator. Ground crew reports, "Stabilizer leading edge and inboard elevator trim tabs moving up." (GC)

CAUTION

Simultaneous actuation of pilot and copilot stabilizer trim control switches in opposite directions will cause rapid deterioration of the electrical trim system with possible breakage of the gear train in the stabilizer driven unit and must be avoided at all times.

i. Stabilizer Trim Control Switch - NOSE UP (P)

"Stabilizer leading edge and inboard elevator trim tabs moving down." (GC)

j. Stabilizer Trim Cutout Switch - STAB TRIM CUTOUT (P)

While holding stabilizer trim control switch in NOSE UP position, ascertain that stabilizer ceases to rotate. "Stabilizer movement stopped." (GC)

k. Stabilizer Trim Cutout Switch - Forward, guard positively checked down (P)

Snap guard down with a positive push.

INTERIOR INSPECTION (Cont)

m. Stabilizer Trim Control Switch - Checked (CP)

Copilot moves stabilizer trim control switch to NOSE DOWN and NOSE UP. Ground crew reports movement of stabilizer and inboard elevator trim tabs. Copilot resets trim indicator to zero. Ground crew reports, "Stabilizer leading edge approximately zero."

n. Rudder - Checked (P, GC)

(1) Push in left rudder pedal (P)

"Rudder left, control tab right" (GC)

(2) Push in right rudder pedal (P)

"Rudder right, control tab left" (GC)

(3) Rudder Power Switch - ON (P)

Note pressure buildup on rudder pressure gage to approximately 2400 psi.

(4) Push in full left rudder (P)

"Rudder left, tab left" (GC)

(5) Push in full right rudder (P)

"Rudder right, tab right" (GC)

Rudder pressure will fluctuate during motion check.

(6) Rudder Trim - Checked (P)

Neutralize rudder, crank rudder trim 5 units left and right of center. Rudder pedals should respond in same direction. Return trim to neutral.

NOTE

- During ground check, 5 trim units will move the tab full throw. Additional units will not move the tab further and only apply unnecessary windup force to the torsion bar.
- Deflection of the control tab, either left or right, with rudder in the neutral position and rudder power ON, can occur when there is insufficient ram air pressure in the Q-spring. The control tab will streamline with an increase in ram air pressure (approximately 70 KIAS) in the Q-inlet.

41. Flap and Speed Brakes Warning Horn - Checked (P, CP)

NOTE

In order to accomplish the flap warning horn check, it will be necessary to insure that the leading edge flaps are in the fully extended position.

Advance No. 3 throttle to full open (P). With flap lever at FLAP DOWN setting, warning horn should sound. Move flap lever to the 40 degree detent (CP). The warning horn should sound. Move flap lever thru 30 and 20 degree detents (CP). Warning horn should not sound. Move flap lever to FLAP UP position (CP). Warning horn should sound. Move flap lever to 30 degree position (CP). Move speed brake lever toward aft position (P). Warning horn should sound. Return speed brake lever to 0 degrees (P). Retard No. 3 throttle (P) and return flap lever to the FLAP UP position (CP).

42. Radios - Checked (P, CP)

a. Where reception is possible, pilot and copilot each tune and identify the appropriate ILS and VOR frequencies and check his respective HSI and ADI, as applicable, to determine if the correct course signals are being received. Pilot tunes and identifies the appropriate TACAN frequency, selects TACAN on both TACAN select switches and checks pilot's and copilot's HSI, RMI, and range indicators for correct indications.

NOTE

The TACAN antenna switch should be in the BOTTOM position when the function selector switch is in the REC or T/R position for air to ground TACAN operation.

b. Copilot makes operational check of command radios. Obtain altimeter setting and advise pilot and navigator. Advise ground control of airplane location and engine start time.

WARNING

Simultaneous keying of an unsecure HF or UHF transmitter is prohibited when command 1 or 2 UHF is being used for classified conversation in the same airplane compartment or area.

43. Altimeters - Checked and RESET (P), Checked and STBY (CP)

a. Altimeters - Set, STBY flag in sight

Note altimeter reading. Insure each altimeter indicates within 75 feet of a known elevation. Pilot checks that an altimeter correction card is installed.

b. RESET-STBY Lever - RESET

Hold in RESET position 2 to 3 seconds.

c. STBY Flag - Out of sight

Compare altimeter reading with standby mode reading. Altimeters should read within 75 feet of standby mode reading. Insure each altimeter indicates within 75 feet of a known elevation.

d. RESET-STBY Lever - STBY (CP)

e. Radio Altimeter - Checked

Press-to-test the TEST button and check for proper indications. Vary MDA index and check MDA lights.

*44. FD Mode Selector - HDG (P, CP)

Set heading marker under lubber line and check for wings level command. Set command bars to 6 to 8 degree pitchup position.

45. Instruments - Checked (P, CP)

Check all instruments for normal readings. Check ADI's by depressing press-to-test button, ADI should display approximately 20 degrees right bank, 10 degrees climb; command bars drive out of view; GYRO and COMPTR flags appear. Appropriate red attitude warning lights illuminate. Press TEST RESET to reset warning lights.

NOTE

Do not depress pilot's and copilot's ADI test buttons at the same time or all red attitude warning lights will illuminate.

45A. FD Mode Selector - RGA (P, CP)

Command bars should indicate a wings-level zero pitch command and T/O MAX annunciators on. Either pilot or copilot actuates RGA switch and checks that both ADI's indicate proper rotation commands.

46. Autopilot - Checked (P, CP)

See Section IV for autopilot check.

After checking the autopilot, set the stabilizer trim to the takeoff setting unless climatic conditions dictate otherwise. If the airplane is to be left unattended for extended periods under snow or icing conditions, the stabilizer trim will be set to 2.5 units airplane nosedown position.

NOTE

Setting the stabilizer trim to full airplane nosedown position during icing conditions may cause the nosedown limit switch to freeze open and prevent electric nosedown trimming after takeoff.

*47. FD Mode Selector - GYRO (P, CP)

NOTE

If a more comprehensive preflight of the FD/RGA system is desired for pilots' checkout or familiarization, refer to FD/RGA SYSTEM PREFLIGHT in Section IV.

*48. Seats, Pedals, Belts, and Harnesses - Adjusted (P, CP)

Adjust seat back to the full vertical position to prevent sliding up the seat back when heavy rudder pedal force is applied. Adjust seat and rudder pedals horizontally so that the knee can be locked at full rudder pedal travel with allowance for compression of clothing and parachute/seat cushion.

WARNING

- Proper adjustment of seat and rudder pedals is of paramount importance if full rudder deflection is required during the 3 to 5 minute critical take-off and climbout segment of the mission.
- Pilots must insure that their seat horizontal adjustment lever is in the down and locked position to prevent possible inadvertent seat movement.

INTERIOR INSPECTION (Cont)

*49. Navigation (Position) Lights - FLASH and BRIGHT (CP)

*50. Fuel Panel - Set for takeoff (P, CP)

a. All 8 fuel boost pump switches ON (CP)

b. No. 2 Tank to Engine Manifold Valve Switch - OPEN (CP)

Check engine manifold low pressure warning light extinguished.

c. Line Valve Switch - OPEN (CP)

*50A. Auxiliary Pumps - OFF (P)

If the airplane is being cocked for alert, check the wing flaps fully retracted prior to turning the auxiliary pumps off.

If a cartridge start is not to be made and the crew does not intend to disembark prior to starting engines, disregard remaining items and proceed to STARTING ENGINES AND BEFORE TAXIING checklist.

*51. External Power Switch - TRIP (CP, N, BO)

Coordinate with navigator and boom operator prior to tripping external power switch.

*52. Battery Power Switch - OFF (P)

*53. Cartridge(s) - Insert in starter (P, GC)

Pilot checks start switches and start selector switch in the OFF position prior to GC inserting cartridges in starter. See T.O. 1C-135(K)A-2-4.

WARNING

- Prior to installing a new cartridge, all electrical power must be turned off (except during alert operations) and the starter and start selector switches must be OFF to preclude accidental firing due to a faulty ignition circuit.
- Except in an emergency, engine operation is prohibited when a live (unfired) cartridge is installed in the starter. Abnormal cartridge conditions of explosive nature could be generated due to the combination of vibration and high temperature that can exist in the engine nacelle.

54. Cockpit Thermal Radiation Curtains and Eye Protective Devices - Checked and installed, sealed (if applicable) (P, CP)

Refer to ALERT PROCEDURES, this section.

NOTE

- During weather conditions in which ice or snow is continually accumulating during ground operation just prior to takeoff, ice accumulation may be kept to a minimum by the application of cold concentrated deicing fluid to the previously deiced surfaces just prior to engine start. Refer to COLD WEATHER PROCEDURES, Section IX. Takeoff should be made within thirty minutes of the application. The cold deicing fluid has greater viscosity than warm fluid and will tend to remain longer on the surfaces, affording a longer time period of protection from ice accumulation.
- If, after the INTERIOR INSPECTION checklist has been accomplished, any significant maintenance is required, the airplane will be uncocked by use of the UNCOCKING checklist. Once the aircraft has been uncocked, the normal preflight checklists will be used to prepare the aircraft for flight.

STARTING ENGINES AND BEFORE TAXIING (CP reads)

Only items in bold face print need be accomplished during scramble operations.

WARNING

If airplane is directly behind another operating jet airplane, or will be run up with its tail into the wind and CO contamination is suspected, all crew members will use 100% OXYGEN during ground operations. (Toxicology tests conducted during close interval taxiing and minimum interval takeoffs revealed that maximum CO concentration was negligible.)

1. **BATTERY SWITCH—EMERGENCY (P)**

2. External Power Switch - CLOSE, if auxiliary power available (CP)

3. **PARKING BRAKES—SET (P)**

4. **RESERVE BRAKE PRESSURE—CHECKED (P)**

   Pressurize the reserve brakes until a pressure increase of at least 300 psi above preload pressure is observed.

5. **CHECK WITH GROUND—READY TO START ENGINES (P, GC)**

   Ground crew's mike and headset will be plugged into external interphone receptacle; pilot states "Ready to start engines," ground crew replies "Chocks in place, engines clear, fire guard standing by." When external interphone capability does not exist, the pilot will (except for actual EWO or impending disaster) review with the ground crew the standard hand signals and procedures to be used during engine start and before taxi.

6. **START ENGINES—STARTED (P, CP, GC)**

CAUTION

- If, after placing the starter switch in the GROUND START position, there is no indication of engine rpm, turn the starter switch to OFF and investigate the cause prior to attempting another start. Disintegration of the starter can result on a subsequent start attempt if the starter shaft has failed.
- During a normal engine starting operation, if the exhaust gas temperature does not rise, indicating a no start condition, or exceeds the starting temperature, indicating a hot start, or does rise with no increase in rpm, indicating a false start, the following procedure must be followed:

  a. Throttle - CUT-OFF

  b. Starter Switch - OFF

  c. Boost Pump Switches (Applicable) - OFF

  d. Investigate to find reason for difficulty.

  e. Wait for one minute for fuel to drain and have ground crew inspect engine for fuel puddles prior to attempting another start. When necessary to clear trapped fuel or vapors from the engine, motor the engine with starter for 10 to 20 seconds with the throttle in CUT-OFF.

STARTING ENGINES AND BEFORE TAXIING (Cont)

- Under all conditions, if the throttle is inadvertently retarded to the CUT-OFF position, there will be an immediate flameout. Do not reopen the throttle. Introducing unburned fuel in the tailpipe area can create a fire hazard.

- Due to high starting temperatures associated with cartridge starting operation (without), a ground observer with a fifty pound CO_2 bottle or one 10 gallon bromochloromethane (CB) will be stationed adjacent to the engine being started with the cartridge. The ground observer should stand between the engine inlet and the plane of the starter turbine on the right side of the engine.

- For engine starts where two or more cartridges are fired simultaneously (with), a 50 pound CO_2 bottle or one 10 gallon bromochloromethane (CB) will be positioned at each wing tip. The ground observer will monitor all engines from a position at the nose of the aircraft and will respond to an engine with the nearest extinguisher.

NOTE

- For cartridge-pneumatic starter limitations and cartridge malfunctions, refer to Section V.

- **Pneumatic starter cutout should occur when engine rpm reaches 43 to 54%. Maximum pneumatic starter actuation should not exceed two minutes, after** which a 3-minute waiting period should be observed. After the second and each subsequent start attempt, a 10-minute waiting period must be observed.

- If No. 4 engine bleed air is used for starting remaining engines, then No. 2 and No. 1 engine may be started simultaneously. If external air is used, they will be started one at a time.

- When only battery power is used during engine starts, all engine oil pressure gages are inoperative until a generator is on the line and 28 volt AC power is available. On airplanes with , engine No. 1, 2 and 3 oil low pressure warning lights are inoperative until a generator is on the line and 28 volt DC power is available from T-R BUS NO. 1.

a. Cartridge-Pneumatic Start (Without)

When starting No. 4 engine with a cartridge, move the No. 4 starter switch to GROUND START, pull out the No. 4 start selector switch and hold it in CTG START position. After positive indication of rpm on the tachometer, release the No. 4 start selector switch to OFF and upon reaching 12% engine rpm, move the No. 4 throttle smoothly to START in approximately one second. After a positive rise in EGT is observed, and upon reaching 30% rpm, move throttle to IDLE position. When starting No. 4 engine pneumatically, actuate the starter switch to GROUND START and place the start selector switch to PNEU START. Upon reaching 15% engine rpm, move the No. 4 throttle smoothly to START in approximately one second. After a positive rise in EGT is observed, and upon reaching 30% rpm, move throttle to IDLE position. Pilot carefully observes fuel flow (if power is on the line) and EGT for indication of a hot start and monitors engine instruments as the engine accelerates. The oil low pressure warning light should extinguish, and with power on the line, oil pressure can be observed on the gage. Check fuel flow peak at 1200 to 1400 pph between 40 and 50% rpm, and EGT limits. Pilot places ignition and starter switch (followed by start selector switch, after a pneumatic start) to OFF after passing 50% rpm. Check hydraulic pump inoperative light extinguished. If external pneumatic power is to be used for starting the remaining engines, pilot will retain the No. 4 throttle in IDLE position; otherwise, he will smoothly advance the throttle to approximately 90-95% rpm. Do not exceed TRT dry.

CAUTION

On airplanes with TCTO 738, the engine oil low pressure warning switches are set to actuate at 37 ± 2 psi. Under some conditions, the oil low pressure warning light may be on when the engine is at idle. Cross-check the light with the oil pressure gage to make sure a minimum of 35 psi is available at idle. If no AC power is available for gage operation, advance the throttle above IDLE; if the light remains on, shut down the engine. On airplanes less TCTO 738, the switch actuates at 28 to 36 psi and the light should go out within 30 seconds of initiating the start.

b. Pneumatic Start (Without TCTO 920)

(1) Pilot reports "Ready to start No. 3" and when cleared by ground crew, places the starter switch to GROUND START. Upon reaching 15% engine rpm, the throttle is advanced smoothly to START in approximately one second. After a positive rise in EGT is observed and upon reaching 30% rpm, move throttle to IDLE position. Pilot carefully observes fuel flow (if power is on the line) and EGT for indication of a hot start. On airplanes with TCTO 738 (if power is on the line), cross-check the oil low pressure warning light with the oil pressure gage to make sure a minimum of 35 psi is available at idle. Upon reaching 50% rpm the pilot will move the starter switch to OFF. Check hydraulic pump inoperative light extinguished.

NOTE

- During alert response, after one engine is running and advanced to 90-95% rpm, the three remaining engines may be started simultaneously. During hot day or high altitude conditions, closely monitor engine instruments during starting. If one engine noticeably lags the other two engines in accelerating to 15% rpm or if acceleration on all engines is abnormally slow to 15% rpm, return the starter switch for the slowest engine to OFF, and continue start procedure for two remaining engines. The starting procedure for the remaining engine may be reinitiated after engine rotation, as indicated by tachometer, has ceased.

- During alert response, as soon as the engine reaches idle rpm, the generator breaker switch may be closed. Refer to ELECTRICAL SYSTEM OPERATION, Section VII.

(2) Pilot reports "Ready to start No. 2 and No. 1" and when cleared by ground crew, starts remaining engines using same procedures as for No. 3 engine.

c. Cartridge - Pneumatic Start (With TCTO 920)

When starting any engine with a cartridge, move the starter switch for that engine to GROUND START, pull out the start selector switch and hold it in CRTG START position. After positive indication of rpm on the tachometer, release that start selector switch to OFF and upon reaching 12% rpm, move the throttle for that engine smoothly to START in approximately one second. After a positive rise in EGT is observed, and upon reaching 30% rpm, move the throttle to IDLE position. When starting any engine pneumatically, actuate the starter switch for that engine to GROUND START and place the start selector switch to PNEU START. Upon reaching 15% engine rpm, move the throttle for that engine smoothly to START in approximately one second. After a positive rise in EGT is observed, and upon reaching 30% rpm, move throttle to IDLE position. Pilot carefully observes fuel flow (if power is on the line) and EGT for indication of hot start and monitors engine instruments as the engine accelerates. The No. 4 oil low pressure warning light should extinguish. With power on the line, numbers 1, 2 or 3 oil low pressure warning lights should extinguish and oil pressure can be observed on the gage. Check fuel flow peak at 1200 to 1400 pph between 40 and 50% rpm, and EGT limits. Pilot places starter switch to OFF after passing 50% rpm. Check hydraulic pump inoperative light extinguished. If external pneumatic power is to be used for starting the remaining engines, pilot will retain the No. 4 throttle in IDLE position; otherwise he will smoothly advance the throttle to approximately 90-95% rpm. Do not exceed TRT dry. The start selector switch will be turned to OFF after the last starter switch is placed to OFF position.

STARTING ENGINES AND BEFORE TAXIING (Cont)

CAUTION

On airplanes with TCTO 738, the engine oil low pressure warning switches are set to actuate at 37 ± 2 psi. Under some conditions, the oil low pressure warning light may be on when the engine is at idle. Cross-check the light with the oil pressure gage to make sure a minimum of 35 psi is available at idle. If no AC power is available for gage operation, advance the throttle above IDLE; if the light remains on, shut down the engine. On airplanes less TCTO 738, the switch actuates at 28 to 36 psi and the light should go out within 30 seconds of initiating the start.

d. Cartridge Start (Quick Start/EWO Start) (With TCTO 920)

When starting all four engines simultaneously with cartridges, move the starter switches for all four engines to GROUND START, pull out on the start selector switch, and hold it in CRTG START position. After positive indication of rpm is observed on all tachometers, release the start selector switch to OFF and as each engine reaches 12% rpm, move the throttle for that engine smoothly to START in approximately one second. After a positive rise in EGT of each engine is observed, and upon reaching 30% rpm, move each throttle to IDLE position. Pilot and copilot carefully observe fuel flow (if power is on the line) and EGT for indication of a hot start and monitor engine instruments as the engines accelerate. The No. 4 oil low pressure warning light should extinguish. With power on the line, numbers 1, 2 and 3 oil low pressure warning lights should extinguish and oil pressure can be observed on the gages. Check fuel flow peak at 1200 to 1400 pph between 40 and 50% rpm. Check all engines for EGT limits. Pilot places starter switches for all engines to OFF after passing 50% rpm. Check hydraulic pump inoperative light extinguished.

CAUTION

On airplanes with TCTO 738, the engine oil low pressure warning switches are set to actuate at 37 ± 2 psi. Under some conditions, the oil low pressure warning light may be on when the engine is at idle. Cross-check the light with the oil pressure gage to make sure a minimum of 35 psi is available at idle. If no AC power is available for gage operation, advance the throttle above IDLE; if the light remains on, shut down the engine. On airplanes less TCTO 738, the switch actuates at 28 to 36 psi and the light should go out within 30 seconds of initiating the start.

7. GENERATOR BREAKER SWITCHES—CLOSE (CP)

NOTE

The AIMS altimeter may go to STBY due to power interruption during power transfer.

8. **ROTATING BEACON AND NAVIGATION LIGHTS — BOTH ON, STEADY (CP)**

Both beacon light colors will be used.

9. **EXTERNAL POWER, CHOCKS, AND INTERPHONE—REMOVED** (P, GC)

Clear the ground crew to disconnect external power and remove chocks. Ground crew reports: "Over-wing and aft hatches checked closed; chocks, pitot covers, ground wires, and external power removed; upper and lower rotating beacons on and rotating; disconnecting interphone cord and (if applicable) coming aboard."

CAUTION

Do not taxi until it has been determined that ground equipment and obstructions are clear of the airplane and the ground crew has given a visual "clear to taxi" signal.

NOTE

Items 10, 11, 12, and 13 may be accomplished while waiting for the ground crew report.

10. **COPILOT'S INSTRUMENT POWER SWITCH—START (CP)**

After light is extinguished, release switch.

11. **BATTERY SWITCH—NORMAL (P)**

12. **ALTIMETERS — RESET (P), STBY (CP)**

NOTE

The copilot's altimeter may be operated in the RESET mode if desired. In this case the pilot's altimeter must be in STANDBY.

13. Belts and Harnesses - Fastened (P, CP)

WARNING

The pilot will ensure that the occupants of the pilot and copilot positions have their safety belts and shoulder harnesses adjusted and fastened at all times that the airplane is in flight.

14. Radio Call - Completed (P, CP)

Request taxi and takeoff instructions.

15. **TAXI REPORT—COMPLETED (BO, N, CP)**

Copilot sounds alarm bell and announces "Taxi report." Crew reports in following order: BO, N, CP - "Alarm bell checked, ready to taxi;" in addition, copilot will report door warning light extinguished. Navigator will coordinate with boom operator and report for him if boom operator is still performing his checklist.

CAUTION

Do not taxi until it has been determined that ground equipment and obstructions are clear of the airplane and the ground crew has given a visual "Clear to taxi" signal.

ENGINE GROUND OPERATION

Except for ambient temperature of -30°C (-22°F) and below, where a two minute warmup is required, no warmup period is required for the engines. Normally, as soon as the engines stabilize at idle rpm the throttles can be advanced to takeoff rated thrust.

NOTE

Engine ground operation will be limited to a maximum of five minutes at 90% rpm or above when the engine is fully cowled to prevent overheating engine accessories.

After starting, however, the engines should be allowed to run at idling speed until readings have stabilized and ground check is completed. Rapid movement of the throttle should be avoided at all times to prevent exceeding allowable exhaust gas temperatures. A minimum of two seconds should be used for transition from IDLE to takeoff rated thrust.

TAXI

Taxi without delay to conserve fuel. Use the largest radius of turn possible, and never attempt a turn while not rolling. See figure 2-2. Make all turns at slow taxi speed to avoid skidding and chattering of nose wheel. Outboard engines may be used to supplement nose wheel steering during turns. Do not read or perform the taxiing checklist while moving through a congested area. Use of the largest radius of turn possible and the absolute minimum use of inside truck braking is mandatory while taxiing at high gross weight. During all ground operations, avoid use of differential braking for directional control. Painted areas on runways, taxiways and ramps are significantly more slippery than nonpainted areas. In addition, painted areas sometimes serve as condensation surfaces and it is possible to have wet, frosty, or even icy conditions on painted areas when the overall weather condition is dry.

CAUTION

- Avoid turns on the ground which require nose wheel steering deflection more than the limits imposed by the placard located behind the steering wheel. This procedure is necessary to insure maximum life to landing gear components.
- When painted areas are wet, the braking condition may deteriorate to the extent that the RCR is near that for an icy condition.

AIRPLANE PITCH-UP DUE TO AFT CG CONDITION

There may be a tendency to pitch up at the beginning of taxi and takeoff runs with certain aft cg conditions. (Refer to Section V.) The pitch-up is frequently accompanied with a temporary loss of nose gear steering. Brake applications during taxiing may produce a bobbing or porpoising due to nose wheel strut compression and extension which is not apparent at more forward cg conditions. Scrubbing of the nose wheel tire may be apparent during normal use of nose gear steering. It is possible to lose nose gear steering at brake release due to the tendency of the airplane to rotate nose up under these conditions. This can be avoided by using a gradual application of power during the beginning of the takeoff run instead of full power prior to brake release. Continue with normal takeoff technique. Use of this technique can increase the takeoff run as much as 1000 feet, but this should not seriously prejudice the takeoff run since the condition exists in the low to medium gross weight range. Landing characteristics are not affected by the limitations determined for takeoff.

TAXIING (CP reads)

Only items in bold face print need be accomplished during scramble operations

1. **BRAKES AND STEERING—CHECKED (P)**

2. Flight Controls - Checked, if applicable (P, GC)

   If a complete flight controls check was not made during the interior inspection due to wind conditions, the airplane will be taxied to a place where the pilot and ground crewmen can complete the check prior to takeoff.

3. **ENGINE ANTI-ICING SWITCH—AS REQUIRED (CP)**

   Actuate (at low power) the anti-icing switch for 15 seconds to clear any water collected in the engine nose section. If ice fog exists or if the outside air temperature is between 47° F and 0° F (8°C and -18°C) and visible moisture exists (rain, wet snow, or visibility one mile or less in fog), leave the engine anti-icing switch in the ON position during taxi and takeoff.

   CAUTION

   In severe icing conditions (heavy supercooled fog, freezing rain or wet snow) ice can form on engine inlet guide vanes and early stages of the compressors during extended ground idle operations with anti-icing air ON. Periodic engine run-ups to as high a thrust setting as practical, dependent on taxiway conditions, can minimize these ice buildups. Such run-ups should approximate 10 seconds duration at 10 minute intervals. Subsequent takeoff under these conditions should be immediately preceded by a static engine run-up for observation of EPR and EGT to assure normal engine operation. If surface conditions preclude advancing power enough to dissipate inlet icing, or icing remains visible on the inlet cowl or guide vanes, takeoff should not be attempted.

4. **FLIGHT INSTRUMENTS—CHECKED (P, CP)**

   Check attitude indicators (including turn and slip indicators), horizontal situation indicators, RMIs and magnetic compasses for proper operation and indications during a turn in either direction.

ENGINE DANGER AREAS

WARNING

(FULL AND IDLE POWER)

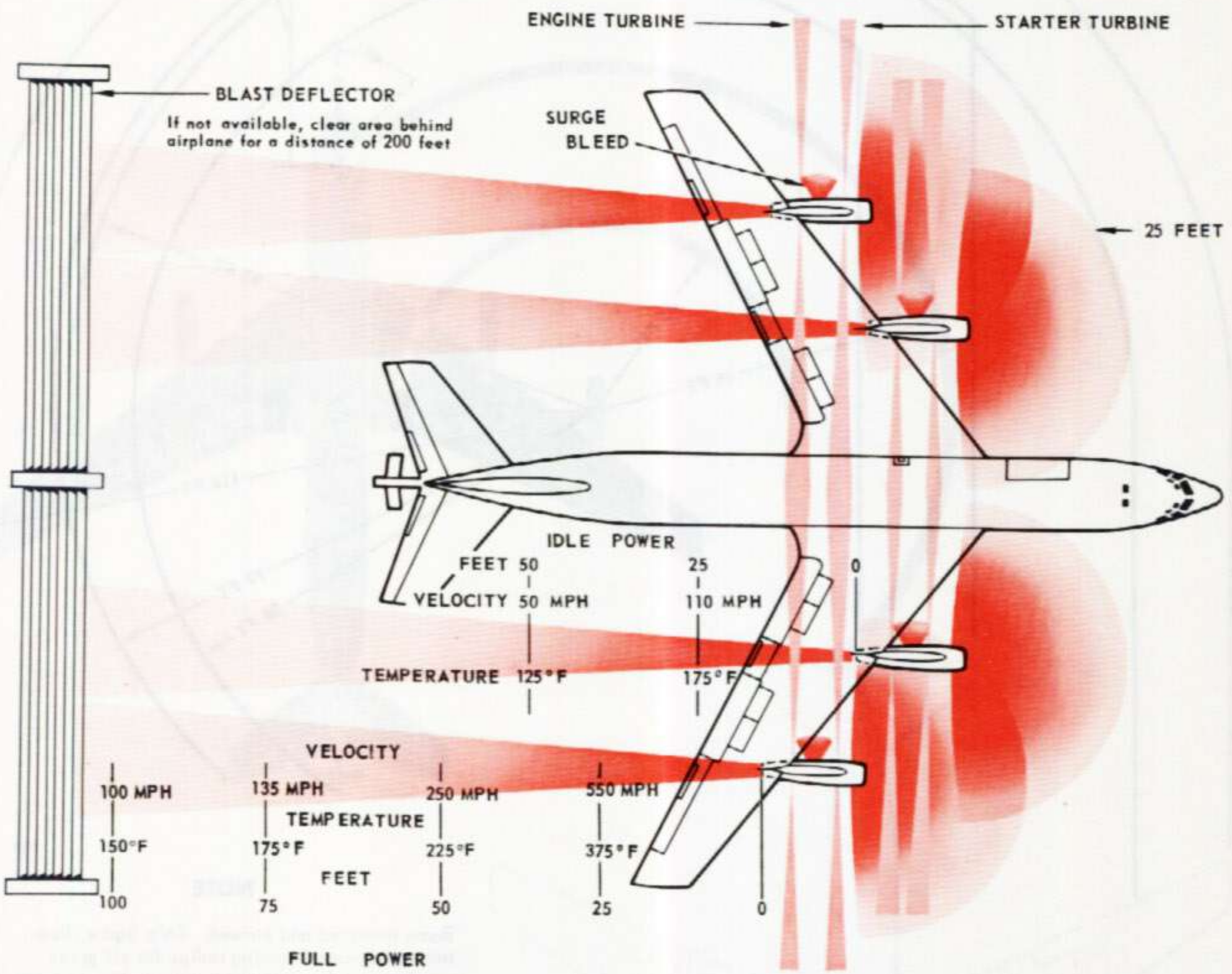
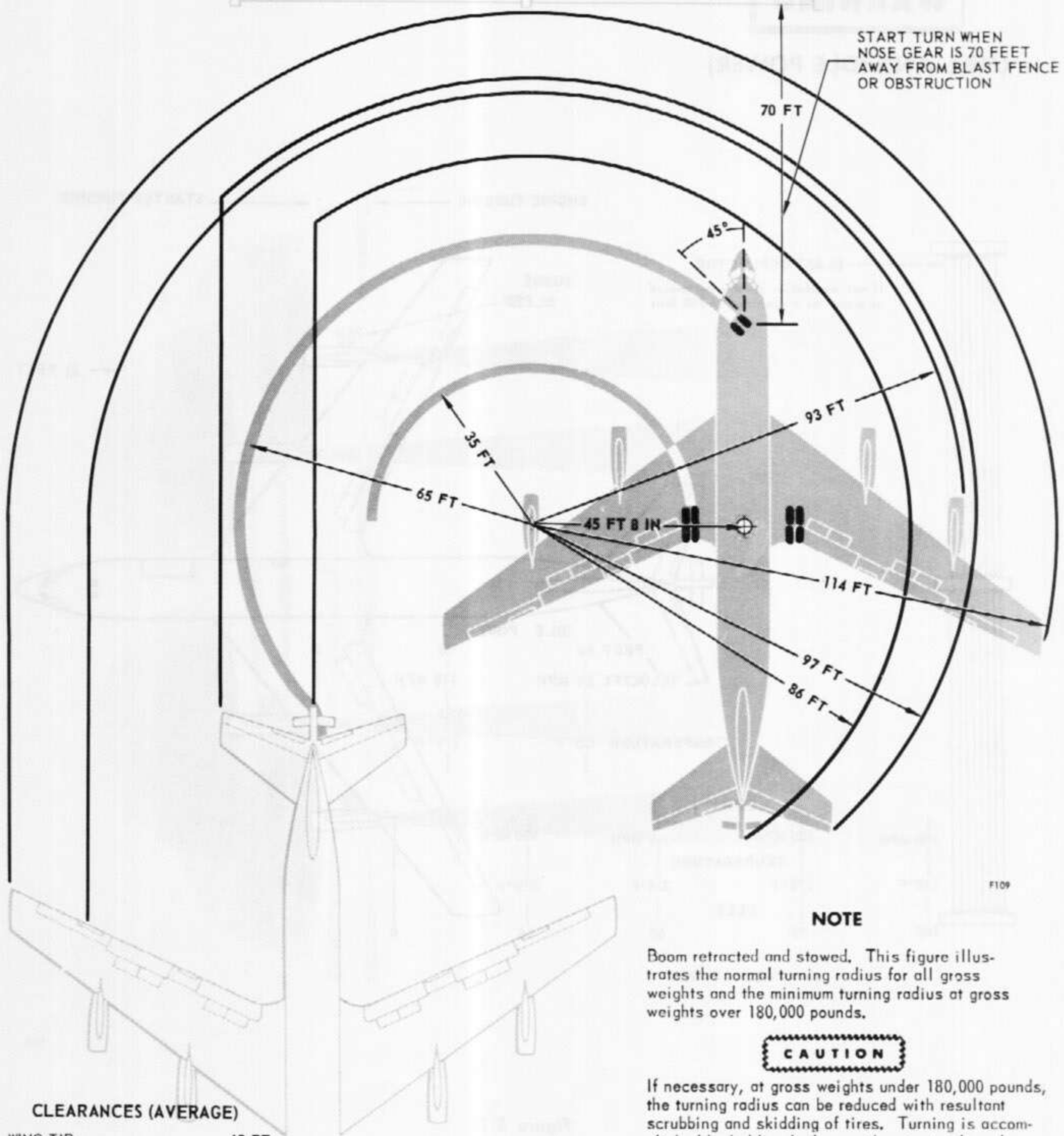


Figure 2-1

MINIMUM TURNING RADIUS



F109

NOTE

Boom retracted and stowed. This figure illustrates the normal turning radius for all gross weights and the minimum turning radius at gross weights over 180,000 pounds.

CAUTION

If necessary, at gross weights under 180,000 pounds, the turning radius can be reduced with resultant scrubbing and skidding of tires. Turning is accomplished by holding brakes on the pivot side and applying opposite side thrust. However, this procedure is restricted to emergency use only at gross weights under 180,000 pounds, and is prohibited at gross weights over 180,000 pounds. The turning radius will vary between approximately 80 feet and 103 feet depending on brake holding and thrust application technique.

CLEARANCES (AVERAGE)

WING TIP	12 FT
OUTBOARD NACELLES	57 IN.
INBOARD NACELLES	33 IN.
FUSELAGE TOP	17 FT 8 IN.
VERTICAL FIN	41 FT 8 IN.
HEIGHT (fin folded)	19 FT 7 IN.
AFT TIP ELEVATOR	16 FT 2 IN.

Figure 2-2

Only items in bold face print need be accomplished during scramble operations.

NOTE

This checklist may be accomplished while taxiing in uncongested areas.

1. Parking Brakes - Set, if applicable (P)

2. **ELECTRICAL PANEL—CHECKED (CP)**

3. **STABILIZER, AILERON AND RUDDER TRIM—SET FOR TAKEOFF (P, CP)**

   Set stabilizer trim and check aileron and rudder trim neutral.

WARNING

Failure to set the stabilizer correctly could result in:
a. Inadvertent early rotation and a stall if the stabilizer is set too nose-high (airplane noseup). (Excessive control column push forces.)
b. Longer than predicted takeoff ground runs if the stabilizer is set too nose-low (airplane nosedown). (Excessive control column pull forces.)

4. **SPEED BRAKES—0 DEGREES (P)**

5. **FLAPS – SET FOR TAKEOFF (P, CP)**

   Flap indicators should indicate all main flaps within 2 degrees of selected setting. Check leading edge flaps extended.

6. **RUDDER POWER—ON, SYSTEM CHECKED (P)**

   a. System and Rudder Power Hydraulic Pressures - Check 2800 psi or more

   b. Push in full left rudder

   c. Push in full right rudder and hold

      Full left to full right rudder travel should be accomplished in approximately 2 seconds. During this operation, rudder pressure will drop momentarily but should return to 2800 psi or more within approximately 3 seconds.

   d. Push in full left rudder and hold

      Rudder travel and hydraulic pressure characteristics should be approximately the same as above.

7. Radio Call - Completed (P, CP, N)

   Copilot and navigator receive and copy air route traffic clearance if not already accomplished. Obtain current runway temperature, wind direction and velocity (to include wind at unstick end of runway if available), altimeter setting and pressure altitude.

BEFORE TAKEOFF (Cont)

8. **TAKEOFF DATA—CHECKED** (P, CP)

Recompute takeoff data (if applicable). Review EPR settings, S_1 and rotation speed. Review takeoff procedures, initial climbout procedures, and emergency considerations with the copilot.

WARNING

Runway wind and surface condition will also affect certain takeoff data. Proper corrections must be made as specified in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1.

NOTE

- When the planned critical field length exceeds 90% of the runway available or if the climbout is critical, any actual condition existing at time of takeoff which will make the takeoff or climbout more critical will require recomputation of all applicable takeoff data.

- All applicable takeoff data will be recomputed if any weather condition or airplane configuration changes more than the amounts shown below:
  a. Runway temperature - 5 degrees F.
  b. Pressure altitude - 200 feet.
  c. Gross weight - 2000 pounds.
  d. Percent of MAC - .5%.

- For wet thrust takeoffs at temperatures above 100 degrees and for all dry thrust takeoffs, the EPR will be recomputed if the actual runway temperature varies more than two (2) degrees from that used for computation.

9. TACAN Select Switches - As required (P, CP)

10. **SLIDING WINDOWS—CLOSE** (P, CP)

NOTE

Placing objects in the hole to the rear of the sliding window handle may cause difficulty in opening the window during an emergency egress.

11. **WINDOW HEAT—NORMAL** (CP)

CAUTION

- The pilots' window anti-icing system will not be operated when the sliding windows are open. Due to lack of air blast on the windows they may overheat and possible breakage of the sliding window could occur.

- Window heat shall be kept on NORMAL unless icing conditions severe enough to warrant a higher setting are anticipated during ascent. Window heat shall be operating at all times during flight to increase impact strength of the windows.

12. Oxygen - ON and 100% (P, CP)

13. Pressurization and Air Conditioning Panel - Set (CP)

CAUTION

Do not operate the air conditioning system during the time water injection is used. To do so will cause cabin fog and possible damage to the air cycle machine turbine wheels.

14. **PITOT AND Q-INLET HEAT—ON** (CP)

15. **FD MODE SELECTOR SWITCHES —RGA (P, CP)**

NOTE

- Do not set FD mode selectors to RGA position while accelerating, decelerating, or turning the airplane.
- Voltage transients may cause the copilot's ADI command bars to fly from view and a computer flag to appear when the copilot's flight director mode selector is placed to RGA. These transients in the power supplied to the copilot's RGA computer may have occurred when the copilot's instrument power switch was placed to START (power switched to the 1 KVA hydraulic generator). If this situation occurs, turn the copilot's FD mode selector to another mode, turn the RGA power switch OFF momentarily then ON to reset the system, and return the FD mode selector to RGA.

16. **TAKEOFF CLIMB SELECTOR SWITCHES — AS DESIRED (P, CP)**

WARNING

The AC-CL position will not be used for EWO operations. If installed, the EWO switch/indicator will not be used.

NOTE

- Both pilot and copilot must have the same takeoff climb (AC-CL or MAX) mode selected to avoid an RGA comparator warning indication when the commands of the two modes conflict by more than 3 degrees.
- If the mode selector is moved or recycled after selecting the AC-CL position, the climb selector will return to the MAX position and must be repositioned to AC-CL after the mode selector is again in the RGA position.
- If the RGA pushbutton switch is actuated while on the ground (weight-on-wheels) and neither of the FD mode selectors are in RGA, the CMPTR flag will appear and the command bars will drive out of view. To rearm the RGA system for takeoff, turn both FD mode selectors to another mode, turn both RGA power switches to OFF momentarily then ON and reselect RGA mode.

17. **WARNING INDICATORS, FLAGS AND ANNUNCIATORS — CHECKED (P,CP)**

Check comparator and attitude warning indicators not illuminated, applicable warning flags out of view.

18. Takeoff Report - Completed (BO, N, CP)

Copilot announces over interphone "Takeoff report." Each crewmember will respond with "Ready for takeoff," and prefixed by crew position in the order of boom operator, navigator, and copilot.

WARNING

If freezing precipitation is severe, a final physical check of the surfaces should be made just before takeoff to determine if the surfaces are still free of ice. From the control cabin, it is difficult to see coatings of as much as one-fourth inch of clear ice on the wings.

TAKEOFF

GENERAL

Close attention must be given to the recommended procedures in order to obtain the best takeoff performance. The normal takeoff technique is that which will be required to produce the results indicated in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1. These procedures are the most desirable for safety considerations and the attainment of minimum practical takeoff distance. Engine failure techniques should be mentally reviewed just prior to takeoff. Consider runway conditions and wind to determine probable technique.

Performance Data

All factors which affect the performance of the airplane must be considered when computing takeoff data. Any one factor or combination of factors may jeopardize the safe accomplishment of the takeoff and pilots must have complete knowledge of the effects of gross weight, temperature, pressure altitude, runway available, runway gradient, runway condition, and wind on the performance of the airplane.

WARNING

Takeoff distance and climbout performance can be adversely affected to a dangerous degree by snow and ice accumulations on the airplane. Refer to ICE AND RAIN, Section IX.

RGA System Operation

The FD/RGA system controls (FD mode selector and RGA pushbutton switch) must be operated in the correct sequence to obtain a command bars display for takeoff and prevent a malfunction indication. See ROTATION GO-AROUND SYSTEM OPERATION, Section IV.

After the mode selector switch is placed to RGA, the pilots will position the takeoff climb selector switch to AC-CL or MAX based upon the desired climb profile commands after initial rotation. For a discussion of AC-CL and MAX climbout profiles, see CLIMBOUT, this Section, and Part 3 of the Appendix, T.O. 1C-135(K)A-1-1. In either AC-CL or MAX position, the command bars will display an initial climb (rotation) command of 8.5 degrees pitchup for 20 degrees of flaps or 8 degrees pitchup for 30 degrees of flaps.

During takeoff roll, the ADI command bars will indicate command for level flight (RGA mode prior to RGA pushbutton actuation). Just prior to reaching rotation speed (V_{ROT}) (within 10 knots), both RGA pushbutton switches are depressed to establish the most accurate zero pitch attitude reference for the RGA system pitch computations. (Depressing both RGA buttons insures correct display for both pilot and copilot.) The ADI command bars represent true pitch attitude as determined by the 8.5° or 8° angle measurement from the zero attitude at RGA pushbutton actuation. Thus, to establish the most accurate pitch attitude reference, forward pressure on the flight control wheel must be sufficient to maintain nose wheel contact with the runway when the RGA pushbutton switches are depressed.

Flap and Stabilizer Settings

In general, a large flap angle will allow a higher takeoff weight for a given runway length but will always reduce the climbout or acceleration capability, especially in the event of an engine failure. For proper flap setting, see Parts 2 and 3 of the Appendix, T.O. 1C-135(K)A-1-1. The stabilizer trim setting required for takeoff depends upon the rotation speed, center of gravity location, and the airplane weight. The correct stabilizer trim setting may be determined from a chart in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1.

Thrust Settings

Since EPR is the only engine parameter that indicates thrust, TRT + .02 EPR shall not be exceeded. The charted EPR setting should be corrected in accordance with existing instructions when air conditioning or engine anti-icing are to be used. When making a static dry takeoff, if an engine fails to reach the EPR setting for TRT, the takeoff shall not be started. When making a running takeoff or static wet takeoff, if an engine fails to reach TRT + .02 EPR between 40 and 80 knots, the takeoff shall be aborted.

Takeoff Planning

Adequate takeoff planning must always include the possibility of loss of thrust of other malfunction during the takeoff run. Pilots must be prepared to cope with any circumstance which may require optimum

technique in order to safely complete the takeoff. Refer to TAKEOFF EMERGENCIES, Section III.

WARNING

- Do not attempt to takeoff on a normal or training mission if the powered rudder is inoperative (rudder hydraulic pressure less than 2800 psi, steady state), or if the rudder power switch is not in the ON position.
- If full rudder deflection is required during the 3 to 5 minute critical takeoff and climbout period, it cannot be obtained without proper adjustment of seat and rudder pedals.
- For a takeoff or landing with fuel in any main tank below 9000 pounds, fuel should be present in all main wing tanks. All tank to engine manifold valves will be opened and the boost pumps will be turned ON. The A/R pumps shall not be operated during takeoff or landing, except during an emergency, but may be used as necessary for other phases of operation, including the traffic pattern.

RUNNING TAKEOFF

When entering the runway for the running takeoff, advance the throttles sufficiently to begin the taxi roll and then retard them to below that point where water injection switches actuate. See figure 1-9. For wet takeoff, actuate the water injection system when the throttles are retarded below this point as the airplane begins to roll onto the runway. Advance the throttles slowly (3 to 4 seconds) to approximately TRT to avoid exceeding engine limits. Adjust throttles so as to obtain TRT plus .02 EPR between 40 and 80 knots.

STATIC TAKEOFF

Pilot aligns the airplane with the runway and holds brakes. Pilot advances throttles slowly so that the EPR and rpm do not lag the throttle position. Set TRT dry for dry takeoffs. If any engine does not reach the charted dry EPR setting, the takeoff shall not be started. For wet takeoffs, the brakes should be released as soon as possible after wet thrust is indicated on all engines. Advance throttles so as to obtain TRT plus .02 EPR between 40 and 80 knots. If a delay of more than 10 seconds is experienced between the first indication of wet thrust and release of brakes, the takeoff shall be aborted.

ALL TAKEOFFS

If wet thrust is to be used for takeoff, the wet data will be planned, briefed, and used. If, prior to S_1, a loss of water occurs, the takeoff will be aborted.

If conditions are such that a subsequent dry thrust takeoff can be accomplished, the dry data will be planned, briefed, and used. A combination of wet and dry thrust (prior to S_1) is not recommended due to the unknown performance associated with the variable power available.

After advancing the power to approximately takeoff rated thrust, the pilot will turn the throttles over to the copilot. The copilot will follow the pilot through on the throttle advancement with his left hand, assume full control of the throttles at the direction of the pilot, and make the final power adjustments between 40 and 80 knots. After the pilot relinquishes the throttles to the copilot, he will assume full control of the control column with the right hand, and will hold it full forward as the takeoff run is started. The pilot's left hand will be on the nose gear steering wheel for directional control as required. The copilot will also follow through on the control column with his right hand, being prepared to assist with control of the airplane at the direction of the pilot, should an emergency occur in which the pilot elects to assume throttle control. As the takeoff run progresses, forward pressure on the control column will be decreased gradually such that a positive forward pressure, sufficient to insure nose gear contact with the runway, still remains immediately prior to rotation. As airspeed increases and rudder becomes more effective, primary directional control should be maintained with the rudder. Nose gear steering should be considered as a backup to the rudder. Pilot will shift his left hand to the control column at 90 knots or the speed at which full directional control can be maintained with rudder, whichever is higher. At approximately 90 knots, the pilots will cross-check airspeed indicators.

WARNING

- For dry runway conditions, the most effective nose wheel steering occurs at about 12 to 15 degrees of steering wheel turn. A greater angle will result in skidding and scrubbing with the turning effect rapidly decreasing to near zero. Optimum steering angles are less for slippery conditions. Skidding or skipping of the nose wheel can generally be recognized by heavy chatter felt through the steering wheel; if this occurs steering angle should be reduced until chattering ceases.
- If either nose wheel tire fails during the takeoff run, the pilot must be alert to the possibility of failure of the remaining tire. If failure occurs prior to S_1 speed, abort the takeoff. If failure occurs after S_1 speed, continue the takeoff maintaining only sufficient forward pressure on the control column to insure nose wheel contact with the runway. Use the rudder as the primary means of maintaining directional control. Also see NOSE WHEEL TIRE FAILURE DURING TAKEOFF, Section III.

NOTE

- The rudder is to be considered the primary means of maintaining directional control with the nose gear steering thought of as a backup. The rudder is sufficiently effective at airspeeds above 90 knots to give adequate control of crosswinds up to the maximum allowable crosswind (figures 1A2-24, 1A10-18A, and 1A10-19) with four engines operating. The pilot will continue to use nose wheel steering until sufficient speed is attained to permit full directional control with the rudder. Releasing nose wheel steering as soon after 90 knots as possible will reduce tire scrubbing and the possibility of tire failure.
- Copilot takeoffs induce certain problems because of necessary exchange of some pilot and copilot duties plus coordination required to maintain directional control. All procedures must be thoroughly briefed. To insure directional control, the pilot will keep his left hand on the nose gear steering wheel until 90 knots and use nose gear steering as necessary.

Near S_1 speed, the pilot should be concerned primarily with deciding whether to go or to abort. Both pilots must monitor their airspeed indicators as the airspeed approaches computed S_1 speed to insure both are aware of the moment the airplane accelerates through decision speed. An abort after S_1 may result in an inability to stop within the confines of the runway. See PILOTS DECISION, Section III. The copilot will call out "S_1" when airspeed reaches S_1 speed.

If a definite loss of thrust occurs or if directional control becomes a problem prior to reaching S_1, the pilot will initiate an abort. Takeoff may be aborted for any emergency prior to reaching S_1 with assurance that a safe abort capability exists. Any abort below 90 knots is easily managed; after 90 knots, the pilot has complete control of the column and can initiate an abort immediately. After power reduction, adequate directional control exists with the rudder. If additional control is needed at lower speeds, the pilot may return his left hand to the nose gear steering wheel. If a loss of thrust occurs after S_1 is passed, the takeoff will be continued since it can be safely completed. S_1 is the speed after which the takeoff is committed.

Just prior to rotation speed (within 10 knots), both pilot and copilot will actuate their RGA pushbutton switches. The command bars on both systems will then indicate the initial rotation command (8.5 degrees with 20 degrees flaps; 8 degrees with 30 degrees flaps). See TAKEOFF illustration, Section IV.

The copilot will call off "Rotate" as airspeed reaches rotation speed. Upon reaching this predetermined speed, the pilot will bring the control column back so that rotation to takeoff attitude will be accomplished in 3 to 4 seconds. Failure to rotate at the proper rate will result in an abnormal feel. The movement of the column should be smooth and sustained rather than abrupt. The copilot will continue to monitor the throttles.

A change of airplane body angle of approximately 8 degrees is required for a normal takeoff. The takeoff attitude should be 8 degrees to 9 degrees on the attitude director indicator. Actual airplane attitude during and after rotation should be cross-checked between the attitude director indicator, visual outside reference, if available, and other flight instruments.

TAKEOFF FLARE

Takeoff flare begins at unstick and ends when reaching climbout speed at approximately 35 feet. During the takeoff flare, airspeed and pitch attitude must be closely monitored. Do not allow airspeed to decrease. Do not make abrupt pitch changes in an attempt to control increasing airspeed.

TYPICAL TAKEOFF AND INITIAL CLIMB

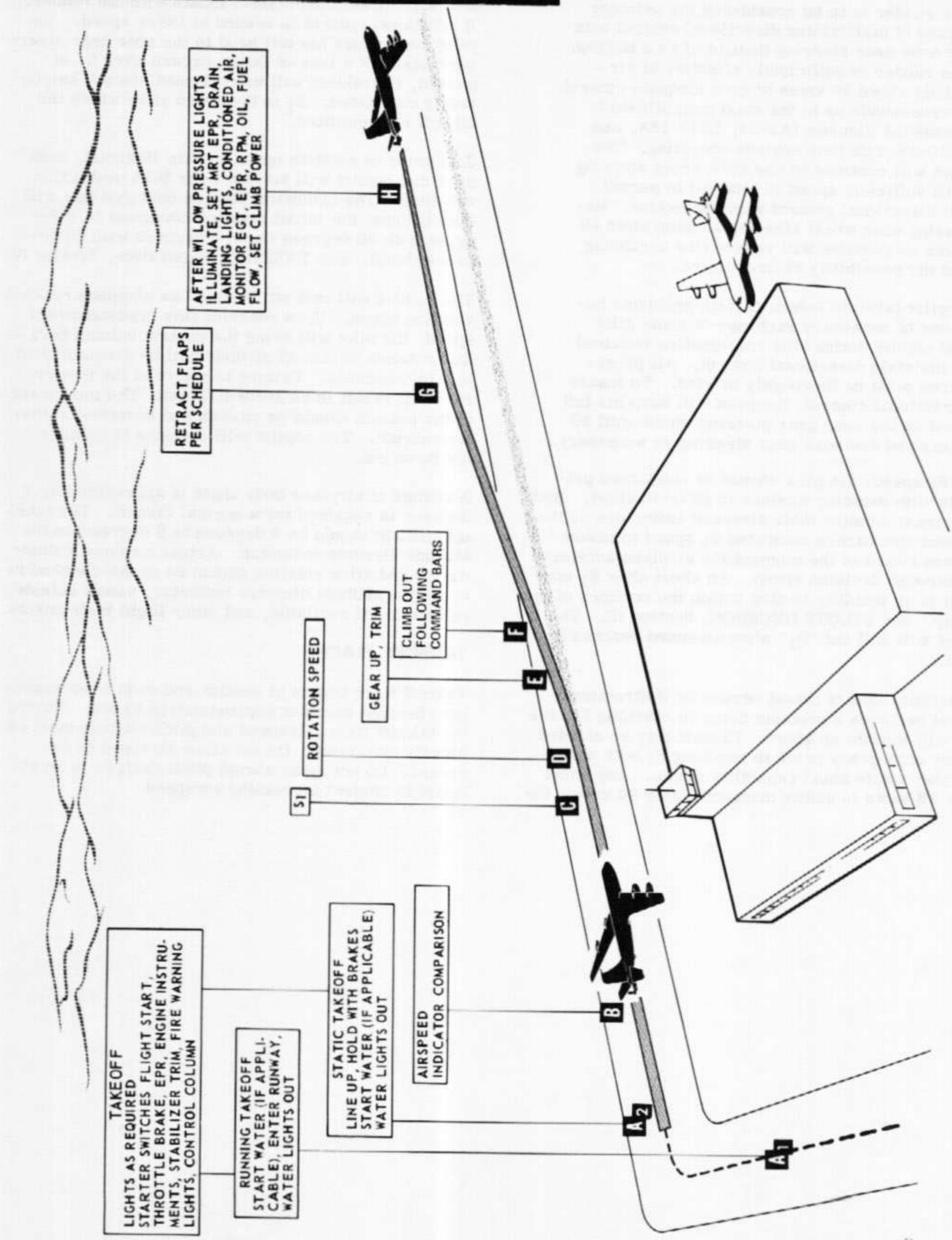


Figure 2-3

OBSTACLE CLEARANCE TAKEOFF

There is no particular obstacle clearance takeoff procedure. The flap settings for takeoff are shown in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1. Part 3 of the Appendix will show whether the obstacle may be cleared without reducing gross weight.

GUSTY WIND CONDITIONS

Refer to WIND AND GRADE in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1.

CROSSWIND TECHNIQUE

Prior to the time of takeoff, the surface wind direction and velocity should be ascertained. Refer to Part 2 of the Appendix, T.O. 1C-135(K)A-1-1, for maximum crosswind limitations. Unless a strong wind exists, no unusual characteristics should be expected during the takeoff run or the takeoff. At brake release, the copilot will assume full control of the throttles at the direction of the pilot. As the takeoff run progresses, the pilot will keep alert for any tendency of the upwind wing to rise. Wings will be held level by use of lateral control, as required. As the airspeed increases during the takeoff ground run and rudder becomes more effective, the pilot should gradually assume directional control primarily with the rudder; however, his left hand should remain ready on the nose gear steering wheel until reaching 90 knots. The pilot will continue to keep the nose gear in contact with the runway and maintain wings level with the lateral control, as necessary, until rotation. Any nose pitchup tendency encountered indicates forward control column pressure is insufficient. Any rudder control which is used to compensate for crosswind during the takeoff run, must be considered as a reduction of rudder control available in the event of an engine loss on the upwind side of the airplane. If difficulty is experienced in maintaining directional control, or if it appears that control is about to be lost at or prior to reaching S_1, abort the takeoff immediately. See also ALL TAKEOFFS, this Section. Follow abort procedures as outlined in Section III. Differential thrust will not be used prior to reaching S_1. Differential thrust should not be used unless, after passing S_1, all normal means of maintaining directional control have been exhausted.

WARNING

For takeoffs from a dry runway, an upwind outboard engine failure after S_1 may require the use of nose wheel steering to maintain directional control if a moderate to high crosswind exists.

TAKEOFF (CP reads through item 5)

For all normal operations, the RUNNING TAKEOFF procedure should be used.

CAUTION

In those situations where runway/taxi conditions are such that safety could be compromised, a static takeoff should be made. When making running takeoffs, pilots will insure that turning speeds do not exceed normal taxi speeds, and that turning radius restrictions are not exceeded. Excess speed and reduced turning radius decrease life of wheel bearings and possibly other landing gear components.

1. Throttle Brake - Set (P)

2. Lights - Set, as required (CP)

   Rotating beacon, navigation, and landing lights as required. Unless otherwise restricted by operational commitments, both beacon lights colors will be used.

TAKEOFF (Cont)

3. Starter Switches - FLIGHT START (P)

CAUTION

Do not use GROUND START at any time except during a ground start since continuous ignition is not provided. The FLIGHT START position may be used at any time at any throttle setting from START through OPEN. However if conditions permit, limit the use of FLIGHT START position on the ground to 5 minutes or less since excessive use of continuous ignition may cause igniters to fail. Continuous ignition may be extended to 10 minutes in flight since cooling capability is increased.

4. Water Boost Pumps - START if applicable (CP)

Actuate the water injection system when the throttles are retarded to below that point at which the water injection switches actuate. Hold the switch in the START position for 5 seconds after water low pressure warning lights are extinguished.

CAUTION

- Water injection will not be used when ambient temperature is below 20° F (-6.7° C). When ambient temperatures are between 20° F (-6.7° C) and 40° F (4.4° C), ascertain that water temperature is at or above 60° F (15.6° C). This is to preclude any possibility of water injection icing in the engine inlet section. Water injection may be used when both the ambient and water temperatures are 40° F (4.4° C) and above.

- Except in an emergency water injection must not be deactivated by retarding throttles. If necessary to deactivate the water system on all engines before water runout, it will be deactivated by moving the water boost pump control switch to the STOP position. This action is necessary since retarding throttles will cause a system surge with resultant damage to the water system components. In those instances where water injection is being used on two or more engines and it is desired to deactivate water injection on one engine, the procedure will be to retard the throttle on that engine or pull the appropriate circuit breaker. During a takeoff abort or other emergency, water injection can be deactivated by retarding the throttles to below approximately 80% rpm; however, the water boost pumps switch should then be moved to the STOP position to deactivate the water boost pumps.

- Do not operate the water boost pumps under no-flow conditions for periods longer than 3 minutes at a time. Allow a 15 minute cooling period between pump operations when they have been run the maximum time.

5. Throttles - Set TRT (P, CP)

For running takeoffs, as the airplane is aligned with the runway, advance throttles slowly to obtain charted wet or dry TRT plus .02 EPR between 40 and 80 knots. For static dry takeoffs, advance the throttles to obtain TRT on all engines before releasing brakes. For static wet takeoffs, the brakes should be released as soon as possible after wet thrust is obtained on all engines. Adjust throttles so as to obtain TRT plus .02 EPR between 40 and 80 knots. Do not change the throttle position during the remainder of takeoff except to avoid exceeding EGT or RPM limits. The copilot will guard the throttles throughout the takeoff period.

NOTE

If the airplane starts to slide on ice or snow during application of takeoff thrust for a static takeoff, release brakes immediately and begin takeoff run.

WARNING

- If any engine does not reach the EPR setting for TRT, the engine is not providing the required rated thrust, and the takeoff will not be accomplished.
- For wet takeoffs, if the delay between indication of wet thrust and starting the takeoff run exceeds 5 seconds, water runout may be expected to occur at a lower altitude and airspeed than planned. At high gross weights, this could result in water runout prior to flap retraction, with a serious reduction in acceleration and climbout capability. At any gross weight if the delay between first indication of wet thrust and starting the takeoff run exceeds 10 seconds, the takeoff shall be aborted. Climbout capability should be carefully considered before initiating a takeoff after any unknown amount of available water has been expended. If there is any possibility of water runout prior to flap retraction, a dry takeoff should be made (provided the airplane has a dry takeoff capability) or the airplane should be reserviced. Do not continue the takeoff run unless water injection is attained on all engines, because serious directional control problems can be encountered if a subsequent malfunction occurs, or if a strong crosswind exists. If water injection is lost on one or more engines prior to reaching S_1, abort the takeoff regardless of dry capability. A subsequent dry takeoff may be made subject to braking limitations and airplane gross weight and performance.

CAUTION

Exceeding the EPR for TRT can cause structural damage and rapid engine deterioration.

NOTE

- During a running takeoff or a static wet takeoff, EPR readings may increase above TRT plus .02 EPR as the takeoff run progresses past 80 knots. During static dry takeoffs, EPR readings may increase above TRT after brakes are released. No effort should be made to compensate for this effect.
- Rapid throttle movement can induce engine compressor stall. If a wet takeoff is being made, too rapid throttle movement can result in premature water injection with possible slow engine acceleration or surges.
- If the charted EGT limit (from Section V, figure 5-2) is reached before the computed EPR for TRT is obtained, the takeoff should not be continued.
- On wet and dry takeoffs, when ambient temperature is 100° F or below, full throttle will normally not be required to obtain computed EPR for TRT. If full throttle is required, write it up in the Form 781 as a discrepancy at the completion of the flight. The engine is either improperly trimmed or it needs cleaning.
- On takeoffs, when the temperature exceeds 100° F, full throttle will probably be required to obtain computed EPR for TRT. This is normal and will not require an entry in the Form 781.

TAKEOFF (Cont)

6. Engine Instruments, Airspeed Indicators, Stabilizer Trim, and Fire Warning Lights - Monitor (CP)

At approximately 90 knots, pilots will cross-check airspeed indicators.

WARNING

Each pilot should make certain that his thumb is clear of the stabilizer trim control switch on the control wheel to prevent inadvertent stabilizer trim actuation during the takeoff run.

7. Control Column - Full Forward (P)

Forward pressure will be decreased gradually as the takeoff run progresses.

WARNING

Failure to maintain nose gear contact with the runway until reaching rotation speed will result in a change in attitude with an associated change in position error. This change in attitude may result in erroneous initial rotation commands and ground roll increases in excess of 500 feet.

8. S_1 - "S_1" (CP, P)

At S_1 speed, the copilot will call over interphone "S_1." The pilot will monitor the airspeed to verify that the takeoff is committed.

WARNING

- When continuing a wet thrust takeoff after an engine failure, throttles must be advanced to the full forward position prior to unstick to realize chart 3-engine climbout performance. (See CLIMBOUT-WATER INJECTION. Part 3 of T.O. 1C-135(K)A-1-1.)
- Takeoff will not be aborted after S_1 unless in the opinion of the pilot, the emergency renders the airplane incapable of flight (loss of thrust exceeds the equivalent of loss of one engine). In those cases where the pilot attempts to abort after S_1, he must accept the fact that he will probably fail to stop within the confines of the runway.

CAUTION

In event of water failure on any engine, the throttle on that engine should never be advanced, prior to or during rotation, any further than that required for TRT (dry) as determined from T.O. 1C-135(K)A-1-1, figure 1A2-11.

9. Rotate - "Rotate" (CP, P)

Both pilot and copilot will actuate the RGA pushbutton switch just prior to reaching rotation speed (within 10 knots) and check for initial rotation command on the ADI. At rotation speed, the copilot will call over interphone "Rotate." The pilot verifies airspeed indication and rotates the airplane to takeoff attitude (flight director command bars reference) using the ADI pitch tape as a cross-check for proper takeoff pitch attitude.

WARNING

- Airplane rotation will not be delayed in order to actuate the RGA pushbutton switch.
- If neither of the RGA pushbutton switches is depressed prior to rotation, the command bars will not display the rotation command. Actuation of the RGA switch during or after rotation will cause an overrotation and erroneous climb display.
- The RGA rotation and climbout commands should not be used if neither of the pilots' flight director mode selector switches is set to RGA position prior to starting takeoff roll. If the FD mode selector switch is set to RGA while accelerating to rotation speed, the takeoff rotation command will be correct but the initial climb command will be less than required for safe climbout.
- Do not rotate the airplane above the three-point attitude prior to reaching rotation speed. Such early rotation will increase the takeoff ground run. Excessive early rotation could approach a stall with the accompanying buffet condition also evident. This latter condition could result in an extremely long takeoff ground run if not totally preventing a takeoff.
- Every effort will be made to rotate the airplane at the charted or corrected rotation speed. A late rotation will result in flight director command bar pitch commands that will not direct the charted or corrected airspeed envelope nor provide the correct climbout flight path in relation to the planned unstick point. If the rotation is delayed (speed increased), the command bars will command a reduced pitch during climbout and provide an increase in climbout speed approximately equal to the increase in rotation speed. The climbout flight path slope for a given "K" will remain approximately as charted (never a lower angle) but will start at the actual extended rather than the planned unstick point. Therefore, the distance from unstick to an obstacle will be less than planned by an amount equal to the takeoff ground run increase.
- Extreme care should be taken not to overrotate because drag increases very rapidly with increased angles of attack above the optimum takeoff angle. Overrotation may result in an excessive nose-high attitude during the takeoff flare immediately after liftoff causing the airspeed to decrease. A pitch attitude at or immediately after liftoff of only 2 to 3 degrees in excess of the recommended takeoff attitude (8 to 9 degrees on the ADI) may place the airplane in a position from which it can neither accelerate nor climb.
- Pilot not flying the airplane will cross-check his attitude director indicator against the other pilot's instrument during and after rotation and be prepared to take immediate corrective action in the event of overrotation or ADI malfunction.

NOTE

- If the RGA switch is not depressed prior to rotation or if an incorrect rotation command is displayed, rotate 8 to 9 degrees pitch attitude on the ADI pitch tape.
- During rotation, the vertical velocity indicator may show an initial rate of descent up to 850 fpm and the altimeter may show a decrease up to 75 feet. The airspeed will appear to have stopped increasing, but actually the airplane will still be accelerating. These momentary indications are a result of changing position error. See Part I of the Appendix, T.O. 1C-135(K)A-1-1.

AFTER TAKEOFF

GENERAL

The ability of the airplane to climb out during the critical period following takeoff depends on gross weight, number of engines operating, temperature, and pressure altitude. The climbout flight path (profile) directed by the flight director command bars depends upon the climb mode (AC-CL or MAX) selected by the pilots prior to takeoff. In the AC-CL (accelerated climb) mode, the ADI command bars direct a wings-level accelerated climb to flap retraction speed and then direct a wings-level climb which compensates for loss of lift during flap retraction. The MAX (maximum climb) mode commands an attitude which closely approximates the attitude provided by recommended flight manual climbout speed plus allowable speed deviations (figures 1A3-9, 1A3-11, 1A10-25, and 1A10-27, T.O. 1C-135(K)A-1-1). The AC-CL mode will provide the smoothest transition to the end of flap retraction while the MAX mode commands the maximum altitude gain for distance traveled from the unstick point. In either mode, acceleration to the proper airspeed is very important since the rate of climb drops off very fast at the lower airspeeds.

CLIMBOUT PROCEDURE

When the airplane is definitely airborne and a positive rate of climb is established (vertical velocity pointer above zero), retract the landing gear. In either mode, AC-CL or MAX, follow the flight director command bars reference using the ADI pitch tape as a cross-check for proper takeoff pitch attitude. Follow the command bars throughout flare and climbout. Follow the procedures described in this section for the climb mode selected and type thrust (wet or dry) being utilized. Upon reaching the appropriate cleanup height or maximum flaps down height, if the flaps are still extended, level off (3-engines, wet) or decrease rate of climb to a minimum (dry or 4-engines, wet) and retract them per flap retraction speed schedule in Part 3 of the Appendix, T.O. 1C-135(K)A-1-1. At this point, select HDG or NAV LOC mode with the flight director mode selector switch and adjust the manual pitch command knob to set the command bars for desired pitch command. When the flaps are up and at the required altitude, accelerate to enroute climb speed. Terrain permitting, enroute climb speed should be attained prior to reaching 2000 feet above the runway.

WARNING

- If the flight director command bars fail during or immediately after takeoff, climbout at recommended 3-engine climbout airspeed (three engines) or recommended 3-engine climbout airspeed plus 10 knots (four engines) with the takeoff flap setting (4-engine climbout speed for EWO).
- Do not climb at a speed less than the recommended 3-engine climbout speed.
- When for any reason takeoff speed is increased, climbout speed must be increased an equal amount. If rotation is delayed (takeoff speed increased) the command bars will still direct the approximate charted flight path for a given "K," but the path will begin at the extended unstick point and provide a new climbout speed envelope whose base is higher by approximately the amount of rotation speed increase.
- Caution must be exercised when using bank angles in excess of 10 degrees if performance is critical. A bank angle of 30 degrees at climbout speed with flaps down could reduce climb capability by as much as 400 fpm. As speed decreases, the effect becomes more severe, particularly in the clean configuration.

ALLOWABLE SPEED DEVIATION (MAX MODE)

In MAX mode, the command bars are computer programmed to accelerate the airplane to climbout speed plus an additional few knots at climbout factors (K) above 4. This increased speed (allowable speed deviation) is to accommodate the higher airplane acceleration at the higher K factors. The airspeed indicator lag resulting from airplane acceleration during takeoff flare and initial climbout is difficult to anticipate. Flight tests have demonstrated that pilots tend to overshoot recommended climbout speeds at the higher K factors when using airspeed climbouts. Using recommended climbout speed as target speed assures that even with a small overshoot, the MAX mode climbout profiles will not be penetrated. The RGA system commands are not influenced by the airspeed indicator lag; however, flight tests have shown that the system commands an attitude which causes an overshoot of the recommended climbout speeds by an amount up to the allowable speed deviation. This allowable speed deviation happens to be the approximate amount of pilot overshoot using airspeed for pitch control. If airspeed is allowed to exceed recommended 3-engine climbout speed plus allowable speed deviation (with 3 engines), the profiles may be penetrated. The allowable speed deviation is used as a limit to an operating band of speed only in conjunction with operational command bars when they are used for pitch commands during climbout.

MAXIMUM CLIMB MODE (MAX) (Dry Thrust)

With four engines operating, accelerate to the recommended 3-engine climbout speed plus 10 knots and climb out to 1000 feet above the runway or obstacle clearance height, whichever is higher, using the command bars for pitch commands.

If an engine failure occurs during climbout, continue to follow the command bars. With inoperative command bars, if an engine failure occurs during or immediately after takeoff, climb at recommended 3-engine climbout speed; if an engine failure occurs after attaining 3-engine climbout speed, continue to climb at the speed attained at the point of engine failure. The height for flap retraction is not affected by the loss of an engine.

MAXIMUM CLIMB MODE (MAX) (Wet Thrust)

With four engines operating, accelerate to the recommended 3-engine climbout airspeed plus 10 knots and climb out to 3-engine level-off height plus 300 feet using the command bars for pitch commands. At this point, decrease rate of climb to a minimum and retract flaps per flap retraction speed schedule.

NOTE

If the cleanup height (3-engine level-off height plus 300 feet) exceeds 1000 feet above the runway, use 1000 feet above the runway as cleanup height unless a higher altitude is dictated by obstacle clearance height.

If cleanup height has not been reached at 110 seconds of water operation, level off, terrain permitting, in order that flaps may be retracted prior to water runout. Total water operation time is approximately 125 seconds. When the flaps are up, accelerate to enroute climb speed. If additional terrain clearance is necessary, maintain flaps up speed and continue to climb.

Adjust throttles to MRT when water runs out. NRT may be set if enroute climb speed has been attained when water runs out. If enroute climb speed is reached prior to water runout, it may be advisable to stop the water boost pumps and drain the tank as enroute climb speed is established.

If an engine failure occurs during climbout, continue to follow the command bars. With inoperative command bars, if an engine failure occurs during or immediately after takeoff, climb at recommended 3-engine climbout speed; if an engine failure occurs after attaining 3-engine climbout speed, continue to climb at the speed attained at the point of engine failure. Level off at the 3-engine cleanup height or engine failure altitude, whichever is higher and retract flaps per minimum flap retraction speed schedule. It is important that the climbout and flap retraction be completed before any attempt is made to return to the field. This is necessary to prevent running out of water with the flaps down since this could reduce performance to the point where the airplane would neither accelerate nor climb.

MAXIMUM CLIMB MODE (MAX) (Wet or Dry Thrust)

During climbout, the command bars will direct an attitude which closely approximates the attitude provided by recommended flight manual climbout speed plus allowable speed deviations. See Parts 3 and 10 of the Appendix, T.O. 1C-135(K)A-1-1. Following the command bars will normally allow airspeed to increase above the recommended climbout speed by an amount equal to the allowable speed deviation. Maintaining airspeed at no less than recommended climbout speed, but not to exceed climbout speed plus allowable speed deviation, will assure at least the height above runway provided by the MAX mode climbout profiles. If the airspeed drops below the recommended 3-engine climbout speed or exceeds recommended 3-engine climbout speed plus the allowable speed deviation (three engine operation) or 3-engine climbout speed plus 10 knots plus allowable speed deviation (four engine operation), the command bars are not giving the proper climbout commands and pitch corrections must be made in order to keep the airspeed within these limits. The angle of attack indicator may also be used as a reference and will indicate .7 or .8 after takeoff flare at 4-engine climbout speed and up to .86 at 3-engine climbout speed.

NOTE

- For EWO operation, the speed range is from 4-engine climbout speed to 4-engine climbout speed plus allowable speed deviation.
- During four engine high performance conditions, the above climbout procedure, using airspeed as primary reference, may result in exaggerated nose-high attitudes (in excess of 15 degrees). To avoid such conditions, if terrain clearance is not critical, maintain a pitch attitude of 15 degrees or follow command bar reference if in MAX mode and allow the airspeed to increase beyond the 3-engine climbout speed plus 10 knots. Flaps may be retracted during the climbout when speed exceeds minimum flap retraction speed provided altitude is at least 200 feet above the runway. By holding 15 degrees pitch attitude during four-engine high performance conditions, the pilot is assured of clearing any obstacle which can be cleared during an engine-out condition following engine-out procedures.

ACCELERATED CLIMB MODE (AC-CL) (Wet or Dry Thrust)

With three or four engines operating, climbout using the command bars for pitch commands. The RGA system is programmed to command a nose-down pitch change during climbout at a rate of 1 degree every 6 to 7 seconds. This smooth reduction in pitch attitude allows the airplane to accelerate to flap retraction speed during climbout. Initiate flap retraction during climbout at flap retraction speed, provided altitude is at least 200 feet above the runway. Once the flaps are retracted above 16.5 degrees, the command bars will command a pitch attitude which will decrease the rate of acceleration until a constant speed climb is attained (less than enroute climb speed).

WARNING

Prior to flap retraction, do not allow the airspeed to fall below the minimum recommended flight manual climbout airspeed. (3 or 4 engines).

When following the command bars, if the rate of climb during climbout is relatively high (high performance "K") but not so high that the command bar pitch limit is reached, the AC-CL pitch down command may not be great enough to allow acceleration to flap retraction speed prior to reaching 1000 feet above the runway. In any event, continue to follow command bars until reaching 1000 feet above the runway unless a higher altitude is dictated by obstacle clearance.

WARNING

- With wet thrust, if flap retraction speed is not attained by the maximum flaps down height or 1000 feet above the runway whichever is lower, decrease climb attitude and accelerate to minimum flap retraction speed. Retract flaps and accelerate to enroute climb speed or continue climbout using speed attained at end of flap retraction until reaching obstacle clearance.
- If the command bars fail after initiating flap retraction, continue the climbout holding approximately 10° pitch attitude until the flaps are up. Then, using the airspeed attained at the end of flap retraction, continue climbout until reaching 1000 feet above the runway unless a higher altitude is dictated by obstacle clearance.

NOTE

With four engines operating (wet), add 300 feet to maximum flaps down height.

FLAPS

If flap retraction is started too soon, acceleration may not be rapid enough to insure a safe margin above the stall point, and if started too late the flap structural speed may be exceeded or water injection may terminate before flaps are retracted. Takeoff flaps settings should be as indicated in Part 2 of the Appendix, T. O. 1C-135(K)A-1-1. For flap procedures on takeoffs see FLAP RETRACTION SPEED SCHEDULE, Part 3 of the Appendix, T. O. 1C-135(K)A-1-1.

ENROUTE CLIMB

Either military rated thrust or normal rated thrust as defined by charted EPR will be used for climb, depending upon the conditions encountered, mission requirements and engine life expected. NRT will be used when gross weight and mission requirements permit, since engine life will decrease with the higher engine speeds and higher temperatures encountered at MRT. A slight saving in fuel will be realized when MRT is used. MRT is determined by EPR settings obtained in Part 4 of the Appendix, T. O. 1C-135(K)A-1-1, and is restricted by EGT or time limits specified in Section V. Except when necessary to reduce thrust setting to avoid exceeding a temperature limit, EGT, RPM and fuel flow must never be used as a primary means of setting thrust. Climbs should not be made at less than normal rated thrust since this procedure will result in a loss of range because of the excessive time spent in climbing.

NOTE

- Where the use of MRT is necessary for mission requirements, it may be possible to reduce the total time at MRT by using a split NRT/MRT climb. As an example, NRT might be used for the first two thirds of the climb and MRT for the final one third of the climb to cruise altitude.
- For all MRT climbs, full throttle will normally not be required to achieve computed EPR. If full throttle is required, write it up in the Form 781 as a discrepancy.

CLIMB DATA

A study of the climb charts, Part 4 of the Appendix, T.O. 1C-135(K)A-1-1, will show that a constant airspeed is maintained during the first part of the climb until reaching the altitude where a constant climb Mach number is to be maintained for the duration of the climb. Maintain same climb speed schedule with the loss of an engine.

NOTE

For fuel management information, refer to Section VII.

AFTER TAKEOFF — CLIMB (CP accomplishes)

1. Landing Gear - UP (P, CP)

WARNING

Do not retract gear before a definite rate of climb (vertical velocity pointer above zero) is established. During initial gear retraction sequence there is a period of increased drag while the gear doors are open. Premature retraction of the landing gear with its momentary drag increase could therefore cause the airplane to settle unless adequate climb margin has been established.

CAUTION

To avoid damage to the main landing gear truck leveling cylinder, do not apply wheel brakes to stop wheel rotation after becoming airborne. Sufficient braking is automatically applied when the landing gear handle is placed in the up position.

2. Flaps - UP (P, CP)

Upon reaching minimum flap retraction speed and altitude, pilot notifies copilot "Flaps UP." Copilot monitors flap position indicators for proper movement and assures that flap handle is positively seated in the UP detent to insure against inadvertent flap extension. The ADI command bars display must be ignored while accelerating to flap retraction speed when in RGA MAX mode.

WARNING

- Do not allow the airplane to descend during flap retraction or during acceleration to enroute climb speed.

- Any unusual rolling moment encountered during flap operation could indicate an unsymmetrical main or fillet flap condition for which corrective action must be taken immediately. If the flap position indicators become unsynchronized during flap movement the flap action should be stopped. Every action possible should be taken to return flaps to a synchronized condition, if control characteristics, airspeed and altitude considerations permit. If all means of flap synchronization fail and conditions permit, institute fuel dumping, and land as soon as possible.

AFTER TAKEOFF — CLIMB (Cont)

CAUTION

- If inadvertent or incorrect stabilizer trimming occurs during flight, the runaway is most apt to be caused by a stuck trim switch and can best be stopped by actuating the same switch in the opposite direction. Opposite actuation of both trim switches as an emergency measure is permissible, but must be held to a minimum to prevent possible loss of electrical trim. See STABILIZER TRIM EMERGENCY OPERATION, Section III.

- Avoid unnecessary operation of the trim actuator when stick forces are high. Release the stabilizer trim control switch immediately if the trim actuator is inadvertently stalled. A stalled trim actuator is easily detected, as the horizontal stabilizer trim control wheel on the control stand will stop rotating. When manual trimming is necessary, ease up on pilot forces on the control column as manual trimming is difficult with forces in excess of 30 lb on the control column.

2A. Rudder Hydraulic Pressure - Checked (P)

Pilot checks rudder hydraulic pressure in low range (800 to 1175 psi).

WARNING

If the gage indicates in excess of 1175 psi above 260 KIAS, place the rudder power switch OFF. This will limit the amount of rudder deflection which can be applied at high speeds and will prevent possible damage to the vertical fin. Return rudder power switch to ON at airspeeds below 250 KIAS.

3. Landing Lights Switch - OFF (CP)

Copilot turns lights OFF if they were used for takeoff.

4. Throttles - Adjust (if required) (CP)

At termination of water augmentation adjust the throttles to the planned dry EPR setting after water runout (MRT). This EPR setting is based upon the predicted ambient temperature at water runout. See Part 3, T.O. 1C-135(K)A-1-1. NRT may be set if enroute climb speed has been attained.

5. EPR, EGT, RPM, Oil Pressure, Fuel Flow - Monitor (CP)

6. Water Injection Tank Drain Valve Switch - DRAIN, if applicable (CP)

Hold switch in the DRAIN position for a few seconds to insure that the valve is fully open.

7. Engine Anti-Icing Switch - As required (P, CP)

CAUTION

- Indiscriminate or prolonged use of engine anti-icing may cause cracking of inlet guide vanes. Anti-icing should be used only as necessary in prevention of icing and not for prolonged periods in dry air. When the possibility of encountering icing conditions no longer exists, engine anti-icing should be turned off.

- When turning on engine anti-ice, retard throttles to NRT or below, set engine ignition switches to FLIGHT START and then turn engine anti-ice switch ON. Throttles may then be returned to the desired EPR. This procedure is to prevent engine surge or flame-out. As soon as RPM and EPR stabilize, turn engine ignition OFF.

AFTER TAKEOFF—CLIMB (Cont)

8. Climb Thrust - Set (CP)

Climb thrust will be checked and readjusted as necessary during the climb at approximately 10,000 ft intervals.

9. Starter Switches - OFF (P)

Perform this step after establishing climb power.

9A. Fuel Panel - Set for enroute climb (P, CP)

Turn override pumps on and place all four tank to engine manifold valve switches to OPEN.

10. Autopilot - Rudder axis ON, aileron and elevator axes as required (P)

Complete autopilot FLIGHT check in Section IV, before engaging autopilot. The autopilot rudder axis shall remain engaged during all normal operations from AFTER TAKEOFF-CLIMB to BEFORE LANDING except for authorized training or demonstration maneuvers. Autopilot rudder axis should be engaged as soon as practical after takeoff.

11. Air Conditioning Master Switch - COND AIR (CP)

12. A/R Line Valve Switch - Closed (CP)

13. Oxygen Panels and Cabin Pressurization - Checked (P, CP)

Cabin altitude will be checked when airplane passes 10,000 feet. If not previously accomplished, check oxygen regulators set to 100% and ON prior to 10,000 feet.

NOTE

When operating for extended periods at altitudes of 20,000 feet or below, the recommended cabin altitude for normal climb and cruise is field pressure altitude plus 500 feet with the differential control and controller operating normally. If the cabin gets too warm, adjust the cabin altitude upwards.

14. RGA Power Switches - OFF (P, CP)

15. Altimeters - Set at 29.92 (as applicable) (P, CP, N)

Set altimeter to 29.92 inches Hg when climbing through transition altitude. Pilot and copilot set radio altimeter MDA index to 2000 feet. Pilot and copilot will periodically cross-check altimeter readings in flight. If an altimeter's indications fail to move during climbs or descents while in the RESET mode, the altimeter should be placed in standby mode.

CRUISE

MAXIMUM RANGE

The performance of a jet airplane is such that maximum range is attained by flying at one particular Mach number and gradually increasing altitude as airplane weight is decreased through fuel consumption. Such a climbing flight path is accomplished by setting the throttles so as to provide a given engine pressure ratio (EPR) for a corresponding cruise Mach number and checking the altitude frequently to make certain it agrees with that specified by the altitude curve. The rate of climb required will be very small. Therefore, rather than attempt to fly at some specified rate of climb, check the flight altitude with that given in the altitude curve at frequent intervals to assure that the proper climbing flight path is being maintained. Operating the engines at the proper pressure ratio setting should provide the proper amount of thrust to produce the correct climbing flight path. The cruise Mach number should be checked frequently by means of the airspeed indicator.

CAUTION

Cruise at airspeeds in excess of max/best range is detrimental to engine life and should be avoided except when mission requirements dictate. Refer to part 5 of the Appendix, T.O. 1C-135(K)A-1-1.

The Mach indicator may be inaccurate, causing a range loss of several percent. For accuracy, the desired Mach number will be converted to an indicated airspeed. Adjust target EPR to maintain this airspeed and starting altitude for the airplane gross weight. The Mach No. hold function of the autopilot may then be used to provide climb cruise, but frequent checks will be required to insure that the power setting is providing the desired profile. If the Mach No. hold function is inoperative or erratic, altitude hold may be used in a step climb profile. This will require adjusting altitude at frequent intervals, not to exceed 30 minutes. Excess speed acquired during level flight with constant power will be used to climb to the proper altitude for the aircraft gross weight. Refer to Part 5 of the Appendix, T.O. 1C-135(K)A-1-1, for additional information.

SUSPECTED FUEL ICING

The fuel flow should be monitored for fluctuations. If fuel icing is suspected, periodically varying the throttle setting will help dislodge ice particles which may have formed in the fuel control. Every 2 hours when above 25,000 feet altitude, manipulate the throttles slowly from cruise to military rated thrust to cruise thrust, two engines at a time. If for any reason throttles are adjusted, manipulate them slowly and closely monitor fuel flow for fluctuations. If icing of the fuel system appears evident by erratic engine operation, consideration should be given to landing as soon as practicable. When mission requirements permit, maintain sufficient fuel in the forward body tank for use during descent, landing, and possible go-around. Approximately 10 minutes prior to descent begin operating the engines from the forward body tank if body tank fuel is available. Accomplish the fuel tank changeover, two engines at a time, because the warmer fuel from the forward body tank may dislodge ice from the screens, causing momentary engine fluctuations. Position the fuel panel switches as follows:

A. If fuel icing is suspected, place the engine ignition switches in the FLIGHT START position for descent and landing.

B. All main tank boost pump switches ON.

C. Tank to engine manifold valve switches No. 1 and No. 4 CLOSED, No. 2 and No. 3 OPEN.

D. A/R manifold to engine manifold valve switch OPEN.

E. Forward body tank forward pump switch ON.

F. Turn off other valves and switches as necessary. Operate the inboard engines from the forward body tank for approximately 5 minutes to insure stabilized engine operation. Then begin operation of the outboard engines from the forward body tank as follows:

G. Tank to engine manifold valve switches No. 1 and No. 4 OPEN.

Allow approximately 5 additional minutes for engine stabilization before starting descent. If use of forward body tank fuel is not available because of mission requirements, use center wing tank as an alternate. As in the case of the forward body tank fuel, accomplish the fuel tank changeover, two engines at a time, allowing five minute engine stabilization periods.

NOTE

The use of fuel from forward body or center wing tank will require modification of the normal fuel sequencing procedures set forth in Section VII. Care must be taken to maintain cg limits. See also FUEL MANAGEMENT PROCEDURES in Section VII.

CENTER OF GRAVITY

Control of the center of gravity of this airplane during any cruise operation is quite simple if fuel is used or transferred using the recommended procedure in Section VII. As fuel is consumed the cg location will shift considerably, and a running check will be maintained so that the approximate cg location is known at all times. The stabilizer trim wheel may be used to make such a check. For maximum

range cruise operation at the chart Mach number the stabilizer trim indicator should be in the vicinity of "0" units. If the stabilizer setting is within the limits of 1 unit noseup and 1 unit nosedown, the cg is within the normal limits. If the stabilizer trim is set outside of these limits, the cg location should be checked, and the fuel loading adjusted accordingly. Refer to Section V for complete center of gravity information.

ENDURANCE

Maximum endurance is frequently desired during operational missions when it becomes necessary to hold over a check point, rendezvous with a receiver, accomplish a navigational check or to provide time to correct airplane functional difficulties. Maximum endurance can be attained only if the recommended airspeeds are observed within ± 10 knots and by operating the number of engines specified in Part 6 of the Appendix, T.O. 1C-135(K)A-1-1.

Endurance Procedures

Maximum endurance is accomplished by flying at a gradually decreasing airspeed and gradually increasing altitude as the gross weight is decreased through fuel consumption. If endurance operation will be of less than a 40,000 pound weight change, the gain in endurance by flying a climbing flight path is negligible and constant altitude operation is recommended. The optimum endurance airspeed at any weight and altitude is the airspeed at which the pounds of fuel per hour is at a minimum. This is approximately the airspeed at which the airplane drag is a minimum. Shutting down some engines at certain altitudes and airspeeds will result in the remaining engines operating in a more favorable range of rpm with higher efficiencies. See Part 6 of the Appendix, T.O. 1C-135(K)A-1-1.

FLIGHT CHARACTERISTICS

Refer to Section VI.

AIR REFUELING

Refer to T.O. 1-1C-1, T.O. 1C-135(K)A-1-1 and Section IV of this manual.

DESCENT

DESCENT TO CRUISE OR HOLDING ALTITUDE

Descent may be accomplished by positioning all throttles to IDLE. If it is desired to maintain the pressurization schedule, follow procedures outlined under ENROUTE DESCENT. Speed brakes may be used as required. Rate of descent may be increased to approximately 2500 feet per minute by extending speed brakes to 60 degrees.

ENROUTE DESCENT

During enroute descent, the outboard engines may be placed in idle while utilizing the inboard engines to maintain cabin pressurization and heating. This may be accomplished by setting the inboard throttles to 2.0 EPR at 40,000 feet and reducing 0.2 EPR for each 5000 feet of descent. If this EPR schedule is followed, all throttles should be in idle at approximately 20,000 feet and below. The air conditioning system should maintain the desired cabin altitude under these conditions; however, the throttles may be adjusted as required.

NOTE

To maintain adequate engine anti-icing (if required), at least 80% rpm should be used during descent. If icing conditions are anticipated and it is not practicable to maintain 80% rpm or higher, place the starter switches to FLIGHT START before encountering icing conditions.

Enroute descent performance charts are based on Mach .78 until passing 32,500 feet and an indicated airspeed of 285 knots below that altitude. Performance charts provide for approximately 1500 feet per minute descent. This rate may be varied as desired by either decreasing or increasing airspeed and/or lowering the landing gear. At approximately 10,000 feet or below, flaps may be extended to 30 degrees at airspeeds below 210 KCAS to facilitate descent to approach altitude and deceleration to approach speed. Observe landing gear and flap placard speeds.

The use of speed brakes in addition to the landing gear is recommended only as an alternate descent procedure. The gain in descent rate may not be worth the annoyance or the increased lateral control sensitivity and spoiler buffeting. The use of speed brakes and flaps simultaneously is not recommended due to the intensified buffeting encountered in this configuration.

PENETRATIONS

For descent to initial penetration altitude, use the same procedure outlined under DESCENT TO CRUISE OR HOLDING ALTITUDE, this Section. Prior to starting penetration, initiate the DESCENT checklist. Conform to published procedures outlined in the appropriate high altitude instrument approach chart. Use a maximum bank angle of 30 degrees in turns. During descent the navigator will report over interphone 2000 and 1000 feet prior to an assigned or published level-off altitude and alert the pilot approaching level off.

1. For jet penetrations, use the following procedure:

   a. Retard throttles to IDLE, or as required.

NOTE

To maintain adequate engine anti-icing (if required), at least 80% rpm should be used during penetration. If icing condi-

tions are anticipated, and it is not practicable to maintain 80% rpm or higher, place the starter switches to the FLIGHT START position before starting the penetration.

b. Lower landing gear as desired, position speed brakes as required.

NOTE

A speed brake lever position of less than 40 degrees is not recommended, due to a tendency to overcontrol at these settings.

c. Descend at a rate required for the penetration being performed.

d. At approximately 1000 feet above level off altitude, retract speed brakes in preparation for level-off.

LANDING DATA

The desired landing data should be computed prior to descent. The cg can be determined by using the load adjuster. Refer to Sections V and VII for weight and cg limitations. The pattern/approach speeds, touchdown speed, flight minimum control speed, runway wind component, and landing ground roll are all computed from charts in Part 9 of the Appendix, T.O. 1C-135(K)A-1-1. See also figure 2-4. In the case of landings with the cg at or near the forward limit, it is essential that the stabilizer trim be used to eliminate control pressures on final approach; otherwise, insufficient elevator travel will be available for flare and landing. In the event of a go-around, control pressures to counter the airplane's natural pitchup tendency are not excessive, especially if the landing gear and flaps have been started up.

WARNING

Precautions must be taken to assure that the center of gravity remains within the limits for landing. With the center of gravity near the forward limit, extreme care must be exercised during the approach and landing. If it is found that the center of gravity is near the forward limit, it is recommended that fuel management be employed to obtain a more favorable center of gravity before a landing is attempted.

DESCENT (CP accomplishes)

NOTE

To reduce the possibility of pilot distraction during a critical phase of flight, this checklist must be completed through item 10, "Altimeters," prior to actual descent. If incomplete at the time descent clearance is received, delay descent if possible, until these items are accomplished.

1. Radio Call - Completed (CP)

Request from appropriate facility the current altimeter setting, runway temperature, pressure altitude, and wind information. A comparison of forecast altimeter setting with the setting obtained from approach facility or controlling agency will be made.

2. Landing Data Card - Completed (P, CP, BO)

The boom operator will determine the CG. If it is found to be aft of 35% MAC, movement toward the aft end of the airplane will be avoided until the tail support is installed.

3. Review Penetration and Approach - Accomplished (P, CP, N)

Prior to starting penetration or letdown, the pilot will ensure that the copilot and navigator are informed as to the specific terminal area chart and type of approach to be used. The pilot will review the approach with the copilot and navigator with particular emphasis on the transitional altitude, any intermediate altitude restrictions, minimum altitude and minimum visibility for the type of approach, and missed approach procedures. The pilot flying the approach should set the radio altimeter MDA index to the published HAT or HAA for the approach being flown. The other pilot should leave his MDA index set at 2000 feet until the MDA indicator illuminates, then set to 100 feet above HAT or HAA. Notify crew to prepare for landing.

NOTE

The radio altimeter indicates absolute altitude only and should not be used as the primary decision height altitude indication except for published radio altitude (RA) approaches.

4. TACAN Select Switches - As required (P, CP)

5. Window Heat, Engine Anti-Ice, Pitot Heat, Q-Inlet Heat - As required (P, CP)

Set window heat to NORMAL or HIGH, depending on weather conditions. If engine inlet icing conditions are anticipated, turn engine anti-icing switch ON.

CAUTION

When turning on engine anti-ice, retard throttles to NRT or below, set engine ignition switches to FLIGHT START and then turn engine anti-icing switch ON. Throttles may then be returned to the desired EPR. This procedure is to prevent engine surge or flame-out. As soon as rpm and EPR stabilize, turn engine ignition OFF.

NOTE

- To maintain adequate engine anti-icing (if required), at least 80% rpm should be used during penetration. If inlet icing conditions are anticipated, and it is not practicable to maintain 80% rpm or higher, place the starter switches to FLIGHT START before starting penetration.

- The rain repellent system cannot be used as a windshield washer; it should be used only in heavy rain when the windshield wiper system does not provide adequate visibility. Do not apply repellent in very light rain or to a dry windshield. When applied under these conditions, repellent residue may reduce visibility in the impingement and runback areas. In the event of inadvertent application of rain repellent on a dry windshield, do not operate the windshield wipers as smearing will result and visibility will be restricted. Remove repellent or residue by a thorough fresh water rinse at the earliest opportunity.

6. Electrical Power System Indicators - Checked (CP)

7. Autopilot - Rudder axis ON, other axes as desired (P)

8. Cabin Pressure Controller - Set at 500 feet above field pressure altitude (CP)

9. Hydraulic System, Brakes and Powered Rudder - Checked (P, CP)

Pilot checks pressure switches ON, and checks pressures on left, right, reserve brake and powered rudder gages. Powered rudder should be ON for landing provided system operation is normal. Copilot checks quantity. Pilot checks for gage fluctuation indicating brake actuation is occurring. The pilot who will accomplish the braking during ground roll will check brakes last.

DESCENT (Cont)

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

    Set altimeters to station pressure immediately prior to initiating penetration or upon passing through transition altitude.

11. Throttles - IDLE, or as required (P)

12. Landing Gear - DOWN, or as required; if extended, 3 down and checked (P, CP)

    If landing gear is extended, both pilot and copilot check the landing gear lever in the DN position, the landing gear warning light knob extinguished, and that the three landing gear position indicators show down and locked. Do not activate the warning horn release prior to receiving a down and locked indication on the gear.

NOTE

During transition from cruise to descent, the airplane will tend to pitch slightly nose up when the gear is lowered with a negligible trim change taking place during speed brake actuation.

13. Antiskid System (TCTO 550) - Checked, if applicable (P)

    If the gear has been extended for descent, the antiskid will be checked at this time.

    a. Antiskid Indicators - REL

       All indicators should show REL (release).

    b. Antiskid Test Switch - INBD

       With test switch in INBD position, the inboard indicators should be blank and the outboard indicators should show REL.

    c. Antiskid Test Switch - OUTBD

       With test switch in OUTBD position, the outboard indicators should be blank and the inboard indicators should show REL.

CAUTION

If the antiskid test indicates a system malfunction (any one indicator does not respond properly), the pilot should use light braking and be prepared for asymmetric brake effectiveness. If two or more indicators do not respond properly, the ANTISKID INBOARD and OUTBOARD circuit breakers should be pulled and the procedures for landing with antiskid inoperative should be observed. Refer to Section VII.

14. Altitude Calls - Completed (N, P, CP)

BEFORE LANDING

WARNING

During approach and landing the copilot shall monitor airspeed, altitude, and attitude and advise the pilot of any deviations from the normal.

Referring to figure 2-4, the downwind leg should be entered at the local specified traffic pattern altitude, flaps 30 degrees, and airspeed reduced to pattern speed as determined from the PATTERN/APPROACH SPEED CHART for flaps 30 degrees but never less than inflight minimum control speed. Altitude will be maintained on the downwind leg. The turn from downwind to the base leg should be a descending 90 degree turn with a gradual reduction in altitude throughout the maneuver. Flaps may be lowered to 40 degrees after initiating the turn to base leg. Once the flaps are set to 40 degrees, reduce airspeed to 40° flap pattern speed. Roll out wings level on base leg and visually clear the aircraft in all directions. Flaps may be lowered to 50 degrees after starting the turn to final. Once flaps are set to 50 degrees, reduce airspeed to 50° flap approach speed.

NOTE

- 50 degree flap approaches will not be planned with less than 4 engines operating or with rudder power inoperative.
- Instrument approach procedures are discussed in Section IX.
- Approaches with less than 50 degrees flaps will be flown at the appropriate approach speed.

WARNING

- Inflight minimum control speed shall always be compared with approach and pattern speeds. If inflight minimum control speed is greater, increase approach speed and pattern speed to equal inflight minimum control speed. Threshold and touchdown speed will remain unchanged.
- For a takeoff and landing with fuel in any main tank below 9000 pounds, fuel should be present in all main wing tanks. All tank to engine manifold valves will be opened and the boost pumps will be turned ON. The A/R pumps shall not be operated during a takeoff or landing, except during an emergency, but may be used as necessary for other phases of operation including the traffic pattern.

During the final approach, the airspeed will be held constant. The normal procedure will be to arrive over the end of the runway at threshold speed, 50 degrees of flaps, no speed brakes and stick forces trimmed to zero. Airspeed must be reduced to threshold speed prior to starting landing flare in order to realize charted FLARE DISTANCE. An idle power approach in the landing configuration can be an extremely hazardous maneuver if sufficient power is not applied as the descent is arrested. If the descent is arrested without application of sufficient power, the angle-of-attack will increase causing a rapid decrease in airspeed. Due to relatively slow engine acceleration from idle power, sufficient time/altitude may not be available to preclude airplane stall and loss of control.

WARNING

Steep idle power approaches or all approach angles and rates of descent requiring large changes in pitch attitude during the landing flare, must be avoided. If steep approach angles requiring use of idle power during the latter part of the approach are encountered, serious consideration should be given to the execution of a go-around.

CAUTION

It is essential that the stabilizer trim be used to follow-up and trim out elevator control forces as rapidly as these forces occur for any sustained flight condition during the final approach. The landing flare should be performed by use of elevator control only. This should not be construed to imply that abnormal stick forces should not be relieved by use of stabilizer trim if necessary. Using stabilizer trim as the primary means of performing the flare will cause changing elevator control loads resulting in the pilot's loss of feel for control characteristics.

As the touchdown point is reached, the airspeed will be dissipated and touchdown made at not less than touchdown speed for the flap setting being used. Throttles will be used as necessary to maintain the proper airspeed and rate of descent prior to touchdown.

NOTE

During approach and landing, the stabilizer trim should be used only for its intended purposes of eliminating sustained elevator control forces. Do not accomplish the round-out by using stabilizer trim. Use of stabilizer trim for round-out might induce a strong pitch-up tendency that would be difficult to control in event that a go-around is attempted.

LANDING

GENERAL

Normally, landings will be accomplished with flaps set at 50 degrees; however, the pilot may elect to land with flaps set at 40 degrees provided the landing ground roll can be safely accomplished within the confines of the runway. In arriving at a decision to land with flaps set less than 50 degrees, the pilot should consider the effects of the increased touchdown speed. Hydroplaning, brake wear, kinetic energy, tire wear, and landing ground roll are all increased due to the increased touchdown speed.

WARNING

- If crosswind conditions permit, consideration should be given to using 50 degree flaps when stopping distance is critical, when the RCR value is 9 or less, or when touchdown speed must be increased more than 10 knots for gusts.

- Landings with less than full flaps will increase landing ground roll distances because of increased touchdown speeds. Prior to landing, determine that runway length and surface conditions permit adequate stopping capability after touchdown.

- When landing with less than full flaps, avoid excessive flare with resultant floating in an attempt for a smooth landing. Make a normal flare and touchdown at touchdown speed.

CROSSWIND LANDING

Technique in crosswind landing is conventional for tricycle geared airplanes. Crab or a combination of crab and wing low may be maintained down to the flare. During the flare, remove as much of the crab as possible just before touchdown, maintaining a slight wing low attitude into the wind, as necessary to counteract drift.

CAUTION

Touchdown with a large crab angle and with wings level may result in a rapid rising of the upwind wing and may cause the downwind engine nacelles to drag on the runway.

Care should be taken that the up-wind wing is not lowered excessively as engine nacelles may drag the runway. Touchdown may be made on one of the main gear, if required, while simultaneously maintaining alignment with the runway using opposite rudder to the low wing. As soon after touchdown as possible, the nose gear should be gently lowered to the runway and the copilot will normally, at the direction of the pilot, assist the pilot in holding the control column full forward and in keeping the wings level with aileron as required. The pilot will maintain directional control with rudder, differential braking and nose wheel steering. After positive control is assured, the speed brake lever will be actuated smoothly to the 60 degree position. Abrupt actuation of the speed brakes should be avoided, as yaw may be induced when near full aileron is used for lateral control. As an alternate procedure, the pilot may elect to perform all control activity upon landing, with the copilot raising the speed brakes at the direction of the pilot. The procedure to be used will be thoroughly briefed prior to landing. Refer to Part 9 of the Appendix, T.O. 1C-135(K)A-1-1, for maximum crosswind component and flap setting.

Bounce Recovery

During adverse landing conditions such as crosswind or turbulent air, an undersirable bounce may result on touchdown. A high bounce or ballooning situation may cause a series of skips and yawing of the airplane, resulting in the possibility of dragging an engine pod. The nose gear may be damaged in severe cases. Recovery from the bounce requires avoiding an excessive attitude change which may result in the possibility of dragging the tail or touching down nose gear first with resultant damage. Do not overrotate the airplane to a nose high attitude to check the sink rate or apply excessive nose down control to avoid the high bounce. Maintain the airplane in an approximate landing attitude and allow the airplane to settle for subsequent runway contact. Immediately after the main gear is firmly on the runway, gently lower the nose gear to the runway and raise the speed brakes to the 60 degree position. Consideration should be given to initiating a go-around if doubt exists as to safe bounce recovery capability.

LANDING ON SLIPPERY RUNWAYS

If a landing must be made on a wet or icy runway and if doubt exists as to actual runway conditions, make a practice visual approach to the landing runway, if weather permits, observing surface, overruns and obstacles. The traffic controller will report information concerning runway surface condition for airplanes enroute and anticipating a landing. Use the RCR in accordance with the instructions in Part 9 of the Appendix, T.O. 1C-135(K)A-1-1, to ensure that adequate stopping distance will be available after touchdown. Use an RCR of 9 for wet runways, and use an RCR of 4 for icy runways and snow covered runways to obtain stopping distances if an RCR is not available. Establish a normal approach with strict adherence to the correct approach speeds. Excessive threshold speeds under low temperature conditions will result in the airplane floating during the flare.

NOTE

- RCR values will normally be reported only for hard surface runway conditions such as slush, snow or ice. Water on the runway will be reported as "Wet Runway" (no RCR value will normally be given)".

- During landing, under low temperature conditions and all engines at idle, the increased idle thrust of the engines, due to low temperatures, will increase the stopping distance.

- When landing on slippery runways, all means of reducing landing roll should be used to the maximum. Retard all throttles to IDLE on touchdown. The inboard engines may be cut once the pilot determines there is no possibility of successfully completing a go-around. Before cutting any engines, a failed engine or any inoperable system must be considered. Braking should begin as soon as practicable and be continued until arriving at a safe taxi speed. Anytime an RCR of 7 or less is used for landing, the aircraft must be brought to a full stop as soon as practicable. If taxi is then initiated, extreme caution must be used to avoid a skid when exiting the runway and proceeding along the taxi route.

GUST CORRECTION FACTOR

Gusts seldom exceed 50% of the average wind velocity. The approach speed and touchdown speed should be increased by full amount of the gust velocity. For example, with a wind velocity of 25 knots and gusts to 35 knots, 10 knots should be added to approach speed and touchdown speed. When chart touchdown speeds must be increased because of gust or crosswind effects, landing ground roll distances should be increased. Refer to Part 9 of T.O. 1C-135(K)A-1-1.

BEFORE LANDING (CP reads)

1. Speed Brakes - 0 degrees (P)

WARNING

Speed brakes will not be used during approach below 1000 feet AGL.

2. Autopilot - Disengaged (P)

Disengage autopilot unless it is to be used for an automatic approach.

CAUTION

Because of heavy control forces required to overcome the autopilot, the autopilot will be disengaged prior to landing.

3. RGA Power and Speed Deviation Switches - ON (P, CP)

Check G/A ARM annunciators on.

4. Flaps - 30 degrees (P, CP)

Pilot reduces speed to 210 knots and requests copilot to extend 30 degrees of flaps. Observe flap placard speeds.

5. Rudder Hydraulic Pressure - Checked (P)

Pilot checks rudder hydraulic pressure in the high range (2800 psi steady state minimum).

6. Landing Gear - DOWN; 3 down and checked (P, CP)

Both pilot and copilot check the landing gear lever in the DN position, the landing gear warning light knob extinguished, and that the three landing gear position indicators show down and locked. If not previously accomplished, retard any one throttle to IDLE momentarily to check that warning horn does not sound.

7. Antiskid System 550 - Checked, if required (P)

Check antiskid system, if not previously accomplished.

a. Antiskid Indicators - REL

All indicators should show REL (release).

BEFORE LANDING (Cont)

b. Antiskid Test Switch - INBD

With test switch in INBD position, the inboard indicators should be blank and the outboard indicators should show REL.

c. Antiskid Test Switch - OUTBD

With test switch in OUTBD position, the outboard indicators should be blank and the inboard indicators should show REL.

CAUTION

If the antiskid test indicates a system malfunction (any one indicator does not respond properly), the pilot should use light braking and be prepared for asymmetric brake effectiveness. If two or more indicators do not respond properly, the ANTISKID INBOARD and OUTBOARD circuit breakers should be pulled and the procedures for landing with antiskid inoperative should be observed. Refer to Section VII.

8. Starter Switches - As required (P)

If engine inlet icing or fuel icing is anticipated or suspected, move the starter switches to the FLIGHT START position.

CAUTION

If conditions permit, limit the use of ignition to 10 minutes or less, as excessive continuous ignition may cause the engine ignition system components to fail.

9. TACAN Select Switches - As required (P, CP)

10. Landing or Taxi Lights - As required (CP)

11. Flaps - 40 degrees (P, CP)

Flaps may be lowered to 40 degrees during the 90 degree turn to base leg. Lower flaps to 40 degrees just before starting descent for a straight in approach.

12. Fuel Panel - Set for landing (P, CP)

All eight boost pumps on, tank to engine manifold valves as required.

13. Flaps - 50 degrees (P, CP)

With 4 engines operating, flaps may be lowered to 50 degrees after starting the turn to final approach. See Section IX for flap procedures during instrument approaches.

GO-AROUND

The decision to go-around should be made as early as possible. For all go-arounds, regardless of the number of engines operating, the normal GO-AROUND checklist shall be referred to. The pilot's intentions and airplane performance capability will determine action to be taken. Upon initiating a go-around:

A. Actuate RGA switches.

B. Advance the throttles to increase thrust as required.

C. Insure that the speed brakes are not extended.

D. Raise flaps to 30 degrees if they had been extended further.

E. Retract the landing gear after descent ceases and a rate of climb has been established. If a climbout is desired, retract remaining flaps per flap retraction schedule and establish a normal climb, and then accomplish the AFTER TAKEOFF-CLIMB checklist. However, if the pilot desires to remain in the traffic pattern for further pattern work, the flaps should be left at 30 degrees and the landing gear left down if all engines are operative. If establishing a climb or maintaining pattern altitude become a problem during operation on less than four engines, the gear should be retracted. Delay lowering the landing gear again until there is no doubt that the runway can be reached. Refer to the TRAFFIC PATTERN checklist on downwind leg and fly a normal traffic pattern.

CAUTION

For normal four engine go-around, do not exceed the EPR as determined from the EPR FOR GO-AROUND chart in Part 9 of the Appendix, T.O. 1C-135(K)A-1-1.

Time and fuel allowance for go-around is 5 minutes and 2500 pounds of fuel.

GO-AROUND

1. RGA Switch - Actuate (P, CP)
2. Throttles - Increase thrust as required (not to exceed MRT) (P)
3. Speed Brakes - 0 degrees (P)
4. Flaps - 30 degrees or as desired (P, CP)

   Retract flaps as desired, depending upon conditions; observe placard speeds.

5. Landing Gear - UP or as desired (P, CP)

   When vertical velocity indicator and the altimeter show a definite rate of climb, retract the gear if desired.

6. Speed - Maintain pattern speed (P)

TOUCH AND GO LANDING

NOTE

- This checklist will be accomplished on the runway.
- 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. Compute takeoff and inflight minimum control speed and use whichever is higher.
- During multiple touch and go landings, the landing gear should remain down after takeoff.

1. Flaps - 30 degrees (CP)
2. Stabilizer Trim - Set for takeoff (CP)

   The stabilizer trim setting required to maintain level flight (zero stick force) at pattern speed (with gear down and flaps at 30 degrees) may be used as takeoff trim setting on touch-and-go landings.

NOTE

Pilot not flying airplane will reset stabilizer trim and flaps to takeoff setting.

3. Throttles - One-half open, then charted EPR (P, CP)

   This will allow time for equal engine acceleration. Use charted EPR as a target thrust setting. Refer to maximum charted EPR for touch and go landings in the Appendix, T.O. 1C-135(K)A-1-1, Part 9.

WARNING

Rotation will be initiated at not less than takeoff speed or inflight minimum control speed, whichever is higher.

NOTE

Positive forward pressure will be held on the control column until rotation. If airplane is to remain in closed traffic after takeoff, power will be adjusted to climb out at the same speed to be used on the downwind leg, and at a rate of climb of approximately 1000 feet per minute.

TYPICAL LANDING AND GO-AROUND PATTERN

WARNING

ON BASE AND CROSSWIND LEG, MOMENTARILY LEVEL WINGS AND VISUALLY CHECK FOR OTHER TRAFFIC. AFTER PASSING END OF RUNWAY AND REACHING APPROPRIATE ALTITUDE, THE FIRST TURN MAY BE INITIATED.

NOTE

LANDINGS SHOULD NORMALLY BE MADE WITH 50° FLAPS. IF LESS THAN 50° FLAPS ARE SELECTED FOR LANDING, STOPPING DISTANCE MUST NOT BE CRITICAL. REFER TO PART 9 OF THE APPENDIX T.O. 1C-135(K)A-1-1.

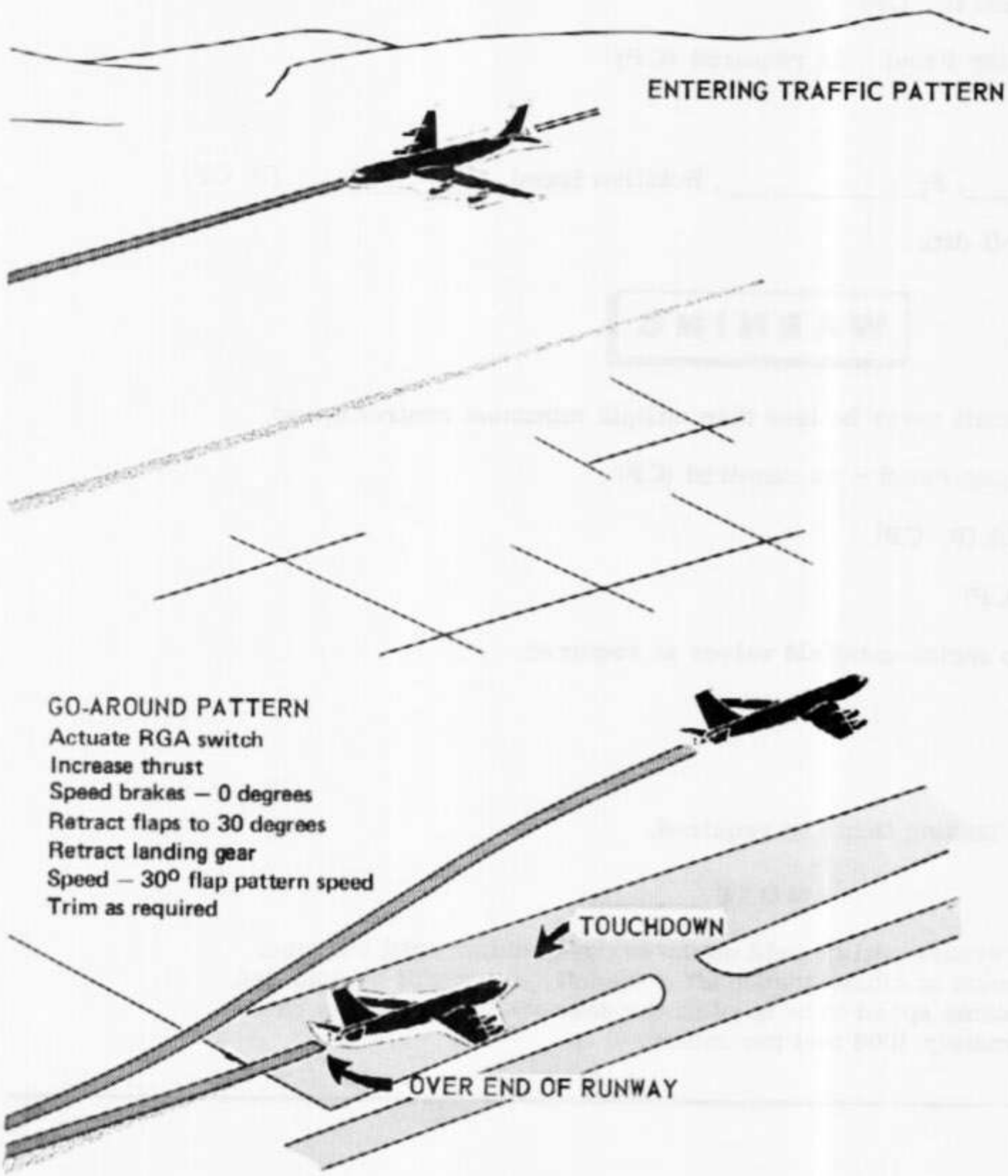
BEFORE TURNING BASE LEG
Altitude – Local specified
Flaps – 30 degrees
Speed – 30° flap pattern speed

BASE LEG (See WARNING)
Altitude – Approx. 1000 feet
Flaps – 40 degrees
Speed – 40° flap pattern speed

FINAL APPROACH
Altitude – As required
Flaps – 50 degrees
Speed – 50° flap approach speed
Autopilot – Disengaged

Figure 2-4 (Sheet 1 of 2)

ENTERING TRAFFIC PATTERN
Altitude – local specified
Flaps – 30 degrees
Speed – 30° flap pattern speed
Landing gear down
Power as required



WARNING

Maintain prescribed traffic pattern speeds consistent with flap settings, gross weight, number of engines operating and inflight minimum control speeds.

Figure 2-4 (Sheet 2 of 2)

MULTIPLE FULL STOP LANDINGS (CP Only)

AFTER LANDING

1. Lights - As required (CP)

   Rotating beacon lights BOTH ON, navigation lights BRIGHT and STEADY, and taxi lights as required.

2. Flaps - Set for takeoff (P, CP)

3. Speed Brakes - 0 degrees (P)

4. Stabilizer, Aileron and Rudder Trim - Set for takeoff (P, CP)

5. FD Mode Selector Switches - GYRO (P, CP)

6. Pressurization and Air Conditioning Panel - As required (CP)

BEFORE TAKEOFF

1. Takeoff Data - EPR_____, S_1_____, Rotation Speed _____ (P, CP)

   Copilot computes applicable takeoff data.

WARNING

Takeoff speed used shall never be less than inflight minimum control speed.

2. Pressurization and Air Conditioning Panel - As required (CP)

3. FD Mode Selector Switches - RGA (P, CP)

4. Fuel Panel - Set for takeoff (P, CP)

   All eight boost pumps on, tank to engine manifold valves as required.

5. Radio Call - Completed (CP)

6. Lights - As required (CP)

   Rotating beacon, navigation, and landing lights as required.

NOTE

Positive forward pressure will be held on the control column until rotation. If airplane is to remain in closed traffic after takeoff, power will be adjusted to climb out at the same speed to be used on the downwind leg, and at a rate of climb of approximately 1000 feet per minute.

TRAFFIC PATTERN (CP reads)

NOTE

This checklist will be used for multiple touch and go landings, multiple full stop landings, or multiple low approaches. Initiate the TRAFFIC PATTERN checklist after rolling out on the downwind leg for second and subsequent approaches or landings.

1. Speed Deviation Switches - ON (P, CP)

2. Fuel Panel - As desired (P, CP)

3. Flaps - 30 degrees (P, CP)

   Set flaps at 30 degrees for traffic pattern.

4. Pattern Speeds, Approach Speed, and Touchdown Speed _____ Knots (CP)

   Copilot recomputes gross weight, pattern speeds, approach speed, and touchdown speed, confirms CG within limits, and relays pertinent information to pilot.

NOTE

Pattern, approach, and touchdown speeds need not be recomputed for every approach or landing; however, speeds must be recomputed after each 10,000 pounds gross weight change or for each approach or landing when a change in a wind condition requires a new adjustment to the charted approach and touchdown speed.

5. Review Approach - Accomplished (P, CP, N)

   Pilot checks appropriate navigational aids tuned and identified and reviews the approach with the copilot and navigator with particular emphasis on minimum altitude and visibility for the type approach and missed approach procedures. The pilot flying the approach should set the radio altimeter MDA index to the HAT or HAA for the approach being flown. The other pilot should set his MDA index to 100 feet above HAT or HAA.

6. TACAN Select Switches - As required (P, CP)

7. Landing Gear - DOWN; 3 down and checked (P, CP)

   Both pilot and copilot check the landing gear lever in the DN position, the landing gear warning light knob extinguished, and that the three landing gear position indicators show down and locked. If not previously accomplished, retard any one throttle to IDLE momentarily to check that warning horn does not sound.

8. Hydraulic System - Checked (P, CP)

   Pilot checks pressure; copilot checks quantity.

9. Landing or Taxi Lights - As required (CP)

10. Flaps - 40 degrees (P, CP)

    Flaps may be lowered to 40 degrees during the 90 degree turn to base leg.

NOTE

Instrument approach procedures are discussed in Section IX.

11. Fuel Panel - Set for landing (P, CP)

    All eight boost pumps on, tank to engine manifold valves as required.

TRAFFIC PATTERN (CP reads) (Cont)

12. Flaps - 50 degrees (P, CP)

Flaps may be lowered to 50 degrees after starting turn to final approach.

NOTE

If a touch and go landing or a full stop taxi back has been planned, proceed to the TOUCH AND GO or MULTIPLE FULL STOP LANDINGS checklist as applicable.

AFTER LANDING

After the main landing gear is on the runway, check the throttles retarded to IDLE and gently lower the nose gear to the runway. After the nose gear touches down, the copilot will normally, upon the direction of the pilot, assist the pilot in holding the control column forward; the pilot will raise the speed brakes fully and apply wheel brakes as necessary. As an alternate procedure, the pilot may elect to perform all control activity upon landing, with the copilot raising the speed brakes at the command of the pilot.

NOTE

If the alternate procedure is to be used, it will be briefed prior to landing.

Directional control will be maintained primarily with rudder, nose gear steering, and differential braking in that order.

CAUTION

During the landing ground roll, use a braking technique which will cause a minimum number of antiskid brake release cycles on airplanes without Mod 550. Three to five cycles of the antiskid during landing ground roll, normally will produce best braking effectiveness. On airplanes with Mod 550, the pilot should apply full brake pedal to obtain minimum stopping distance under any runway condition. Any chattering of brakes will be noted in the Form 781.

NOTE

On icy runways the primary directional control will be with rudder until the airspeed has been reduced to 80 knots.

Nose gear steering need not be used until the airplane has slowed to taxi speed; however, with a crosswind it may be used sooner. For braking technique, refer to BRAKE SYSTEM OPERATION, Section VII.

AFTER LANDING (CP reads after clear of runway)

1. Hydraulic Pressure - Monitor (P)
2. Starter Switches - OFF (P)
3. Lights - As required (CP)

Check rotating beacon lights BOTH ON, navigation lights BRIGHT and STEADY, and taxi lights as required.

CAUTION

Limit ground operation of nacelle illumination lights to 15 minutes to prevent distortion of pressure windows covering the lights.

4. Anti-Icing Equipment, Q-Inlet Heat and Pitot Heat - OFF (P, CP)

   Window heat may be left on if required.

5. Flaps - UP (CP)

6. Speed Brakes - 0 degrees (P)

7. Cabin Manual Pressure Control - FULL DECREASE (CP)

   Check cabin altimeter to see that cabin is fully depressurized before any hatch is opened.

8. Air Conditioning Master Switch - RAM AIR (CP)

9. Pilots' Search Radar Intensity Control - Full CCW (CP, N)

   Turn intensity control full counterclockwise.

10. FD Mode Selector Switches - GYRO (P, CP)

11. Inboard or Outboard Throttles - CUTOFF, if desired (P)

    To avoid excessive speed, brake wear, and to conserve fuel during taxi, the inboard or outboard throttles may be placed in CUTOFF. Before shutting down the inboard or outboard engines, the throttles will be advanced to 75% for not less than 15 nor more than 30 seconds to provide proper oil scavenging.

ENGINE SHUTDOWN (CP reads)

1. Parking Brakes - Set (P)

   After any final turn to line up with a parking spot, the airplane should be taxied in a straight line for a short distance to eliminate torsional loads in the main gear.

2. Ciphony Control Panel - Zeroize KY-28 (if required) (P)

3. Battery Power Switch - EMERGENCY (P)

4. Throttles - 75% (P)

5. Throttles - CUT-OFF (P)

   Before shutting down, throttles will be advanced to 75% rpm for not less than 15 nor more than 30 seconds to provide proper oil scavenging.

CAUTION

Normally an engine will be sufficiently cool after landing to permit immediate shutdown. If the engine has been operated above 85% rpm for periods exceeding one minute after landing, allow the engine to idle for at least 5 minutes before shutting down. This idling period permits the engine to cool down slowly to prevent possible damage resulting from rapid temperature changes.

6. Oxygen Supply Lever - OFF and 100% (P, CP)

7. All Switches and Electrical Equipment - OFF/CLOSED (P, CP)

   a. Window Heat Switches

   b. Instrument Power Gyro Switches

   c. Boost Pump and Fuel Valve Switches

   d. RGA Power Switches

   e. FD No. 1 and No. 2 Master Power Switches (With TCTO 879)

   f. Radios and Autopilot

   g. Hydraulic Pressure Switches

   h. Lights

NOTE

Leave rudder power switch ON.

ENGINE SHUTDOWN (Cont)

8. Wheel Brakes - Checked (CP, GC)

Ground crew will report any wheel brake(s) which indicate an abnormally cold or hot condition. If no ground crew is available the copilot will perform a wheel brake check to determine if any individual brake(s) indicate a relatively cold or hot condition compared to all other brakes. The wheel brake check should be accomplished as soon after engine shutdown as possible. Any abnormal condition will be entered in the Form 781.

WARNING

Personal injury may result if brakes are overheated. Do not enter vicinity of landing gear if overheated condition is suspected. Refer to BRAKE LIMITATIONS, Section V. Use caution when touching brakes to preclude burn injury to hands.

9. Parking Brakes - OFF (P)

Release brakes after chocks are in place.

10. Battery Power Switch - OFF (P)

CAUTION

During ground handling, extreme care should be taken to keep the cg at or ahead of 37% MAC to reduce the possibility of the airplane tipping on its tail. The tail support strut should always be installed except when the airplane is moving, engines are operating, the airplane is on alert status or when directed otherwise. For operational purposes, when using the load adjuster, keep the cg at or ahead of 36% MAC.

NOTE

If no ground crew is available to perform postflight inspection, the pilot will accomplish a walk-around to inspect for any obvious airplane damage and will place the manual refueling valve handle in the REFUEL position.

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.

INSTRUCTIONS

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 the following:

1. Exterior Inspection

2. Interior Inspection

Going on Alert

The airplane will be placed in a cocked configuration by the aircrew using the appropriate checklists up to the STARTING ENGINES AND BEFORE TAXIING checklist. Cocking procedures are a coordinated crew effort and crewmembers will remain at the airplane until the pilot has ascertained that all crewmembers have completed their checklists.

NOTE

If the airplane has been previously cocked, a recheck of airplane cocking will be accomplished.

Thermal Radiation Curtains

During initial acceptance check for an EWO alert aircraft or prior to deploying to assume satellite EWO alert, the aircrew will inspect and install the thermal radiation curtains in all cockpit, cargo, and boom compartment windows. Curtains will be inspected and checked for proper fit in accordance with the instructions below. The curtains for the pilot's and copilot's forward (No. 1), sliding (No. 2), and rear (No. 3) windows will be removed and placed in the storage container for reinstallation as soon as practical after takeoff from EWO alert posture. All other curtains will remain installed while the aircraft is on alert.

If the aircraft is to deploy to a satellite alert base, all curtains will be removed and placed in appropriate stowage containers for the deployment flight. When assuming alert at the satellite base, the curtains need not be reinspected; however, they must be installed and fitted in accordance with initial alert acceptance procedures.

During installation, thermal radiation curtains must fit closely enough to prevent direct outside light rays (straight line) from hitting a crewmember in his normal sitting position. Window glass must not be visible to any crewmember while seated in his normal position. If either of these cases exist, the curtain(s) must be readjusted. Translucent light (bright contrasts of indirect light due to scuffing, etc) is acceptable. However, pin holes, cuts, tears or curtains that cannot be adjusted to prevent direct light rays will be cause for rejection and appropriate AFTO 781 entry. Pin holes can be located by installing all curtains and visually inspecting for light penetration when sun is shining (clear day) on the aircraft windows. If the aircraft is in a hanger, the sun obscured by clouds, or at night, use a 300-to-500 watt floodlight approximately 18 to 30 inches from aircraft windows to simulate sunlight. Light ray penetration through curtain stitching holes or attaching eyelets is not acceptable.

CAUTION

Use extreme care when handling thermal curtains. The aluminized surface of each curtain is highly susceptible to contamination and must be refurbished following use. Oil (oil or perspiration from a person's skin), grease or dirt on the aluminum face of the material will result in failure of the curtains to withstand the required thermal radiation. Oil or grease base material will ignite upon exposure to thermal radiation. Do not remove the curtains from the protective containers except for training or operational use. Use the tabs sewn on the back side and at each end of the curtain for handling.

Eye Protective Devices

When assuming alert duty, the pilot, copilot, and boom operator will check that the flashblindness goggle case seal is not broken and the cases positioned where they are readily available. Monocular eyeshields for remaining crewmembers will be positioned where they are readily available.

Hatches

When the airplane is cocked, all hatches will be closed except the crew entry hatch, which may be left open with the ladder installed, weather permitting.

Daily Preflight While Airplane Is On Alert

At a predesignated time each 24 hours, the aircrew will perform a "Daily Alert Preflight Checklist." Upon completion of the DAILY PREFLIGHT checklist it will NOT be necessary to complete any other checklist as the airplane is in a COCKED configuration.

Maintenance While on Alert

At any time while the airplane is cocked, if a requirement exists to refuel, the aircrew will uncock the airplane using the "Uncocking Checklist." Normal servicing requirements for water, oxygen, hydraulics, pneumatics or fuel top off which do not require access to the cockpit may be accomplished on a cocked airplane. Maintenance may be performed without uncocking provided force timing is not degraded, power is not placed on the airplane, access to the cockpit is not required and no electrical component is involved. After maintenance or refueling is completed, the airplane will be recocked by the alert aircrew using the normal preflight checklists.

Scramble

Aircrews will use the normal checklist when the execution order is given except when responding from POSTURE 5. Engines may be started with only the pilot in position. The BEFORE TAKEOFF checklist will be completed as a continuation of the TAXIING checklist without stopping the airplane prior to entering the runway.

WARNING

The thermal radiation curtains not previously installed in the pilots' windows must be installed as soon as possible after takeoff from EWO alert posture. The pilot will direct that all curtains be inspected and action taken to eliminate any light leakage detected. Failure to properly close thermal curtains (during EWO) may result in flash blindness from nuclear detonation.

Coming Off Alert

Aircrews will complete the AFTER LANDING and ENGINE SHUTDOWN checklists when the airplane is removed from alert posture. The ground crew will inspect and repair, if necessary, all thermal radiation curtains prior to returning them to the stowage containers.

TAXI BACK (CP reads)

NOTE

If an airplane is exercised while in alert status, but does not actually take off, the TAXI BACK checklist should be used to return the airplane to the ramp and a cocked configuration.

As Soon as Airplane is Clear of Runway

1. Hydraulic Pressure - Monitor (P)
2. Starter Switches - OFF (P)
3. FD Mode Selector Switches - GYRO (P, CP)
4. Taxi Lights - As required (CP)
5. Anti-Icing, Window Heat, Pitot Heat, Q-Inlet Heat - OFF (CP)
6. Speed Brakes - 0 degrees (P)
7. Flaps - UP (CP)

After Airplane is Parked

8. Parking Brakes - SET when parked (P)

8A. Rotating Beacon and Navigation Lights - OFF, FLASH (CP)

9. Stabilizer Trim - Reset (if applicable) (P, CP)

If the airplane is to be left unattended for extended periods under snow or icing conditions, the stabilizer trim will be set to 2.5 units nose down position.

NOTE

Setting the stabilizer trim to full airplane nose down position during icing conditions may cause the nose down limit switch to freeze open and prevent electric nose down trimming after takeoff.

10. Oxygen - OFF and 100% (P, CP)
11. Battery Switch - EMERGENCY (P)

Prior to shutting down engines, preposition a ground crewmember with a new cartridge in optimum position for reinstallation in number 4 engine.

12. No. 1, 3, and 4 Throttles - Advance to 75% rpm, then CUT-OFF (P)
13. No. 4 (No. 1, 3, and 4 with TC10 T120) Engine Starter Circuit Breaker(s) - Open (P, CP, BO)
14. Cartridge(s) - Insert (P, CP, GC)

The pilot and copilot will determine visually or orally from the ground crewmember that cartridge insertion is complete.

WARNING

Do not attempt to insert a new cartridge until there is no evidence of exhaust smoke at the exhaust duct and at least 5 minutes have elapsed since the last cartridge start initiation.

15. No. 4 (No. 1, 3, and 4 with TCTO 920) Engine Starter Circuit Breaker(s) - Close (P, CP, BO)

16. No. 2 Throttle - Advance to 75% rpm, then CUT-OFF (P)

16A. No. 2 Engine Starter Circuit Breaker (With TCTO 920) - Open (P, BO)

16B. Cartridge (With TCTO 920) - Insert (P, GC)

The pilot will determine visually or orally from the ground crewmember that cartridge insertion is complete.

WARNING

Do not attempt to insert a new cartridge until there is no evidence of exhaust smoke at the exhaust duct and at least 5 minutes have elapsed since the last cartridge start initiation.

16C. No. 2 Engine Starter Circuit Breaker (With TCTO 920) - Close (P, BO)

After wheel chocks are in place.

NOTE

If the airplane has been towed into position, the pilot will insure that the ground crew removes and stows ground safety locks and places the manual refueling valve handle to the flight position. Reposition both hydraulic system pressure switches to ON and check wheel well doors closed utilizing left auxiliary pump as necessary.

17. Parking Brakes - OFF (P)

18. External Power Switch - CLOSE (CP)

19. Battery Switch - NORMAL (P)

20. Starter Centrifugal Switches - Checked (P, N, BO or GC)

a. The pilot will place the starter switch to ground start for the engine being checked then return switch to OFF. PNEU START mode will be used when checking No. 4 engine (No. 1, 2, 3, and 4 with TCTO 920).

WARNING

Injury to personnel or damage to equipment could result from ignition of starter cartridge if the mode selector is placed in the CTG START position.

b. The navigator, boom operator or ground crewmember will check for an audible click in the J-6 relay panel at station 370 to insure that starter relay contacts close.

TAXI BACK (CP reads) (Cont)

21. Engine Igniters - Checked (P, GC)

    Each engine should be checked for operation of both igniters.

    a. The pilot will place the start switch to FLIGHT START for the engine being checked.

    b. The ground crewmember should hear an audible sound at the side of the engine adjacent to the igniter.

    c. The pilot will return the start switch to OFF after both igniters are checked.

22. External Power Switch - TRIP (CP)

23. Battery Switch - OFF (P)

NOTE

Airplane is now cocked.

DAILY PREFLIGHT

NOTE

Upon arrival at the airplane, the boom operator will start the APU and the copilot will obtain a main gear door down lock while the pilot is accomplishing the first 3 items of the checklist.

1. Circuit Breakers - Set (P)

2. Battery Power Switch - EMERGENCY (P)

3. Hydraulic Pressure Switches - OFF (P)

4. Manual Defueling Valve Cover - Closed (CP)

5. Wheel Well Door - Open (P, CP, GC)

When cleared by the pilot, the copilot or ground crew will open the right main gear wheel well and install the door lock. Pilot will insure that the hydraulic pressure switches and the hydraulic system auxiliary pump switches remain OFF while the ground crew and copilot are in the wheel well.

NOTE

Pilot will accomplish items 6, 7, 8, and 9 while copilot is accomplishing items 10, 11, and 12.

6. External Power Switch - CLOSE (P)

7. Battery Power Switch - NORMAL (P)

8. Inboard Spoiler Switch - CUTOFF (P)

9. Oxygen Quantity - Checked (P)

10. Manual Refuel Valve Handle - FLIGHT POSITION (CP)

11. Single Point Refuel Panel Cover - Closed (CP)

12. Water Quantity - Checked (CP)

13. Wheel Well Door - Clear (P, GC)

After the water quantity check is completed, the copilot will remove the wheel well door lock and bring it aboard the airplane. Ground crew will advise the pilot when the wheel well door is clear.

14. Hydraulic Pressure Switches - ON (P)

15. Hydraulic System Auxiliary Pump Switches - AUTO (P)

16. Landing Gear Warning Light - Extinguished (CP)

17. Hydraulic System Pressure and Quantity - Checked (P, CP)

A complete hydraulic system check is not required. Hydraulic pressure will build up more quickly if the rudder power switch is OFF. After system pressure builds up, return rudder power switch to ON and complete check.

18. Inboard Spoiler Switch - NORMAL (P)

19. Flight and Trim Controls - Checked for freedom of movement (P, CP)

A complete control and trim check is not required.

20. Hydraulic System Auxiliary Pump Switches - OFF (P)

21. Pitot Heat - ON, OFF (P, CP)

22. VOR, TACAN and Command Radios - Checked (P, CP)

22A. RGA Mode - Checked (P, CP)

Set flight director mode selector to RGA. Command bars should indicate a wings level zero pitch command and T/O MAX annunciators on. Either pilot or copilot actuate RGA switch and check that both ADI's indicate proper rotation commands. Return FD mode selector to GYRO.

23. Battery Charging Ammeter - Checked (P)

Insure that the battery is fully charged and the DC ammeter and voltmeter selector switch is not in the BATT position.

24. External Power Switch - TRIP (CP)

25. Battery Power Switch - OFF (P)

UNCOCKING (CP reads)

1. VOR, TACAN, and Command Radios - OFF (P, CP)

1A. RGA Power Switches - OFF (P, CP)

2. External Power Switch - CLOSE (CP)

3. Battery Power Switch - NORMAL (P)

4. Fuel Panel - Checked (CP)

   Check all fuel valves are closed and all switches are off.

5. Instrument Power Gyro Switches - OFF (P, CP)

6. FD No. 1 and No. 2 Master Power Switches (With 1C10 879) - OFF (P, CP)

7. Hydraulic System Auxiliary Pump Switches - OFF (P)

8. Hydraulic System Pressure Switches - OFF (P)

9. Cabin Manual Pressure Control - Full DECREASE (CP)

10. Air Conditioning Master Switch - OFF (CP)

11. Autopilot Power Switch - OFF (P)

12. Lights - OFF (P, CP)

13. External Power Switch - TRIP (CP)

14. Battery Power Switch - OFF (P)

15. Main Landing Gear Door Locks and All Landing Gear Pins - Installed (P, GC)

16. Cartridge(s) - Remove from starter (P, GC)

    Pilot checks starter switches and start selector switch in OFF position prior to GC removing cartridge from starter.

NOTE

If airplane is to be "uncocked" for maintenance after taxiing back to parking area the normal AFTER LANDING and ENGINE SHUTDOWN checklists will be accomplished in normal sequence instead of the TAXI BACK checklist.

POSTURE 3/4 CHECKLIST

Normally, POSTURE 3/4 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, use APU or external power and monitor UHF radio for further progression into the launch procedure. If launch progression occurs, crew initiates the STARTING ENGINES AND BEFORE TAXIING checklist and continues normal "Scramble" procedures.

If any engine has been started, No. 2 engine must be running to assume POSTURE 3/4 using the following checklist.

5. Wheel Well Door - Open (P, CP, GC)

When cleared by the pilot, the copilot or ground crew will open the right main gear wheel well and install the door lock. Pilot will insure that the hydraulic pressure switches and the hydraulic system auxiliary pump switches remain OFF while the ground crew and copilot are in the wheel well.

NOTE

Pilot will accomplish items 6, 7, 8, and 9 while copilot is accomplishing items 10, 11, and 12.

6. External Power Switch - CLOSE (P)

7. Battery Power Switch - NORMAL (P)

8. Inboard Spoiler Switch - CUTOFF (P)

9. Oxygen Quantity - Checked (P)

10. Manual Refuel Valve Handle - FLIGHT POSITION (CP)

11. Single Point Refuel Panel Cover - Closed (CP)

12. Water Quantity - Checked (CP)

13. Wheel Well Door - Clear (P, GC)

After the water quantity check is completed, the copilot will remove the wheel well door lock and bring it aboard the airplane. Ground crew will advise the pilot when the wheel well door is clear.

14. Hydraulic Pressure Switches - ON (P)

15. Hydraulic System Auxiliary Pump Switches - AUTO (P)

16. Landing Gear Warning Light - Extinguished (CP)

17. Hydraulic System Pressure and Quantity - Checked (P, CP)

A complete hydraulic system check is not required. Hydraulic pressure will build up more quickly if the rudder power switch is OFF. After system pressure builds up, return rudder power switch to ON and complete check.

18. Inboard Spoiler Switch - NORMAL (P)

19. Flight and Trim Controls - Checked for freedom of movement (P, CP)

A complete control and trim check is not required.

20. Hydraulic System Auxiliary Pump Switches - OFF (P)

21. Pitot Heat - ON, OFF (P, CP)

22. VOR, TACAN and Command Radios - Checked (P, CP)

22A. RGA Mode - Checked (P, CP)

Set flight director mode selector to RGA. Command bars should indicate a wings level zero pitch command and T/O MAX annunciators on. Either pilot or copilot actuate RGA switch and check that both ADI's indicate proper rotation commands. Return FD mode selector to GYRO.

23. Battery Charging Ammeter - Checked (P)

Insure that the battery is fully charged and the DC ammeter and voltmeter selector switch is not in the BATT position.

24. External Power Switch - TRIP (CP)

25. Battery Power Switch - OFF (P)

UNCOCKING (CP reads)

1. VOR, TACAN, and Command Radios - OFF (P, CP)

1A. RGA Power Switches - OFF (P, CP)

2. External Power Switch - CLOSE (CP)

3. Battery Power Switch - NORMAL (P)

4. Fuel Panel - Checked (CP)

   Check all fuel valves are closed and all switches are off.

5. Instrument Power Gyro Switches - OFF (P, CP)

6. FD No. 1 and No. 2 Master Power Switches (With IC10 879) - OFF (P, CP)

7. Hydraulic System Auxiliary Pump Switches - OFF (P)

8. Hydraulic System Pressure Switches - OFF (P)

9. Cabin Manual Pressure Control - Full DECREASE (CP)

10. Air Conditioning Master Switch - OFF (CP)

11. Autopilot Power Switch - OFF (P)

12. Lights - OFF (P, CP)

13. External Power Switch - TRIP (CP)

14. Battery Power Switch - OFF (P)

15. Main Landing Gear Door Locks and All Landing Gear Pins - Installed (P, GC)

16. Cartridge(s) - Remove from starter (P, GC)

    Pilot checks starter switches and start selector switch in OFF position prior to GC removing cartridge from starter.

NOTE

If airplane is to be "uncocked" for maintenance after taxiing back to parking area the normal AFTER LANDING and ENGINE SHUTDOWN checklists will be accomplished in normal sequence instead of the TAXI BACK checklist.

POSTURE 3/4 CHECKLIST

Normally, POSTURE 3/4 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, use APU or external power and monitor UHF radio for further progression into the launch procedure. If launch progression occurs, crew initiates the STARTING ENGINES AND BEFORE TAXIING checklist and continues normal "Scramble" procedures.

If any engine has been started, No. 2 engine must be running to assume POSTURE 3/4 using the following checklist.

COCKING (POSTURE 3/4) (CP reads)

1. Parking Brakes - Set (P)
2. Battery Power Switch - EMERGENCY (P)

   Prior to shutting down engines, preposition a ground crewmember with new cartridge(s) in optimum position for reinstallation in number 4 engine (No. 1, 2, 3, and 4 with ICIO 920).
3. External or Auxiliary Power - Checked (CP, BO or GC)
4. No. 1, 3, and 4 Throttles - Advance to 75% rpm, then CUT-OFF (P)
5. No. 4 (No. 1, 3, and 4 with ICIO 920) Engine Starter Circuit Breaker(s) - Open (P, CP, BO)
6. Cartridge(s) - Insert (P, CP, GC)

   The pilot and copilot will determine visually or orally from the ground crewmember that cartridge insertion is complete.

WARNING

Do not attempt to insert a new cartridge until there is no evidence of exhaust smoke at the exhaust duct and at least 5 minutes have elapsed since the last cartridge start initiation.

7. No. 4 (No. 1, 3, and 4 with ICIO 920) Engine Starter Circuit Breaker(s) - Close (P, CP, BO)
8. No. 2 Throttle - Advance to 75% rpm, then CUT-OFF (P)
9. No. 2 Engine Starter Circuit Breaker (With ICIO 920) - Open (P, BO)
10. Cartridge (With ICIO 920) - Insert (P, GC)

    The pilot will determine visually or orally from the ground crewmember that cartridge insertion is complete.

WARNING

Do not attempt to insert a new cartridge until there is no evidence of exhaust smoke at the exhaust duct and at least 5 minutes have elapsed since the last cartridge start initiation.

11. No. 2 Engine Starter Circuit Breaker (With ICIO 920) - Close (P, BO)
12. External Power Switch - CLOSE (CP)
13. Battery Power Switch - NORMAL (P)

    Use normal STARTING ENGINES AND BEFORE TAXIING checklist for starting engines. If launched from this condition, continue using applicable normal checklists.

POSTURE 5 CHECKLIST

POSTURE 5 may be assumed from a normal alert reaction or as the result of generation procedures. Assumption by either method requires completion of all checklists through the BEFORE TAKEOFF checklist to ensure that all items are accomplished. Subsequent procedures eliminate some items to avoid duplication. When in POSTURE 5 the ground crewman assigned to accompany the sortie will remain on the airplane with the flight crew. Windows may be opened as provided in the checklist, but hatches will remain closed. Doors will be closed except as provided in local plans for crew relief and/or changeover. Flight crews will ensure that takeoff data and trim are updated at all times as climatic conditions require. Pilots will remain currently informed on new data as a pretakeoff review will not be accomplished during a scramble. Ground crew support for engine start must be provided from additional sources.

COCKING (POSTURE 5) (CP reads)

1. Parking Brakes - Set (P)
2. Flaps - UP (CP)
3. Engine Anti-Ice, Window Heat, Pitot Heat, Q-Inlet Heat - OFF (P, CP)
4. Rotating Beacon and Navigation Lights - OFF, FLASH (CP)
5. Stabilizer Trim - Set for takeoff (CP)

NOTE

During extended periods of snow or icing conditions the stabilizer trim will be set 2.5 units airplane nose down position.

6. Oxygen Regulators - OFF, 100% (P, CP)
7. Battery Power Switch - EMERGENCY (P)
8. External Interphone - Connected (CP, GC)
9. External or Auxiliary Power - Checked (CP, BO or GC)

Prior to shutting down engines, preposition a ground crewmember with new cartridge(s) in optimum position for reinstallation in number 4 engine (or No. 1, 2, 3, and 4 with ICTO 920).

NOTE

Prior to shutting down engines, ensure that airplane is parked in a location where command post radio reception is possible.

COCKING (POSTURE 5) (Cont)

10. No. 1, 3 and 4 Throttles - Advance to 75% rpm, then CUT-OFF (P)

11. No. 4 (No. 1, 3, and 4 with 1510 920) Engine Starter Circuit Breaker(s) - Open (P, CP, BO)

12. Cartridge(s) - Insert (P, CP, GC)

The pilot and copilot will determine visually or orally from the ground crewmember that cartridge insertion is complete.

WARNING

Do not attempt to insert a new cartridge until there is no evidence of exhaust smoke at the exhaust duct and at least 5 minutes have elapsed since the last cartridge start initiation.

12A. No. 4 (No. 1, 3, and 4 with 1510 920) Engine Starter Circuit Breaker(s) - Close (P, CP, BO)

13. No. 2 Throttle - Advance to 75% rpm, then CUT-OFF (P)

13A. No. 2 Engine Starter Circuit Breaker (With 1510 920) - Open (P, BO)

13B. Cartridge (With 1510 920) - Insert (P, GC)

The pilot will determine visually or orally from the ground crewmember that cartridge insertion is complete.

WARNING

Do not attempt to insert a new cartridge until there is no evidence of exhaust smoke at the exhaust duct and at least 5 minutes have elapsed since the last cartridge initiation.

14. No. 2 Engine Starter Circuit Breaker (With 1510 920) - Close (P, BO)

15. Battery Power Switch - OFF (P)

16. Sliding Windows - As desired (P, CP)

17. Water Heater Switches - ON, if applicable (CP, BO)

If assigned posture 5 configuration is power-off, the airplane is now cocked and steps 18 through 21.d. need not be accomplished. If assigned a power-on configuration continue the checklist to completion.

18. Battery Power Switch - EMERGENCY (P)

19. External Power Switch - CLOSED (CP)

20. Battery Power Switch - NORMAL (P)

21. Electrical Equipment - OFF (P, CP)

a. Radios (except one UHF) - OFF

b. Autopilot - OFF

c. Fuel Boost Pumps - OFF

d. Pilots' Instrument Gyro Switches - OFF (P, CP)

SCRAMBLE (POSTURE 5) (CP reads)

1. Pilots' Instrument Gyro Switches - ON (P, CP)

WARNING

Because of differences in erection rates between the N-1 and J-4 compasses, the J-4 compass will be more reliable for up to 6 minutes after power application to the system or after short power interruptions with subsequent reapplication. After takeoff in extremely short reaction situations, where an accurate heading reference is required, compare compass headings using the J-4 as primary reference if a notable difference exists.

2. Battery Switch - EMERGENCY (P)

3. Reserve Brake Pressure - Checked (P)

Pressurize the reserve brakes until a pressure increase of at least 300 psi above preload pressure is observed.

NOTE

Copilot will accomplish items 4, 5, 6 and 7 while pilot checks and builds up reserve brake pressure.

4. Fuel Boost Pumps - ON (CP)

5. Autopilot - ON (CP)

6. Radios - ON (CP)

7. Flap Handle - Set for takeoff (CP)

8. Check with Ground - Ready to start engines (P, GC)

9. Start Engines - Started (P, CP, GC)

10. Generator Breaker Switches - CLOSE (CP)

11. Rotating Beacon and Navigation Lights - BOTH ON, STEADY (CP)

12. Notify Ground - "Remove external equipment and chocks, report ready to taxi, and remove interphone." (P, GC)

NOTE

Taxiing may be initiated at anytime after this item if a visual signal is received indicating all equipment and personnel are clear. Accomplish remaining items while awaiting taxi signal or while taxiing.

13. Copilots Instrument Power Switch - START (CP)

14. Battery Power Switch - NORMAL (P)

15. Altimeters - RESET (P), STBY (CP)

16. Sliding Windows - CLOSED (P, CP)

SCRAMBLE (POSTURE 5) (Cont)

17. Engine Anti-Icing, Pitot Heat, Window Heat, Q-Inlet Heat - As required (P, CP)

18. Stabilizer Trim - Set for Takeoff (P, CP)

19. Door Warning Light - Extinguished (CP)

20. Landing, Navigation, Beacon Lights - As required (CP)

21. Belts and Harnesses - Fastened, if time permits (P, CP)

22. FD Mode Selector Switches - RGA (P, CP)

NOTE

Do not set FD mode selector to RGA position while accelerating, decelerating, or turning the airplane.

23. Warning Indicators, Flags and Annunciators - Checked (P, CP)

24. Starter Switches - FLIGHT START (P)

25. Water Boost Pumps - START (CP)

Takeoff can now be continued using normal takeoff procedures.

NOTE

The pilots' normal and alert procedures also appear in T.O. 1C-135(K)A-1CL-1 which is an abbreviated checklist. The abbreviated checklist has each numbered step of the normal, alert, and emergency procedures in shortened form.

NOTE: Page 2-57 and 2-58 may be cut out and removed from the manual.

T.O. 1C-135(K)A-1

KC-135 EMERGENCY TAXI CHECKLIST (PILOT)

1. Status of Aircraft - CHECKED (P)
   Pilot will check with ground crew for status of aircraft for taxiing and desired starting mode for cartridge /pneumatic starter and issue instructions to:
   (a) Prepare for Starting:
      (1) Cartridge - Insert in starter (if applicable)
      (2) MA-1A Air Cart - Connect to aircraft (if applicable)
   (b) Ground Crew - Report on Interphone
2. Circuit Breakers - SET (P)
3. Battery Switch - EMERGENCY (P)
4. No. 1 Command Radio - ON (P)
5. Pressurize Reserve Brake to 3000 PSI (P)
6. Fire Switches - CHECKED IN (P)
7. Air Condition Cross Over Switch - OPEN (P)
8. Bleed Switches - OPEN (P)
9. Autopilot Power Switch - ON (P)
10. Fuel Panel - SET (P)
    (No. 1 & 4 boost pump switches ON)
11. Parking Brakes - SET (P)
12. Radio Call - COMPLETED (P)
    Contact control room or tower and advise ready to start engines and request instructions.
13. Check with Ground Crew - READY START #4 ENGINE (P, GC)
14. Start #4 Engine - STARTED (P)
15. Starter Switch - OFF (P)
    If starter malfunctions, call control room identify parking spot and request an MA-1A air cart.
16. Check with Ground Crew - READY TO START #1 ENGINE (P, GC)
17. Start #1 Engine - STARTED (P)
18. Generator #1 - ON (P) BUS TIES CLOSED
19. Wheel Well Doors - Clear (P, GC)
20. Hydraulic System Pressure Switches - ON (P)
21. Battery Switch - NORMAL (P)

(Cont)

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T.O. 1C-135(K)A-1

22. Chocks and Interphone - Disconnect and remove (P, GC)
23. Crew Entry Door - Closed (GC)
24. Rotating Beacon and Navigation Lights - BOTH ON, STEADY (P)
    Taxi on visual signal from ground crew (if available).
25. Brakes and Steering - CHECKED (P)

ENGINE SHUTDOWN CHECKLIST

1. Parking Brakes - Set (P)
2. Battery Power Switch - EMERGENCY (P)
3. Throttles - 75% (P)
4. Throttles - CUT-OFF (P)
   Before shutting down, throttles will be advanced to 75% rpm for not less than 15 nor more than 30 seconds to provide proper oil scavenging.
5. All Switches and Electrical Equipment - OFF/CLOSED (P)
   a. Hydraulic Pressure Switches
   b. Boost Pump and Fuel Valve Switches
   c. Radios and Autopilot
   d. Lights

NOTE

Leave rudder power switch ON.

6. Parking Brakes - OFF (P)
   Release brakes after chocks are in place.
7. Battery Power Switch - OFF (P)

MINIMUM CREW - ONE PILOT AND ONE GROUND CREWMEMBER

THIS CHECKLIST IS DESIGNED FOR EMERGENCY USE AND IS TO BE PLACED IN THE COCKPIT OF EACH AIRPLANE. IT IS NOT TO BE CARRIED IN THE CREWMEMBER'S INDIVIDUAL CHECKLIST HOLDER.

10 August 1973 EXTRACTED FROM PAGE 2-58



Section III

EMERGENCY PROCEDURES

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NOTE

This Section contains text and amplified checklists that describe procedures to be followed in any emergency except those in connection with auxiliary equipment. The Section is presented in chronological order similar to the format of Section II, with emergency procedures grouped as they might logically be expected to occur during the course of a mission. The amplified checklists describe in detail the actions to be taken. Certain checklist actions in this Section are given in capital letters and bold face type. These actions are called "critical actions" and constitute the minimum required steps to be taken by a crewmember to ensure survival. These steps must be committed to memory.

STOP——THINK——COLLECT YOUR WITS

A thorough evaluation of each emergency should be made prior to initiating corrective action.

CREW COORDINATION

An emergency requires the full, coordinated effort of each crewmember. Emergency procedures should be practiced at every opportunity so the crew will become proficient in every procedure. A well trained crew will know the problem and if properly indoctrinated, will react correctly and effectively under any condition.

EMERGENCY SIGNALS

If the time and circumstances permit, the crew should be warned of the emergency, given instructions, and acknowledgement received, by interphone. The boom operator and/or navigator will insure that passengers and/or extra crewmembers are notified of the emergency.

ON THE GROUND

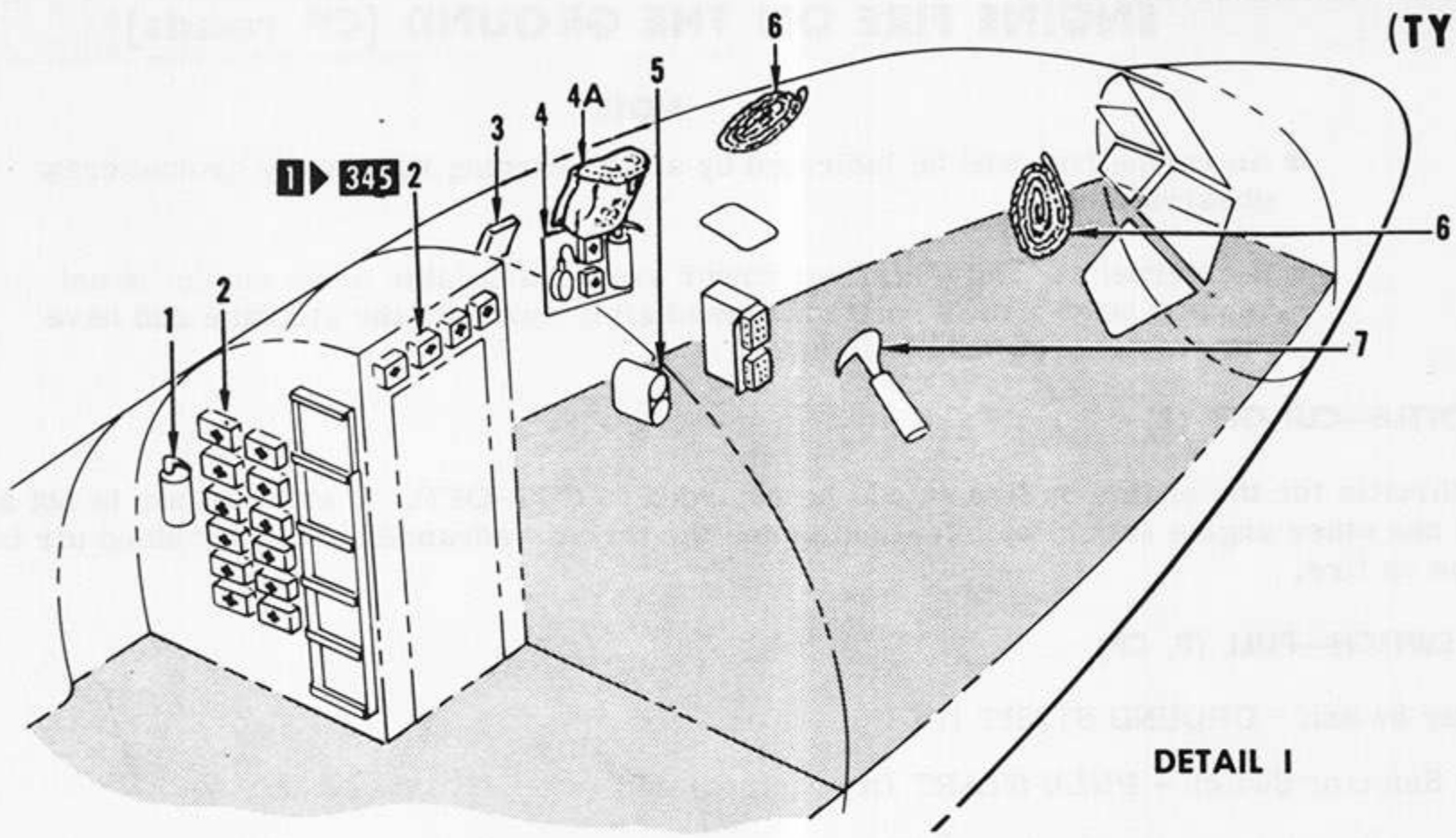
1. Prepare to abandon airplane: Three short rings.
2. Abandon airplane: One long sustained ring.

IN THE AIR

1. In the event an immediate bailout is required and there is insufficient time for complete preparation, the pilot will place the alarm bell switch to the ON position and announce on interphone, "Bail out, Bail out, Bail out." Pilot will depressurize the airplane; navigator or boom operator will pull the chinning bar and open floor grille. All personnel will immediately evacuate the airplane.
2. Prepare to bail out: Three short rings on the alarm bell.
3. Bailout: One long sustained ring.
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 take-off: One long sustained ring.

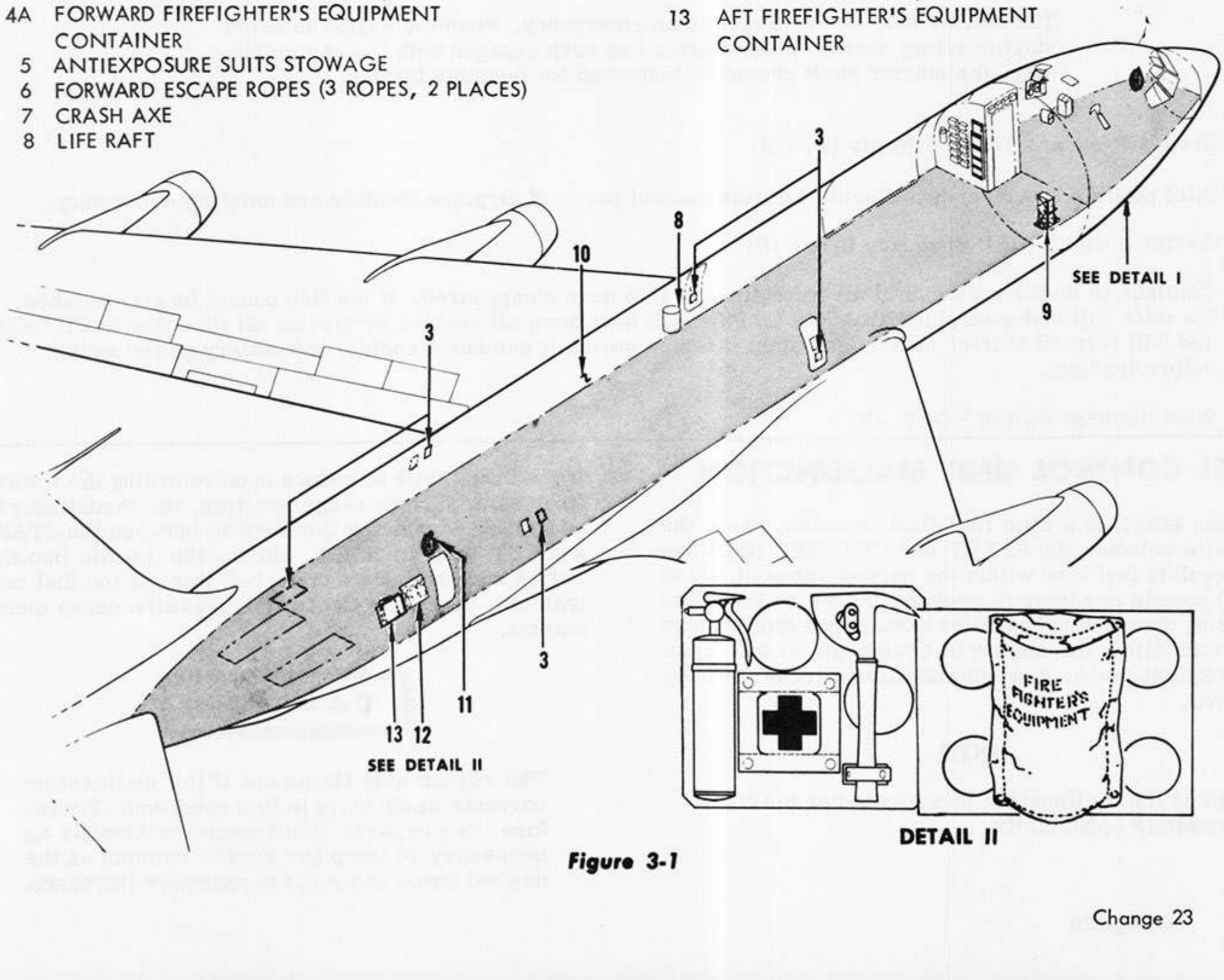
EMERGENCY EQUIPMENT

(TYPICAL)



DETAIL I

1 HAND FIRE EXTINGUISHER
2 FIRST AID KITS (2 PLACES)
3 THERMAL RADIATION CURTAINS (4 PLACES)
4 FORWARD EMERGENCY EQUIPMENT PANEL (SIGNAL LAMP, FIRST AID KITS, AND HAND FIRE EXTINGUISHER)
4A FORWARD FIREFIGHTER'S EQUIPMENT CONTAINER
5 ANTIEXPOSURE SUITS STOWAGE
6 FORWARD ESCAPE ROPES (3 ROPES, 2 PLACES)
7 CRASH AXE
8 LIFE RAFT
9 SURVIVAL KIT STOWAGE RACK
10 MAIN GEAR AND FLAP EMERGENCY CRANK
11 AFT ESCAPE ROPE
12 AFT EMERGENCY EQUIPMENT PANEL (CRASH AXE, FIRST AID KIT, AND HAND FIRE EXTINGUISHER)
13 AFT FIREFIGHTER'S EQUIPMENT CONTAINER



DETAIL II

Figure 3-1

GROUND EMERGENCIES

ENGINE FIRE ON THE GROUND (CP reads)

NOTE

- An engine fire will be indicated by a fire warning light or by ground crew observation.
- If external air and electrical power are not available or an engine is not running when fire is noticed, immediately evacuate the airplane and have the ground crew handle fire.

1. **THROTTLE—CUT-OFF (P)**

   The throttle for the engine on fire should be retarded to CUT-OFF. If external air is not available, at least one other engine should be left running and the throttle advanced to supply bleed air to motor the engine on fire.

2. **FIRE SWITCH—PULL (P, CP)**

3. Starter Switch - GROUND START (P)

3A. Start Selector Switch - PNEU START (if required) (P)

If engine No. 4 is on fire (without) or any engine is on fire (with), place the start selector switch to PNEU START.

CAUTION

The starter may be reengaged in an emergency, when the engine is below starter cutout speed. If the starter has been engaged with the engine running, the starter shaft should be inspected for possible failure.

4. Ground Crew and Tower - Notify (P, CP)

   Pilot notifies ground crew. Copilot informs control tower of airplane location and existing emergency.

5. Starter Switch - OFF when fire is out (P)

   Continue to motor engine until all indications of fire have disappeared. If the fire cannot be extinguished, the pilot will order airplane abandoned. Pilot will shut down all engines by placing all throttles to CUT-OFF and will turn off starter switch (and start selector switch if number 4 engine) and battery power switch before leaving.

6. Start Selector Switch - OFF (P)

FUEL CONTROL UNIT MALFUNCTION

During start, if a high fuel flow is noted, move the throttle between the START and CUT-OFF positions to regulate fuel flow within the normal range of 800 to 1000 pounds per hour to prevent the engine from exceeding the starting limits for exhaust gas temperature and still allow the engine to accelerate to idle rpm. Subsequent power and acceleration checks must be normal.

NOTE

Have the malfunction investigated at the first possible opportunity.

If the thrust fails to reduce upon retarding the throttle from some cruise range position, the thrust may be controlled by moving the throttle between the START and CUT-OFF positions. Moving the throttle into this region mechanically meters fuel through the fuel control unit, bypassing the burner pressure servo mechanisms.

CAUTION

The engine may flame out if the malfunction corrects itself while in this condition. Therefore, be prepared to advance the throttle as necessary to keep the engine running at the desired thrust as the air temperature increases.

NOSE GEAR STEERING FAILURE

If the nose gear steering will not control the direction of the airplane, steering can be accomplished by brake and throttle application. The nose gear will caster freely if the nose gear steering wheel is not restricted. Any restraint of the steering wheel will result in a hydrostatic lock that prevents castering.

CAUTION

Extreme caution should be used during taxi operations under conditions of nose gear steering failure. The airplane should only be taxied as necessary to clear the active runway.

BRAKE EMERGENCY OPERATION

Pilot brake pressure is normally supplied by the left hydraulic system with a separate brake accumulator. This accumulator and the pilot's brake system are isolated by check valves and will remain pressurized even though the left system is inoperative or depressurized. There is antiskid equipment on the pilot's brake system. With the antiskid system operative and the left hydraulic system not functioning, the fluid in the brake accumulator would be dissipated almost immediately by the application of pilot's brakes. For this reason, the antiskid circuit breaker(s) should be pulled before landing if the left hydraulic system is inoperative. On airplanes with [illegible], if the antiskid test indicates a system malfunction, (any one indicator does not respond properly), the pilot should use light braking and be prepared for asymmetric brake effectiveness. If 2 or more indicators do not respond properly, the ANTI-SKID INBOARD and OUTBOARD circuit breakers should be pulled and the procedures for landing with antiskid inoperative should be observed. Refer to Section VII. With the antiskid inoperative, sufficient fluid for approximately three applications of the pilot's brakes are stored in the brake accumulator which can be recharged by holding the left system auxiliary pump switch in the RESERVE BRAKE position. Best results will be obtained by using a steady application of pressure on the brake pedals. If the right hydraulic system is inoperative or depressurized, the copilot's brakes will not operate.

EMERGENCY ENTRANCE

All emergency exit hatches may be opened from the outside of the airplane. To open the hatches push the button on the flush mounted handle in the upper left hand corner of the emergency exit hatch. This will release the handle and allow it to be pulled out about 4 inches. When the handle is pulled out it can be rotated to release the emergency exit hatch. When the hatch is released, push it in. If the airplane fuselage is damaged to the extent of making it impossible to open the emergency exit hatches, chop through the airplane skin in the yellow outlined areas. See figure 3-2.

TAKEOFF EMERGENCIES

ENGINE FAILURE DURING TAKEOFF OR CLIMBOUT AFTER TAKEOFF

The possibility of an engine failure during the takeoff run influences takeoff procedure and should always be considered and planned for prior to the time the takeoff run is started. When an engine failure occurs on takeoff, the pilot must be able to stop on the runway remaining or continue the takeoff safely. To aid the pilot in making a decision to stop or continue takeoff, takeoff data is presented in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1.

PILOT'S DECISION

The decision whether or not to abort the takeoff should be based on the following considerations:

A. If any emergency or loss of thrust occurs prior to S_1, abort the takeoff.

B. If an emergency occurs after S_1 is reached, the takeoff is committed.

WARNING

Takeoff will not be aborted after S_1 unless in the opinion of the pilot, the emergency renders the airplane incapable of flight (loss of thrust exceeds the equivalent of loss of one engine). In those cases where the pilot attempts to abort after S_1, he must accept the fact that he will probably fail to stop within the confines of the runway.

DIRECTIONAL CONTROL

The first and most probable indication of engine failure on the ground will be the associated airplane yaw. Failure of an outboard engine necessitates immediate pilot response to prevent deviations from the takeoff path. With the powered rudder operating, the pilot must avoid excessive rudder inputs (at speeds above V_{MCG}) to counteract yaw since rudder available is greater than rudder required to compensate for an outboard engine failure. The following recommended steps will aid the pilot in maintaining directional control and coping with the degradation of performance caused by a loss of thrust:

A. Be mentally prepared for engine failure.

B. Immediately apply rudder as required to counteract yaw.

EMERGENCY ENTRANCE

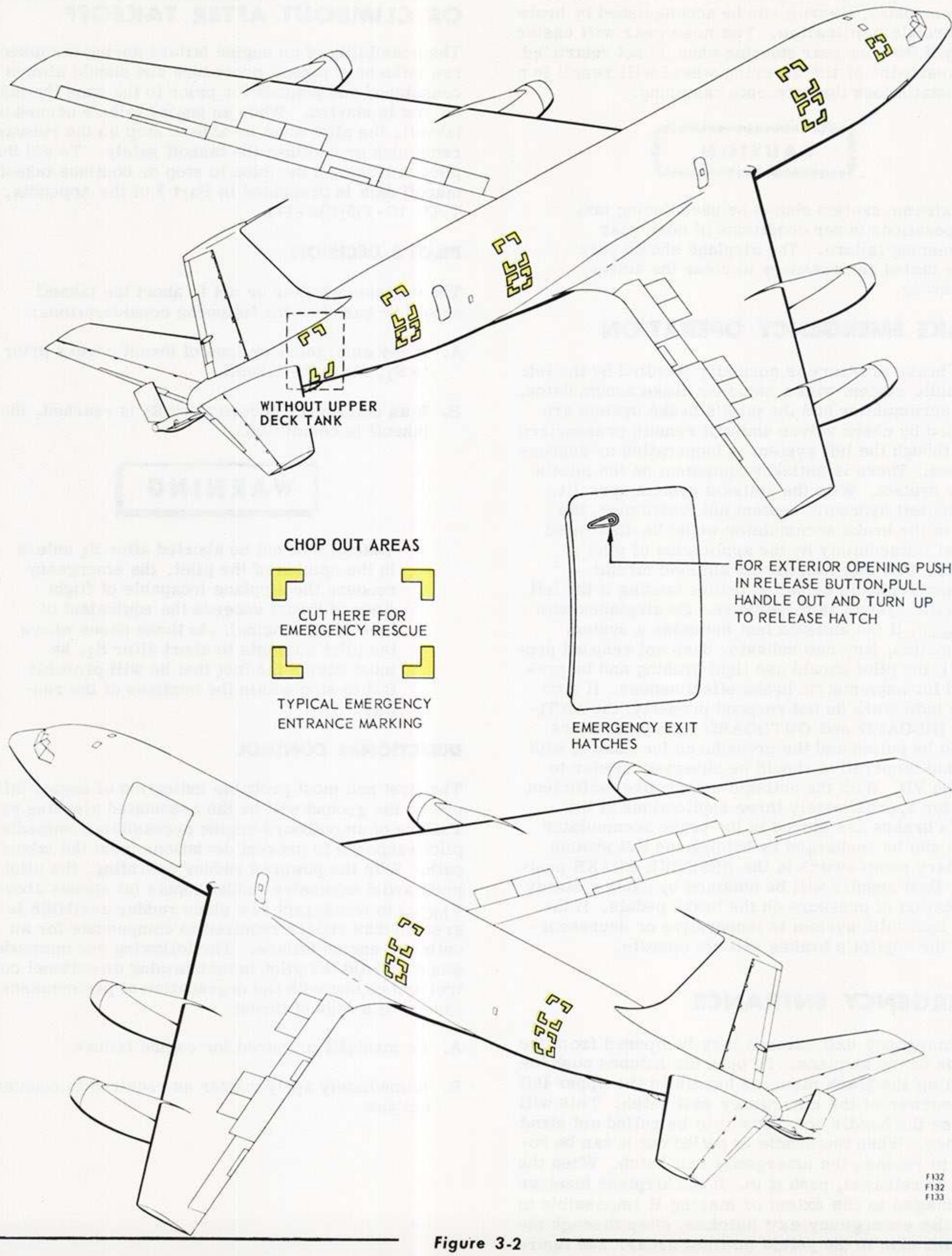


Figure 3-2

C. Advance throttles on good engines (wet thrust).

WARNING

Three-engine climbout charts for wet thrust takeoffs are based on full throttle operation on the remaining engines. Advantage of the additional thrust should be taken as soon as practicable after an engine failure. If a directional control problem exists, throttles on symmetrical engines should be advanced to full throttle. The remaining throttle should be advanced as soon as directional control permits.

D. Do not rotate prior to rotation speed.

WARNING

- Rotation should never be initiated prior to rotation speed. It is highly advantageous to delay rotation when runway and obstacle clearance permit.

- Airspeed indicator errors exist during sideslip. An actual airspeed 7 knots lower than indicated will exist at 10 degrees of sideslip.

E. Overcome the tendency to relax rudder during rotation and liftoff.

F. Maintain the rudder and bank combination requiring the least amount of control wheel deflection during climbout.

WARNING

Use extreme caution when bank angle is used, since the outboard engine pod will make contact at a bank angle of approximately 8 degrees.

The seat and rudder pedals should be adjusted so that full rudder pedal deflection can be maintained if required. The remote possibility exists that an engine failure after V_{MCG} may be accompanied by loss of powered rudder; for this reason, the seat back must be in the vertical position to prevent the pilot from sliding up the seat back if heavy rudder forces are required.

Nosewheel steering effectiveness increases up to 12 to 15 degrees of steering wheel angles. The natural tendency is to attempt to use angles beyond optimum if yaw is severe. Steering angles beyond optimum normally result in skidding or skipping and almost total loss of nosewheel steering effectiveness. When chattering is noted, the steering angle must be reduced until nosewheel scrubbing has ceased or is just barely detectable. Effectiveness of nosewheel steering depends upon the runway condition as well as the proper steering technique. Nosewheel steering should not be used as a substitute for additional rudder. If directional control cannot be maintained with full rudder then use nosewheel steering as required.

Charted ground minimum control speeds for a dry runway are based on immediate use of rudder plus nosewheel steering as required. Use of lateral control should not be required except under strong crosswind conditions.

WARNING

For takeoffs from a dry runway, an upwind outboard engine failure after S_1 may require the use of nosewheel steering to maintain directional control if a moderate to high crosswind exists.

Flight manual ground minimum control speeds for wet and icy runway conditions assume nosewheel steering to be totally ineffective. Even with optimum technique, deviations up to 25 feet from the takeoff path can be expected.

ROTATION AND TAKEOFF FLARE

After minimum control speed has been reached, the loss of an outboard engine during or immediately after rotation can be controlled by the immediate application of full rudder and lateral controls. Normal pilot reaction time of 3 to 4 seconds may allow a yaw angle of 9 to 12 degrees and bank angles of up to 15 degrees to develop prior to the initiation of correction action. At takeoff speed, yaw and bank control response is not immediate. Assuming a 3.5 second pilot reaction time after the loss of an outboard engine at takeoff speed, wings would be level in approximately an additional 1 second with application of full powered rudder and aileron, and an additional 2.5 seconds with application of full rudder only. Ailerons only are incapable of producing the required opposite yawing motion to balance the engine loss. Lateral control can be reduced once the yawing motion has stopped. Rudder application is to be considered the primary means of maintaining directional control and should be reduced only after yaw has stopped, wings are approaching a level attitude, and the required lateral control has been reduced to a minimum. In this critical situation, extreme care must be taken to maintain proper pitch attitude while controlling yaw/roll motions. The required pitch attitude is normally that attitude directed by the flight director command bars in RGA mode. With an inoperative RGA system, the attitude should be 8 to 9 degrees on the pitch tape until reaching climbout speed. Reducing the required takeoff pitch attitude 1 to 2 degrees at takeoff speed could result in loss of altitude and possible ground contact. As airspeed increases toward climbout speed during takeoff flare, pitch attitude becomes less critical.

CLIMBOUT

Airplane directional control in flight with an engine out can be achieved with many different rudder and bank combinations. However, in climbout particularly, it is essential to obtain the minimum drag configuration. The minimum drag configuration will be the rudder and bank combination requiring the least amount of control wheel deflection. Use rudder and control wheel as required to maintain directional control, but attempt to reduce control wheel deflections by applying more rudder pedal on the side towards which the control wheel is rotated. It should be possible to obtain sufficient rudder deflection to center the control wheel in nearly all situations with one engine inoperative.

LANDING GEAR

If an engine fails during or immediately after the takeoff, climb performance is considerably reduced until the landing gear is retracted. Gear drag lowers the rate of climb approximately 350 fpm at takeoff with flaps down on a 275,000 pound airplane. Therefore, the landing gear should be retracted as soon as a positive rate of climb (vertical velocity pointer above zero) is established. An engine failure decreases the rate of climb approximately an additional 900 fpm under the same conditions.

FLAPS

In the event of an engine failure during takeoff, the normal acceleration and flap retraction procedure should be followed before any attempt is made to return to the field. This is necessary to prevent running out of water at too low an airspeed while flying around the traffic pattern. Refer to Part 3 of the Appendix, T.O. 1C-135(K)A-1-1, for the FLAP RETRACTION SCHEDULE and the speeds for maximum rates of climb with flaps down while operating on four or three engines.

NOSE WHEEL TIRE FAILURE DURING TAKEOFF

Failure of either nose wheel tire during the takeoff run will impose additional loading on the remaining tire. Proper use of the control column and nose wheel steering as described under normal procedures therefore becomes even more important. If either tire fails prior to S_1, abort the takeoff. If failure occurs after S_1, continue the takeoff using light but sufficient forward pressure on the control column to ensure nose wheel contact with the runway. Use the rudder for directional control and, if possible, avoid the use of nose wheel steering. If nose wheel steering is required, maintain light forward pressure on the control column and do not exceed 12 - 15 degrees of steering wheel turn. A greater angle of turn will reduce steering effectiveness and will increase the possibility of tire failure from excessive scrubbing.

ABORT (CP reads)

1. **THROTTLES— IDLE (P)**
2. **SPEED BRAKES— 60° (P)**
3. **BRAKES — APPLY (P)**

WARNING

Whenever excessive braking has been used, consideration should be given to abandoning the airplane. See BRAKE LIMITATIONS, Section V.

NOTE

If a safe stop appears improbable, retard throttles to CUT-OFF. If collision with an obstruction is probable, a ground loop should be attempted, terrain permitting, or attempt to retract the landing gear.

4. Water Boost Pumps Switch - STOP (CP)
5. Starter Switches - OFF (P)
6. Lights - As required

   Rotating beacon lights BOTH ON, navigation lights BRIGHT and STEADY, and taxi lights as required.

ENGINE FAILURE-TAKEOFF CONTINUED (CP reads)

WARNING

- WET TAKEOFFS - If an engine failure is experienced during a wet thrust takeoff, and the takeoff is continued, the throttles for the remaining engines must be advanced to INCREASE THRUST. The critical field lengths are based on part throttle operation but the three engine climbout after takeoff charts are based on full throttle.

- WET TAKEOFFS - If loss of water injection occurs on one or more engines after the takeoff is committed, advance the throttles for the affected engines to TRT dry. The wet engines may be operated at full throttle.

- DRY TAKEOFFS - If an engine fails during a dry thrust takeoff and the takeoff is continued, do not advance the remaining throttles beyond TRT until after the airplane becomes airborne. Advancing the remaining throttles prior to or during rotation may cause engine flameout.

- Thrust in excess of TRT wet as determined from figure 1A2-10 or TRT dry as defined by curved line (regardless of pressure altitude) of figure 1A2-11 requires an entry in Form 781.

- Rotation should never be initiated prior to reaching rotation speed. It is highly advantageous to delay rotation when runway and obstacle clearance permit. The rotation should be made using the normal technique and time. At least 1000 feet of runway must be reserved for the distance from rotation to unstick. If rotation is delayed (takeoff speed increased) the command bars will still direct the approximate charted flight path for a given "K," but the path will begin at the extended unstick point and provide a new climbout speed envelope whose base is higher by approximately the amount of rotation speed increase.

MAINTAIN FLIGHT

1. **THROTTLES—ADVANCE TO INCREASE THRUST (WET ONLY) (P, CP)**

2. Rotate - Rotation speed (CP, P)

3. Landing Gear - UP (P, CP)

WARNING

Do not retract gear before a definite rate of climb (vertical velocity pointer above zero) is established. During initial gear retraction sequence there is a period of increased drag while the gear doors are open. Premature retraction of the landing gear with its momentary drag increase could therefore cause the airplane to settle unless adequate climb margin has been established.

ENGINE FAILURE–TAKEOFF CONTINUED (CP reads) (Cont)

ENGINE SHUTDOWN

1. Throttle for Failed Engine - CUT-OFF, if hazardous (P)

WARNING

Throttle reduction in response to a failed engine/engine flameout during takeoff or initial climbout after takeoff should not be made prior to landing gear retraction.

2. Fire Switch - PULL (if required) (P, CP)

CLEAN UP

1. Flaps - UP (P, CP)

   Retract per flap retraction schedule.

2. Fuel - Dump as required (CP)

WARNING

Do not operate the forward A/R pumps and the landing gear simultaneously. Slow operation of the gear with reduced climbout performance will result. Do not operate the aft A/R pumps and the wing flaps simultaneously. Slow operation of the powered rudder with reduced rudder effectiveness will result.

3. Throttle for Failed Engine - CUT-OFF, if not previously accomplished (P)

4. Generator Control Switch - TRIP, if applicable (CP)

CRASH LANDING IMMEDIATELY AFTER TAKEOFF

1. **FLAPS — 50 DEGREES (P,CP)**

   Upon direction of the pilot, the copilot will position the wing flaps to 50 degrees.

2. **LANDING GEAR — DOWN (P, CP)**

Copilot gives the brace for crash landing warning over CALL position of interphone and one long ring on the alarm bell upon direction of pilot. Crewmembers unsnap parachute harness, tighten shoulder harness and safety belts, and lock inertia reels. Pilot maintains 50 degree flap approach speed and lands straight ahead, changing direction only enough to miss obstacles. Make contact with the ground in the normal landing attitude.

WARNING

- Extension of the gear for impact is considered beneficial from the standpoint of lessening the severity of impact but not to the extent that an excessive rate of descent or an uncontrollable situation is created. Delay extension if necessary to clear obstructions. Prudent judgment must be exercised in determining action to be taken.

- Do not stall the airplane. Such action will probably result in complete destruction of the underside of the fuselage and may cause the fuselage to break completely apart.

- If the takeoff and /or immediate departure is over water and a crash landing into the water is imminent, do not extend the landing gear.

NOTE

The crewmember is prevented from bending forward when the shoulder harness inertia reel is locked. Therefore, all switches not readily accessible should be set as desired prior to locking the shoulder harness.

3. **THROTTLES – CUT-OFF AFTER TOUCHDOWN (P)**

The engines should be cut immediately upon touchdown to allow time for fuel to drain from the manifold drain valves before the airplane comes to a stop.

WARNING

Do not cut engines prior to touchdown. This would result in a loss, after a few seconds, of all primary electrical power and all hydraulic pressure except that still remaining in the accumulators. Loss of hydraulic power will cause the spoilers to blow down. Electrical control of the stabilizer trim will be lost leaving only manual trim. The spoilers will operate for only a few seconds on accumulator pressure.

CARGO DOOR OPENING AFTER TAKEOFF (CP reads)

Opening of the cargo door during or after takeoff will be noted by illumination of the door warning light and probably severe buffeting of the airplane. During the takeoff ground run the pressure differential between the cabin and the outside air is sufficient to push the bottom of the cargo door into the slipstream if it has not been properly latched. The door will probably not swing to the full open position until rotation. When this occurs a right yaw and right roll tendency will be noted by the pilot. Although the door is initially restricted at its upper travel by its actuating system, experience indicates that the actuator will fail before a landing can be made. This failure will allow the door to swing up against the fuselage to almost a vertical position. When this occurs a loud breaking noise will be heard and an increase in airplane buffeting will be noted. After airplane clean-up, a controllability check should be made prior to landing. Refer to CONTROLLABILITY CHECK, this Section.

1. Directional Control - Maintain (P)

2. Landing Gear - UP (P, CP)

3. Flaps - UP (P, CP)

   If conditions permit, maintain a flap setting of 20 degrees. This will retain use of outboard ailerons for roll control. Retract flaps per flap retraction schedule plus 5 KIAS. Observe flap placard speed.

4. Fuel - Dump as required (CP)

5. Controllability Check - Accomplished (P)

   Determine optimum airplane configuration and airspeeds for approach and landing.

STABILIZER TRIM MALFUNCTION (RUNAWAY) DURING TAKEOFF

Airplane pitch-up on takeoff may be caused by stabilizer runaway or excessive stabilizer mistrim and must be counteracted at once to prevent stalling the airplane. The immediate corrective action is to hold wings level and apply forward control column pressure to counteract the out-of-trim condition.

WARNING

Do not lower a wing at low altitude to reduce a pitch-up attitude; to do so may cause the airplane to settle in, drag a wing, and cartwheel. The proper technique is to hold wings level and apply forward control pressure. Avoid, if possible, pulling negative "g's" as this will trip the generators causing loss of AC power. However, the primary consideration is safe control of the airplane.

If pitch-up is caused by excessive mistrim, retrim to proper trim setting after full control of the airplane is gained; see JAMMED STABILIZER in this Section. If pitch-up is caused by stabilizer runaway, stop runaway condition as quickly as possible as described in ELECTRICAL TRIM MALFUNCTION, this Section, and retrim manually after full control of the airplane is gained. Enough elevator control exists to overcome most runaway stabilizer trim conditions if immediate action is taken to stop the rotation of the manual stabilizer trim wheel. An airplane nose-down out-of-trim condition may, however, result in a longer than expected ground run, due to higher stick forces encountered in rotating the airplane to takeoff attitude. Extreme nose down and forward cg may result in an inability to rotate for takeoff.

LATERAL AND DIRECTIONAL CONTROL DIFFICULTY DURING TAKEOFF

Control problems must be correctly analyzed before corrective action is taken. Most lateral and directional control difficulties are associated with engine, autopilot or flight control system malfunctions. The indications for engine failure and control recovery are covered under ENGINE FAILURE DURING TAKEOFF, this Section. A failure within the autopilot resulting in unscheduled control surface movement will usually be indicated by deflections of the associated control system. A malfunction of the autopilot rudder axis or the powered rudder control system may cause a condition resulting in unscheduled deflection of the rudder pedals. Any autopilot axis is capable of exerting only a limited amount of force which can be overcome by disengaging the autopilot or exerting a control force against that axis. Normal rudder pedal force required to overcome the autopilot is 65 pounds. Normal wheel force required to overcome the autopilot is 25 pounds. The powered rudder will, in most cases, give the pilot the necessary directional control to counter any yaw. Reduction of power on an outboard engine can assist in regaining directional control. During certain adverse control conditions with the flaps retracted, the lack of outboard aileron control will reduce recovery capability. If any control system jams, there should be no reluctance to use force as necessary to overcome the jammed system. An immediate check of the wing flap position indicators should be made for an unsymmetrical flap position or movement. Such a condition will require immediate corrective action as outlined in the AFTER TAKEOFF-CLIMB checklist in Section II. If the cargo door or hatch not latched warning light is illuminated and airplane buffeting is being experienced, the crew entry door and cargo door should be checked. If the cargo door has opened, follow the procedure outlined under CARGO DOOR OPENING AFTER TAKEOFF, this Section. For rudder system malfunctions, refer to RUDDER EMERGENCY OPERATION in this Section.

CAUTION

The sudden reversal of rudder direction, at high rudder deflections, due to improper rudder application or abrupt release, can result in overstressing the vertical fin. This condition could be brought about during recovery attempts from a flight condition induced by a lateral control malfunction.

CONTROL DIFFICULTY DUE TO SPOILER MALFUNCTION

If spoiler malfunction results in control difficulty, proceed as follows: Move the outboard spoiler switch to CUT-OFF. If this step does not correct the difficulty, move the inboard spoiler switch to CUT-OFF. When the control difficulty is encountered immediately after takeoff, climb to a safe altitude and airspeed and perform a visual check of each set of spoilers by separately moving each spoiler switch to NORMAL and visually checking for malfunctions. Upon determining the malfunctioning spoiler, the applicable spoiler switch will be placed in CUT-OFF and will remain so for the remainder of the flight. No training procedures will be practiced when any flight control is inoperative. The landing should be performed with caution; see LANDING WITH INOPERATIVE SPOILERS, this Section.

WARNING

Caution should be exercised when using sustained spoiler deflections if performance is marginal. Rate of climb will be reduced approximately 90 fpm for each 10 degrees of spoiler deflection. However, it should be noted that the flight manual performance data for the engine out condition accounts for normal spoiler deflections required for control.

INFLIGHT EMERGENCIES

ENGINE FAILURE

ENGINE FAILURE INDICATIONS

Engine failure in flight may be indicated either from the associated yaw, excessive lateral control requirements to keep wings level or engine instruments. EPR, RPM, EGT and fuel flow will change, depending upon the type of failure. Oil or fumes may enter the cabin through the air conditioning system or there may be visual evidence of smoke or fire at the engine.

ENGINE FAILURE/AUTOPILOT OPERATION

When an engine fails in flight, the autopilot rudder axis shall be disengaged and the following procedural practices observed:

A. Re-engage the rudder axis when thrust and airspeed are stable and the airplane is trimmed for the engine-out condition.

B. Disengage the rudder axis before each subsequent change to speed or thrust, retrim after the new airspeed and thrust stabilize and re-engage the autopilot rudder axis.

ENGINE FAILURE DURING CLIMB

Engine failure during a climb is not considered critical provided the recommended airspeed climb schedule is followed. If an engine failure is encountered during a climb, the rate of climb will decrease. If the mission is to be continued, a new climb schedule will have to be flown. Applicable charts covering 3-engine operation are included in Part 4 of the Appendix, T.O. 1C-135(K)A-1-1. Directional control can be easily maintained by adding rudder trim and a slight amount of lateral trim. Achieve minimum drag rudder/bank control combination if possible.

ENGINE FAILURE DURING CRUISE

The engine failure procedure is combined with engine fire procedures. Refer to ENGINE FIRE OR FAILURE DURING FLIGHT in this Section. If an engine fails during a cruise condition, cut the engine by moving the throttle to the CUT-OFF position. Compensate for the unbalanced thrust condition by adding appropriate directional and lateral trim. Failure of an engine during cruise will not appreciably affect directional control but will result in a decrease in speed. Also, the cruise altitude will normally be decreased depending upon the amount of fuel remaining, type of mission being flown, etc. Achieve minimum drag rudder/bank control combination if possible. Applicable charts covering four, three and two engine operation are included in Part 5 of the Appendix, T.O. 1C-135(K)A-1-1. If the engine which failed was not on fire and the malfunction can be corrected, restart the engine as outlined under ENGINE AIR STARTING, this Section.

CAUTION

On an engine windmilling above 25% rpm, have fuel available to the firewall fuel shutoff valve, push the fire switch in, and advance the throttle to IDLE for 3 minutes out of every hour to prevent overheating the fuel control unit.

ENGINE FIRE OR FAILURE DURING FLIGHT (CP reads)

Pod mounted jet engines considerably reduce the dangers associated with engine fires. Due to the low ventilation rate between the cowling and engine, any fuel or oil leaks will result in an over-rich mixture making the mixture hard to ignite and reducing the flame temperature of the fire. Oil is especially hard to ignite and the resulting fire is generally of short duration. Generally, if any oil fire occurs, the crew may not be aware of it until after landing. The following procedure should be used at the first indication of an engine fire or failure.

1. THROTTLE—CUT-OFF (UNLESS NEEDED) (P)

Engine instruments should be checked to determine the extent of loss of power. If a fire warning light comes on, check the engine instruments to see if the engine is still providing thrust. Do not retard the throttle for the engine if its thrust is needed unless the engine has completely lost thrust or is vibrating seriously. When the landing gear and wings flaps have been retracted and a safe altitude is reached, retard the throttle for the engine on fire to IDLE to see if the fire warning light will go out. If the light goes out, the engine should be shut down when thrust requirements permit. The source of heat can cause additional damage to the engine or its accessories even though the temperature has been reduced sufficiently for the light to go out. If light remains on, retard throttle to CUT-OFF. Do not lower flaps or use speed brakes until fire is controlled, unless it is absolutely necessary for an emergency landing.

2. FIRE SWITCH—PULL (IF REQUIRED) (P, CP)

If a fire is suspected or the engine has seized, the copilot will pull the fire switch upon direction of the pilot. The engine should be visually checked for evidence of fire. While the crewmember is scanning the engine from the cargo compartment, he will maintain interphone liaison with the pilot.

If a fire becomes uncontrollable, immediately increase airspeed to the maximum allowable indicated airspeed or Mach number and initiate a shallow descent, if conditions permit. Descending will allow increased acceleration to maximum speed with resultant decrease in the angle of attack. This will help keep fire from the wing until the fire is extinguished or controlled.

WARNING

- If fire appears to be burning into the wing, abandon the airplane or land as soon as possible.
- In the event of catastrophic engine failure accompanied by fire, prompt action to activate the fire switch should be taken. Failure to accomplish this may result in loss of fire switch controls due to burned electrical wiring bundles.

NOTE

Cowling burn-through should not be confused with fire burning into the wing. When blackened discoloration appears on cowling, burn-through is probably only a few seconds away and fire will be exposed to the airstream. If fire intensifies and spreads to the strut area, the upper strut surface and wing should be closely observed. Discoloration of the upper strut indicates the fire will probably spread to the wing.

3. Autopilot Rudder Axis - Disengage (P)

See ENGINE FAILURE/AUTOPILOT OPERATION, this Section.

NOTE

With the RGA power switch on, disengaging the autopilot rudder axis with the autopilot disengage button will cause the flight director to give a go-around command presentation.

4. Engine Anti-Icing Switch - OFF (If fire exists, except in severe icing conditions) (CP)

This action will reduce the flow of ventilating air supporting a fire between the engine and cowling.

5. Fuel - Dump as required (CP)

See EMERGENCY JETTISONING, this Section.

WARNING

Do not operate the forward A/R pumps and the landing gear simultaneously. Slow operation of the gear with reduced climbout performance will result. Do not operate the aft A/R pumps and the wing flaps simultaneously. Slow operation of the powered rudder with reduced rudder effectiveness will result.

6. Generator Control Switch - Trip, if applicable (CP)

If the fire switch has been pulled, the generator failure light will not illuminate but the generator control has been tripped.

CAUTION

Move the applicable generator control switch to the TRIP position if engine No. 1, 2, or 3 is shut down in flight and is windmilling. This will prevent damage to generator control components due to extended operation at low voltage and frequency.

7. Autopilot Rudder Axis - Engage (if applicable) (P)

PRACTICE ENGINE SHUTDOWN (CP reads)

An altitude between 10,000 feet and 35,000 feet is recommended for practice engine shutdown and air starting. Practice starts should be made in the normal windmilling start area shown in the air start envelope, figure 3-3. Air starts may be demonstrated in the probable start range but the slow or hot start area should be avoided except in an actual emergency. Practice starts shall be made on only one engine at a time. Practice shutdown procedure is as follows:

CAUTION

Prior to retarding the throttle for engine shutdown, disengage the autopilot rudder axis.

1. Throttle - Retard to IDLE for one minute (P)

CAUTION

- The throttle for the engine to be shut down should be retarded to IDLE for 1 minute before the engine is shut down. If the engine is shut down from a power setting above cruise power, cool the engine at IDLE for 2 to 3 minutes before placing the throttle in CUT-OFF.
- Do not pull engine fire switch for practice engine shutdown. Damage to hydraulic pump may occur since hydraulic oil is needed for cooling and lubrication.

2. Throttle - CUT-OFF

After windmilling rpm has stabilized, the engine will be started using the procedure outlined under ENGINE AIR STARTING, this Section.

PRACTICE MANEUVERS WITH ONE OR MORE ENGINES INOPERATIVE

For practice maneuvers simulating failure of one engine, a gross weight of less than 185,000 pounds is recommended. Under these conditions, such maneuvers as traffic patterns, approaches and go-arounds may be safely practiced. For practice maneuvers simulating failure of two engines, a gross weight of less than 140,000 pounds is recommended, and an altitude of at least 10,000 feet above the terrain. For such operations, it is not recommended that the engine or engines be shut down but that the throttle or throttles be retarded to IDLE. This reduction of thrust will provide control and maneuverability problems essentially the same as with a complete loss of thrust on the engines affected. Refer also to RUDDER in Section VI.

WARNING

- Practice maneuvers simulating the loss of two engines, especially two engines on the same side, demand optimum pilot techniques and must be practiced with caution. Power and trim adjustments must be made smoothly and carefully and an adequate margin of speed maintained above the inflight minimum control speed for the configuration being practiced. Failure to observe these precautions can result in loss of control, a great loss of altitude, and possible structural damage.
- Practice maneuvers with rudder power off are not recommended except for demonstrations, and then with only one engine out. Do not turn on rudder power with large rudder pedal deflections as the resulting increased rudder angles may over-stress the fin structure.
- 50 degree flap approaches will not be flown during practice maneuvers with rudder power off, or maneuvers simulating loss of one or more engines.

ALL ENGINES

AIR START ENVELOPE

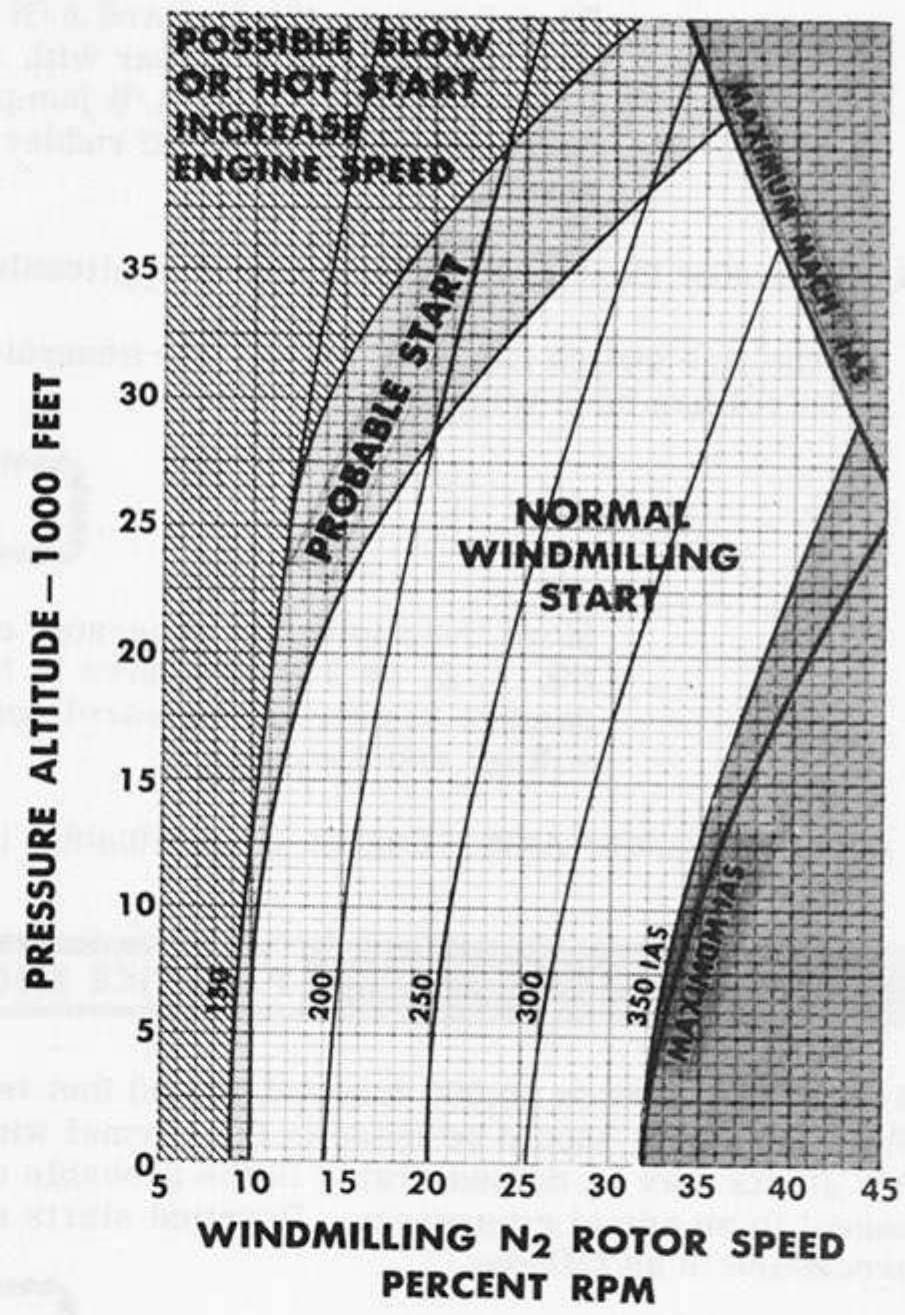


Figure 3-3

ENGINE AIR STARTING

The air start envelope, figure 3-3, indicates the altitude and engine speed envelope in which windmilling starts should normally be attempted. The indicated airspeed lines on the curve are approximate. Starts attempted at a windmilling rpm higher than 45% may result in blowouts or failure to obtain a light. Attempts to start in the probable start range or below may result in a hot start.

CAUTION

- An engine air start after an emergency shut-down should not be attempted unless it is ascertained that it is reasonably safe to do so. A recurrence of the emergency could be more serious than the first occurrence. Should an engine air start be attempted and not completed, a one minute waiting period should be observed before attempting a second or subsequent start. This is to allow adequate fuel drainage from the rear cowling, thus preventing a possible cowl fire.

- Immediate response by the pilots to an engine flameout can make it unnecessary to descend to the altitudes and RPM limits shown in Figure 3-3 and to follow the complete engine air starting procedure. This type of relight may be made as low as 65% rpm. To obtain a relight actuate the start switch to FLIGHT START and retard throttle to IDLE. Do not place start switch to FLIGHT START at engine rpm below 65% without following the complete procedure because engine fire or damage can result from accumulation of fuel in the engine.

- Unless the engine is urgently needed, do not attempt an air start until it can be positively determined that the flameout was not caused by a ruptured fuel line or similar circumstance which might result in a fire.

ENGINE AIR STARTING (CP reads)

1. Engine Anti-icing Switch - OFF (CP)

   Turn off the engine anti-icing system, engine airbleed and accessory loads that are not needed until after the engine has been successfully started.

2. Throttle - CUT-OFF (P)

3. Engine Fire Switch - In (P)

4. Boost Pump Switches - ON (P)

5. Engine Speed - Maintain within normal air start range (P)

   Establish an indicated airspeed which will give an engine speed within the normal windmilling start range of the air start envelope (figure 3-3).

6. Oil Pressure Gage - Checked (P)

7. Starter Switch - FLIGHT START (P)

8. Throttle - IDLE (P)

9. Engine Instruments - Check (P)

   Leave the throttle at IDLE until engine instrument readings have stabilized as follows:

   a. Tachometer - 65 to 85% rpm.

   b. EGT - Approximately 340° C normal

   c. Oil Pressure - Within limits (See Section V)

NOTE

If start does not occur within 30 seconds after the throttle has been advanced to IDLE, and the engine fails to accelerate to idle within approximately 1 - 1-1/2 minutes after start, the exhaust temperature exceeds limits, or the oil pressure does not reach minimum psi, discontinue the restart by retarding the throttle to CUT-OFF and place the starter switch OFF. Allow the engine to windmill for one minute before attempting another restart.

10. Throttle - Advance as desired (P)

11. Starter Switch - OFF (P)

12. Generator Breaker Switch - Reset if applicable (CP)

FIRE

Fire should always be considered an emergency. When fire is discovered in any part of the airplane by any crew member, notify the pilot at once, go on 100% oxygen and proceed with the proper fire control procedures. The following fire control procedures should be followed to minimize danger to personnel and equipment.

FUSELAGE FIRE (CP reads)

Pilot or copilot will inform crew, "Fuselage Fire" on CALL position of interphone.

1. **OXYGEN—100% (ALL)**

   All personnel shall don oxygen masks and breathe 100% oxygen. Portable oxygen bottles may have to be used by the crewmembers engaged in fire fighting procedures. One crewmember designated to combat the fire will don the firefighter's mask, connect the mask to a source of 100% oxygen, and don the firefighter's gloves.

2. Fire - Combat (N, BO)

   Boom operator and/or navigator shall institute fire fighting procedures. One crewmember shall keep the pilot informed of the fire condition until it is extinguished or determined to be uncontrollable.

WARNING

- Heavy, dense, black, suffocative, toxic smoke occurs when bromochloromethane (CB) is used on hot metal or open fire. Bromochloromethane (CB) is an anesthetic agent of moderate intensity and exposure may cause pronounced irritation of eyes and nose. Prolonged exposure (5 minutes or more) to high concentrations of CB or its decompositions products should be avoided. Adequate respiratory and eye protection from excessive exposure should be sought as soon as the primary fire emergency will permit. The use of 100% oxygen will provide respiratory protection.

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

3. Airspeed - Adjust (P)

   As soon as possible, take the necessary action to adjust airspeed to within the desirable range for bailout. (Refer to BAILOUT, this Section.)

4. Engine Bleed Switches - CLOSED (CP)

5. Cabin Manual Pressure Control - Full DECREASE (CP)

   This action will depressurize the cabin in approximately 27 seconds.

WARNING

Oxygen duration is extremely limited for crewmembers using the firefighter's mask with the MA-1 portable oxygen system. (See figure 4-35.) The A-21 regulator must be set to the NORM position when used in conjunction with the fire fighter's mask.

6. Bailout Procedure - Initiate, if fire is uncontrollable (P)

After fire is extinguished.

7. Air Conditioning Master Switch - RAM AIR (CP)

8. Repressurize - As desired (CP)

Electrical Fire

If a unit should overheat, turn off the overheated equipment, pull the applicable circuit breakers and continue the flight without operating the overheated equipment. If an electrical fire occurs, accomplish the procedures outlined under FUSELAGE FIRE.

WARNING

If emergency requires electrical system to be shut down, be sure to position fuel valves to desired position before shutdown.

SMOKE AND FUME ELIMINATION (CP reads)

Pilot or copilot will inform crew on CALL position of interphone.

1. **OXYGEN—100% (ALL)**

   All crewmembers don oxygen masks and move oxygen supply shutoff lever to ON and move regulator diluter lever to 100% OXYGEN. If temporary loss of oxygen occurs during operation on 100% OXYGEN or EMERGENCY, switch to portable oxygen bottle.

2. Source and Cause - Locate (ALL)

FROM ELECTRICAL SYSTEM

1. Electrical Equipment - OFF, if fuel fumes are present
2. Applicable Circuit Breakers - Pull

FROM AIR CONDITIONING SYSTEM

If smoke or fumes are coming through the air conditioning system, the most probable cause will be oil entering the low pressure compressor due to a leaking oil seal or bearing damage. If abnormal or erratic oil pressure is noted, closing the respective engine bleed valve may isolate the smoke and fumes and make it unnecessary to accomplish the procedural steps. The air cycle machine can also produce smoke and fumes due to seal rubbing; this is generally accompanied by rumbling noise in the ACM. The cause of smoke and fumes should first be determined and isolated followed by ventilation procedures to eliminate the smoke and fumes. These procedures will isolate the cause of smoke and fumes to the ACM, an individual engine, or to either engines 1 and 2 or 3 and 4. Failure of one or more of the system valves could prevent a clear determination of the origin of the smoke and fumes. Terminate checklist when the source of smoke and fumes is determined and isolated.

NOTE

Unless smoke and fumes appear to be increasing in density after a switch movement, allow time for the smoke and fumes occupying the air conditioning ducts to clear before assuming that switch movement caused smoke and fumes to increase.

Determination and Isolation of Source

AIR CYCLE MACHINE

1. Air Conditioning Master Switch - OFF (CP)
2. Left Alternate Pressurization Switch - ON (CP)

SMOKE AND FUME ELIMINATION (Cont)

3. Right Alternate Pressurization Switch - Increase, check for smoke and fumes (CP, BO, N).

   Boom operator or navigator will check air conditioning ducts for smoke and fumes.

NOTE

The alternate pressurization valve requires 20 seconds to cycle from full closed to full open.

   a. If smoke and fumes do not recur, source is the ACM.

      Ventilate as necessary and continue mission, cycling the alternate pressurization valve for heat/pressurization as required.

   b. If smoke and fumes recur, proceed to next step.

ENGINE THROUGH A BLEED VALVE

4. Right Alternate Pressurization Switch - DECREASE (CP)

   Actuate for 20 seconds to close alternate pressurization valve.

5. Engine Bleed Switches - CLOSED (CP)

6. Air Conditioning Master Switch - COND AIR (CP)

7. Engine Bleed Switches - OPEN, one at a time, check for smoke and fumes (CP, BO, N)

   The copilot will open the engine bleed valves one at a time while the boom operator or navigator checks the air conditioning ducts for smoke and fumes. Once the source of smoke and fumes has been determined, leave that bleed valve switch CLOSED and all other bleed valve switches OPEN. Ventilate as necessary and continue mission. If unable to determine source, proceed to next step.

EITHER SOURCE COMBINED WITH SYSTEM VALVE(S) FAILURE

8. Air Conditioning Crossover Switch - CLOSED (CP)

9. Engine Bleed Switches - OPEN, check for smoke and fumes (CP, BO, N)

   a. If smoke and fumes do not recur, the source was engine bleed 1 and/or 2. Ventilate as necessary and continue mission.

   b. If smoke and fumes recur, proceed to next step.

10. Air Conditioning Master Switch - OFF (CP)

11. Right Alternate Pressurization Switch - INCREASE, check for smoke and fumes (CP, BO, N)

   a. If smoke and fumes do not recur, the source was engine bleed 3 and/or 4. Ventilate as necessary and continue mission, cycling the alternate pressurization valve for heat/pressurization as required.

   b. If smoke and fumes recur, proceed to the ENGINE BLEED ISOLATION procedure if heat and/or pressurization is required or to ADDITIONAL PROCEDURES FOR SMOKE AND FUMES if mission is to be continued depressurized.

6. Allow Non-essential Personnel to Bail Out (time and altitude permitting) (P)

   Each situation must be evaluated on its individual merits to determine if it is feasible or desirable to bail out non-essential personnel.

7. Aft Emergency Exit Hatch - Install (N, BO)

   Install hatch when jettisoning is completed.

8. Landing Gear - DOWN (P, CP)

9. Flaps - 50° (P, CP)

   Upon direction of the pilot, the copilot will position the wing flaps to 50 degrees.

10. Battery Switch - EMERGENCY (P)

    Place the battery switch to EMERGENCY prior to turning on final approach.

11. Engine Hydraulic Oil Fire Shutoff Circuit Breakers - Pull (as required) (P, N or BO)

    Prior to final approach, if one main gear is not extended pull the ENGINE HYDRAULIC OIL FIRE SHUTOFF circuit breakers (on the SBCBP) for the 2 engines on the same side as the retracted main gear. Pulling these 2 circuit breakers will preclude loss of hydraulic pressure when the fire switches are pulled.

12. Direct All Personnel to Assume Crash Landing Positions (P)

NOTE

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 properly positioned before moving the handle.

13. Control Cabin Windows - Open (P, CP)

14. Crew - Brace for crash landing (P)

15. Alarm Bell - One long ring before touchdown (CP)

16. Airspeed - Reduce to slowest safe speed (P)

17. Fuel Panel - Set for touchdown (CP)

    All boost pump switches off, all fuel valve switches closed just prior to touchdown.

Subsequent steps and procedures vary according to the airplane landing configuration:

NOSE GEAR RETRACTED, BOTH MAIN GEAR EXTENDED

Accomplish a normal approach and touchdown. After main gear contact, raise the speed brakes. For maximum aerodynamic braking, hold the nose slightly higher than normal touchdown attitude. Steer with the rudder to line up with the runway foam and use light, steady braking pressure. The braking effort will tend to pitch the nose down. Lower the nose gently to the runway while elevator control is still effective. Begin normal braking. Maintain directional control with rudder and differential braking.

18. Speed Brakes - 60 degrees (CP)

    Raise speed brakes after touchdown.

CAUTION

When landing is accomplished with the right hydraulic system depressurized or inoperative, withhold speed brake actuation. The airplane will pitch down with only inboard spoilers raised.

LANDING WITH GEAR FAILURE (Cont)

19. Fire Switches - Pull (CP)

Pull fire switches after touchdown when the airplane slows down to approximately 40 knots.

WARNING

Do not pull fire switches or cut engines prematurely. This would result in the loss of electrical power and hydraulic pressure required during the ground roll.

20. Throttles - CUT-OFF (P)

21. Battery Switch - OFF (P)

ONE MAIN GEAR RETRACTED, ONE MAIN GEAR AND NOSE GEAR EXTENDED

With this landing gear configuration, accomplish the following steps and procedures after completing steps 1 through 17 under LANDING WITH GEAR FAILURE. Prior to final approach, open the ENGINE HYDRAULIC OIL FIRE SHUTOFF circuit breakers on the SBCBP for only the two engines which are on the same side as the retracted main gear. This will allow these hydraulic supply shutoff valves to remain open and provide hydraulic pressure after touchdown. Accomplish a normal approach and plan to touch down on the side of the runway opposite to the retracted gear side. Touch down on the extended main landing gear and avoid a nose wheel first contact which could result in porpoising. Ease the nose wheel gently to the runway and hold the wings level. The speed brakes should be raised immediately to 20 degrees for maximum lateral control capability. Maintain directional control with rudder, differential braking and nose wheel steering. The two fire switches for the engines on the retracted gear side should be pulled, and the boost pump and fuel valve switches should be turned off/closed just prior to ground contact on the retracted gear side. After the unsupported outboard engine nacelle contacts the runway, use heavy differential braking, rudder and nose wheel steering for directional control.

18. Speed Brakes - 20 degrees (CP)

As the airplane approaches a stop, accomplish the following steps:

19. Fire Switches - Pull (CP)

The two fire switches for the engines on the retracted gear side should be pulled just prior to ground contack of that side.

20. Fire Switches - Pull (CP)

Pull remaining fire switches.

21. Throttles - CUT-OFF (P)

22. Engine Hydraulic Oil Fire Shutoff Circuit Breakers - Close (P, N or BO)

If time and circumstances permit, reset the ENGINE HYDRAULIC OIL FIRE SHUTOFF circuit breakers previously opened. This will preclude leaking hydraulic fluid from starting or feeding a fire.

23. Battery Switch - OFF (P)

After closing the ENGINE HYDRAULIC OIL FIRE SHUTOFF circuit breakers, wait at least 2 seconds before turning the battery switch off.

NOSE GEAR EXTENDED, BOTH MAIN GEAR RETRACTED

With this configuration, accomplish the following after completing steps 1 through 17 under LANDING WITH GEAR FAILURE. If both main gear cannot be extended, the landing should be made with the nose gear extended. Make a normal approach and avoid excessive airspeeds which will prolong the floating distance after the landing

flare is made. The landing flare should be made so the initial contact is made on the aft body structure with the nose gear slightly above the landing surface, being prepared for a sudden drop of the nose following aft body ground contact. For initial contact, a nose high attitude of at least 8-1/2 degrees above the horizontal will be required. The following sequence should begin as soon as possible after the nose wheel has been lowered to the runway:

18. Fire Switches - Pull (CP)

19. Throttles - CUT-OFF (P)

20. Battery Switch - OFF (P)

ONE MAIN GEAR EXTENDED, ONE MAIN GEAR AND NOSE GEAR RETRACTED

The procedure to be followed when in this landing gear configuration is a combination of those detailed above. Accomplish steps 1 through 17 under LANDING WITH GEAR FAILURE. Just prior to final approach the ENGINE HYDRAULIC OIL FIRE SHUTOFF circuit breakers for the engines on the unsupported side should be opened. This will allow these hydraulic supply shutoff valves to remain open and provide hydraulic pressure after touchdown. The pilot should make a normal wings level approach, planning to touch down on the side of the runway opposite to the unsupported wing side of the airplane. The nose of the airplane should be held slightly higher than normal on touchdown. Caution should be exercised to make sure no sudden braking pressure is applied, because braking tends to pitch the nose down. Control characteristics are such that the nose can be held off the runway longer than can the unsupported wing. However, if the nacelles on the unsupported wing are allowed to contact the runway before the nose is lowered, the nose could be pitched down suddenly, which would increase the chances of structural breakup of the airplane. Therefore, the nose should be gently lowered to the runway just prior to the time the engine nacelles on the unsupported wing are allowed to contact the runway. The two fire switches for the engines on the retracted gear side should be pulled just prior to ground contact of that side. After the nose and nacelles have made contact with the runway, heavy braking on the main gear may be used as necessary along with the rudder in maintaining directional control.

18. Speed Brakes - 20 degrees (CP)

    The speed brakes should be raised to 20 degrees as soon as possible after touchdown.

CAUTION

When landing is accomplished with the right hydraulic system depressurized or inoperative, withhold speed brake actuation. The airplane will pitch down with only inboard spoilers raised.

19. Fire Switches - Pull (CP)

    The two fire switches for the engines on the retracted gear side should be pulled just prior to ground contact of that side.

As soon as it becomes evident that directional control is about to be lost:

20. Fire Switches - Pull (CP)

    Pull remaining fire switches.

21. Throttles - CUT-OFF (P)

22. Engine Hydraulic Oil Fire Shutoff Circuit Breakers - Close (P, N or BO)

    If time and circumstances permit, reset the ENGINE HYDRAULIC OIL FIRE SHUTOFF circuit breakers previously opened. This will preclude leaking hydraulic fluid from starting or feeding a fire.

23. Battery Switch - OFF (P)

    After closing the ENGINE HYDRAULIC OIL FIRE SHUTOFF circuit breakers, wait at least 2 seconds before turning the battery switch off.

LANDING WITHOUT NORMAL BRAKE SYSTEM PRESSURE (CP mod)

Any hydraulic malfunction will affect the brakes to some extent. The loss of only one engine-driven pump probably would not be noticed if the other pumps were operating normally. Loss of both left hydraulic pumps will leave only reserve brake accumulator pressure and the left auxiliary hydraulic pump for pilot's brakes but normal brake pressure to the copilot's brakes. On airplanes without 1010 550 the ANTI-SKID circuit breaker should be pulled if the left hydraulic system is depleted; on airplanes with 1010 550 pull the ANTI-SKID INBOARD and OUTBOARD circuit breakers. Loss of all four hydraulic pumps leaves only reserve brake accumulator pressure and the auxiliary hydraulic pumps to operate the brakes, landing gear, flaps, and speed brakes and spoilers. See also LANDING WITH INOPERATIVE SPOILERS, this Section. The reserve brake accumulator, when fully charged, will supply pressure for approximately three applications of the brakes. A leaking hydraulic line in the left system may deplete the hydraulic supply and leave only the reserve brake accumulator for pilot's brakes; however, the copilot's brakes will have normal pressure. A hydraulic leak resulting in complete loss of hydraulic fluid from both hydraulic systems will leave only reserve brake accumulator pressure for braking; it should be noted that under this condition the landing gear and main flaps will have to be lowered manually. Hydraulic leakage that is confined to either brake system will cause the hydraulic fuses upstream of the deboost valve to actuate. This will result in no braking pressure to the tandem wheels guarded by the fuse; however, the remaining brakes and other components of the hydraulic system will operate normally. See figure 1-53. Use the following procedure if it is suspected that both the pilot's and copilot's normal brake systems are inoperative:

1. Crew - Alert (P)

   Inform crew on CALL position, "Prepare for crash landing."

2. Airplane - Depressurize (CP)

   See AIRPLANE DEPRESSURIZING, Section IV.

3. Fuel - Dump as required (CP)

4. Landing Gear - DOWN (P, CP)

   If hydraulic pressure is lost, lower and lock landing gear down manually. See MAIN LANDING GEAR SYSTEM EMERGENCY OPERATION and NOSE GEAR SYSTEM EMERGENCY OPERATION, this Section. After the main landing gear is down and locked, check that the pilot's reserve brake pressure gage reads no less than 2800 psi. If pressure is less than prescribed, hold the left system auxiliary pump switch to the RESERVE BRAKE position until pressure rises to 2800-3000 psi.

5. Flaps - Set (P, CP)

   Upon direction of the pilot, the copilot will extend the wing flaps. Land as short as possible. If hydraulic pressure is lost, lower flaps manually. See MAIN FLAP EMERGENCY OPERATION, this Section.

6. Antiskid Circuit Breaker(s) - Pull (BO or N)

   Pulling the antiskid circuit breaker(s) will prevent rapid depletion of reserve brake accumulator pressure.

7. Control Cabin Windows - Open (P, CP)

8. Safety Belt and Shoulder Harness - Lock (ALL)

9. Speed Brakes - 60 degrees after touchdown (P)

   If hydraulic pressure is lost the speed brakes will not raise. See LANDING WITH INOPERATIVE SPOILERS, this Section.

10. Wheel Brakes - Apply (P)

    After airplane has slowed down, brake to a stop with one brake application if possible. Do not taxi.

NOTE

Reserve brake pressure can be replenished by holding the left system auxiliary pump switch in the RESERVE BRAKE position and using return line fluid.

11. Throttles - CUT-OFF (if required) (P)

NOTE

If collision with an obstruction is probable a ground loop should be attempted, terrain permitting, or attempt to retract the landing gear. If a safe stop appears improbable retard throttles to CUT-OFF.

LANDING WITH BOOM IN TRAIL (CP reads)

In the event of a boom hoist malfunction and it is not possible to latch the boom using the procedure under either EMERGENCY BOOM HOIST or BOOM HOIST CABLE BROKEN, it may be necessary to land with the boom in trail.

1. Line Valve - CLOSED (CP)

2. A/R Pumps - OFF (CP)

3. Fuel Dump Switch - FUEL DUMP (CP, BO)

   Allow boom to drain of all fuel.

4. Fuel Dump Switch - NORMAL (CP)

5. Control Tower - Notify (P)

   Request fire department to put strip of foam approximately 12 feet wide on center of runway.

6. Landing - Use normal approach and landing procedure. At touchdown cut inboard engines to reduce landing roll. Stop on runway. Do not taxi. (P)

CAUTION

To prevent further damage to boom do not tow airplane until boom is raised.

LANDING WITH 30 DEGREES FLAPS OR LESS

When landing with 30 degrees flaps or less make approach and touchdown at not less than the approach and touchdown speeds associated with the particular flap setting. The airplane should be flown and flare-out made in a normal manner.

CAUTION

If lower approach and touchdown speeds are used, airplane attitude becomes abnormally nose high and the boom might contact the runway.

After touchdown use normal procedure, touch down nose wheel and bring speed brakes to 60 degree position. Caution must be observed if a less than full flap landing is practiced for pilot checkout and also during conditions of high gross weight, unsymmetrical power, high altitude fields, etc.

For flaps up landings, the outboard ailerons will not be available and the rudder will only have low range hydraulic pressure. Consideration should be given to opening the circuit breaker marked RUDDER PRESS CONT on the SBCBP to obtain the high range hydraulic pressure for the rudder system. If the rudder hydraulic pressure is in the low range for landing, see LANDING WITH RUDDER POWER INOPERATIVE OR LOW RUDDER HYDRAULIC PRESSURE, this section.

LANDING WITH MANUAL FLAP CONTROL ONLY

When landing with only manual control of the flaps it will be necessary to start lowering the flaps well before the final approach is reached. Stopping distance, go-around capability, and time element involved (810 turns total for inboard and outboard flaps) should be considered in determining the degrees of flaps to lower. See LANDING WITH 30 DEGREES FLAPS OR LESS, this Section; see also figure 3-18. At least 23 degrees of outboard flaps must be cranked down before the full outboard ailerons become available. (Alternate the lowering of the inboard and outboard flaps, maintaining a maximum of 5 degrees differential, starting with the outboard flaps.) The airplane will have a tendency to nose up when inboard flaps are lowered and nose down when outboard flaps are lowered. See MAIN FLAP EMERGENCY OPERATION, this Section.

LANDING WITH PARTIAL AILERON CONTROL

In the event of a cable failure in the aileron control tab system, lateral control from spoilers and partial aileron control would be lost on one side. A minimum approach and touchdown speed of 140 KIAS should be maintained to assure an available roll rate of at least 10 degrees per second from the remaining aileron control. At 140 KIAS this amount of control is sufficient to handle 90 degrees of crosswind up to 5 knots. In higher crosswind, the minimum approach and touchdown speed should be increased 1.7 knots for each one knot increase of a 90 degree crosswind.

LANDING WITH INOPERATIVE SPOILERS

With all spoilers inoperative, the main flaps should be extended to at least 23 degrees to assure full outboard ailerons at speeds below 220 KIAS. The outboard ailerons and wing flaps are interconnected and some outboard aileron travel will be available as soon as the wing flaps leave the full up position; however, full travel of the ailerons will not be reached until 23 degrees of main flaps are down. With full use of outboard ailerons over 40% of lateral control is still available; however, landings with inoperative spoilers should be made with caution. Severe cross or gusty wind conditions should be avoided if other more suitable landing facilities are available. Refer to Appendix, T.O. 1C-135(K)A-1-1, Part 9, for maximum crosswind component and minimum recommended touchdown speed for landing with inoperative spoilers.

LANDING WITH RUDDER POWER INOPERATIVE OR LOW RUDDER HYDRAULIC PRESSURE

When landing with rudder power inoperative or low rudder hydraulic pressure (less than 2800 psi), comply with the appropriate inflight minimum control speed obtained from Part 9 of the Appendix, T.O. 1C-135(K)A-1-1.

WARNING

- For landing with less than 2800 psi rudder hydraulic pressure, apply performance data for rudder power inoperative except where hydraulic pressure is in the low range (approximately 1000 psi), in which case apply the performance data for low range hydraulic pressure. If the rudder hydraulic pressure is not in the high range (2800 psi minimum) or low range (approximately 1000 psi) an indeterminate malfunction has occurred which could cause complete loss of rudder hydraulic pressure.
- Do not reduce speed below inflight minimum control speed until landing is assured.

Severe cross or gusty wind conditions should be avoided if other more suitable landing facilities are available. Refer to Appendix, T.O. 1C-135(K)A-1-1, Part 9, for maximum crosswind component and minimum recommended touchdown speed for landing with rudder power inoperative or low rudder hydraulic pressure.

LANDING WITH FLAT TIRE

Crew will assume crash landing stations. Make a normal approach and landing. Dump all unnecessary fuel. Slow to 3 to 5 knots as gently as possible and

Figure 3-9 and all data on pages 3-47 and 3-48 (Deleted)

continue at that speed to the first taxi strip, clear runway and continue taxiing until an area is reached where tires may be changed without blocking other aircraft from using active runway.

NOSE GEAR TIRE FLAT

With one or both nose wheel tires flat, relocate movable equipment and cargo to move the cg to the aft limit. After touchdown hold the nose wheel off as long as possible; then lower it gently. Do not use brakes unless necessary.

CAUTION

Immediately after touchdown do not overcontrol in keeping the nose wheel off the runway, since the airplane will tend to resume flight and a dangerous stall may occur. As soon as nose wheel settles to the runway move speed brake lever to the 60 degree position.

THREE OR LESS TIRES FLAT ON ONE MAIN GEAR

The one good tire should be able to carry the load if a smooth landing is made.

CAUTION

Make all turns in as large a radius as possible. Sharp pivoting turns could result in a broken main gear truck. If an aft outboard tire is determined to be flat, and the airplane gross weight is above 250,000 pounds, avoid turns away from that tire if possible.

ALL TIRES ON ONE MAIN GEAR FLAT

Relocate all loose equipment forward if possible to move the cg toward the forward limit thus throwing more weight on the nose wheel for positive steering. Keep the flat tires off the runway as long as possible. The airplane will try to turn into the flat tires side; therefore, land the airplane with the good tires along the edge of the runway so that more of the runway width is available for the veering tendency during the landing roll. Use aileron to help keep the weight off the flat tires after touchdown. Use brakes on the good tires side and nose wheel steering to maintain a straight landing roll.

CAUTION

Make all turns in as large a radius as possible. Sharp pivoting turns could result in a broken main gear truck.

DITCHING

Factors which could cause a ditching situation are fire, structural damage, impending fuel exhaustion, or power failure. However, experience with four-engine jet aircraft has shown that the requirement for ditching is unlikely. A KC-135 with flaps up can remain airborne on a single-engine at weights up to 160,000 lbs. (The two-engine maximum endurance speed should be used.) Since fuel flow under these conditions is approximately 9000 lb/hour, several hours of continued flight would be possible.

It may not be necessary to abandon the airplane; if the airplane does not sink, it will be better to remain on the airplane since it will provide an excellent platform for survival and rescue. See DITCHING CHART, figure 3-11. When the possibility of ditching exists, all means of radio contact should be used to inform appropriate agencies of existing emergency and aircrew intentions. If it is necessary to abandon the airplane, remain in the vicinity of the airplane as long as possible.

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:

A. Survival kits
B. Exposure suits
C. First aid kits
D. Flashlights
E. Life rafts
F. Life vests

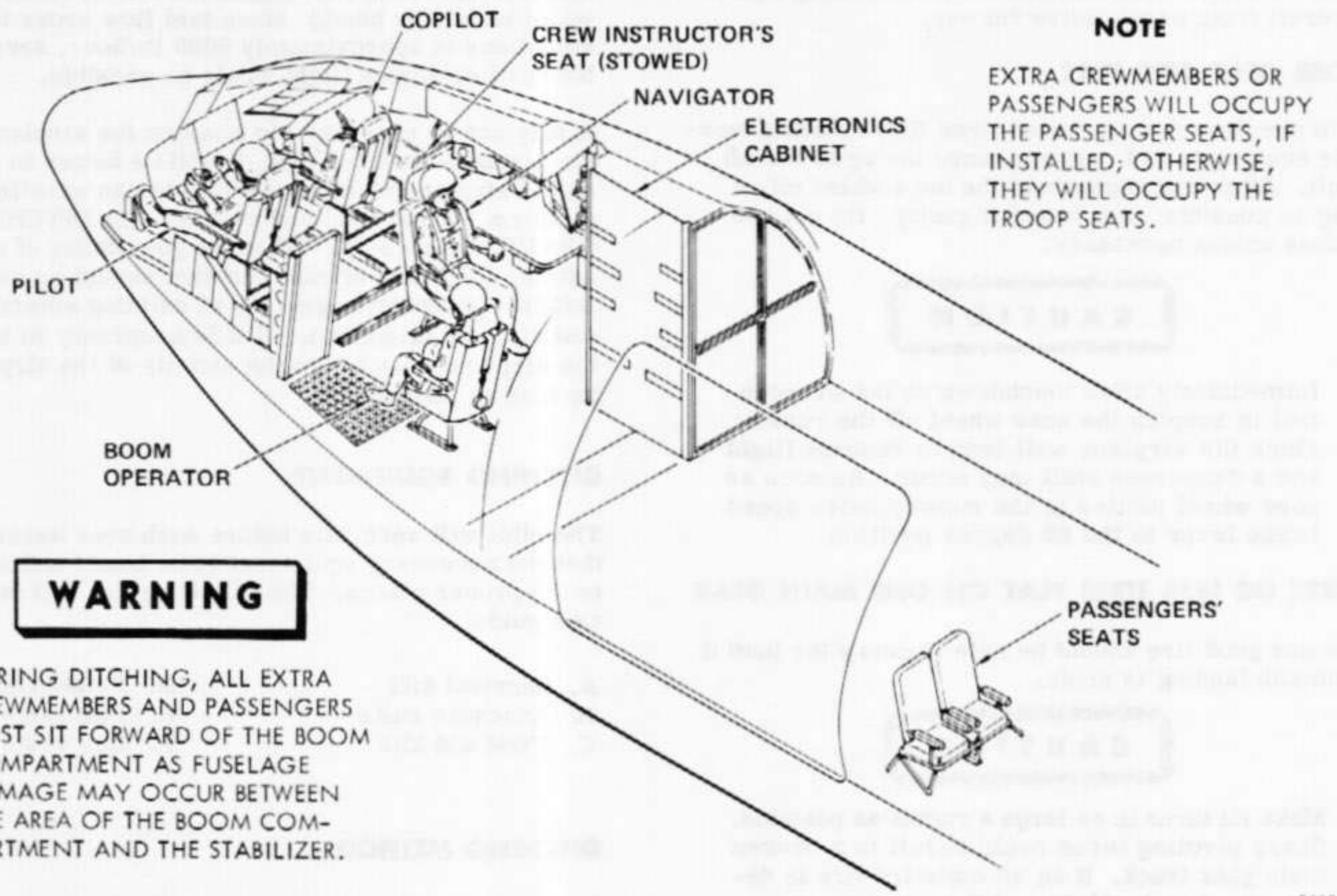
DITCHING METHOD

The primary objective in a safe ditching is to contact the water at the slowest possible forward speed consistent with ample control and with a low rate of descent. To aid in accomplishing this, all fuel that is not essential to the performance of the ditching operation should be jettisoned. This will reduce the required touchdown speed and improve the airplane buoyancy. If a complete power failure is expected, attempt to ditch the airplane while there is still some power available. Ditching should always be accomplished with the landing gear retracted. The following technique is recommended.

Approach

If sufficient thrust is available, establish a 200-300 foot per minute rate of descent at approach speed, 50 degrees of flaps and landing gear up. When operating with asymmetrical thrust, do not reduce the airspeed below inflight minimum control speed. 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. If a crosswind exists, crab the airplane to kill the drift. Hold the wings level. With wind speed 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.

DITCHING AND CRASH LANDING POSITIONS



NOTE

EXTRA CREWMEMBERS OR PASSENGERS WILL OCCUPY THE PASSENGER SEATS, IF INSTALLED; OTHERWISE, THEY WILL OCCUPY THE TROOP SEATS.

WARNING

DURING DITCHING, ALL EXTRA CREWMEMBERS AND PASSENGERS MUST SIT FORWARD OF THE BOOM COMPARTMENT AS FUSELAGE DAMAGE MAY OCCUR BETWEEN THE AREA OF THE BOOM COMPARTMENT AND THE STABILIZER.

Figure 3-10

Night Ditching

Night ditching must be conducted with the aid of instruments to establish the proper attitude of the airplane.

A. Hold the wings level to avoid digging a wing into the sea and cartwheeling the airplane.

B. If power is available, use landing lights to examine the 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. Make an instrument let-down.

Flare and Water Contact

Because of the lack of outside references over water, it will be difficult to determine when to start flare. This is especially true at night. The flare should be accomplished so as to level off approximately 10 feet above the crest of the swell. Slowly retard the throttles and permit water contact in a slightly higher than normal landing attitude. Contact the water at a low rate of sink and a slow, but controllable, forward speed.

WARNING

Under no circumstances should the airplane be stalled in. The resulting structural damage and leaks would greatly reduce the safety of the ditching operation.

The above method is altered when ditching with only one engine operative or power off. In this situation 20 degrees of flaps should be used. The use of more than 20 degrees flaps will result in an excessively high rate of descent during the approach. The approach speed will be the 20° flap approach speed.

NOTE

When a complete thrust loss is experienced, flap extension should be initiated with sufficeint altitude to allow for the increased flap extension time with windmilling engines. For example, at an approach speed of 160 knots it takes approximately 65 seconds for flaps to reach 20 degrees with windmilling engines.

DITCHING CHART

NOTE

Primary exit will be the left overwing hatch. Normally one raft is provided and is launched from the left overwing hatch.

CREWMEMBER/DUTY	PROVIDE	DITCHING POSITION
PILOT Notify crew to prepare for ditching. Direct copilot to give alarm bell signals.	Parachute, Flashlight, Survival Kit and Anti-Exposure Suit.	Pilot's Seat
COPILOT As pilot directs, give alarm bell signals, dump fuel, and turn external lights ON. Assist pilot and act as his alternate.	Parachute, Flashlight, Survival Kit and Anti-Exposure Suit.	Copilot's Seat
NAVIGATOR Transmit airplane position report in accordance with FLIP Enroute Supplement. Place IFF master switch to EMER. Act as alternate for the boom operator.	Navigation Kit, Flashlight, Water, Parachute and Anti-Exposure Suit.	Navigator's Seat (Facing Aft)
BOOM OPERATOR Stow or jettison loose equipment. Supervise and instruct extra crewmembers and passengers.	Life Raft, First Aid Kits, Flashlight, Parachute and Anti-Exposure Suit	Boom Operator's Seat
EXTRA CREWMEMBERS/PASSENGERS	As briefed	Passenger or Troop Seats

WARNING

Do not inflate life rafts in the airplane. They will not pass through the exits when inflated.

NOTE

- Sequence of events during ditching may be varied depending on existing conditions.
- The right overwing hatch may be used as a secondary exit for launching additional rafts or evacuating personnel; additionally, any exit/opening or sliding window may be used to evacuate the airplane.
- If time permits exposure suits will be donned over flight clothing. Life vest will then be put on.
- Rafts should be launched over the leading edge of the wing to prevent damage from torn wing flaps resulting from ditching impact. Rafts have ropes to attach to the airplane structure to prevent the raft from being blown away before it can be boarded.
- When additional rafts are carried a minimum of one crewmember will be assigned to each raft.

Figure 3-11

DITCHING PREPARATION (CP reads)

When it becomes apparent that ditching is necessary:

1. Crew - Alert (P)

   Pilot directs crew to "Prepare for ditching" on CALL position of interphone and receives acknowledgment; directs copilot to give six short rings on the alarm bell.

WARNING

During ditching, all extra crewmembers and passengers must sit forward of the boom compartment as fuselage damage may occur between the area of the boom compartment and the stabilizer.

2. Airplane - Depressurize (CP)

   See AIRPLANE DEPRESSURIZING, Section IV.

3. Landing Gear - UP (CP)

4. Fuel - Dump (time permitting) (CP)

   See EMERGENCY JETTISONING, this Section.

WARNING

Make every effort to dump all body tank fuel. Considerable damage to the fuselage bottom may be expected and any remaining fuel in the body tanks constitutes a fire hazard.

5. Flaps - Set (P, CP)

   Establish ditching configuration consistent with power available.
   a. More than one engine . . . Use 50° flaps
   b. One engine or less . . . . . Use 20° flaps

6. Aft Emergency Exit Hatch - Remove (if required) (N, BO)

   Remove the hatch if loose gear will be jettisoned. See figure 3-7.

7. Loose Gear - Jettison or stow (N, BO)

8. Aft Emergency Exit Hatch - Install (N, BO)

   Install the hatch when jettisoning is completed. See figure 3-8.

9. Anti-Exposure Suit - Don (if time permits)

10. Ditching Position - Assume

    Don helmet, check shoulder harness and safety belt fastened, and lock inertia reel.

11. Absolute Altitude - Obtain from navigator (P)

    If local altimeter setting is not available, obtain absolute altitude from navigator and set in pressure altimeter. Pilot's radio altimeter may be used in determining absolute altitude below 2500 feet.

12. Crew - Brace for impact (P)

WARNING

Do not release safety belt or shoulder harness until airplane comes to a complete stop.

13. Alarm Bell - One long sustained ring (CP)

14. Airspeed - Reduce to slowest safe speed (P)

SYSTEMS EMERGENCY OPERATION

ELECTRICAL SYSTEM EMERGENCY OPERATION

WARNING

- Do not attempt a takeoff using water injection if any of the generator failure, generator breaker or bus tie lights on the electrical control panel are illuminated. Loss of generators can result in loss of water injection with a serious decrease in performance.

- Loss of either generator No. 1 or No. 2 due to underexcitation may trip the applicable gen bus off the synchronizing bus, followed by the generator tripping off in approximately 1 to 8 seconds; under this condition, loss of generator No. 1 would cause loss of water injection to the outboard engines. Loss of generator No. 2 would cause loss of water injection to the inboard engines.

NOTE

After the loss of any generator due to underexcitation or over-excitation, a time delay of approximately 1 minute may be required before the generator bus can be tied to the synchronizing bus.

Loss of a generator could be the result of generator failure, circuit breaker vibration or negative acceleration. During takeoff, the loss of a generator would most likely be caused by generator failure or circuit breaker vibration. The probability of tripping generators by negative accelerations due to rough runways is remote. The negative force required to trip the generator, because of loss of generator drive oil, would be less than zero g's held in excess of 2 seconds. Rough runways would not cause accelerations of this magnitude and duration.

LOSS OF ONE OR TWO GENERATORS

CAUTION

Do not attempt takeoff, practice multiple full stop landings or touch-and-go landings on a normal or training mission with a known generator failure. Inflight fires can result. The condition should be corrected before flight. Landing forces and the thrust used during takeoff may combine to produce rapid destruction of the generator.

If both the generator breaker and bus tie breaker circuit open lights for a generator bus are illuminated, indicating that the bus is de-energized, the following action may be taken to restore the bus.

A. Move generator control switch momentarily to CLOSE.

B. Position paralleling selector to applicable GEN position and check for normal voltage and frequency.

C. Momentarily place generator breaker switch in the CLOSE position to connect the generator to the bus.

D. If generator breaker circuit open light remains extinguished, no further action is required.

   (1) If generator breaker circuit open light illuminates, momentarily move one or more bus tie breaker switches to the CLOSE position as necessary to supply the bus from another generator.

E. If bus again becomes de-energized no further action can be taken. See figure 1-28 for loss of operating equipment.

If after a malfunction the generator breaker circuit open light is extinguished, and the bus tie circuit open light is illuminated, or the generator breaker circuit open light is illuminated and the load bus is energized through the synchronizing bus, no further action is required.

LOSS OF ALL GENERATORS

If loss of all generators is due to negative acceleration, the only light indication will be illumination of the switched DC bus failure light. If generator loss is due to actual generator failure, the generator failure lights in addition to the switched DC bus failure light will illuminate.

A. Move battery power switch to EMERGENCY.

NOTE

- If loss is due to negative acceleration, check that voltage and frequency are normal before closing each generator breaker in turn to restore power. If system appears normal, proceed to step "F."

- To stop the warning horn from sounding when all generators are tripped, and the battery power switch is in the EMERGENCY position, retard the No. 3 throttle until the horn stops sounding.

B. Move all bus tie breaker switches momentarily to the TRIP position.

C. Momentarily move generator switch to CLOSE position, place paralleling selector in applicable GEN position and check voltage and frequency; if normal, move generator breaker switch momentarily to CLOSE.

D. Repeat for remaining two generators.

E. Do not attempt to reclose bus tie breakers unless loss of generators is due to negative acceleration. For further information concerning restoration of full system operation, see figure 3-12.

NOTE

On airplanes 1 ▶ 97, if all generators remain inoperative, to conserve battery power, pull the 10 amp circuit breaker on the SWITCHED DC BUS marked AIC-10 INPH.

F. Move battery switch to NORMAL.

LOSS OF TRANSFORMER-RECTIFIERS

Illumination of the switched DC bus failure light will indicate DC power to the SWITCHED DC BUS has failed; move battery power switch to the EMERGENCY position to energize the SWITCHED DC BUS. The SWITCHED DC BUS will be energized from the battery charging T-R, if operable, or from the battery. See figure 7-8 for load requirements and equipment that can be operated from the SWITCHED DC BUS, BATTERY BUS and HOT BATTERY BUS.

CAUTION

When using the battery charging T-R to power the switched DC bus, limit the load requirements to approximately 20 amps. There is no ammeter reading available to determine switched DC bus load; therefore, the load requirements for each operating circuit must be added to get the total switched DC bus load. There is no time limitation on using the battery charging T-R to power the switched DC bus.

NOTE

- If battery power only is available to the switched DC bus, reduce the load on the switched DC bus to a minimum to conserve the battery as long as possible. If the battery charge level is known (see BATTERY CHARGE LEVEL, Section VII), the hours of battery life can be predicted by dividing the amps discharge reading on the battery charging ammeter into the amp-hours of power remaining in the battery (a fully charged battery has 22 amp-hours of power).

  Example: Battery charge level = 75% prior to the emergency (as determined from the BATTERY CHARGE STATUS chart on the overhead panel).

  Battery discharge rate = 4.5 amps (as determined from the battery charging ammeter).

  Battery life = 75% x 22 amp-hrs = 16.5 amp-hrs. 16.5 amp-hrs ÷ 4.5 amps = 3.66 hours (3 hours and 40 minutes).

- The equipment with the largest DC power requirements is the COMM 1 radio (ARC-34) and the air refueling equipment; unless this equipment is essential to the safety of the crew and airplane, it should not be used when the switched DC bus is being powered from the battery charging T-R, or the battery.

AC POWER SYSTEM EMERGENCY PROCEDURE

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
	FAULTS EVIDENT ON START-UP		
Failure of external power breaker to close	External power phase reversed or one phase open resulting in failure of the phase sequence relay to close	None	External power cannot be applied to airplane with existing ground rig
Generator voltage high	Voltage sensing load circuit open	If voltage is above 215 volts, trip generator control and generator breaker switch then close bus tie breaker switch	Load carried by remaining generators.
	Regulator fault	None	Generator not usable
Generators will not parallel	Auto-paralleling control failure	Trip bus tie circuit breakers Close generator breakers and parallel with bus tie circuit breakers using synchronizing lights	Normal operation
Generator parallels but bus tie breaker trips out	Failure of equalizer loop causing over excitation trip	None	If voltage satisfactory operate generator bus isolated.
Generator failure light on	Generator Control Relay tripped	Close generator control switch	Normal operation
	Voltage regulator fault resulting in over-voltage trip. Fault in differential protection zone	None if light comes back on	Load carried by remaining generators
Generator parallels but trips out after a few seconds	Failure of regulator or equalizer circuit resulting in under-excitation trip	Trip bus tie breaker, reset generator and close generator breaker a. If voltage normal → b. If generator retrips close bus tie breaker →	a. Operate isolated b. System will be carried by remaining generators

Figure 3-12 (Sheet 1 of 3)

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
	FAULTS EVIDENT WITH GENERATORS PARALLELED		
One bus tie breaker light only illuminated (same procedure for other generators)	Over excitation or under excitation trip probably caused by faulty regulator, regulator system, or generator.	Check generator voltage: 1. If voltage is normal: a. Trip generator breaker **CAUTION** Tripping the generator breaker with the corresponding bus tie breaker light illuminated will cause loss of power to the generator bus until the bus tie breaker is closed. Operating the affected generator isolated or paralleling with the bus tie breaker is an alternate crew action to prevent loss of necessary electrical equipment. b. Close bus tie circuit breaker c. Reclose generator breaker → Normal operation d. If light illuminates again → Operate generator bus isolated 2. If voltage is above 210 volts or below 190 volts, trip generator breaker switch then close bus tie breaker switch → Load carried by two remaining generators	

Figure 3-12 (Sheet 2 of 3)

AC POWER SYSTEM EMERGENCY PROCEDURE (CONT)

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
	FAULTS EVIDENT WITH GENERATORS PARALLELED (Cont)		
All bus tie breaker lights illuminate	Negative sequence fault on system Unsymmetrical fault on bus outside differential fault protection zone. Fault in over-under excitation sensing loop	None →	Operate generators isolated
		If subsequent to this, one generator fail light illuminates and generator cannot be restored 1. Reclose bus tie breaker for that bus and bus tie breaker for an energized bus →	1. Operate one generator isolated, one generator feeding two busses
		2. If bus tie breakers retrip, no action →	2. Operate with dead bus
One generator breaker light only illuminated	Underspeed or overspeed	Check frequency meter: 1. If approximately 400 cycles, adjust frequency and KWS division control knob to 400 cycles and close generator breaker	Normal operation
	Faulty generator drive	2. If generator won't come up to 400 cycles, trip generator control switch	System carried by remaining two generators
One generator failure light (generator breaker light will be illuminated also)	Overvoltage Faulty voltage regulator or control	Close generator control switch, check voltage 1. Normal voltage, close generator breaker if lights stay out	1. Normal operation
	Sustained exciter overvoltage	2. If lights illuminate again and	2. System carried by remaining two generators
	Sustained under excitation Three phase symmetrical fault on bus outside differential fault zone Fault in differential protection zone Voltage lead to regulator shorted	a. It voltage is above 230 volts b. If voltage is below 177 volts	
Severe KW unbalance between generators that cannot be balanced by controls	Real load division circuit fault	Trip the bus tie breakers and check 1. If normal →	1. Operate isolated
		2. If not, trip generator control switch of faulty generator and close all bus tie breakers	2. System carried by remaining two generators
Bus voltage low	Voltage regulator loop open	Trip bus tie breakers if voltage is less than 190 volts	Operate with busses isolated
Severe KVAR unbalance between generators	Reactive load division circuit fault	Trip the bus tie breakers and check 1. If normal →	1. Operate isolated
		2. If not, trip generator control switch of faulty generator and close all bus tie breakers	2. System carried by remaining two generators
One bus tie breaker light illuminated followed immediately by generator failure and generator breaker lights illuminating	Voltage regulator fault resulting in over excitation	Reclose bus tie breakers	Operate on two generators

Figure 3-12 (Sheet 3 of 3)

DC POWER SYSTEM EMERGENCY PROCEDURE

INDICATION	POSSIBLE CAUSE	CREW ACTION	RESULT
Ammeter reads zero on T-R No. 1 (same for T-R No. 2)	Fault on feeder from T-R to T-R bus	No action required	System operating on T-R No. 2 (or 1)
	Voltmeter/Ammeter circuit breaker open AC circuit breakers open	Close →	Normal operation
		If circuit breakers do not hold →	System operating on T-R No. 2 (or 1)
No ammeter or voltmeter reading	Faulted T-R bus has opened all limiters	No immediate action will remedy	Operate on one T-R (1)
Switched bus failure light illuminated with battery power switch in NORMAL	Faulted switched DC bus	Close DC distribution breakers →	Normal operation
		If circuit breakers won't hold →	Operate with dead switched DC bus (1)
	Faulted switched DC bus feeders (T-R 1)	Close switched bus breakers →	Normal operation
		If circuit breakers won't hold, change battery power switch to EMERGENCY →	Switched DC bus on battery and/or battery charging T-R unit power (2)
	Faulted T-R bus No. 1	Battery power switch to EMERGENCY position →	Switched DC bus on battery and/or battery charging T-R unit power (2)
Switched bus failure light illuminated with battery power switch in EMERGENCY	Faulted switched DC bus feeders (P14)	Close switched DC bus power supply breakers →	Switched DC bus on battery and/or battery charging T-R unit power (2)
		If circuit breakers won't hold →	Operate with dead DC bus (1)
Battery bus voltage zero	Faulted voltmeter line	Close circuit breaker →	Normal operation
		If circuit breaker won't hold →	No voltage indication
	Fault on battery bus	No action →	One or both battery busses dead
Battery/Battery Charge T-R overheat or fire	Faulted radio noise filters in battery charge control panel	Pull the 3 battery charge CB (5 amp) on MCBP and 1 battery charge CB (50 amp) on battery CBP	Battery recharge capability lost. Battery charge T-R to SBCBP capability lost

(1) See figure 1-32 for loss of operating equipment

(2) Refer to LOSS OF TRANSFORMER-RECTIFIERS, this Section

Figure 3-13

COPILOT'S INSTRUMENT POWER SYSTEM EMERGENCY PROCEDURE

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
Copilot's instrument power off light illuminated	Hydraulic pressure low	Instrument power switch to START	Normal operation
	Generator voltage low	If light remains illuminated, switch to EMERGENCY	Power from secondary source
	Hydraulic motor-generator system faulted	Instrument power switch to EMERGENCY	Power from secondary source

Figure 3-14

FLAP EMERGENCY OPERATION

MAIN FLAP EMERGENCY OPERATION (CP reads)

1. Emergency Hydraulic Crossover Valve Lever - NORMAL (CP)
2. Flap Lever - 50 degrees (CP)
3. CP Instrument Power Switch - EMERGENCY (CP)
4. Right System Hydraulic Pressure Switch - OFF (P)

   Refer to FLIGHT WITH RUDDER POWER INOPERATIVE and LANDING WITH RUDDER POWER INOPERATIVE OR LOW RUDDER HYDRAULIC PRESSURE, this section.

5. Direct Boom Operator or Navigator to Lower Flaps - Accomplished (P)
6. Flap Lever - Actual flap position (CP)

WARNING

When landing with a differential flap configuration, use the pattern, approach, and touchdown speeds for the minimum flap setting. If leading edge flaps are not extended, add 6 knots. If the minimum flap setting is zero degrees, pattern, approach, and touchdown speeds should not be increased as this correction is included in the chart.

NOTE

- 405 turns of the crank are required for 50 degrees of flap travel on each set of flaps.
- The outboard aileron lockout mechanism is operated by the outboard flap drive. To assure adequate lateral control in the lower speed range, the outboard flaps should be started down first and brought up last to permit use of the outboard ailerons for as long as possible during flaps down, low speed flight. Some outboard aileron travel will be available as soon as the wing flaps leave the full up position; however, full travel of the outboard ailerons will not be reached until 23 degrees of wing flaps are down.
- Differential flap positions will cause a variation in the pitch trim of the airplane. Inboard flap extension will cause a slight pitch up tendency, while an increase of outboard flap extension will result in a slight nose down tendency.

LEADING EDGE FLAPS MALFUNCTIONS

Since the leading edge flaps are controlled by the outboard flaps and operate by hydraulic pressure through the outboard spoiler control valve, any malfunction associated with the outboard flaps, outboard spoilers, or the right hydraulic system may also affect the leading edge flaps. However, if the outboard flaps and spoilers operate normally, the leading edge flap malfunction may be failure of one or both leading edge flaps to extend or retract.

CAUTION

When the main flaps are retracted and one or both leading edge flaps remain extended, the airplane should be flown with caution at load factors in excess of 1.5 g's in the speed range between 215 KIAS and 305 KIAS. Damage to the leading edge flaps may occur especially when making turns or pullouts, or flying through turbulent air.

NOTE

If the right hydraulic system is depressurized or the outboard flaps have malfunctioned, the leading edge flaps probably will not extend. If leading edge flaps are not extended, add 6 knots to charted pattern, approach, and touchdown speeds. Flaps up pattern, approach, and touchdown speeds should not be increased as this correction is included in the chart. Refer to Part 9 of the Appendix, T.O. 1C-135(K)A-1-1, for factors to be applied to landing distance due to increased touchdown speeds.

One Or Both Leading Edge Flaps Fail To Retract (CP reads)

If the leading edge flaps fail to retract when the outboard flaps are raised above the 6 degree position and the outboard spoiler switch is in NORMAL:

1. Outboard Spoiler Switch - CUT-OFF (P)

   Place the outboard spoiler switch in CUT-OFF to depressurize the actuators (check valves hold the pressure on the actuators; however, this pressure will gradually bleed off). Unless there is a mechanical interference, the leading edge flaps should blow back to the retracted position as the airspeed is increased.

NOTE

If one or both leading edge flaps fail to retract after takeoff, range performance will be reduced. If mission is to be continued, refer to Part 5, T.O. 1C-135(K)A-1-1.

Before Approach and Landing:

2. Outboard Spoiler Switch - NORMAL (P)

   When the main flaps are extended prior to approach and landing, reactivate the outboard spoilers (for lateral control and braking) by placing the outboard spoiler switch in NORMAL.

An unsymmetrical leading edge flap condition will not be felt until the wing approaches initial buffet. The wing having the retracted leading edge flap stalls first causing a rolling tendency toward that wing. If one leading edge flap fails to retract after takeoff use the procedure outlined above.

One Or Both Leading Edge Flaps Fail To Extend (CP reads)

If the leading edge flaps fail to extend when the outboard flaps are extended below 9-1/2 degrees and the outboard spoiler switch is in NORMAL:

1. Outboard Spoiler Switch - CUT-OFF (if required) (P)

   Check the right system hydraulic fluid quantity gage. If a fluid leak is indicated as the cause of malfunction, place outboard spoiler switch in CUT-OFF.

2. Pattern, Approach, and Touchdown Speeds - Increase 6 knots (P)

   Make normal approach and landing. With only one flap extended, be careful not to stall airplane. Refer to Section VI, figure 6-1, for initial buffet speeds.

FUEL SYSTEM EMERGENCY OPERATION

Due to the structural configuration of the airplane it is not possible during flight to gain access to fuel lines or valves other than the override handle for the A/R line valve and the manual T-handle for the upper deck to aft body tank valve. Circuit protection for all controls in the fuel system is as described in FUEL SYSTEM, Section I.

FUEL QUANTITY INDICATOR FAILURE

A malfunction of any fuel quantity indicator may indicate possible failure that would, with proper sequence of events, allow the introduction of high voltage electrical power into the associated fuel tank. If a malfunction of any fuel quantity indicator occurs, open the associated 115-volt AC fuel quantity indicator circuit breaker on generator No. 1 MCBP.

WARNING

The indicator will not be removed or changed and the circuit breaker will not be reclosed until proper inspection and repairs have been made.

BOOST PUMP FAILURE

The failure of more than one boost pump per wing tank while the airplane is operating at high power settings during takeoff and at high altitude will reduce power and continued operation will damage engine pumps. Therefore, it is recommended that the airplane not be accepted for flight when it is known that a boost pump is inoperative. The engine-driven fuel pumps will not always handle the requirements of high fuel consumption without aid of fuel pressure boost. If such a condition does occur, a crossfeed condition should be set up immediately to supply the needed pressure. It should be remembered that the location and degree of a break can make it impossible to differentiate between a broken fuel line and boost pump failure.

FUEL SYSTEM LEAKAGE

If the circuit protection is operating normally, abnormal fuel flow, pressure warning, or fuel quantity

indication may be considered indication of possible fuel leakage. Indications may be as follows:

Excessive fuel flowmeter reading - A break in the line or leakage between flowmeter and fuel nozzles.

Inadequate fuel flowmeter reading - A break in the system upstream of the flowmeter; valve failure; a boost, override, or air refueling pump failure (where these pumps are being utilized).

Fuel low pressure warning indication (engine manifold in use) - A break any place in the system; valve failure; a boost, override, or air refueling pump failure.

Fuel quantity indication rapidly decreasing - A break any place in the system.

Body tank fuel quantity indication increasing - An increase of fuel in a body tank could be an indication of a fuel leak in the A/R manifold running through or from that tank. A faulty fuel level control valve could also be the cause of the fuel transfer. Other factors would be the inadvertent opening of a gravity transfer valve causing a body tank to increase in quantity, the failure of an A/R pump check valve, or the remote possibility that the manual defueling valve had been left open. All A/R pump switches should be turned OFF. The three circuit breakers for single point refueling on the battery circuit breaker panel should be pulled, to remedy any electrical malfunction with the level control valves. Either one or both A/R pumps should be turned on in the tank that is filling and that fuel used in the engines, pumped out to a receiver, or dumped. It is possible that a leak in a body tank could be serious enough to prevent pumping fuel out of that tank. In this event all A/R pumps should be left off. This is to preclude a critical cg condition occurring. In some cases fuel may be transferred by gravity to correct a cg condition.

WARNING

To preclude structural damage do not allow a body tank to overfill and flood the vent system. If a body tank is allowed to overfill and flood the vent system, and limit load factor is reached during maneuvering or in gusts, permanent set in the structure and fuel cell damage could result.

Severe fuel leaks could make it necessary to empty a main tank to prevent loss of fuel. In this event, the remaining fuel should be routed to feed all four engines, in the manner shown in figure 3-15. The pilot may elect to have the boost pumps in all other tanks inoperative, during this operation; however, he should insure that at least one boost pump is operating in other main tanks as the tank to be emptied approaches the lower 20% of its capacity. The wing to aft body tank valve for the respective main tank may also be opened to hasten the emptying process provided the aft body tank will not be overfilled. At the completion of this operation insure that at least one tank on the opposite side of the airplane has both boost pumps operating, in order that there will be ample pressure to feed the engine normally fed from the empty tank. Feeding this engine from the opposite side of the airplane will help to restore the lateral balance. Major fuel leaks can occur from an integral main tank in the event of a wing skin crack. A serious fire hazard can exist after landing if a fuel leak exists in the vicinity of an engine nacelle, and the engine has not been allowed to cool. Since the possibility exists that a main tank leak is caused by a skin crack rather than fuel line failure, it is mandatory to reduce airspeed and restrict flap operation to reduce the possibility of further structural failure. In the event that a main tank fuel leak is discovered during flight use the following procedure:

A. If a main tank fuel leak occurs in the vicinity of an engine nacelle, shut down the engine as soon as possible. In any event, the engine should be shut down prior to lowering flaps.

B. Reduce airspeed to 255 KIAS or less.

C. Empty the affected tank as described above. If possible retain fuel in outboard reserve tanks.

D. Reduce gross weight by dumping fuel from center-wing, forward body, aft body and upper deck tanks as soon as practicable.

E. Avoid turbulence.

F. Limit flaps down position to 30 degrees or less including landing.

G. Do not use speed brakes.

H. Land as soon as possible.

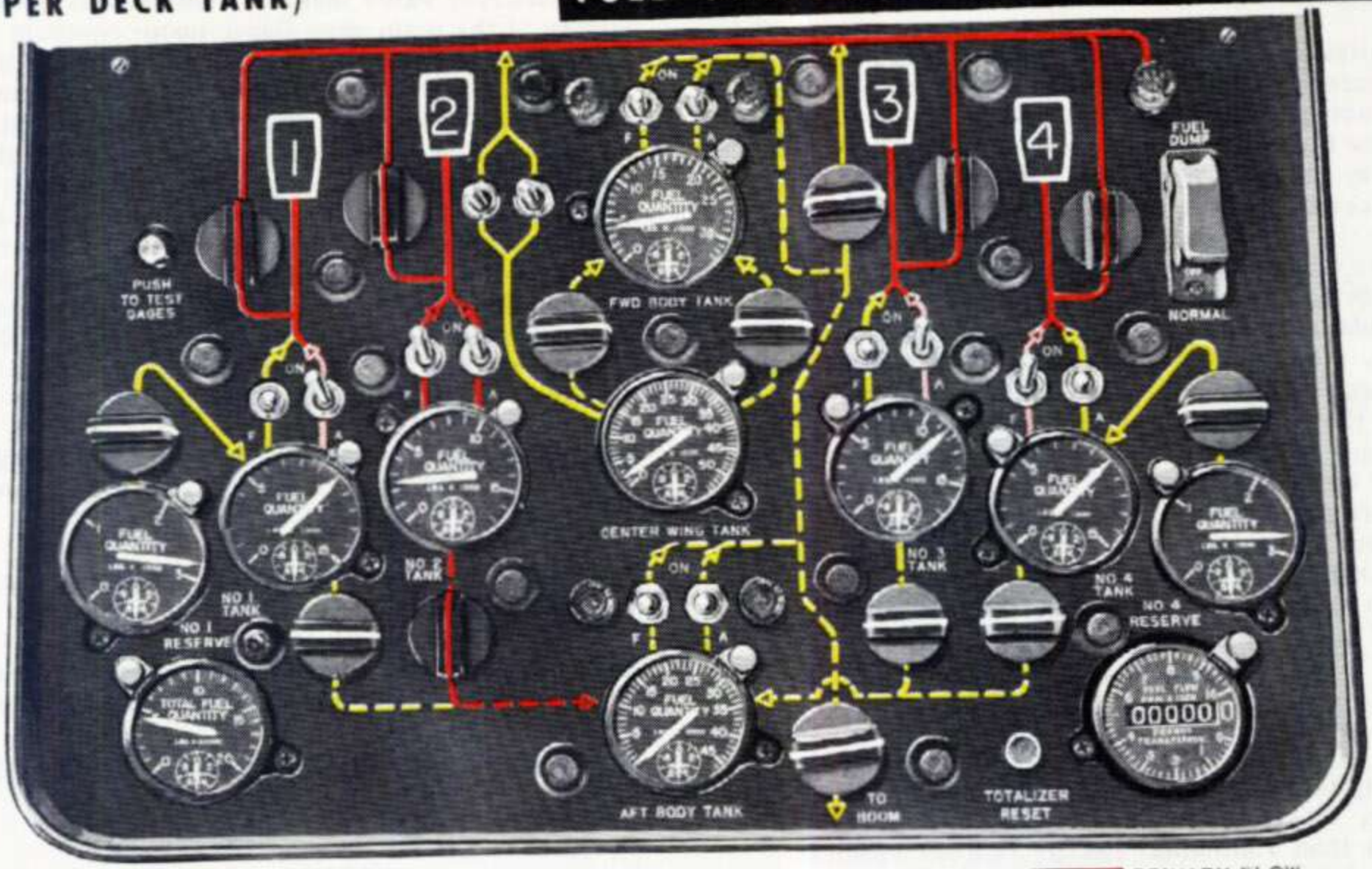
WARNING

To avoid a flameout when operating all engines from a single main tank, extreme care must be exercised to prevent interruption of fuel flow to the engines as the tank becomes empty. Discontinue emergency tank emptying procedure before the fuel quantity indication reaches the "0" marking on the fuel quantity gage.

Emergency emptying of the center wing tank can be conducted in a similar manner to the procedure above for the main tanks. See also Section VII, CENTER WING TANK TO ENGINES. The center wing to forward body valves may also be opened to transfer fuel to the forward body tank. The body tanks should either be off-loaded to a nearby receiver, or crossfed to the engines in the manner described in BODY TANKS TO ENGINES in Section VII.

FUEL SYSTEM EMERGENCY OPERATION

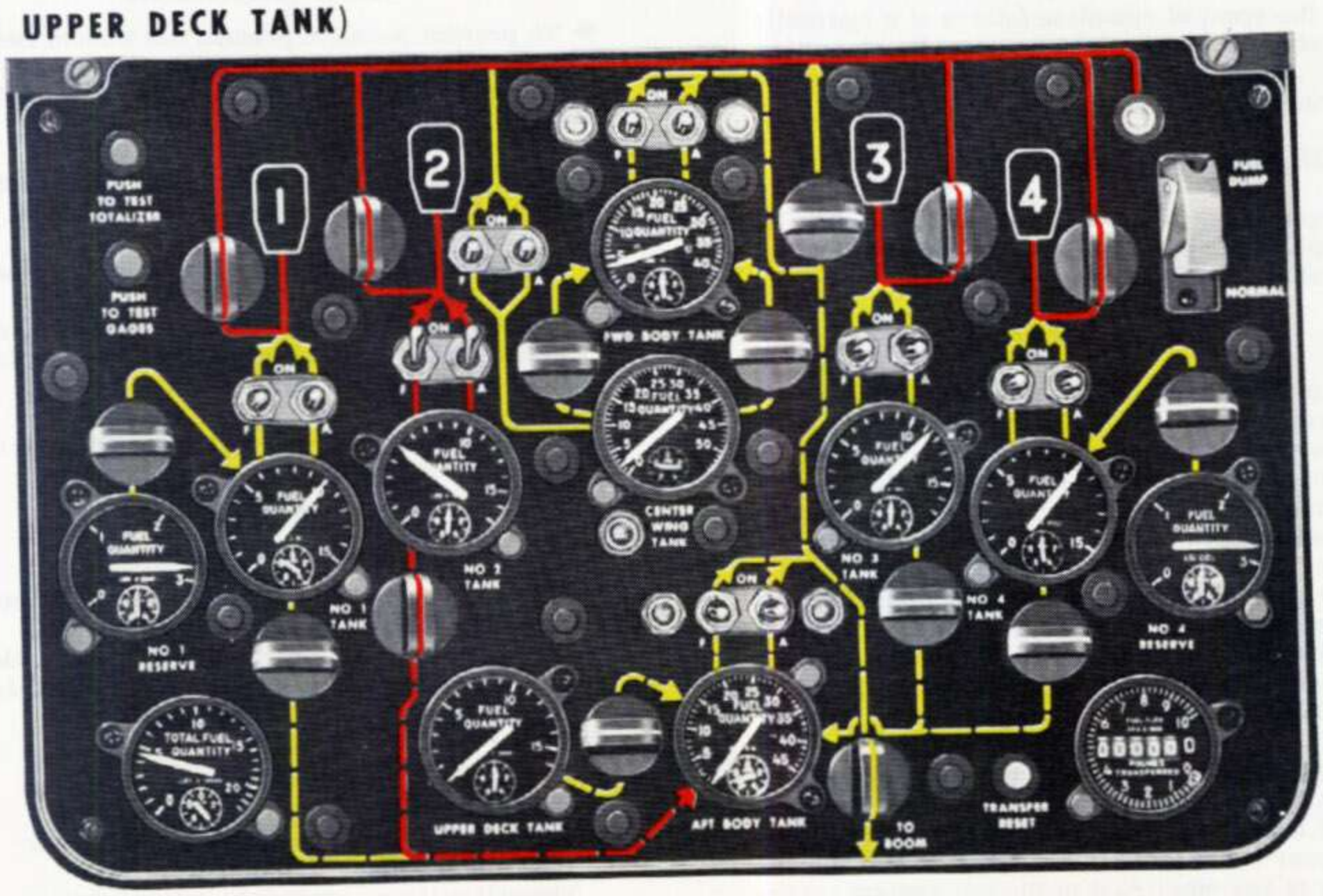
(NO UPPER DECK TANK)



NOTE: For both configurations assume No. 2 tank to be emptied as soon as possible. Both No. 2 boost pumps ON and other tanks boost pumps OFF until No. 2 quantity drops to approximately 20%, then one boost pump in other main tanks ON.

PRIMARY FLOW
ALTERNATE SOURCE
NO FLOW

(WITH UPPER DECK TANK)



F-134
F-135

Figure 3-15

HYDRAULIC SYSTEM EMERGENCY OPERATION

Hydraulically operated components that are essential to the safety of flight or the completion of a mission can be actuated by either hydraulic system. These units are the rudder, flaps and boom, normally operated by the right hydraulic system and the landing gear, normally operated by the left hydraulic system. Placing the emergency crossover valve lever to RH connects the landing gear to the right hydraulic system; moving the lever down to LH connects the powered rudder, flaps and boom to the left hydraulic system. No other component can be operated through the crossover system. The pilot's brake system, including the brake accumulator, is isolated by check valves and will remain operative and can be repressurized by the left auxiliary pump, even though the main left system fails completely. For use of the crossover lever in the event of emergency, see USE OF CROSSOVER VALVE this Section. For use of the reserve brake accumulator, see BRAKE EMERGENCY OPERATION this Section.

CAUTION

- Pump isolation is an emergency operation only. Isolation of the pump for short periods (less than 5 minutes) results in wear which is cumulative and will result in premature failure of the pump. Isolation of a pump in excess of 5 minutes may result in self-destruction of the unit. Enter pump isolation time in Form 781.

- In the event of complete failure of a hydraulic system or leakage which cannot be controlled, the airplane should be landed as soon as practicable.

USE OF CROSSOVER VALVE

If pump leakage is not indicated and loss of fluid continues after pump isolation, attempt to locate the leak before using the crossover valve.

NOTE

It is safe to use the crossover valve after loss of fluid from either hydraulic system, provided pressure can be built up and maintained in the affected system with the appropriate hydraulic pressure and auxiliary pump switches ON. When the LH system is affected, the inboard spoiler switch must be placed in the CUT-OFF position in order to obtain pressure by use of the auxiliary pump. When the RH system is affected, the copilot instrument power switch should be placed in the EMERGENCY position.

If leakage or failure in the gear actuating system occurs causing a loss of fluid in the left system, a loss of fluid in the right system will occur if the crossover valve lever is actuated. If leakage or failure of any other part of the left system occurs, no loss of fluid in the right system will result when the crossover valve lever is actuated. If leakage or failure of the main wing flaps, boom controls or powered rudder occurs causing loss of fluid in the right system, a loss of fluid in the left system will occur if the crossover valve lever is actuated. If leakage or failure of any other part of the right system occurs, no loss of fluid in the left system will result when the crossover valve lever is actuated. If source of leakage in system cannot be determined, the hydraulic fluid quantity gage for the affected system should be monitored during and after actuation of the crossover valve lever. If a fluid loss of the unaffected system is observed, the lever should be returned to the NORMAL position.

After determining that the crossover valve will be utilized, the following steps should be followed to establish the crossover:

A. Place the copilot's instrument power switch to EMERGENCY.

B. Adjust throttles to reduce asymmetric thrust and neutralize rudder pedal inputs if applicable.

C. Depressurize the left and right hydraulic systems.

D. Turn the rudder power switch off.

E. Reposition the hydraulic crossover valve lever.

CAUTION

- To prevent possible pressurization and resultant rupture of return lines, any repositioning of the crossover valve lever should be done smoothly and rapidly.

- The flaps, landing gear or boom should not be actuated until crossover is established.

F. Repressurize the operating hydraulic system.

G. The copilot's instrument power switch may be placed to the start position if the right hydraulic system is operational.

H. Rudder power may be reactivated as required.

WARNING

If the pilot is holding rudder pressure when the rudder power switch is placed on, the reduction in pedal force required with rudder power operative may result in an immediate increased rudder deflection.

NOTE

If crossover is made to the left hydraulic system, the leading edge flaps will not extend. Add 6 knots to the appropriate charted pattern, approach, and touchdown speeds.

HYDRAULIC SYSTEM EMERGENCY PROCEDURE

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
Illumination of hydraulic pump inoperative light with no indication of fluid loss	Failure of engine-driven hydraulic pump	Move pump supply switch to CLOSED position	Continue with the remaining hydraulic pump
Illumination of hydraulic pump inoperative light with loss of fluid occurring	Failure of engine-driven hydraulic pump allowing fluid loss through the pump	Immediately move pump supply switch to CLOSED position	Continue with the remaining hydraulic pump
Hydraulic system overheat warning light illuminated with no indication of fluid loss	Overheating hydraulic pump	1. Immediately depressurize affected system. 2. Warning light extinguished in 5 min or less	Continue with the system depressurized. Repressurize only for short periods as required
		3. Warning light remains illuminated in excess of 5 min, close the supply switch for the affected pump	Operation of the affected system on the remaining pump
Hydraulic system overheat warning light illuminated with fluid loss occurring	Engine-driven hydraulic pump failure causing overheating of the system	1. Immediately depressurize affected system 2. Place pump supply switch in close position and monitor fluid quantity 3. If fluid loss stops	Operate the affected system on remaining pump
		4. If fluid loss continues, monitor overheat warning lights	Continue with system depressurized and repressurize, if any fluid remains, only for short periods if required to complete mission or to land the airplane Land the airplane as soon as practicable
Loss of quantity occurring with no other indications	Line leakage	1. Immediately depressurize affected system 2. Momentarily repressurize the affected system to determine if pump inoperative light illuminates 3. If fluid loss stops or is extremely slow after depressurization Cont	Continue with the system depressurized and repressurize it only for short periods as required to complete the mission or land the airplane

Figure 3-16 (Sheet 1 of 4)

HYDRAULIC SYSTEM EMERGENCY PROCEDURE (CONT)

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
Loss of quantity occurring with no other indications (continued)	Line leakage (continued)	4. If pump inoperative light illuminates, close the supply switch for the affected pump. If loss of fluid stops, **NOTE** In some instances a quantity increase may be noted after isolating a hydraulic pump. After the gage stabilizes, check for further loss	Continue with the system operating on the remaining pump
		5. If a hydraulic pump inoperative light does not illuminate after completing Step 2 and loss of fluid continues, proceed to **steps 6, 7, 8 & 9 of this procedure**	
		6. If the above action does not stop fluid loss in the right system, attempt to isolate the leak by closing the boom operator's sighting door and/or placing the rudder power switch OFF and/or placing the outboard spoiler switch to CUT-OFF and/or placing the copilot's instrument power switch to EMERGENCY. If fluid loss is in the left system, attempt to isolate leak by placing the inboard spoiler switch to CUT-OFF. If fluid loss stops	Normal system operation with the affected portion of the system isolated
		7. If the fluid loss continues, move the inboard pump supply switch to closed. If fluid loss stops	Continue with the system operating on the remaining pump
		8. If loss continues, open the inboard pump supply switch and close the outboard pump supply switch. If fluid loss stops	Continue with the system operating on one remaining pump
		9. If leakage cannot be controlled, restore outboard pump and depressurize system	Continue with system depressurized and repressurize, if any fluid remains, only for short periods if required to complete the mission or to land the airplane Land the airplane as soon as practicable

Figure 3-16 (Sheet 2 of 4)

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
Fluctuating pressure or sustained or recurring indication in excess of 3400 psi on a system pressure gage with no indications of overheat or fluid loss	Engine-driven hydraulic pump malfunction	Immediately depressurize affected system	Continue with the system depressurized and repressurize only for short periods of time as required
Fluctuating pressure or sustained or recurring indication in excess of 3400 psi on a system pressure gage with indications of overheat	Engine-driven hydraulic pump malfunction	Follow the procedure as outlined in hydraulic system overheat this section	
Fluctuating pressure or sustained or recurring indication of 3400 psi on a system pressure gage with indications of fluid loss	Engine-driven hydraulic pump malfunction	Follow the procedure as outlined under loss of hydraulic fluid quantity this section	
Low hydraulic pressure with no other indications	Low accumulator preload	1. Depressurize affected hydraulic system 2. Check for proper accumulator preload (see figure 1-65) 3. If preload is low, repressurize and check other gauges in affected system for true system pressure. If normal **NOTE** • The left system pressure may be read on the reserve brake pressure gauge by cycling the pilots brakes. • The right system pressure may be read on the power rudder in the high range or on the pressure gauge for the boom system accumulator in the boom pod.	Gauge is inaccurate continue with system pressurized

Figure 3-16 (Sheet 3 of 4)

HYDRAULIC SYSTEM EMERGENCY PROCEDURE (CONT)

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
		• The power rudder may be placed in the high range by pulling the rudder pressure control circuit breaker on the SBCBP. **CAUTION** Avoid rudder inputs with the rudder pressure in the high range above 250KIAS.	
	Hydraulic pump malfunction or system internal leak	4. If accumulator preload is normal, repressurize system	Continue with system pressurized and expect slow operation of equipment in affected system

Figure 3-16 (Sheet 4 of 4)

EMERGENCY RETRACTION OF LANDING GEAR (Cont)

When Gear Indicators Indicate Gear Is Not Up And Locked:

Make a visual inspection.

1. Lock Alignment Stripes - Check alignment (P, BO or N)

   Check lock alignment stripes for the gear which has the unlocked indication.

   Airplanes 1▶232

   The nose gear stripes cannot be checked when the gear is up on these airplanes. The stripes will appear misaligned in both locked and unlocked condition.

   Airplanes 233▶

   If nose gear stripes are aligned, gear is locked and position indication is wrong. If stripes are not aligned, recycle gear several times and check stripes again (14, figure 1-49).

NOTE

When the nose gear is up, the stripes must be viewed through the inspection window in the lower nose compartment.

All Airplanes, Main Gear

If stripes are aligned, gear is locked and position indication is wrong. If stripes are not aligned, recycle gear several times and check stripes again (8, figure 1-49).

When Landing Gear Lever Warning Light Only Stays On After Gear Is Retracted:

Make a visual inspection.

1. Landing Gear Lever - Check seating (P, CP)

   Check that landing gear lever is solidly seated in up detent. If light is still on, proceed to next step.

2. Landing Gear Doors - Check closed (P, BO or N)

   If doors appear closed, consider gear safe. If any door appears open, recycle gear several times and check doors again.

LANDING GEAR EMERGENCY EXTENSION (CP reads)

To extend and lock either the main landing gear or the nose gear in the event of failure of the normal system, use the following emergency procedure:

When Gear Will Not Leave The Up And Locked Position:

1. Hydraulic Crossover Valve Lever - NORMAL (CP)
2. Landing Gear Lever - DN (CP)

   All operable gear should extend and lock.

3. Left System Hydraulic Pressure Switch - OFF (P)
4. Direct Boom Operator or Navigator to extend gear using manual emergency extension system - Accomplished (P)

For manual extension procedures see BOOM OPERATOR'S AND NAVIGATOR'S EMERGENCY PROCEDURES this Section.

WARNING

Application of hydraulic pressure to the main gear during manual extension may result in injury to the operator.

5. Left System Hydraulic Pressure Switch - ON (P)

CAUTION

If the malfunction is the result of a damaged hydraulic component or line do not repressurize the system. See HYDRAULIC SYSTEM EMERGENCY OPERATION this Section.

6. Gear Indicators - Recheck (CP, BO or N)

When Nose Gear Will Not Extend By Above Procedures, Extend It Manually With Hydraulic Assistance As Follows:

CAUTION

Use of hydraulic assistance for emergency nose gear extension may cause either the door release cable or the door release cable shear pin to break. Therefore, the nose gear must be left down and locked for the remainder of the flight.

1. Hydraulic Crossover Valve Lever - NORMAL (CP)
2. Landing Gear Lever - DN (CP)
3. Left System Hydraulic Pressure Switch - OFF (P, CP)
4. Direct Boom Operator or Navigator to extend gear using manual emergency extension system with hydraulic assistance - Accomplished (P)

   a. Nose Gear Door Release and Access Cover - Pull up and forward to release door. (BO or N)

   Hold open until step 6a is completed. (See figure 3-20.)

   b. Nose Gear Ground Down Lock and Release Handle - Insert handle with striker pointed aft. Move full forward to release nose gear. Hold full forward until completion of step 6a.

WARNING

Before moving the release handle forward, the operator must be positioned forward of the release handle. Any motion transmitted to the release handle will be in the aft direction and could cause possible injury to an operator pushing the release handle from the aft side.

NOTE

If the nose gear ground lock and release handle cannot be moved into the gear release position (full forward), apply as much force as possible without using additional leverage. If one man cannot exert sufficient force, use additional crewmen before accepting a nose gear up landing as inevitable.

LANDING GEAR EMERGENCY EXTENSION (Cont)

5. Left System Hydraulic Pressure Switch - ON (P)

CAUTION

If the malfunction is the result of a damaged hydraulic component or line, do not repressurize the system. See HYDRAULIC SYSTEM EMERGENCY OPERATION, this Section.

6. Direct Boom Operator or Navigator to continue using manual emergency extension system with hydraulic assistance - Accomplished (P)

   a. Gear Lock Alignment Stripes - Check alignment (BO or N)

      Visually check that the gear is down and that the red stripes on drag strut and lock rod are in close proximity but not aligned.

   b. Nose Gear Ground Down Lock and Release Handle - Move aft to lock gear and engage striker on locking hook (BO or N)

WARNING

Do not move the release handle aft until it has been determined that the nose gear is down. If the handle is moved aft too soon and the gear has started to free fall, force can be transmitted to the handle and break the handle if the striker is locked on the hook, thus endangering the operator.

   c. Gear Lock Alignment Stripes - Check alignment (CP, BO or N)

      Visually check the red alignment stripes on the drag strut and the lock rod. The gear is locked when the stripes are aligned. Check with the copilot for a down and locked indication. (An unsafe position indicator, with stripes aligned, would indicate a possible electrical malfunction.)

7. Gear Indicators - Recheck safe indication (CP, BO or N)

NOTE

If visual observation fails to confirm gear down and stripes aligned, or if stripes are observed misaligned, it may be possible to insert the nose gear external downlock through the inspection window in the lower nose compartment. Removal of the window is accomplished by removing seven wingscrews and pulling the window lift (metal finger hook). Insure the airplane is depressurized before attempting to remove the inspection window. It is recommended that a lanyard be attached to the nose gear external downlock prior to window removal to prevent loss of the downlock in case it is dropped. If the wingscrews cannot be removed, or time is critical, use the crash axe to break and remove the inspection window.

When Above Procedures Fail To Extend And Lock Gear, The Following May Be Tried

1. Fly at an altitude where ambient temperature is above freezing to thaw possible ice formation on any components. If temperature at lower altitudes is only a few degrees above freezing, it may be necessary to fly to a warmer climate.

2. After sufficient time for melting of ice, attempt to lower gear hydraulically or manually in accordance with previous procedures.

When Landing Gear Will Not Extend By Using Above Procedures, Manually Extend Gear As Follows:

If there are damaged components in the landing gear system, it may not be possible to extend and lock gear by using above procedures.

1. Hydraulic Crossover Valve - NORMAL (P, CP)

2. Left Auxiliary Hydraulic Pump Switch - OFF (P)

3. Left System Hydraulic Pressure Switch - OFF (P)

With the system depressurized, the hydraulic pumps will still maintain approximately 750 psi pressure on the system.

4. No. 1 and No. 2 Hydraulic Pump Supply Switches - CLOSE (CP)

Isolate the pumps to stop all flow of hydraulic fluid.

CAUTION

Do not isolate pumps until it has been established that the gear will not extend and lock by using other methods described above. Isolating the pumps in excess of 5 minutes may cause permanent damage to the pumps. Isolation of pumps for shorter periods results in wear which is cumulative and will result in premature failure of pump. Enter pump isolation time in Form 781.

5. Direct Boom Operator or Navigator to extend gear using manual emergency extension system (P)

For manual extension procedures see BOOM OPERATOR'S AND NAVIGATOR'S EMERGENCY PROCEDURES this Section.

WARNING

Keep both left pumps isolated and the left hydraulic system depressurized or the gear may unlock.

NOTE

Under the above conditions, a landing will be made with the inboard spoilers inactive and the only pressure available for the pilot's brakes is that which is stored in the brake accumulator. Refer to LANDING WITH INOPERATIVE SPOILERS and BRAKE EMERGENCY OPERATION in this Section.

When Landing Gear Becomes Jammed Due To Inadvertent Gear Release While Landing Gear Lever Is In The Up Position, The Following Action Should Be Taken:

1. Hydraulic Crossover Valve - NORMAL (P, CP)
2. Landing Gear Lever - DN (CP)
3. Left System Hydraulic Pressure Switch - OFF (P)
4. Wait 15 to 20 minutes and Execute Pull-up Maneuvers (P)

Allow the system to remain with the controls in the above positions for 15 to 20 minutes to determine if normal leakage through the door control valve will allow the gear to release. Airplane pull-up maneuvers may be employed near the end of the 20 minute period to assist in release of the gear.

When Position Indicators Indicate Gear Is Not Locked Down:

Make a visual inspection.

1. Lock Alignment Stripes - Check alignment (P, BO or N)

If stripes are not aligned, recycle gear several times. If stripes still do not align, manually lock gear using manual emergency extension system (see figure 1-49).

LANDING GEAR EMERGENCY EXTENSION (Cont)

When Landing Gear Lever Warning Light Only Stays On After Gear Is Extended:

Check by making a visual inspection.

1. Landing Gear Lever - Check seating (P, CP)

   Check that landing gear lever is solidly seated in down detent. If light is still on, proceed to next step.

2. Landing Gear Doors - Check closed (P, BO or N)

   If doors appear closed, consider gear safe and the light indication wrong. If any door appears open, recycle gear several times. If this does not help, land with doors closed as far as possible.

When Warning Horn Blows If Any Throttle Is Retarded Below Middle Set Of Scribe Marks On Control Stand:

1. Landing Gear Position Indicators - Check (P, CP)

   Check that landing gear is down and locked. If other position is indicated, take necessary action described earlier in this Section.

2. Warning Light in Landing Gear Lever - Check (P, CP)

   Check that warning light is off. If light is on, take necessary action described earlier in this Section.

3. Lock Alignment Stripes - Check (P, BO or N)

   Check lock alignment stripes as described earlier in this Section. If stripes align, gear is down and locked and safe for landing.

OIL SYSTEM EMERGENCY OPERATION

OIL PRESSURE LOW

Less Wip 738

When engine oil pressure drops below 40 psi the engine should be monitored closely; if engine oil pressure drops below 35 psi, oil pressure is considered low and the engine should be shut down as soon as possible to prevent extensive engine damage unless its thrust is necessary to maintain flight.

With Wip 738

When engine pressure drops below 40 psi, the following instructions apply:

A. If the oil pressure gage reads below 35 psi and the oil low pressure warning light illuminates, immediately shut down the engine unless its thrust is necessary to maintain flight.

B. If the oil pressure gage reading is normal and the oil low pressure warning light illuminates, engine thrust should be varied to verify proper gage operation. Continue normal operation while closely monitoring the engine instruments. Any erratic operation of any of the affected engine instruments will require an immediate shutdown of the engine unless its thrust is necessary to maintain flight.

C. If the oil pressure gage reading drops below 35 psi or is erratic and the oil low pressure warning light does not illuminate, press to test the light. If the light illuminates when pressed, continue normal operation monitoring the engine instruments.

D. If the oil pressure gage reading is erratic and the oil low pressure warning light illuminates, shut down the engine unless its thrust is necessary to maintain flight.

If the thrust of an engine with low oil pressure is required to maintain flight, the pilot should be aware of the results of operating an engine during oil starvation. If an engine oil system malfunction has caused prolonged oil starvation of engine bearings, the result will be a progressive bearing failure and subsequent engine seizure. This progression of bearing failure starts slowly and will normally continue at a slow rate up to a certain point at which the progression of failure accelerates rapidly to complete bearing failure. The time interval from the moment of oil starvation to complete failure depends on such factors as condition of bearings prior to oil starvation, operating temperature of bearings, and bearing loads. A good possibility exists for up to 30 minutes of operation after experiencing oil starvation. Bearing failure due to oil starvation is generally characterized by a rapidly increasing vibration; when vibration becomes moderate to heavy, complete failure is only seconds away and may be avoided only by immediate engine shutdown. Since the end result of oil starvation is engine seizure, at the first indication of oil system malfunction the procedure outlined below should be followed to forestall engine seizure as long as possible.

A. Immediately shut the engine down unless its thrust is necessary to maintain flight.

B. If thrust is required from the affected engine, reduce thrust to minimum required to maintain flight. Avoid rapid and large variations in thrust settings on affected engine.

C. If gross weight is high, dump fuel to reduce thrust requirements.

D. Avoid all abrupt maneuvers causing high "g" forces; this prevents unnecessary bearing loads.

E. After critical thrust condition is past, immediately shut the affected engine down. Reduction in IAS and altitude will reduce the engine windmilling rpm and delay engine seizure after the engine is shut down.

OIL PRESSURE HIGH

CAUTION

Takeoff should not be attempted if the oil pressure is more than 50 psi. Blown oil system seals and/or loss of lubrication can result. The condition should be corrected before flight.

When an engine oil pressure gage goes to between 50 and 70 psi (steady or transient) in flight, the procedure outlined below should be followed to prevent engine damage. Pressure fluctuations of 5 psi total are permissible provided the average of the fluctuations is no greater than 50 psi.

A. Shut down the engine unless its thrust is necessary to maintain flight.

B. If thrust is required from the affected engine, reduce thrust to minimum required to maintain flight. Avoid rapid and large variations in thrust settings on affected engine.

C. If gross weight is high, dump fuel to reduce thrust requirements.

D. Report the condition as a flight discrepancy on the Form 781.

When an engine oil pressure gage exceeds 70 psi (steady or transient) in flight immediately shut down the engine and record the condition on the Form 781.

OIL PRESSURE ERRATIC

If the engine oil pressure gage shows erratically lowering oil pressure below 40 psi, or rises to approximately 50 psi, monitor the engine and continue normal operation until pressure drops to 35 psi or rises to 50 psi. Oil pressure fluctuations up to 5 psi total are allowable; however the mean should not be lower than 35 psi. It may not be possible to distinguish between an oil pressure transmitting system malfunction and an engine oil pressure system malfunction. Therefore, if the mean engine oil pressure drops below 35 psi, or exceeds the maximum limit, follow the appropriate procedures outlined under OIL PRESSURE LOW or OIL PRESSURE HIGH in this section.

NOTE

If oil pressure fluctuations exceed 5 psi total, but the mean of the readings is no greater than 50 psi, or the mean is no lower than 35 psi, continue normal operation monitoring the engine closely and make a Form 781 entry.

RUDDER EMERGENCY OPERATION

In the event of unscheduled rudder deflection during powered rudder operation, move the rudder power switch to OFF immediately. Actuation of the rudder power switch (16, figure 1-22) from the guarded ON position to the OFF position will remove hydraulic pressure from the rudder system and permit immediate takeover of rudder control by the manually operated backup system.

Loss of ram air pressure in the Q-spring due to damage or system malfunction will produce the same control response as an iced-over Q-inlet. During power on operation, hydraulic rudder capability will remain the same but rudder pedal feel forces will be reduced for all pedal deflections. This type of power on loss of Q-spring pressure can result in a tendency to overcontrol. In the power off mode, rudder response and pedal forces will be normal.

Separation of the Q-spring linkage system from the rudder control will be indicated by low and unchanging pedal forces through full pedal deflection with rudder power on. Airplane response will be normal. If a separation of the Q-spring linkage occurs and power rudder is turned off, there will be no control of the rudder through the rudder pedals. Pedal forces will be normal for small pedal movement but the forces will build up rapidly with further movement.

In each of these cases rudder power should be used; the only restriction is that pilots should use caution when applying large pedal deflections. In most cases of Q-spring system malfunction rudder trim operation will be normal in flight; however, in some cases effectiveness will be reduced.

CAUTION

The sudden reversal of rudder direction, at high rudder deflections, due to improper rudder application or abrupt release, can result in overstressing the vertical fin. This condition could be brought about during recovery attempts from a flight condition induced by a lateral control malfunction.

UNSCHEDULED RUDDER DEFLECTION

Stop the roll by application of full wheel throw and rudder using asymmetric thrust (reduce power on up wing side, if necessary).

1. **RUDDER POWER SWITCH – OFF (P, CP)**

   If an unscheduled rudder deflection occurs or the rudder pedals are displaced and appear to be jammed, turn the rudder power switch OFF immediately. Check rudder pressure bleeds down.

WARNING

If the rudder power valve circuit breaker is pulled (tripped) or electrical power is lost, the rudder system will remain pressurized.

2. **AUTOPILOT – DISENGAGED (P, CP)**

   Disengage the autopilot if engaged. If the control problem still exists, instruct the copilot to turn the autopilot power switch OFF.

STABILIZER TRIM EMERGENCY OPERATION

Stabilizer trim emergencies result from excessive mistrim or system malfunctions. System malfunctions are either mechanical malfunctions or electrical malfunctions or a combination of both. Mechanical trim malfunctions may lock the horizontal stabilizer in position. Electrical trim malfunctions may result either in inability to trim electrically or a runaway trim condition wherein the horizontal stabilizer is driven toward the full NOSE UP or NOSE DOWN position. Trim malfunctions during takeoff or landing must be counteracted at once to prevent stalling or flying into the ground. During high speed flight, trim malfunctions are also critical as high "g" loads resulting from an uncontrolled trim change could cause structural damage. Elevator control may become marginal to counteract extreme out of trim conditions at certain combinations of cg location and airspeed. If the airplane cannot be controlled by any of the following methods, it will be necessary to abandon the airplane.

CREEPING STABILIZER

A creeping stabilizer is a stabilizer that does not remain in a trimmed position. The stabilizer may move in a direction opposite to control column movement. Movement of the stabilizer can be stopped by the pilot holding the trim wheel to maintain trim position. This malfunction will occur if the stabilizer jackscrew has lost partial or complete braking in one or both directions. Improper servicing of the jackscrew can cause brake slippage. The stabilizer will respond normally to electrical trim operation but it will be necessary to hold the trim wheel to prevent undesired stabilizer movement. With autopilot engaged, the trim wheel may cycle intermittently or continually through a few revolutions. Cycling the stabilizer a few times electrically may cause it to act normally for a short time. The airplane should be landed as soon as practicable.

JAMMED STABILIZER

A "jammed" stabilizer is evident when the stabilizer trim wheel cannot be moved either electrically (normal trim switches) or manually (stabilizer hand crank) with no control column force applied. Such a condition could result from icing, failure of jackscrew actuation mechanism, or anything else which may mechanically cause such locking effect. See MECHANICAL TRIM MALFUNCTION this Section.

An apparent jammed stabilizer may actually be a stalled trim actuator caused by excessive stabilizer-elevator mistrim. Excessive mistrim will occur after takeoff if no pilot trimming is accomplished while the flaps and landing gear are retracted and the airplane accelerates to climb airspeed. To correct pitch up, the pilot usually applies a considerable push force on the control column and in doing so, may stall or "jam" the stabilizer electric trim actuator. The force required to manually or electrically trim the stabilizer increases rapidly as control forces are applied; a force of 75 to 100 pounds on the control column may stall the stabilizer electric trim actuator. Misrigged elevator tabs or worn actuator clutches will reduce the control column force required to stall the electric trim actuator. This is not a system malfunction; all components will operate normally. To obtain stabilizer trim the pilot should reduce control forces to near zero by accomplishing the following:

WARNING

When landing with a differential flap configuration, use the pattern, approach, and touchdown speeds for the minimum flap setting. If the leading edge flaps are not extended, add 6 knots. If the minimum flap setting is zero degrees, pattern, approach, and touchdown speeds should not be increased as this correction is included in the chart.

Stabilizer "jammed" in the airplane nose-up condition (forward pressure required on the control column).

A. Reduce airspeed, if practical.

B. Raise inboard speed brakes as required. (Place outboard spoiler switch to CUT-OFF prior to actuation of the speed brake lever.)

NOTE

The use of approximately 35 degrees of speed brakes has been found to be optimum when considering trim moment increase versus drag increase. Further speed brake deflections continue to provide trim effect, but at a lesser rate and at the expense of more drag.

C. Lower outboard flaps, speed permitting.

CAUTION

Observe flap placard speed.

D. Adjust cg forward. (Use aft body or outboard wing fuel, gravity feed center wing fuel to forward body and/or dump aft body fuel, as necessary.)

CAUTION

Do not move cg forward of the established forward cg limit.

E. Actuate stabilizer trim switch with simultaneous release of control column pressure. This may be performed in several rapid movements until normal trim operation is regained.

NOTE

Step E should be performed initially and after each of the above steps in order to obtain normal trim operation as soon as possible.

Stabilizer "jammed" in the airplane nose down condition. (Back pressure required on the control column.)

WARNING

If the airplane nose down stabilizer trim malfunction is encountered during approach, a go-around should be immediately initiated and a planned approach using the following procedures should be accomplished.

A. Maintain or increase airspeed. (Do not permit airspeed to decrease until airplane attitude is corrected by B, C and D below.)

B. Raise outboard speed brakes as required. (Place inboard spoiler switch to CUT-OFF prior to actuation of the speed brake lever.)

C. Lower inboard flaps, speed permitting. (First, lower all flaps 20 degrees to obtain outboard aileron control.)

D. Adjust cg aft. (Use forward body or inboard wing fuel and/or dump forward body fuel as necessary.)

CAUTION

Do not move cg aft of the established aft cg limit. This can occur very rapidly with indiscriminate fuel dumping and/or transferring. Excessive aft cg will cause pitch stability problems in flight and result in the airplane resting on its tail on the ground.

E. Actuate stabilizer trim switch with simultaneous release of control column pressure. This may be performed in several rapid movements until normal trim operation is regained.

NOTE

Step E should be performed initially and after each of the above steps in order to obtain normal trim operation as soon as possible.

Do not engage the autopilot pitch axis when the stabilizer is out of trim; continuous operation of the autopilot servomotor may damage the engaging mechanism. The stabilizer trim motor is much more effective in moving the stabilizer. However, the trim motor should not be run continuously. Actuation of the trim switch should be coordinated with the release of control column pressure.

ELECTRICAL TRIM MALFUNCTION

Electrical trim malfunctions may result in an inability to trim the airplane electrically. If this occurs, check the control circuit breakers, marked PILOT or COPILOT STABILIZER TRIM on the T-R BUS NO. 1 and the operating power circuit breakers marked STABILIZER TRIM on the GENERATOR NO. 2 section of the MCBP. If the electrical trim malfunction cannot be corrected, it will be necessary to trim the airplane manually. Other malfunctions of the electrical trim system might result in a runaway stabilizer. The first indication of this condition will be the increased fore or aft pressure required on the control column, accompanied by rotation of the trim control wheel. Use the following actions to stop the runaway.

A. Pilot should stop rotation of the manual trim control wheel by grasping it quickly and firmly or by forcing the right leg against the wheel; simultaneously call for the copilot to place stabilizer trim cutout switch in the CUTOUT position.

B. If runaway stabilizer occurs following actuation of a trim switch, the runaway is most apt to be caused by a stuck trim switch and can best be stopped by actuating the same switch in the opposite direction. Actuation of the other trim switch should stall the trim motor; however, this action will deteriorate the motor gearing and is likely to cause failure of the trim motor pinion gear, resulting in complete loss of the electrical trim system.

To isolate the electrical trim malfunction, use the following procedure:

A. To check for malfunctioning trim switch, pull both control circuit breakers, marked PILOT and COPILOT STABILIZER TRIM on the T-R BUS NO. 1 section of the MCBP (figure 1-35, sheet 2). Hold the manual trim wheel firmly and return the stabilizer trim cutout switch to the NORMAL position. Reset either the pilot or copilot control circuit breakers and if no force is felt on the trim wheel, it is safe to resume electrical trim operation with the appropriate trim switch. If one trim switch is found to be malfunctioning, check the other one.

B. When isolation of both trim switches does not eliminate the runaway trim condition, return the stabilizer trim cutout switch to the CUTOUT position and pull the operating power circuit breakers marked STABILIZER TRIM in the GENERATOR NO. 2 section of the MCBP (figure 1-35, sheet 3). Use manual trim for the remainder of the flight.

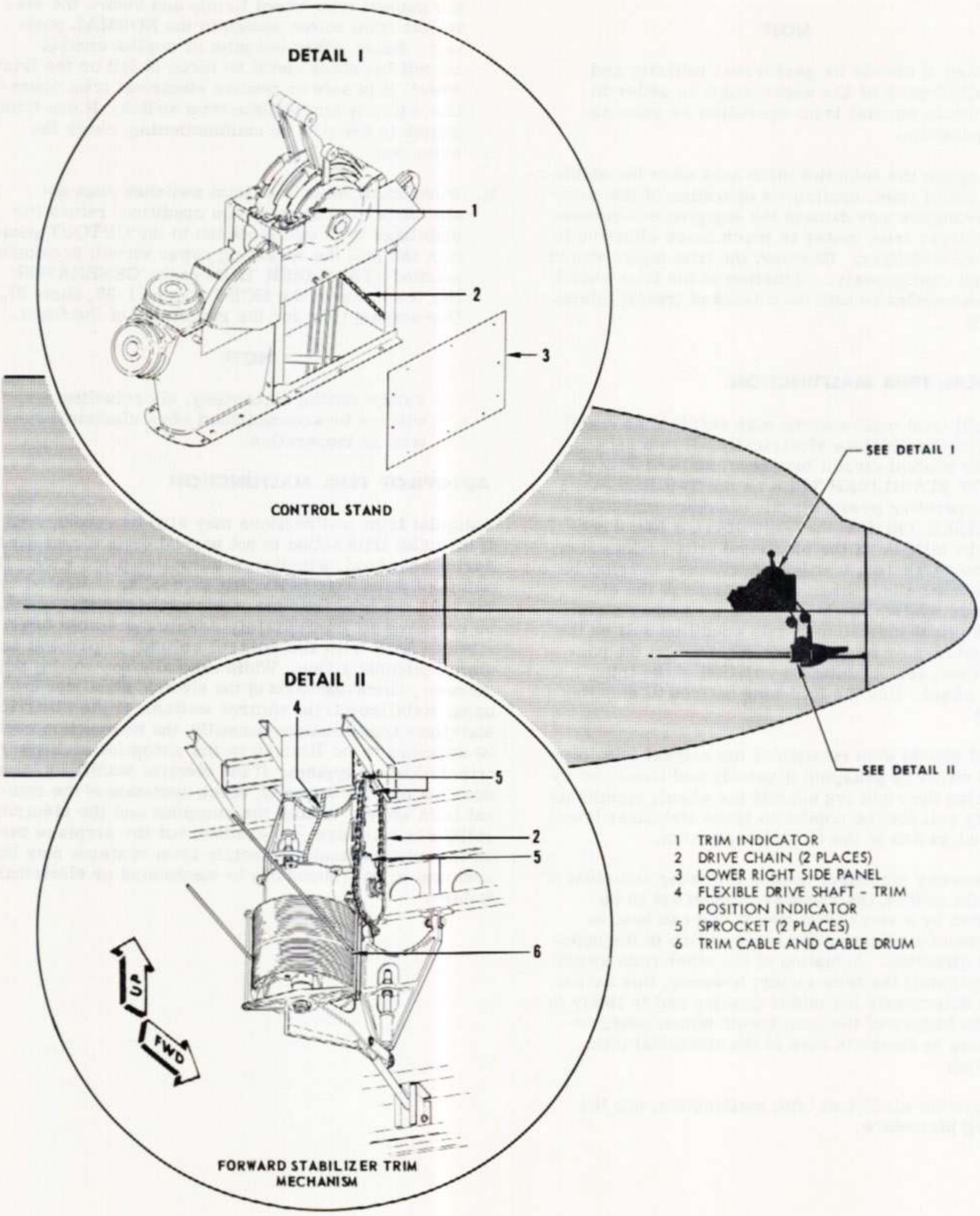
NOTE

Except during emergency, air refueling will not be accomplished when electrical trim is inoperative.

AUTOPILOT TRIM MALFUNCTION

Autopilot trim malfunctions may also be encountered. If autopilot trim action is not normal or is inoperative during checkout, disengage autopilot pitch axis. If autopilot pitch axis is holding torque, as indicated by the trim meter at the time of pitch axis disengagement, be prepared to immediately assume possible heavy elevator load with the control column to prevent an abrupt pitching action. While manually controlling the elevator, check operation of the electric stabilizer trim using stabilizer trim control switch. If the electric stabilizer trim functions normally, the malfunction may be assumed to be limited to the autopilot stabilizer trim follow-up system. If the electric stabilizer trim does not operate normally, check operation of the manual trim wheel. If both the autopilot and the electric stabilizer trim are inoperative, but the airplane can be trimmed manually, electric trim systems may be assumed to be jammed due to mechanical or electrical failure.

STABILIZER MANUAL TRIM MECHANISM



1 TRIM INDICATOR
2 DRIVE CHAIN (2 PLACES)
3 LOWER RIGHT SIDE PANEL
4 FLEXIBLE DRIVE SHAFT - TRIM POSITION INDICATOR
5 SPROCKET (2 PLACES)
6 TRIM CABLE AND CABLE DRUM

F-986
F-987
F-988

Figure 3-17

MECHANICAL TRIM MALFUNCTION

Should it be determined that electrical trim is ineffective due to mechanical trim malfunction, discontinue use of electrical trim and attempt manual trimming. (See also EMERGENCY TRIM OPERATION, this Section.) If the stabilizer is found to be jammed, it may be freed by applying a moderately high force to the trim wheel in the desired direction. If this is not effective, rapidly reverse the direction of trim several times using high forces in each direction. Trim reversal may free a jammed system where a steady force may not. If the airplane cannot be trimmed (even manually), there may be a possibility that the stabilizer jackscrew and/or auxiliary brake unlock gear journal have become frozen. Airplane pitch trim can then be controlled only by use of elevator, speed change, differential spoilers, differential flaps or shift of cg. If the jamming is due to frozen moisture in the mechanism, descent into warmer air (below the freezing level) may free the mechanism and allow normal operation of the stabilizer trim system.

A broken and/or jammed drive chain (2, figure 3-17) in the forward stabilizer trim mechanism may prevent electrical or manual trimming. This malfunction could be recognized by the inability to trim electrically coupled with a free turning or jammed manual trim wheel and no indication of change in trim position. A crew member should be sent to the forward area of the lower nose compartment to definitely establish the malfunction. This requires the crew member to crawl over the nose wheel well then forward to reach the forward manual trim mechanism (Detail II, figure 3-17). Close liaison must be established between the pilot and the crew member in the lower forward compartment; therefore, if a long interphone cord is not available, a second crew member should relay instructions. Two lights are provided in the lower compartment: one light is in the ceiling just inside the aft access door in the crew entry chute with the switch in the upper left on entering; the other light is in the ceiling forward and to the right of the wheel well with the switch adjacent to the light. If the drive chain is found broken and/or jammed, it should be removed.

WARNING

The stabilizer trim cutout switch should be moved to the CUTOUT position before working on the lower mechanism. Inadvertent actuation of the electrical trim could result in injury to the crewmember from the turning sprocket or cable drum.

NOTE

If the drive chain cannot be completely removed from the lower nose compartment, the lower right side panel (3, figure 3-17) on the control stand can be removed giving access to the upper part of the manual trim mechanism.

When removal of the chain is accomplished, an attempt to trim electrically can be made; if trimming does not occur, check the stabilizer trim circuit breakers marked STABILIZER TRIM on the GENERATOR NO. 2 section of the MCBP (figure 1-35, sheet 3). If electric trimming is still not possible, manual trimming may be possible by the crew member in the lower compartment turning the lower sprocket (5, figure 3-17) in the direction instructed by the pilot. The trim indicator will give trim position with the drive chain removed since the indicator is operated by a flexible shaft (4, figure 3-17) connected to the cable drum.

If the stabilizer remains jammed, out of trim conditions may be counteracted by the following procedures: If cruise must be established to reach a suitable landing field, let the airplane seek the speed compatible with the stabilizer setting, provided that speed is within the normal speed range of the airplane. Adjust power to maintain altitude. Prior to landing, the airplane controllability should be checked at no less than 12,000 feet above the terrain. Attempt to shift cg and use differential flaps to arrive at an acceptable landing trim condition without the use of differential speed brakes. This procedure will allow the rapid trim effect of differential speed brakes to be used during the landing as needed. Although use of speed brakes is not recommended for normal landings, the use of differential speed brakes to counteract an out of trim condition is permissible.

EMERGENCY TRIM OPERATION

In the event that the electrical or autopilot systems jam or freeze, manual trim forces would increase to about 30 pounds. This increase is required to disengage the manual trim clutch. Rotating the wheel in the direction of desired trim for approximately one half turn disengages the clutch and continued rotation in the same direction manually positions the trim mechanism. The clutch re-engages when the turning force is removed from the trim control wheel. The greater force required to rotate the trim wheel and a sensation of ratcheting indicate that the manual clutch has disengaged.

NOTE

The pilots' emergency procedures also appear in T.O. 1C-135(K)A-1CL-1 which is an abbreviated checklist. The abbreviated checklist has each numbered step of the normal, alert, and emergency procedures in shortened form.

BOOM OPERATOR'S AND NAVIGATOR'S EMERGENCY PROCEDURES

FUSELAGE FIRE

If fuselage fire is detected, notify pilot on CALL position of interphone.

1. **OXYGEN—100%**

   Don oxygen mask and breathe 100% oxygen. The crewmember not maintaining interphone liaison with the pilot will don the firefighter's mask, connect the mask to a source of 100% oxygen, and don the firefighter's gloves.

2. Fire - Combat

   Upon notification of "Fuselage fire," boom operator and navigator initiate fire fighting procedures.

3. Interphone Liaison - Maintain with pilot (BO or N)

   One crewmember will keep the pilot informed of the fire condition until it is extinguished or uncontrollable.

SMOKE AND FUMES

If smoke and/or fumes are detected, notify pilot on CALL position of interphone.

1. **OXYGEN—100%**

   Don oxygen mask and breathe 100% oxygen.

2. Source and Cause - Locate (ALL)

From Electrical System

1. Electrical Equipment - OFF (if fuel fumes are present) (ALL)
2. Applicable Circuit Breakers - Pull (BO, N, P)

From Air Conditioning System

1. Overhead Air Conditioning Ducts - Check for airflow (P, BO, or N)

EXCESSIVE HEAT ELIMINATION

When directed by the pilot

1. Oxygen Masks - Don

   All crewmembers don oxygen masks and use 100% oxygen.

2. Overhead Air Conditioning Duct - Check for airflow (P, BO, or N)

LANDING WITH GEAR FAILURE

1. Crash Landing Signal - Acknowledge (BO, N, P)
2. Aft Emergency Exit Hatch - Remove (when directed) (BO, N)

   Remove the hatch if loose gear will be jettisoned. See figure 3-7.
3. Loose Gear - Jettison or stow (BO, N)
4. Non-essential Personnel - Bail out
5. Aft Emergency Exit Hatch - Install (N, BO)

   Install the hatch when jettisoning is completed.
6. Engine Hydraulic Oil Fire Shutoff Circuit Breakers - Pull, when directed by pilot (BO or N, P)
7. Crash Landing Position - Assume

   Don helmet, fasten shoulder harness and safety belt. Lock inertia reel.
8. Engine Hydraulic Oil Fire Shutoff Circuit Breakers - Close, when directed by pilot (N, BO)

LANDING WITHOUT NORMAL BRAKE SYSTEM PRESSURE

1. Crash Landing Signal - Acknowledge (BO, N, P)
2. Antiskid Circuit Breaker(s) - Pull (P, BO or N)
3. Crash Landing Position - Assume

   Don helmet, fasten shoulder harness and safety belt. Lock inertia reel.

MAIN FLAP EMERGENCY OPERATION

When cleared by the pilot:

1. Flap Bypass Valve Handle - Pull up and turn 90 degrees CCW (BO or N)

WARNING

On airplanes 1▶19, carefully check that the bypass valve for manual flap operation is fully positioned. The safety arm on the bypass valve handle will allow the crank to be inserted when the valve is not fully seated. System pressurization or a pressure surge could cause rapid rotation of the crank, endangering the operator. To avoid this danger, rotate the receptacle cover in the direction of the indicating arrow to the mechanical stops (approximately 90 degrees). Airplanes 20▶ have safety arms which will not permit the crank to engage until the bypass valve is properly positioned.

NOTE

On airplanes 1▶18, the bypass valve handles cannot be lifted sufficiently to pass over the opposite handle; therefore, only one bypass valve can be positioned at a time. Airplanes 19▶ have redesigned handles which can be raised sufficiently to pass over one another, allowing the inboard and outboard bypass valves to be positioned simultaneously.

2. Main Gear and Flap Emergency Crank - Insert and turn CW to extend flaps or CCW to retract flaps (BO or N)

Starting with the outboard flaps, alternate the lowering of the outboard and inboard flaps, maintaining a maximum of 5 degrees differential.

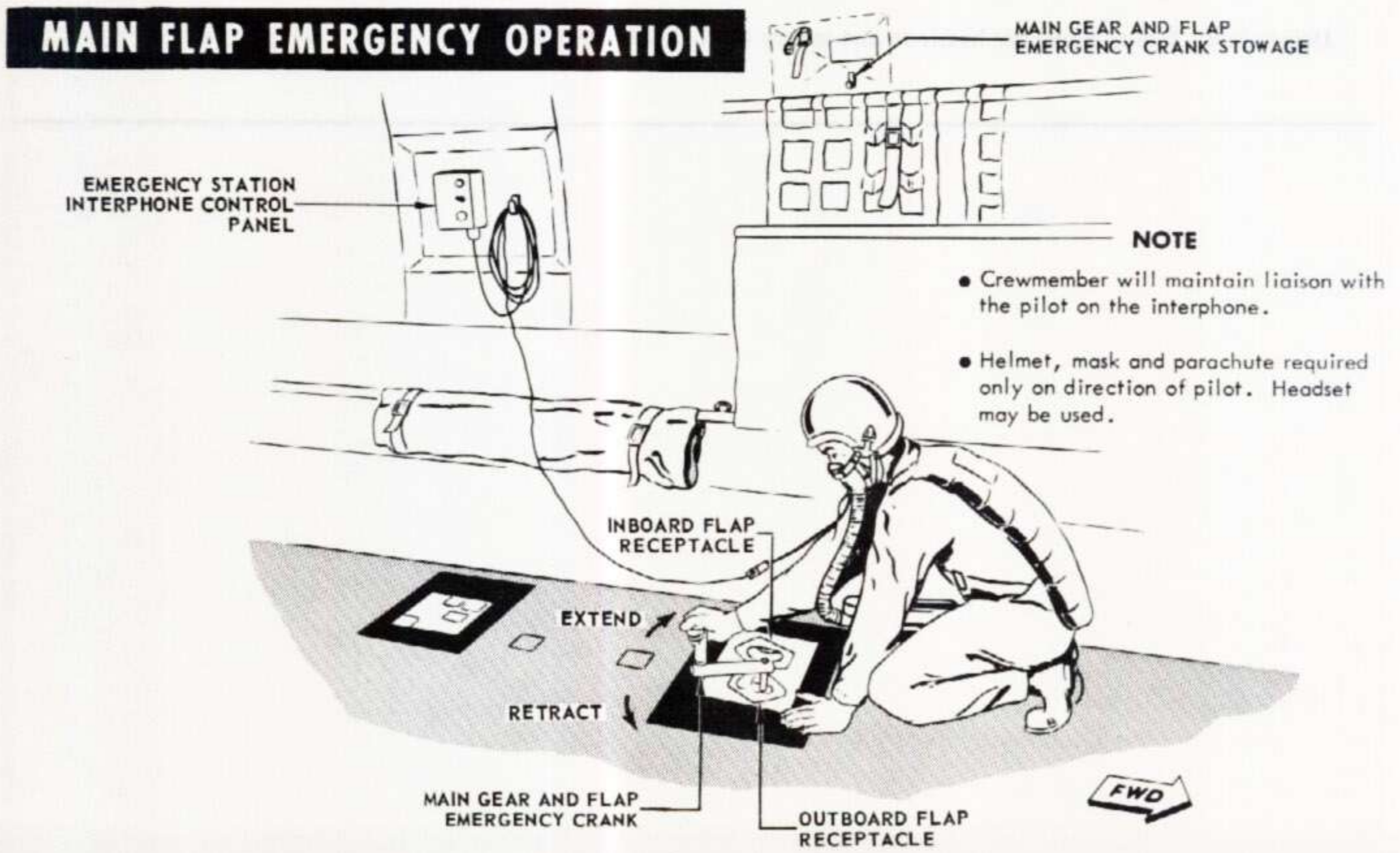


Figure 3-18

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EMERGENCY RETRACTION OF LANDING GEAR

When Landing Gear Lever Will Not Move To The Up Position:

When directed by the pilot accomplish the following:

1. Nose Gear Wheels - Check centering (P, BO, or N)

   When viewed through the inspection window, if not centered, advise pilot of direction they should be moved to center them.

2. Main Gear Leveling Cylinder and Snubber Cylinder - Check attachment (P, BO, or N)

   If one end of leveling cylinder or snubber is loose and swinging free, inform pilot.

3. Truck Level, and Oleo Fully Extended - Check (P, BO, or N)

   Yellow pointer must fall entirely within yellow zone on inner cylinder fork (6, figure 1-49). Yellow mark on torsion link bolt must fall entirely within yellow zone on the torsion link for proper oleo extension (2, figure 1-49).

CAUTION

The two truck level and the two oleo extension indicators must be read carefully. A misread indicator could lead to wheel well damage.

When Gear Indicators Indicate Gear Is Not Up And Locked:

When directed by the pilot accomplish the following:

1. Lock Alignment Stripes - Check alignment (P, BO, or N)

   Check lock alignment stripes for the gear which has the unlocked indication and advise the pilot of their position.

   Airplanes 1▶232

   The nose gear stripes cannot be checked when the gear is up on these airplanes. The stripes will appear misaligned in both locked and unlocked condition.

   Airplanes 233▶

   If nose gear stripes are aligned, gear is locked and position indicator is wrong.

NOTE

When the nose gear is up, the stripes must be viewed through the inspection window in the lower nose compartment.

All Airplanes, Main Gear

If stripes are aligned, gear is locked and position indicator is wrong.

When Landing Gear Lever Warning Light Only Stays On After Gear Is Retracted:

When directed by the pilot accomplish the following:

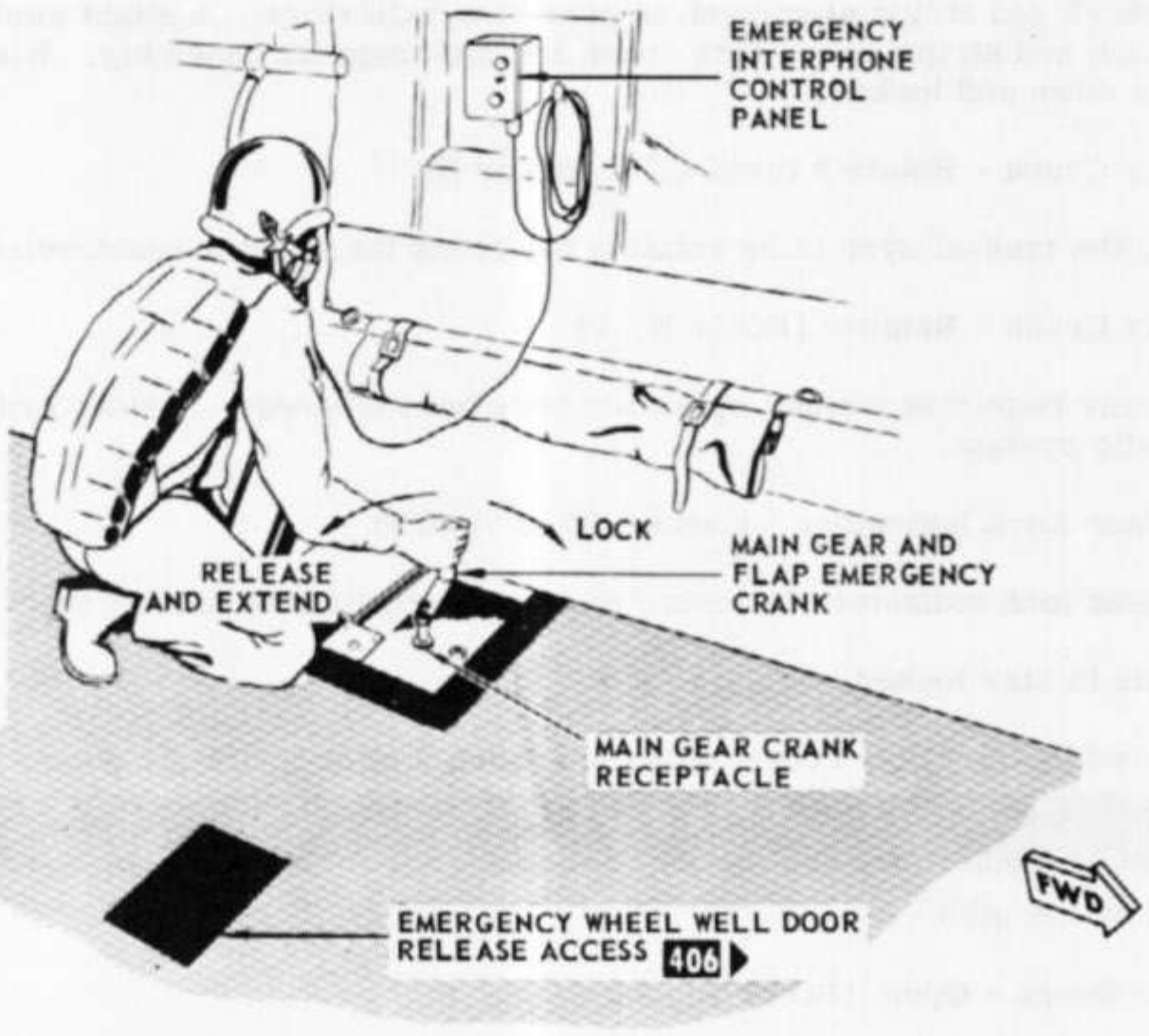
1. Landing Gear Doors - Checked closed (P, BO, or N)

   Visually check doors and advise pilot whether they appear closed or open.

MAIN LANDING GEAR EMERGENCY EXTENSION

NOTE

- Crewmember will maintain liaison with the pilot on the interphone.
- Helmet, mask and parachute required only on direction of pilot. Headset may be used.



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Figure 3-19

MAIN LANDING GEAR EMERGENCY EXTENSION

FAILURE OF LEFT HYDRAULIC SYSTEM. When cleared by the pilot insert main gear and flap emergency crank in gear receptacle and complete the MAIN LANDING GEAR EMERGENCY EXTENSION checklist.

1. Emergency Crank - Rotate 1-1/2 turns CCW (BO or N)

2. Wheel Well Doors - Check open (BO or N)

   Visually check wheel well doors open before performing step 3. On airplanes 406▶, if the doors have not opened, open them by pulling up on the upper cable under the emergency wheel well door release access. (See figure 3-19.)

CAUTION

Rapid completion of three counterclockwise crank turns can allow the gear to fall before the doors have opened sufficiently to clear the path of the free falling gear. This condition is accentuated during extreme low temperature conditions. High viscosity of the hydraulic fluid causes sluggish operation of the door actuator with resultant slow movement of the doors.

3. Emergency Crank - Rotate 1-1/2 turns CCW (BO or N)

4. Landing Gear - Check (BO or N)

   Visually check that the gear has free fallen and stopped moving.

5. Emergency Crank - Rotate CW against stops (BO or N)

   After gear falls, rotate approximately 6 turns CW against the stops.

MAIN LANDING GEAR EMERGENCY EXTENSION (Cont)

6. Stripe Alignment - Check (BO or N)

   Visually check red stripe alignment on gear lock indicators. A slight amount of pressure against the crank will align the red stripe on the lock crank and lock support assembly. When the two stripes are aligned, the gear is down and locked.

7. Emergency Crank - Rotate 3 turns CCW (BO or N)

   Neutralize the manual system by rotating the crank three turns counterclockwise.

8. Emergency Crank - Remove (BO or N, P)

   After all gear requiring manual operation have been extended, remove crank and clear pilot to repressurize the hydraulic system.

9. Landing Gear Lock Indicators - Check (BO or N, CP)

   Recheck gear lock indicators to insure that pressurization of landing gear system did not unlock the gear.

If the gear fails to stay locked:

When cleared by the pilot, repeat steps 5 through 9 after hydraulic pumps have been isolated.

NOSE GEAR EMERGENCY EXTENSION

When cleared by the pilot:

1. Nose Gear Doors - Open (BO or N)

   Pull both sections of the nose gear door release and access cover up and forward to open the nose wheel well doors. Hold open until step 2 is completed. (Place foot on cover as shown in figure 3-20.)

2. Handle - Move full forward (BO or N)

   Insert nose gear ground down lock and release handle with striker pointed aft. Move the handle forward to release the nose gear. Allow 3 to 4 seconds for the gear to fall. Hold forward until step 3 is completed.

NOTE

If the nose gear ground down lock and release handle cannot be moved into the gear release position (full forward), apply as much force as possible without using additional leverage. If one man cannot exert sufficient force, use additional crewmen before accepting a nose gear up landing as inevitable.

3. Stripes - Check for close proximity (BO or N)

   Visually check that the gear is down and that the red stripes on the drag strut and lock rod are in close proximity.

4. Handle - Move full aft and lock (BO or N)

   Move nose gear ground down lock and release handle aft and engage striker on locking hook.

WARNING

Do not move the release handle aft until it has been determined that the nose gear is down. If the handle is moved aft too soon and the gear has started to free fall, force can be transmitted to the handle and break the handle if the striker is locked on the hook, thus endangering the operator.

5. Stripes - Check alignment (BO or N, CP)

   Visually check the nose gear down and locked. The red stripes on the drag strut and the lock rod are aligned when the gear is locked. Check with the copilot for a down and locked indication.

If the nose gear does not extend by use of steps 1 thru 5, the following steps may be attempted to provide hydraulic assistance.

CAUTION

Use of hydraulic assistance for emergency nose gear extension may cause either the door release cable or the door release cable shear pin to break. Therefore, the nose gear must be left down and locked for the remainder of the flight.

WHEN CLEARED BY THE PILOT:

6. Nose Gear Door Release and Access Cover - Pull up and forward (BO or N)

   Hold open until step 9 is completed. (Place foot on cover as shown in figure 3-20.)

7. Nose Gear Ground Down Lock and Release Handle - Move full forward and hold until step 9 is completed. (BO or N)

Insert with striker pointed aft. Moving the handle forward releases the nose gear.

WARNING

Before moving the release handle forward, the operator must be positioned forward of the release handle. Any motion transmitted to the release handle will be in the aft direction and could cause possible injury to an operator pushing the release handle from the aft side.

NOTE

If the nose gear ground lock and release handle cannot be moved into the gear release position (full forward), apply as much force as possible without using additional leverage. If one man cannot exert sufficient force, use additional crewmen before accepting a nose gear up landing as inevitable.

NOTE

- Crewmember will maintain liaison with the pilot on the interphone.
- Helmet, mask and parachute required only on direction of pilot. Headset may be used.

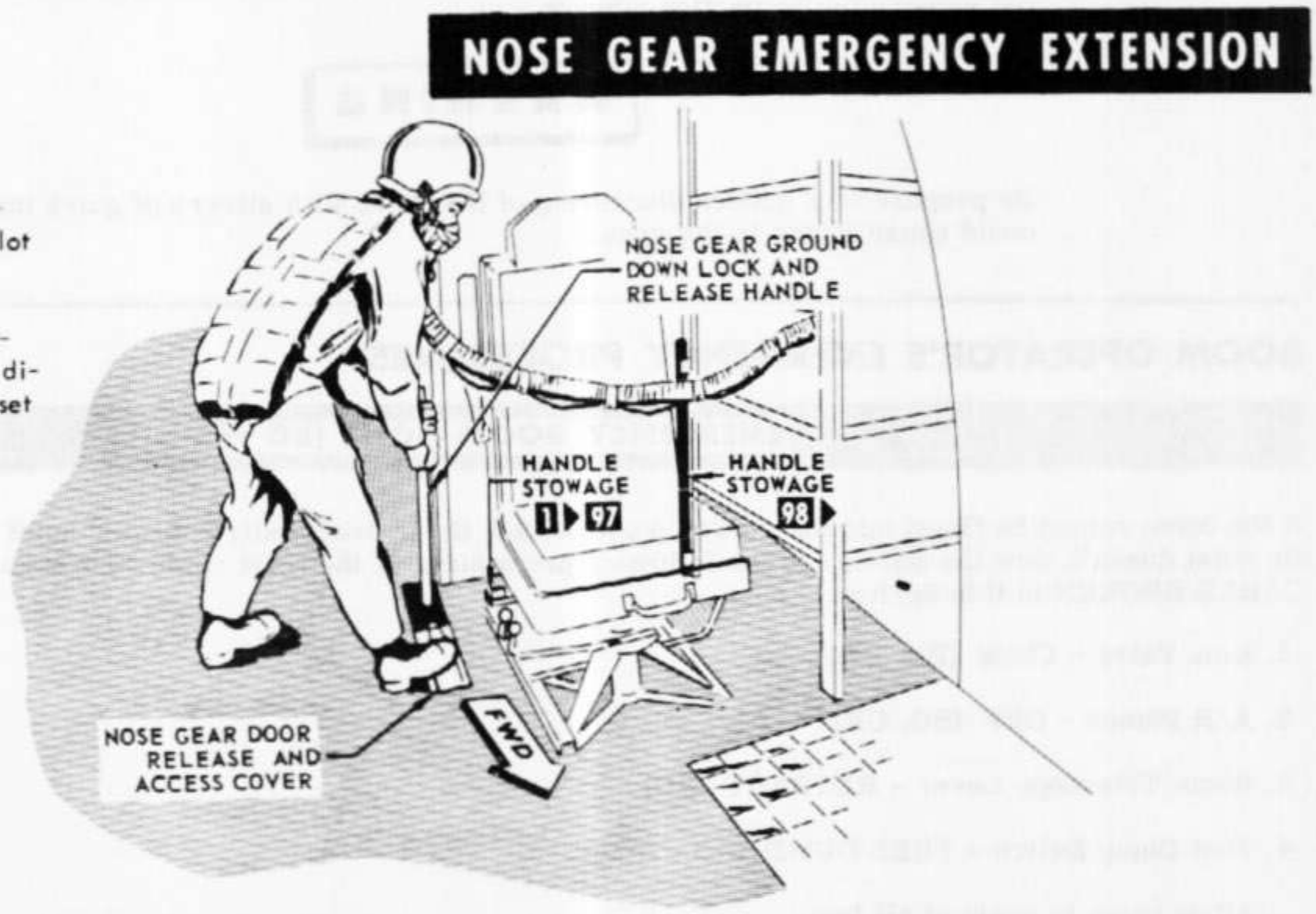


Figure 3-20

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NOSE GEAR EMERGENCY EXTENSION (Cont)

8. Crossover Valve Lever Normal, LH System Pressure Switch ON - NORMAL AND ON (CP, P, BO or N)

   If LH hydraulic system has failed, position crossover valve lever to RH SYSTEM.

9. Gear Lock Indicators - Check alignment of stripes (BO or N)

   Visually check that the gear is down and that the red stripes on drag strut and lock rod are in close proximity.

10. Nose Gear Ground Down Lock and Release Handle - Move aft and engage striker on locking hook (BO or N)

WARNING

Do not move the release handle aft until it has been determined that the nose gear is down. If the handle is moved aft too soon and the gear has started to free fall, force can be transmitted to the handle and break the handle if the striker is locked on the hook, thus endangering the operator.

11. Gear Lock Indicators - Check alignment of stripes (BO or N, CP)

Visually check the red alignment stripes on the drag strut and the lock rod. The gear is locked when the stripes are aligned. Check with the copilot for a down and locked indication. (An unsafe position indicator, with stripes aligned, would indicate a possible electrical malfunction.)

NOTE

If visual observation fails to confirm gear down and stripes aligned, or if stripes are observed misaligned, it may be possible to insert the nose gear external downlock through the inspection window in the lower nose compartment. Removal of the window is accomplished by removing seven wingscrews and pulling the window lift (metal finger hook). Insure the aircraft is depressurized before attempting to remove the inspection window. It is recommended that a lanyard be attached to the nose gear external downlock prior to window removal to prevent loss of the downlock in case it is dropped. If the wingscrews cannot be removed, or time is critical, use the crash axe to break and remove the inspection window.

WARNING

Be prepared for sudden shattering of the glass with slivers of glass that could cause injury to the eyes.

BOOM OPERATOR'S EMERGENCY PROCEDURES

EMERGENCY BOOM HOIST (BO reads)

If the boom cannot be flown into the stowed position, use the hydraulically operated hoist system. If the hydraulic hoist doesn't stow the boom, use the following procedure. If the hoist cable is broken, see BOOM HOIST CABLE BROKEN in this Section.

1. Line Valve - Close (BO, CP)

2. A/R Pumps - OFF (BO, CP)

3. Boom Telescope Lever - RETRACT (BO)

4. Fuel Dump Switch - FUEL DUMP (BO, CP)

   Allow boom to drain of all fuel.

EMERGENCY BOOM HOIST (Cont)

5. Fuel Dump Switch - NORMAL (BO, CP)
6. Boom Hoist Lever - RAISE (BO)
7. Boom - Fly up as far as possible (BO)
8. Boom Hoist Manual Bypass Shutoff Valve - EMERGENCY BOOM HOIST (BO, N)

   Navigator positions valve after boom operator has flown boom up.

9. Boom Hoist Hand Pump - Actuate (BO, N)

   It will be necessary for the navigator to continue pumping while the boom operator is latching the boom to prevent the boom from creeping down.

10. Boom Latching Lever - LATCHED (BO)

NOTE

It may be necessary to reduce the airplane speed before it is possible to pump the boom high enough to be latched.

11. Boom Hoist Manual Bypass Shutoff Valve - NORMAL (N)

BOOM HOIST CABLE BROKEN

Consideration should be given to landing with the boom in trail anytime the boom hoist cable breaks with more than 5 feet of cable attached to the boom. There is a distance of approximately 8 feet between the boom hoist cable attaching point and the ruddevators; this distance can be used to gage the length of cable left attached to the boom. When the boom is stowed, a hoist cable length of approximately 5 to 8 feet left attached to the boom can whip in the slipstream and cause damage to the elevators. Cable lengths of approximately 8 feet or more can whip in the slipstream causing damage to the ruddevators. Prior to completion of step 1, in the following checklist, determine how much cable is attached to the boom. If it can be determined that 5 feet or more is attached to the boom, leave the boom in trail and check to see if cable whip is damaging the elevators or ruddevators. Slower airspeeds will allow the boom to trail at a lower elevation to further reduce the possibility of cable whip damage. If it is decided to land with boom in trail, see LANDING WITH BOOM IN TRAIL, this Section.

NOTE

In the event of cable breakage, refueling may be continued if the situation warrants an emergency offload.

1. Boom - Fly into stowed position (BO)
2. Boom Latching Lever - LATCHED (BO)
3. Sighting Door - Close (BO)
4. Ruddevators - Check locked (BO)

LANDING WITH BOOM IN TRAIL

1. Boom Telescope Lever - RETRACT (BO)
2. Line Valve - Close (BO, CP)
3. Fuel Dump Switch - FUEL DUMP (BO, CP)
4. Fuel Dump Switch - NORMAL (BO, CP)

LANDING WITH BOOM IN TRAIL (Cont)

5. Boom Controls - Operate (BO)

If the boom cannot be latched, damage to the boom can be minimized by: (a) opening the sighting door just prior to landing (on booms with power ruddevators), (b) delay the boom from contacting the runway by holding the ruddevator control stick in the full up position, and (c) close sighting door as soon as boom contacts runway (on booms with power ruddevators).

BAILOUT PREPARATION

Three Short Rings on the Alarm Bell

1. Bailout Signal - Acknowledge (BO, P)
2. Boom - Stow (if applicable)

Boom operator will stow boom if time permits or if an immediate bailout is called, he will fly the boom as far up as possible and place the hoist control lever in the RAISE detent.

3. Over Land - Go to control cabin (on interphone)

Over Water - (a) Stand by to open hatches (on interphone)
(b) Don anti-exposure suit, if time permits
(c) Don life vest

4. Parachute - Don and check
5. Helmet and Oxygen Mask - Don and attach bailout bottle
6. Survival Kit - Attach
7. Emergency Exit Hatches - Open when directed by the pilot

When directed by the pilot to open hatches, the boom operator will open the aft hatch first, then the left overwing hatch.

One Long Ring on the Alarm Bell

8. Over Land - (a) Chinning Bar - Pull down (BO or N)
(b) Crew Entry Chute Floor Grille - Raise (BO or N)
(c) If jumpmaster, go ahead of copilot and pilot but after all other occupants.

Over Water - (a) Life Raft - Release
(b) Bail out from crew entry chute (time permitting, otherwise aft emergency exit hatch)

DITCHING PREPARATION

1. Ditching Signal - Acknowledge (BO, P)
2. Boom - Stow
3. Unnecessary Electrical Equipment - Off
4. Cargo Compartment Lights - On
5. Aft Emergency Exit Hatch - Remove (when directed) (BO, N)

When directed by pilot, remove the aft hatch. See figure 3-7.

6. Loose Gear - Jettison or stow (BO, N)

7. Aft Emergency Exit Hatch - Install (BO, N)

8. Anti-exposure Suit - Don

8A. Life Vest - Don

9. Ditching Position - Assume

Don helmet, fasten shoulder harness and safety belt. Lock inertia reel.

10. Provide - Life raft, first aid kits, flashlight, parachute, and antiexposure unit.

11. Exit - Left overwing hatch

NOTE

The boom operator's emergency procedures also appear in T.O. 1C-135(K)A-1CL-3, which is an abbreviated checklist. The abbreviated checklist has each numbered step of the normal, alert, and emergency procedures in shortened form.

NAVIGATOR'S EMERGENCY PROCEDURES

EMERGENCY BOOM HOIST

When directed by the boom operator:

1. Boom Hoist Manual Bypass Shutoff Valve - EMERGENCY BOOM HOIST (N, BO)

Navigator positions valve after boom operator has flown boom up.

2. Boom Hoist Hand Pump - Actuate (N, BO)

It will be necessary for the navigator to continue pumping while the boom operator is latching the boom to prevent the boom from creeping down.

3. Boom Hoist Manual Bypass Shutoff Valve - NORMAL (N)

Reposition valve after boom is latched.

BAILOUT

Three Short Rings on the Alarm Bell

1. Bailout Signal - Acknowledge (N, P)

2. Parachute - Don and check

3. Helmet and Oxygen Mask - Don and attach bailout bottle

4. Survival Kit - Attach

5. IFF - EMER

Place IFF master switch in EMER.

BAILOUT (Cont)

6. Position Report - Transmit (if required)

   Transmit airplane position report in accordance with FLIP Enroute Supplement. This step may be required, depending on circumstances and location of bailout.

One Long Ring on the Alarm Bell

7. Chinning Bar - Pull down (N or BO)

8. Crew Entry Chute Floor Grille - Raise (N or BO)

9. Bail Out Through Entry Chute

DITCHING PREPARATION

1. Ditching Signal - Acknowledge (N, P)

2. IFF - EMER

   Place IFF master switch in EMER.

3. Position Report - Transmit (if required)

4. Aft Emergency Exit Hatch - Remove (when directed) (N, BO)

   When directed by the pilot, remove the aft hatch.

5. Loose Gear - Jettison or stow (N, BO)

6. Aft Emergency Exit Hatch - Install (N, BO)

7. Anti-Exposure Suit - Don

7A. Life Vest - Don

8. Ditching Position - Assume

   Don helmet, fasten shoulder harness and safety belt. Lock inertia reel.

9. Absolute Altitude - Give to pilot (if required) (N, P)

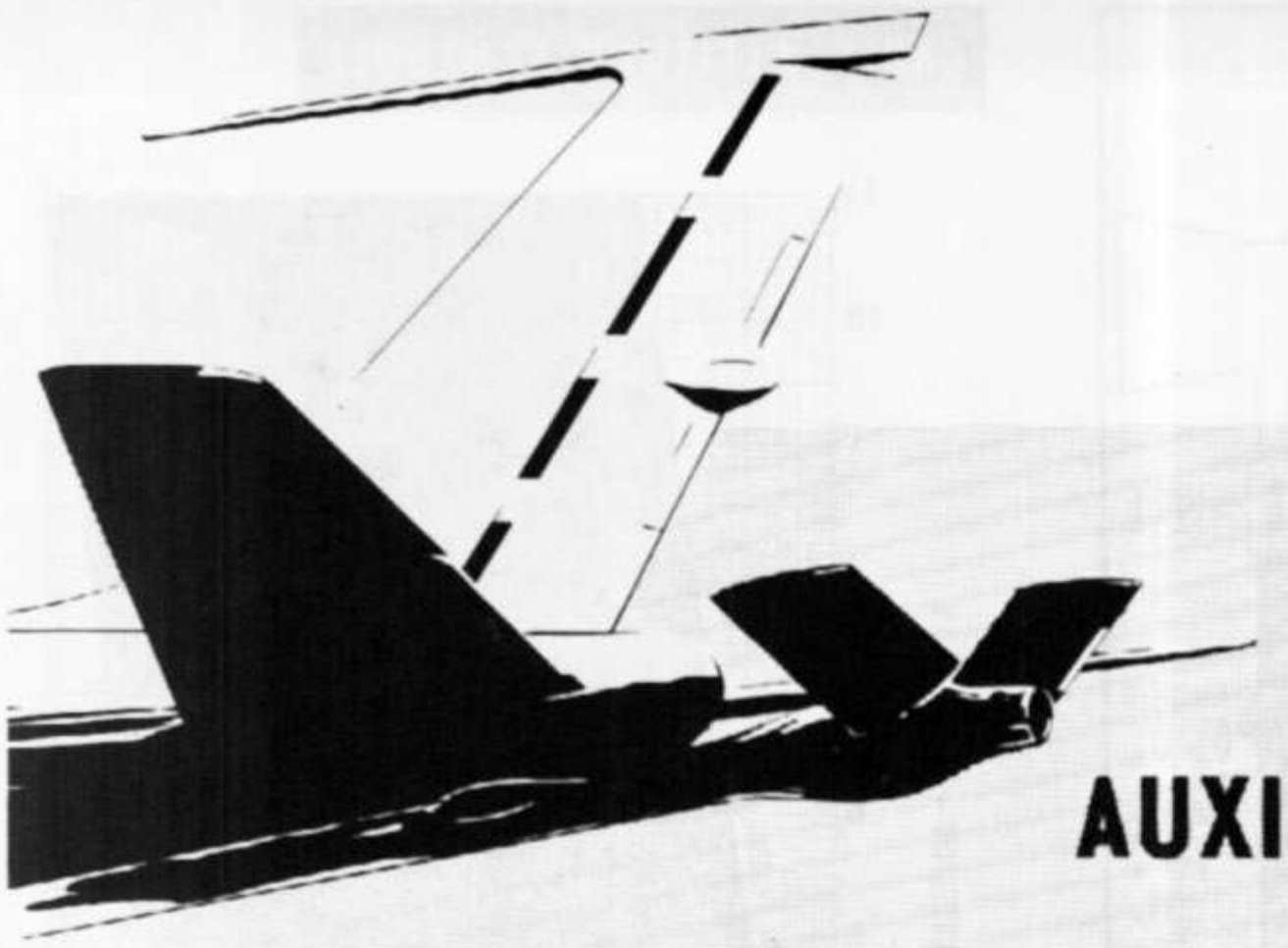
   If local altimeter setting is not available, obtain absolute altitude and give to pilot. Pilot will set absolute altitude on his pressure altimeter. Pilot may use radio altimeter to determine absolute altitude below 2500 feet.

10. Provide - Navigation kit, flashlight, water, parachute and anti-exposure suit.

11. Exit - Left overwing hatch

NOTE

The navigator's emergency procedures also appear in T.O. 1C-135(K)A-1CL-2 which is an abbreviated checklist. The abbreviated checklist has each numbered step of the normal, alert, and emergency procedures in shortened form.



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Section IV

AUXILIARY EQUIPMENT

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ENGINE AIR BLEED SYSTEM

An engine air bleed system (figure 4-1) furnishes low pressure, medium temperature air from the low pressure compressor of each engine for the pneumatic starters, window defrosting, and air conditioning. Low pressure bleed air also is provided for stabilizer trim actuator pressurization, through the air conditioning system. Engine bleed air is ducted into an engine bleed manifold connecting all four engines. High pressure, high temperature bleed air is ducted from the high pressure compressor of each engine, through pressure regulating devices to pressurize the hydraulic reservoirs in each wing, to drive the engine water pumps, for nacelle and engine anti-icing and ground air ejector for the oil cooler. A check valve is provided in the bleed line of each system from each engine to prevent loss of bleed air in case of engine failure. Refer to Parts 2, 3, and 4 of the Appendix, T.O. 1C-135(K)A-1-1, for effect on engine thrust. On airplanes 1▶97 a ground air connection is provided on the lower right side of the fuselage near the wing leading edge for ground operation of low pressure systems when engine bleed air is not available; on airplanes 98▶ the ground air connection is on the left side.

LOW PRESSURE ENGINE AIR BLEED SYSTEM

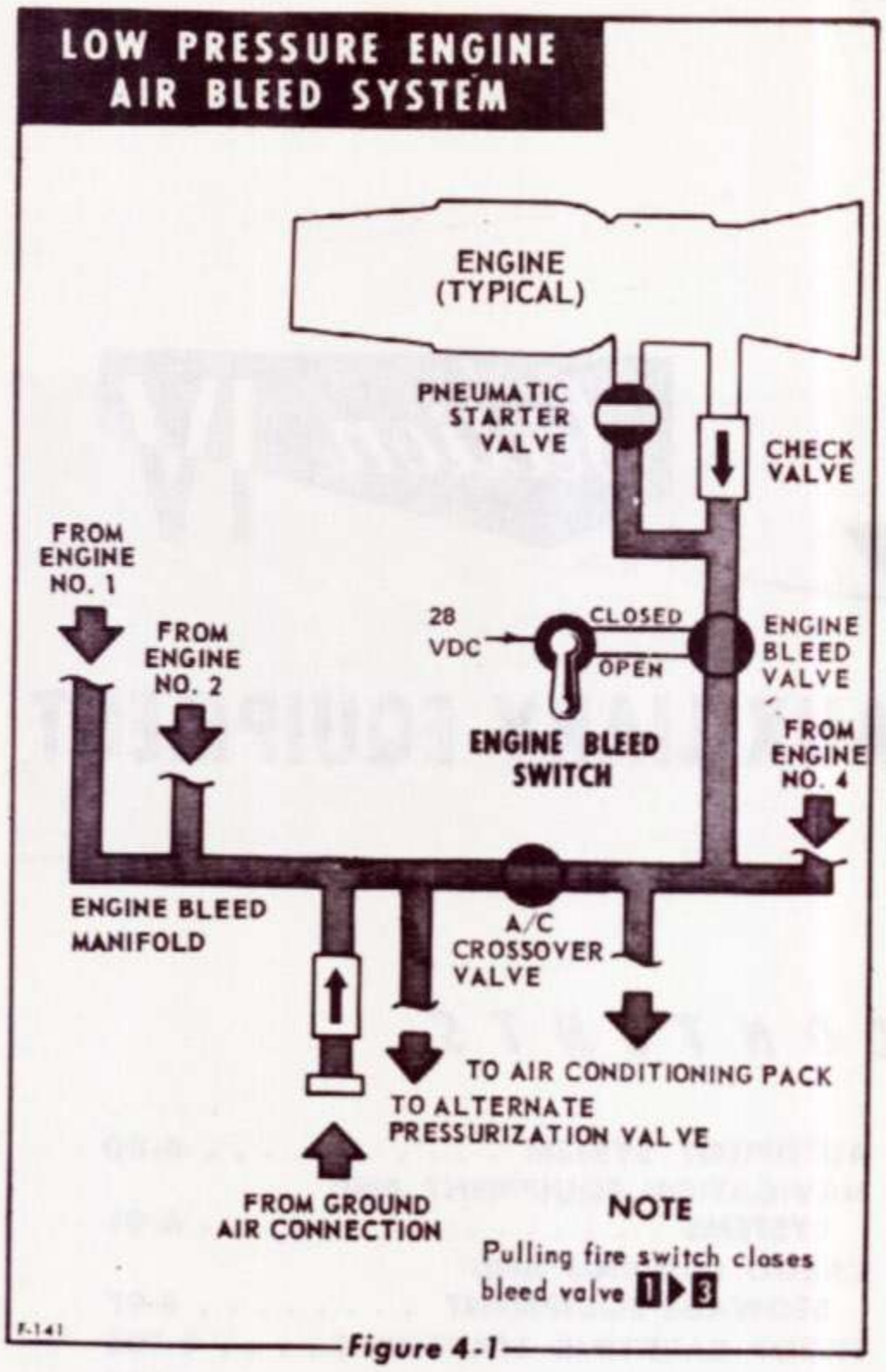
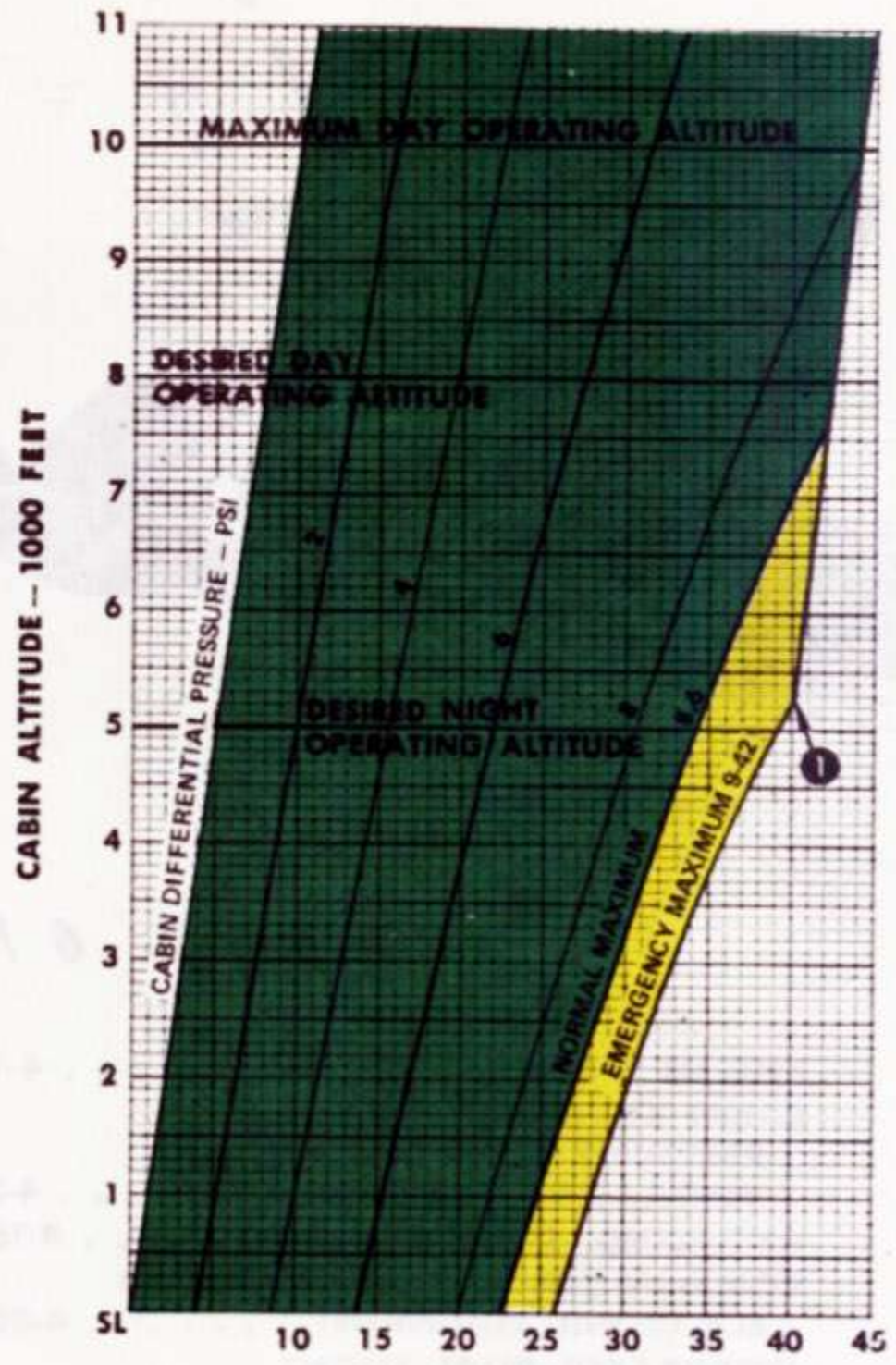


Figure 4-1

CABIN ALTITUDE SCHEDULE



EXAMPLE: During a mission at 30,000 ft it is desired to reduce cabin differential pressure to 6 psi because of a window crack.
SOLUTION: Increase cabin altitude to 9300 feet

❶ Estimated maximum cabin altitude during cruise as limited by engine bleed performance.

CONSTANT CABIN ALTITUDE

DIFFERENTIAL CABIN ALTITUDE

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Figure 4-2

ENGINE BLEED SWITCHES

Four engine bleed switches (3, figure 4-5) with OPEN--CLOSED positions are on the air conditioning panel. Each engine bleed switch will open or close its respective engine bleed valve. On airplanes 1▶3 pulling the engine fire switch will close the engine bleed valve regardless of engine bleed switch position. The engine bleed switches should remain in the OPEN position at all times except when necessary to close the valves for emergency procedures. Operating power is 28 volt DC through 4 circuit breakers marked ENGINE BLEED AIR SHUTOFF 1, 2, 3, 4 on the SBCBP (figure 1-35, sheet 1).

ENGINE FIRE SWITCHES 1▶3

The fire switch (2, figure 1-16) for each engine can be pulled to shut off the bleed valve for that engine. See ENGINE FIRE SWITCHES AND WARNING LIGHTS in Section I.

CABIN AIR CONDITIONING, PRESSURIZATION AND VENTILATING SYSTEM

Air conditioning and cabin pressurization allow the crew to perform their duties with maximum efficiency at a maximum operating altitude. A pressurizing schedule (figure 4-2) shows cabin altitudes that can be maintained for any given airplane altitude. The recommended maximum cabin altitude to maintain conditions for efficient crew operation is 8000 feet for day and 5000 feet for night. Complete control of the system is from the pilots' station. After the system is turned on, its operation is mainly automatic and requires little attention. Both heating and cooling are available to make the airplane easily adaptable to both tropical and arctic conditions.

NOTE

When operating for extended periods at altitudes of 20,000 feet or below, the recommended cabin altitude for normal climb and cruise is field pressure altitude plus 500 feet, with the differential control and controller operating normally. If the cabin gets too warm, adjust the cabin altitude upward.

AIR CONDITIONING SYSTEM

The air conditioning system (figure 4-3 and 4-4), incorporates a "boot strap" air cycle refrigeration system using hot bleed air from the low pressure compressor engine air bleed system. Air is routed from the engine air bleed system and as it passes through the primary heat exchanger, heat is extracted by ram air flowing across the heat exchanger cooling tubes. The air then enters the air cycle machine at the compressor side and is compressed; this action raises the temperature thus more heat is extracted as it passes th.ough the secondary heat exchanger. As the air leaves the secondary heat exchanger it is expanded through the turbine side of the air cycle machine causing a considerable further drop in temperature. Expanding the air through the turbine turns the turbine which is connected to the compressor. After leaving the air cycle machine the air enters the water separator. The 35° F control system valve controls the temperature of the air in the water separator to a minimum of approximately 35° F +5° F or -2° F. A thermostat in the water separator modulates the 35° F control valve to introduce hot air into the water separator; the valve will be full open when the air in the water separator drops to approximately 33° F and will be closed when the air rises to approximately 40° F. If the air is too cool for distribution as it leaves the water separator, warm air is added through the hot air bypass valve. The conditioned air then is distributed through ducts throughout the airplane. The overhead air conditioning distribution duct is protected from overpressurization by blow out panels in the duct. These blowout panels are held in place by spring hinges and the panels will return to their proper position when normal pressure is restored to the duct. The air flow through the air conditioning system is limited by the air flow controller which is automatic in its operation and depends on sensing lines connected to a venturi section downstream of the air conditioning shutoff valve. If the air flow control valve is open and the air flow rate fails below a minimum rate for ventilation, the air cycle machine bypass valve will open and bypass enough air to maintain a minimum air flow for ventilation. A ground air ejector is provided to move ambient air through the heat exchangers for cooling during ground operation. Refer to Part 2 of the Appendix, T.O. 1C-135(K)A-1-1, for effect of air conditioning system on engine thrust.

Engine Bleed Switches

One or more engine bleed switches (3, figure 4-5) must be in the OPEN position before the air conditioning system can be operated. For more information on the engine bleed switches see ENGINE AIR BLEED SYSTEM this Section.

Air Conditioning Master Switch

This channel guarded switch (4, figure 4-5) on the air conditioning control panel has COND AIR--OFF--RAM AIR positions. It controls the air conditioning shutoff valve, the ram air valve, the alternate pressurization valve and the ground air ejector valve through the ground safety switch. When the air conditioning master switch is in the COND. AIR position and the airplane is airborne, the air conditioning shutoff valve will be open, the ground air ejector valve and the ram air valve will be closed. When the airplane is on the ground, and the air conditioning master switch is placed in the COND AIR position, the air conditioning shutoff valve and ground air ejector valve are not interconnected but will open at the same time. The OFF position of the air conditioning master switch closes the air conditioning shutoff valve, ground air ejector valve, and the ram air valve. When the air conditioning master switch is moved to the RAM AIR position, the air conditioning shutoff valve, the alternate pressurization valve and the ground air ejector valve will be closed, and the ram air valve will be opened. Cabin air is prevented from flowing out the ram air duct by a check valve in the conditioned air duct thus preventing distribution duct collapse due to differential pressure. Operating power is 28 volt DC with circuit protection for the A/C shutoff valve through a circuit breaker marked AIR CONDITIONING SHUTOFF VALVE on the SBCBP; the ground air ejector valve through a circuit breaker marked GROUND AIR EJECTOR on the SBCBP; the ram air valve through a circuit breaker marked RAM AIR on the SBCBP; the alternate pressurization valve through a circuit breaker marked ALT PRESS AFT TEMP CONTROL on the SBCBP (figure 1-35, sheet 1). Control power through the A/C master switch for the A/C temperature control is 28 volt DC through a circuit breaker marked AIR CONDITIONING AUTOMATIC CONTROL on T-R BUS NO. 1 of the MCBP (figure 1-35, sheet 2).

Cabin Temperature Control

The cabin temperature control (1, figure 4-5) is a rotary switch and dial on the air conditioning control panel. Cabin temperature control is operative only when the air conditioning master switch is in the COND AIR position. The upper half of the dial has AUTOMATIC, COOLER--WARMER positions and the lower half of the dial has MANUAL, COOLER--WARMER

AIR CONDITIONING AND PRESSURIZATION

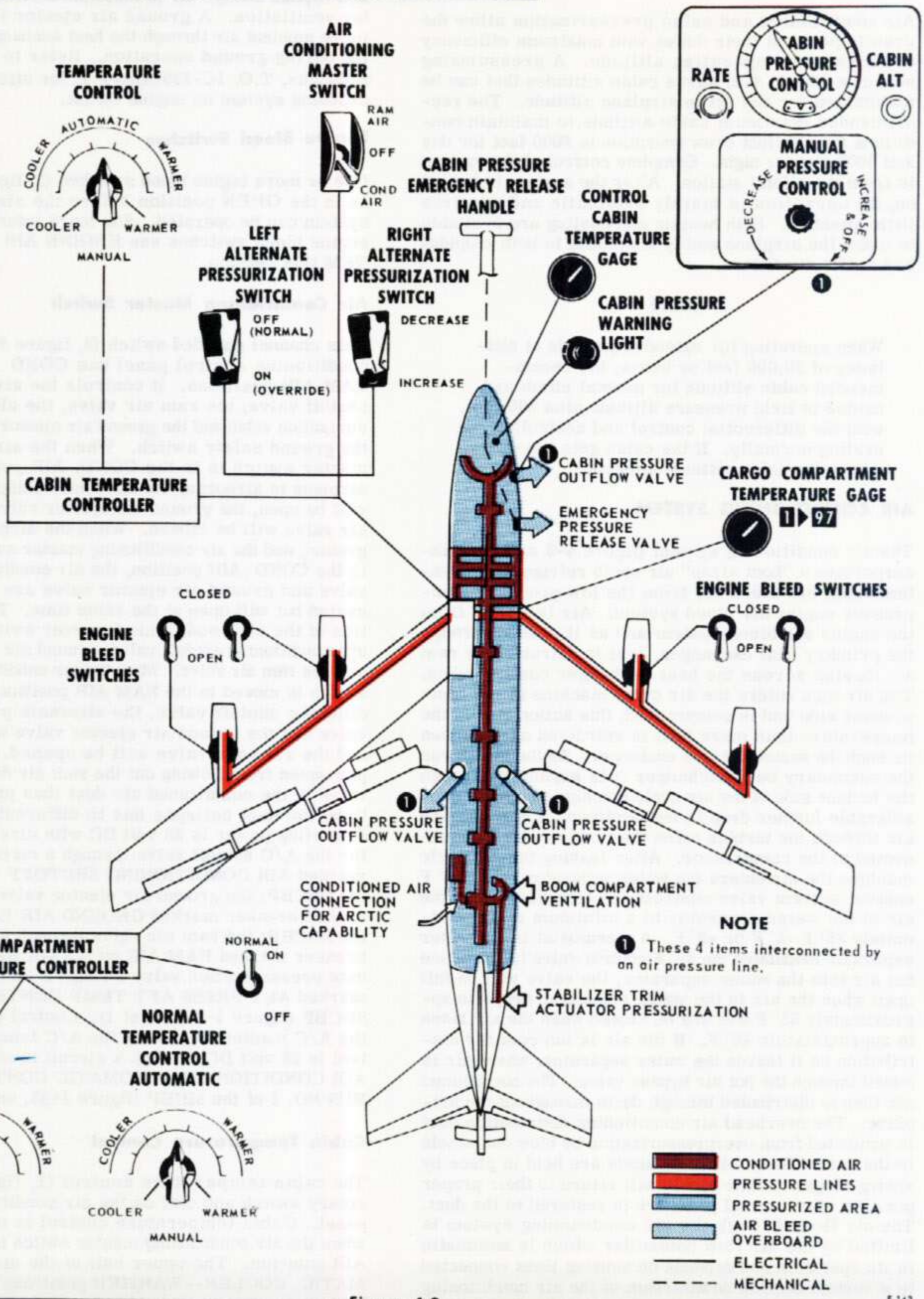


Figure 4-3

positions. The selector is spring-loaded when in the MANUAL range from the COOLER and WARMER positions to the neutral position. When the selector is placed in the AUTOMATIC range, control cabin temperatures from 20° to 100° F can be selected and the selected temperature will be maintained to the limit of the system capacity. When the selector is moved to the MANUAL range the automatic feature is inoperative and control cabin temperature is controlled manually. Holding the selector in the WARMER position during MANUAL control, will actuate the hot air bypass valve to increase the flow of warm air and decrease the flow of cool air to the cabin; the COOLER position will increase the flow of cool air and decrease the flow of warm air into the cabin. Operating power for the hot air bypass valve is 115 volt AC through the cabin temperature control from a circuit breaker marked HOT AIR BYPASS on GENERATOR NO. 1 of the MCBP (figure 1-35, sheet 3). Operating power for the cabin temperature control is 115 volt AC through a circuit breaker on airplanes 1▶70, marked TEMPERATURE CONTROL, and on 71▶ marked CONTROL CABIN TEMPERATURE CONTROL on GENERATOR NO. 2 of the MCBP (figure 1-35, sheet 3). Control power for the temperature control is 28 volt DC through the A/C master switch from a circuit breaker on airplanes 1▶70 marked AIR CONDITIONING AUTOMATIC CONTROL and on 71▶ marked AIR CONDITIONING, CONTROL CABIN on T-R BUS NO. 1 of the MCBP (figure 1-35, sheet 2).

Left Alternate Pressurization Switch

This switch (7, figure 4-5) on the air conditioning control panel has ON--OFF positions (airplanes prior to 98 may have NORMAL--OVERRIDE positions) and is guarded to the OFF (NORMAL) position. When the left alternate pressurization switch is in the OFF (NORMAL) position and the air conditioning master switch is in the COND AIR or OFF position, signals from the cargo compartment temperature regulator will modulate the alternate pressurization valve to maintain the cargo compartment temperature selected on the cargo compartment temperature control. The ON (OVERRIDE) position of the switch bypasses the cargo compartment temperature regulator and allows the pilot to use the right alternate pressurization switch to manually regulate the alternate pressurization valve when the air conditioning master switch is in the COND AIR or OFF position.

Right Alternate Pressurization Switch

This switch (6, figure 4-5) on the air conditioning control panel has INCREASE--OFF--DECREASE positions and is spring loaded and guarded to the neutral OFF position. When the air conditioning master switch is in the COND AIR or OFF position and the left alternate pressurization switch is in the ON (OVERRIDE) position, actuating the right alternate pressurization switch in INCREASE will drive the alternate pressurization valve toward the open position to increase the flow of hot air to the cargo and boom operator's compartment; the DECREASE position will drive the alternate pressurization valve toward the closed position to decrease the flow of hot air going to the cargo and boom operator's compartment. The alternate pressurization valve requires approximately 20 seconds from full open to full closed. Operating power is 28 volt DC and circuit protection is through a circuit breaker marked ALT PRESS AFT TEMP CONTROL on the SBCBP (figure 1-35, sheet 1).

A/C Crossover Switch

The A/C crossover switch (5, figure 4-5) on the air conditioning panel has OPEN--CLOSED positions and is guarded to the OPEN position. In the OPEN position the air conditioning system will operate normally. The CLOSED position closes the crossover valve and prevents flow of engine bleed air from engines 1 and 2 to the air conditioning shutoff valve and air cycle machine. Similarly it prevents flow of bleed air from engines 3 and 4 to the alternate pressurization valve and ground air ejector. See figure 4-4. The CLOSED position also prevents complete loss of air conditioning if a rupture occurs in the engine bleed manifold. Operating power is 28 volt DC through circuit breakers marked AIR CONDITIONING VALVES, CROSS OVER on the SBCBP (figure 1-35, sheet 1).

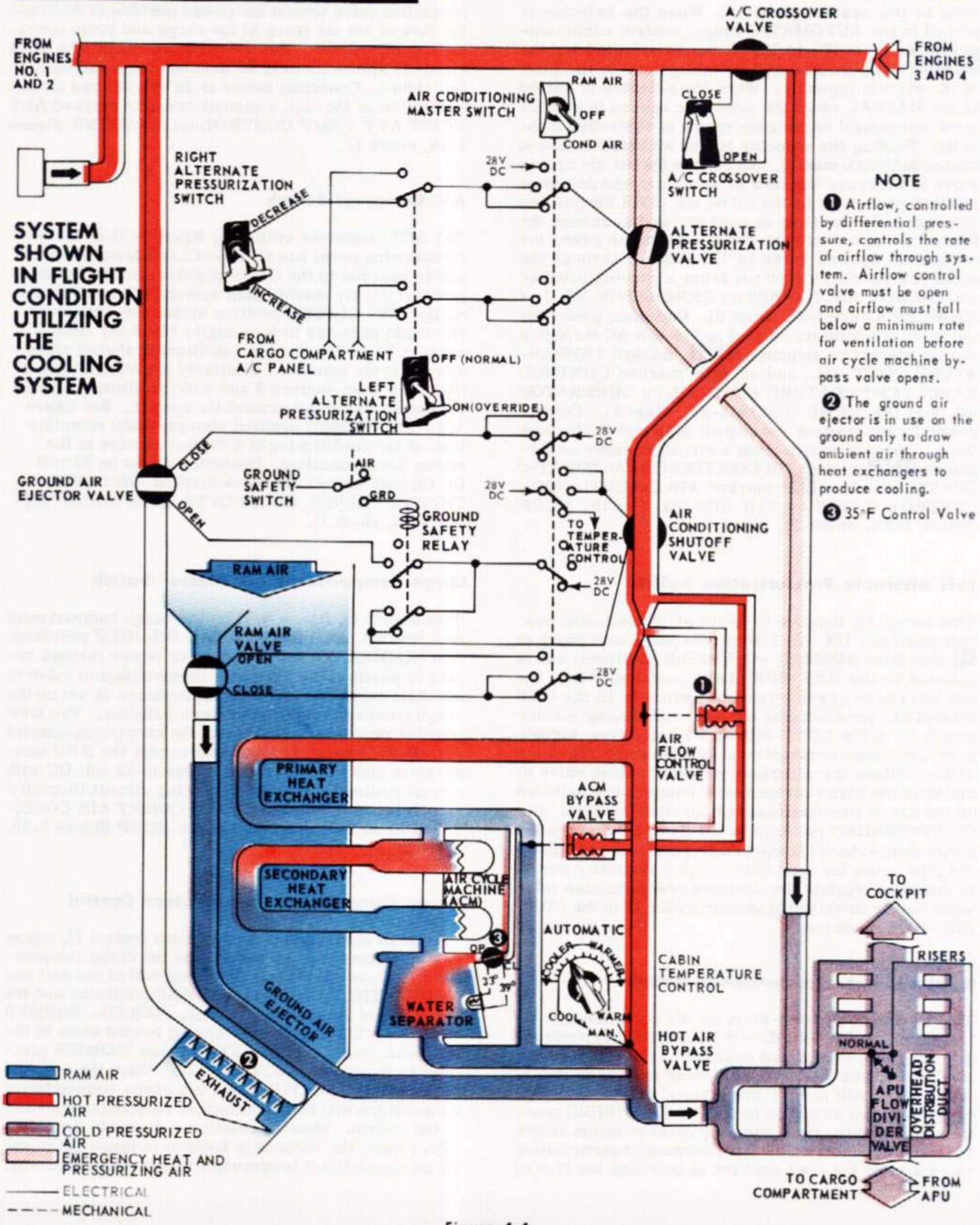
Cargo Compartment A/C Master Switch

This switch (3, figure 4-7) on the cargo compartment A/C control panel has NORMAL ON--OFF positions. The NORMAL ON position supplies power through relays to position the alternate pressurization valve to maintain cargo compartment temperature as set on the cargo compartment temperature selector. The OFF position removes power from all the cargo compartment A/C control panel components except the APU temperature control. Operating power is 28 volt DC with circuit protection for the operating circuit through a circuit breaker marked CARGO COMPT AIR CONDITIONING on T-R BUS NO. 1 of the MCBP (figure 1-35, sheet 2).

Cargo Compartment Temperature Control

The cargo compartment temperature control (2, figure 4-7) is a rotary switch and dial on the cargo compartment A/C control panel. The upper half of the dial has AUTOMATIC, COOLER--WARMER positions and the lower half of the dial has MANUAL, COOLER--WARMER positions. The selector is spring loaded when in the MANUAL range from the COOLER and WARMER positions to the center neutral position. When the selector is in the AUTOMATIC range the cargo compartment temperature will be maintained as selected to the limit of the system. When the selector is moved to the MANUAL range, the automatic feature is inoperative and cargo compartment temperature is controlled manually.

AIR CONDITIONING SYSTEM



SYSTEM SHOWN IN FLIGHT CONDITION UTILIZING THE COOLING SYSTEM

NOTE

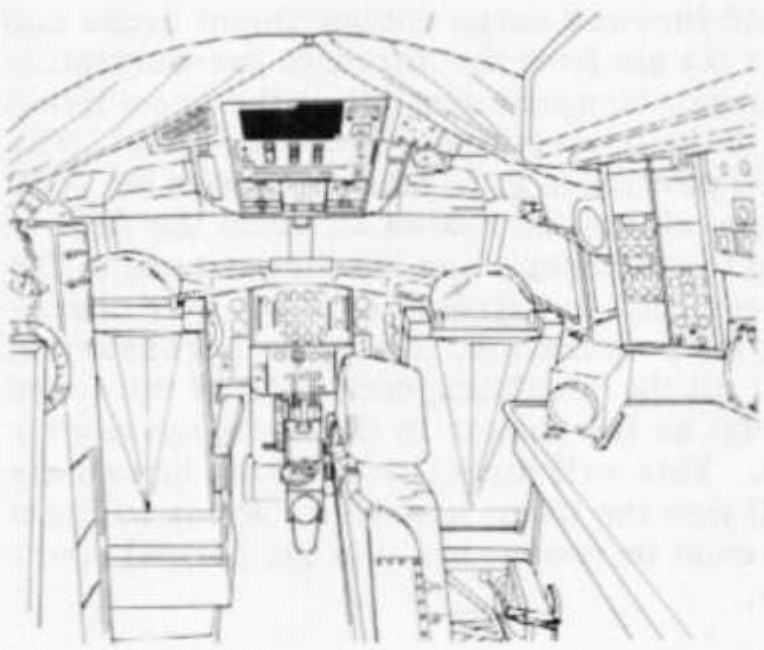
❶ Airflow, controlled by differential pressure, controls the rate of airflow through system. Airflow control valve must be open and airflow must fall below a minimum rate for ventilation before air cycle machine bypass valve opens.

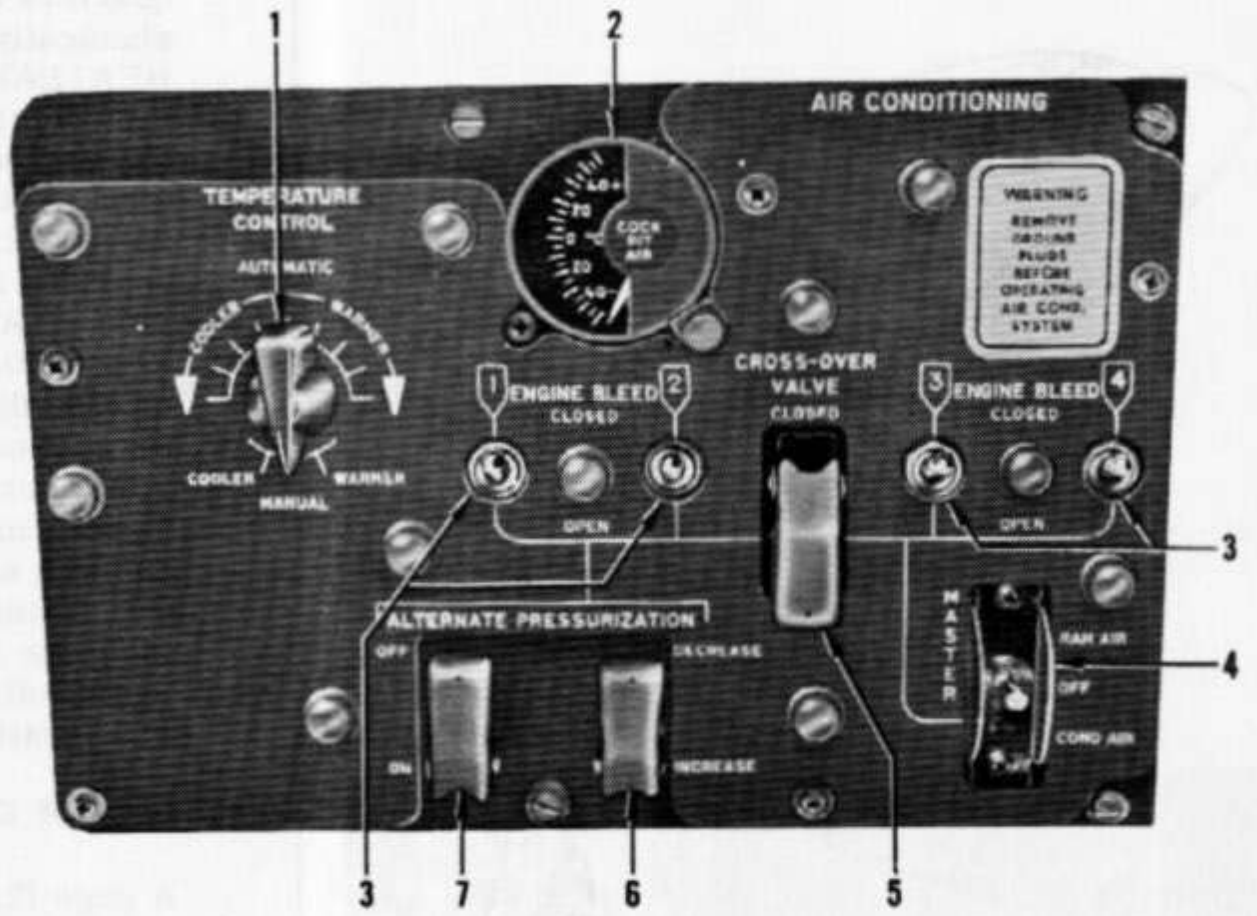
❷ The ground air ejector is in use on the ground only to draw ambient air through heat exchangers to produce cooling.

❸ 35°F Control Valve

Figure 4-4

AIR CONDITIONING PANEL





1 CABIN TEMPERATURE CONTROL
2 CONTROL CABIN TEMPERATURE GAGE
3 ENGINE BLEED SWITCHES (2 PLACES)
4 AIR CONDITIONING MASTER SWITCH
5 A/C CROSSOVER SWITCH
6 RIGHT ALTERNATE PRESSURIZATION SWITCH
7 LEFT ALTERNATE PRESSURIZATION SWITCH

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Figure 4-5

Holding the selector in the WARMER position during MANUAL control will open the alternate pressurization valve to increase the flow of warm air to the cargo compartment; the COOLER position will decrease the flow of warm air. Operating power is 115 volt AC through a circuit breaker marked CARGO COMPT TEMPERATURE CONTROL on GENERATOR NO. 2 of the MCBP (figure 1-35, sheet 3). Control power is 28 volt DC through a circuit breaker marked CARGO COMPT AIR CONDITIONING on T-R BUS NO. 1 of the MCBP (figure 1-35, sheet 2).

APU Temperature Control

This control knob, on the cargo compartment air conditioning control panel (1, figure 4-7) adjusts the setting of an automatic temperature regulator to control a valve within the APU that directs the incoming air directly over the heat exchanger; partially over the heat exchanger; or directly to the air conditioning duct without heating. This is a thermostatic type control with COOLER--WARMER positions. Compartment temperature may be adjusted by moving the pointer toward the desired position. Circuit protection is provided by the TEMP. CONTROL circuit breaker on the APU circuit

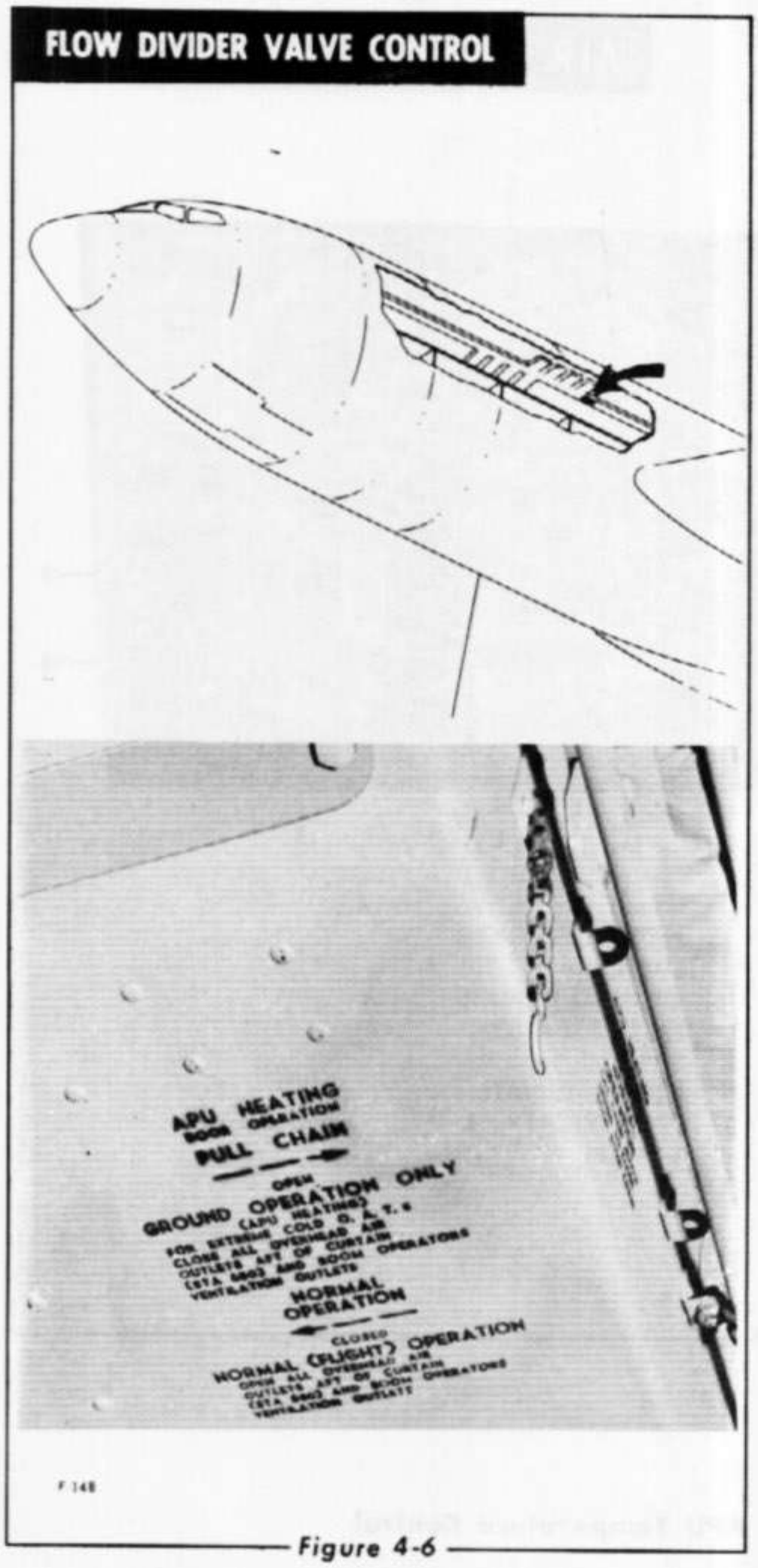


Figure 4-6

breaker panel (figure 1-35, sheet 6). Should this control malfunction, a temperature control manual override (14, figure 4-58 and 5, figure 4-60) may be used to make temperature adjustments. Remove electrical power by disconnecting the electrical plug from the mixer valve, release the manual control knob by loosening the knurled setscrew, push the knob in and rotate it slightly to engage the clutch serrations, then rotate to control cabin temperature. The knob is marked with HEAT and COOL directional arrows. It is turned clockwise for more heat and counterclockwise for cooler air.

Flow Divider Valve

The flow divider valve (figure 4-6) is in the overhead air conditioning duct at the aft end of the crew living quarters in the cargo compartment. The valve is mechanically actuated by a chain and has NORMAL--APU HEATING positions. The NORMAL position distributes the conditioned air from the air conditioning pack to the cockpit and forward cargo compartment areas and directs all the hot air from the alternate pressurization valve to the cargo compartment aft of the crew living quarters and to the boom operator's compartment. The APU HEATING position is to be used only when the APU is operating and allows the heated air from the APU to be distributed to the cockpit and the forward end of the cargo compartment. In extreme cold weather operations, during APU operation, it may be necessary to close some or all the ventilating outlets aft of the sound curtain, as well as the outlets in the boom operator's compartment. This will direct most of the heated air from the APU into the living quarters. Prior to flight these outlets must be opened again to the normal operation settings.

Control Cabin Air Temperature Gage

A gage (2, figure 4-5) on the air conditioning control panel for control cabin air temperature indicates temperature in degrees Centigrade. Operating power for the gage is 28 volt DC with circuit protection through a circuit breaker marked CABIN TEMPERATURE INDICATOR on T-R BUS NO. 2 of the MCBP (figure 1-35, sheet 2).

PRESSURIZATION SYSTEM

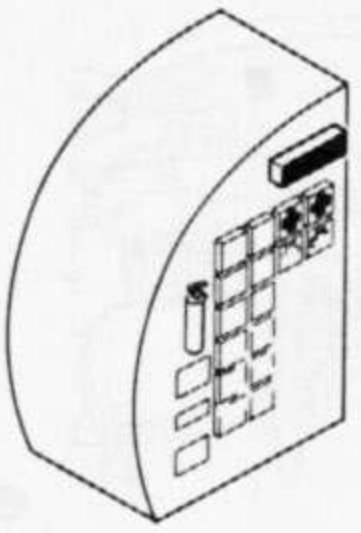
The pressurization system as shown schematically in figure 4-3, utilizes compressed air from the low pressure compressor engine bleed system. Cabin altitudes from minus 1000 feet to 10,000 feet may be selected up to a normal maximum cabin to ambient differential pressure of approximately 8.6 psi with differential control and controller operative. An emergency maximum cabin to ambient differential pressure of approximately 9.42 psi can be maintained during relief valve operation with controller inoperative. Three outflow valves, one in each wheel well, regulate the cabin pressure and prevent overpressurization which could result in possible structural damage to the airplane. The cabin outflow valves act as vacuum relief valves when cabin pressure is less than ambient pressure. A cabin emergency pressure release valve is provided to depressurize the airplane in an emergency. A cabin pressure warning light is provided to warn the crew when cabin pressure altitude exceeds 12,000 feet.

Cabin Pressure Controller

The cabin pressure controller (1, figure 4-8) on the overhead panel is used in conjunction with the outflow valves to control the cabin pressure. This unit provides a means of selecting a desired cabin altitude rate

CARGO COMPARTMENT A/C CONTROL PANEL

1. CARGO DOOR ENTRY LIGHTS SWITCH
1A. APU TEMPERATURE CONTROL
2. CARGO COMPARTMENT TEMPERATURE CONTROL
3. CARGO COMPARTMENT A/C MASTER SWITCH



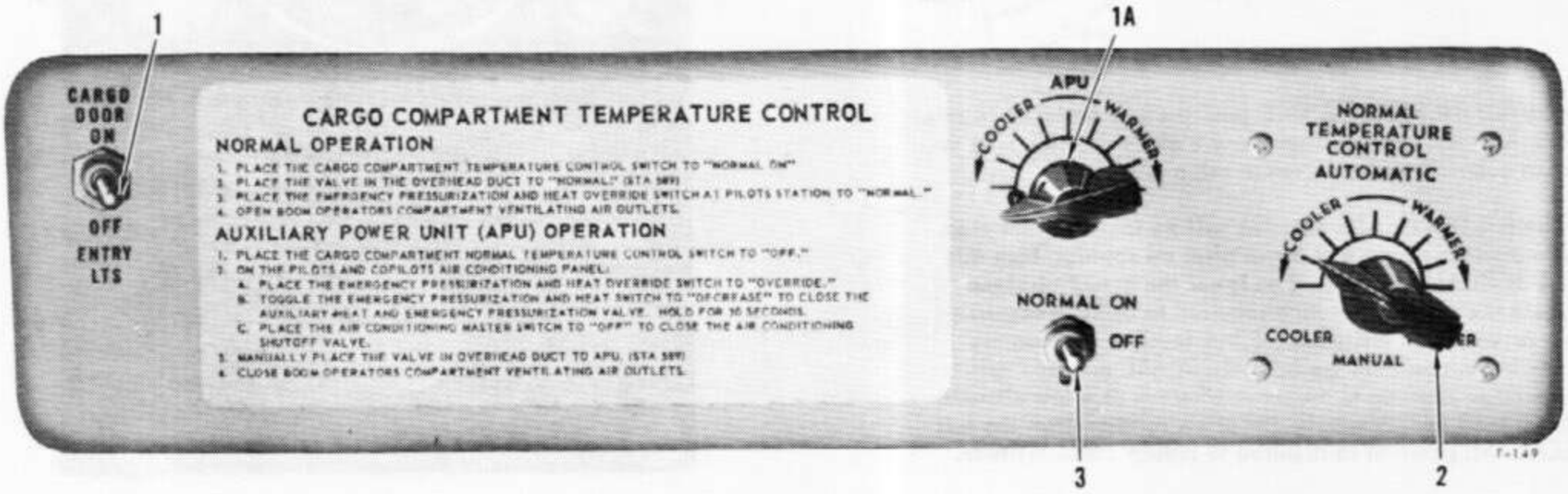


Figure 4-7

of change, selecting a desired cabin altitude, and maintaining a constant differential cabin pressure when the maximum controllable cabin altitude is reached. The cabin pressure controller consists of a dial calibrated from minus 1000 feet to 10,000 feet for indicating the selected cabin cruising altitude. The cabin altitude selector knob (4, figure 4-8), at the lower right of the dial (2, figure 4-8) and connected to the dial pointer (3, figure 4-8) provides a means of selecting cabin altitude. The maximum airplane altitude window (5, figure 4-8) will show the maximum airplane altitude for the cabin altitude as selected by the dial pointer.

NOTE

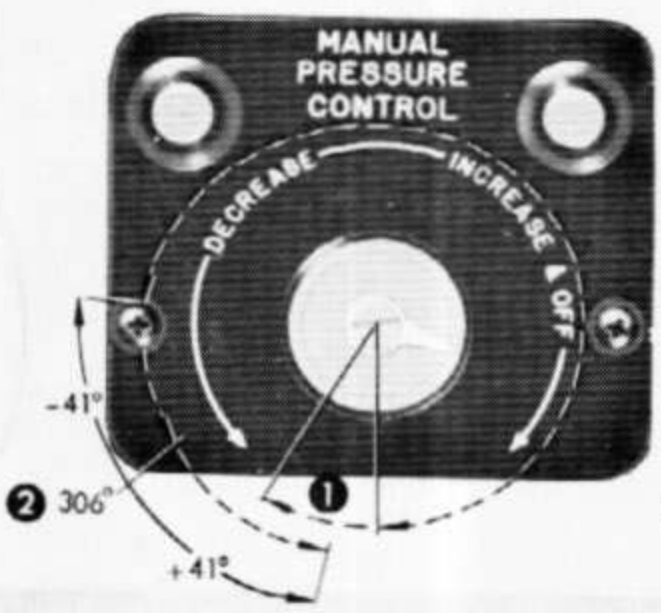
Two types of cabin pressure controllers may be installed in the airplane and the only difference between the controllers is in the rotation of the dial pointer. One controller has a dial pointer that can be rotated approximately 1-1/2 revolutions from the lower mechanical stop to the upper mechanical stop. Before making an initial cabin altitude selection with this controller, rotate the dial pointer counterclockwise until it hits the lower mechanical stop; then rotate clockwise to the desired cabin altitude. If the cabin altitude selection is made on the second clockwise revolution instead of the first, cabin altitude will be controlled approximately 16,000 feet higher than indicated by the dial pointer and the maximum airplane altitude window.

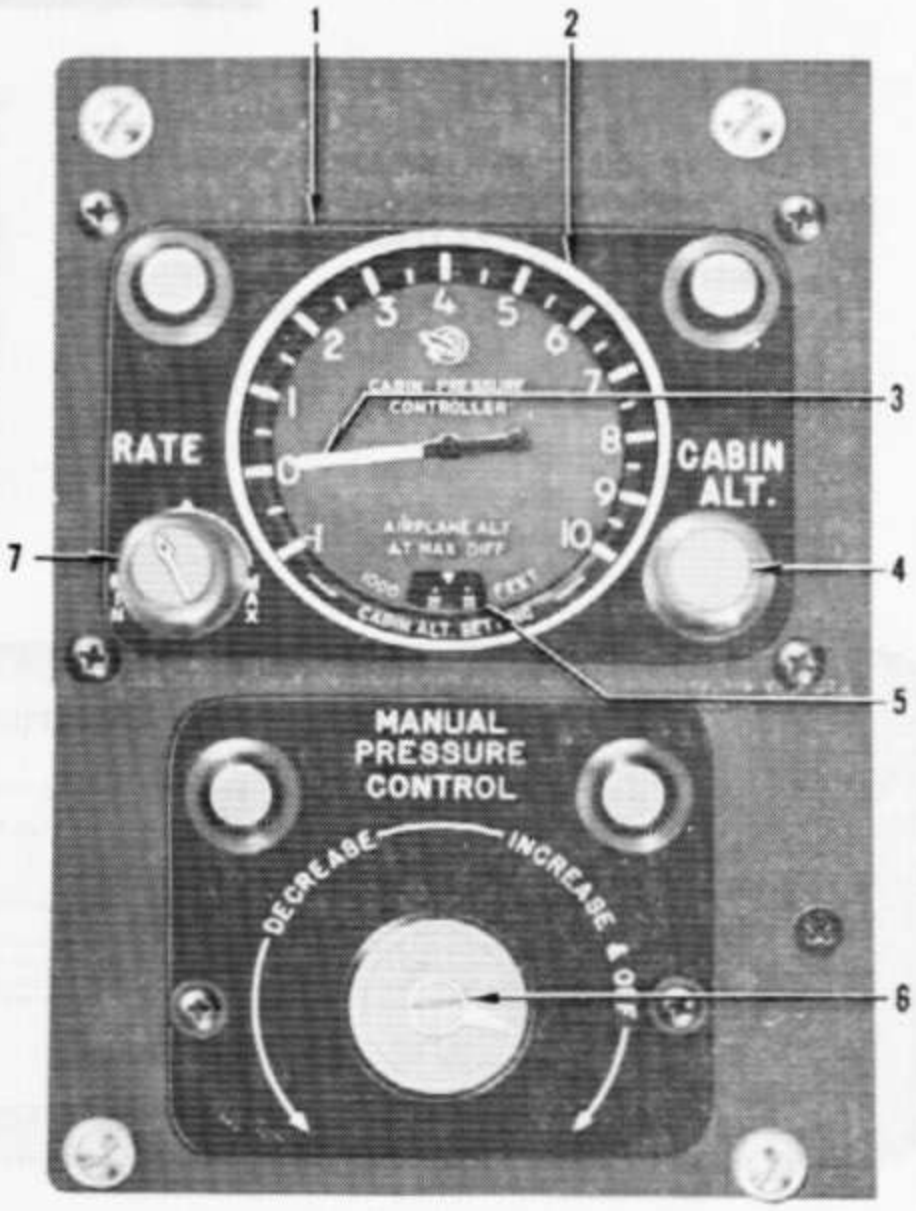
The second controller (modified) has an upper mechanical stop which limits the dial pointer to one revolution. Using this controller the dial pointer may be rotated directly to the desired cabin altitude.

The cabin rate of change knob (7, figure 4-8), to the lower left of the dial provides a means of selecting the desired cabin altitude rate of change from 50 to 2000 fpm within the differential limit of approximately 8.6 psi.

CABIN PRESSURE CONTROLLERS







❶ The full INCREASE & OFF position will be found in this area. Any ccw rotation from the 6 o'clock position will increase cabin altitude (decrease cabin pressure).

❷ The full DECREASE position will be found in this area. Cabin pressurization will begin after cw rotation from this full DECREASE position. The lower the actual airplane altitude the more cw rotation required to begin pressurization. At very high altitudes (45,000 feet), approximately 5° of cw rotation from the full DECREASE position will cause cabin altitude to decrease whereas at a low altitude (10,000 feet) approximately 30° of cw rotation from the full DECREASE position is required to reduce cabin altitude.

1 CABIN PRESSURE CONTROLLER
2 DIAL FACE
3 POINTER
4 CABIN ALTITUDE SELECTOR KNOB
5 MAXIMUM AIRPLANE ALTITUDE WINDOW
6 CABIN MANUAL PRESSURE CONTROL
7 CABIN RATE OF CHANGE KNOB

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Figure 4-8

Cabin Manual Pressure Control

The cabin manual pressure control (6, figure 4-8) on the overhead panel has DECREASE--INCREASE & OFF indicating arrows. The normal position of the cabin manual pressure control is the OFF position attained by rotating the control fully clockwise. This position allows the cabin pressure controller to maintain a constant cabin altitude up to a maximum cabin differential pressure of approximately 8.6 psi. The cabin manual pressure control can be used to depressurize the cabin by rotating it counterclockwise to the full DECREASE position. On airplanes 1 ▶ 131 , rotation from the full DECREASE to the full INCREASE & OFF position requires 720 degrees of movement. This control provides a manual means of controlling cabin differential pressure automatically between approximately 0.172 to 8.6 psi when used in conjunction with the cabin pressure controller. When the cabin pressure controller is inoperative the cabin pressure manual control provides a means of manually controlling cabin differential pressure between approximately 0.172 psi to a maximum of approximately 9.42 psi. Airplanes 132 ▶ have an improved cabin manual pressure control that provides specific isobaric (constant) cabin pressurization up to a maximum of 9.42 psi. From the full DECREASE to the full INCREASE and OFF position requires 306 ± 41 degrees of travel. When the cabin pressure controller is inoperative and the cabin manual pressure control is rotated counterclockwise from the full INCREASE & OFF position to the 6 o'clock position, a constant sea level cabin altitude will be maintained

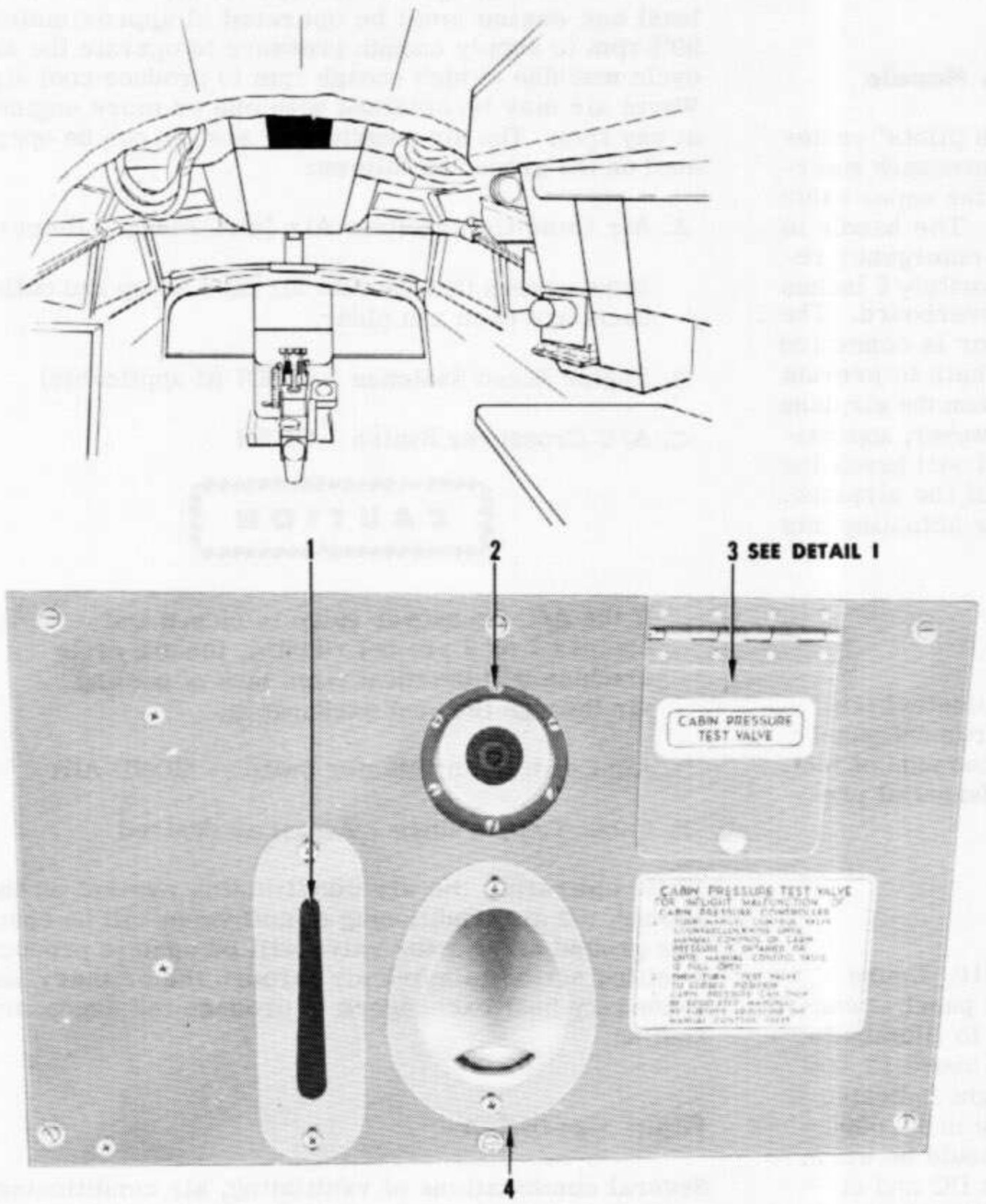


Figure 4-9

up to a maximum cabin pressure of approximately 9.42 psi. Any counterclockwise rotation beyond this calibration point will result in a proportional drop in cabin pressure.

NOTE

The cabin altitude selector (4, figure 4-8) and the cabin manual pressure control (6, figure 4-8) turn in opposite directions to obtain the same result. For example, an increase in cabin differential pressure (decrease in cabin altitude) is obtained by rotating the cabin altitude selector counterclockwise or by rotating the cabin manual pressure control clockwise (toward INCREASE).

Cabin Pressure Test Valve Handle

The cabin pressure test valve handle (3, figure 4-9) on the auxiliary overhead panel has NORMAL--DIFF. TEST--CLOSED positions. The NORMAL position allows the cabin pressure controllers to operate normally. In the DIFF TEST position, a constant cabin differential pressure of approximately 8.6 psi will be held; cabin altitude will change as airplane altitude changes. The CLOSED position locks out the cabin pressure controller and all control of cabin pressure must be made with the cabin manual pressure control. If the cabin pressure controller should malfunction the pressurizing test valve should be placed in the CLOSED position and the cabin pressure regulated manually by

adjustment of the cabin manual pressure control. The door over this valve handle can be closed only when the handle is in the NORMAL position.

Cabin Pressure Emergency Release Handle

This handle (16, figure 1-17) is on the pilots' center instrument panel and controls the cabin pressure emergency release door (2, figure 4-10) on the upper cabin wall opposite the cargo loading door. The handle is cable connected to the cabin pressure emergency release door. Pulling this handle approximately 8 inches will rapidly dump the cabin pressure overboard. The cabin pressure emergency release door is connected to the airplane structure by a bead chain to prevent loss of the door if the handle is pulled when the airplane is on the ground and depressurized. However, approximately 1/2 pound pressure differential will break the chain and allow the door to fall free of the airplane. It is not possible to repressurize after actuating this handle during flight.

Cabin Air Pressure Gage

The cabin air pressure gage (cabin altimeter) (15, figure 1-19) on the copilot's flight instrument panel indicates cabin pressure altitude in thousands of feet. This indicator does not show cabin differential pressure.

Cabin Pressure Warning Light

The red cabin pressure warning light (10, figure 1-19) on the copilot's flight instrument panel is connected to a pressure switch that is set to illuminate the light when the cabin pressure goes above 12,000 feet ± 1000 feet. Illumination of the light indicates to the crew that cabin pressure altitude is 12,000 feet or above and that oxygen masks should be worn. Operating power for the light is 28 volt DC and circuit protection is through a circuit breaker marked CABIN PRESS WARN on the SBCBP (figure 1-35, sheet 1).

CABIN AIR CONDITIONING, PRESSURIZING, AND VENTILATING SYSTEMS NORMAL OPERATION

Ground Operation

NOTE

External conditioned air can be connected directly into the crew compartment through the conditioned air connection (36, figure 1-65).

One or more engines must be running or external power and air must be connected during ground operation of the air conditioning system. If cool air is desired at least one engine must be operated at approximately 90% rpm to supply enough pressure to operate the air cycle machine at high enough rpm to produce cool air. Warm air may be obtained with one or more engines at any rpm. The air conditioning system can be operated on the ground as follows:

A. Air Conditioning Ram Air Inlet Plugs - Remove

Make certain that the ram air inlet scoop and outlet ducts are open and clear.

B. Engine Bleed Switches - OPEN (if applicable)

C. A/C Crossover Switch - OPEN

CAUTION

If the A/C crossover valve is closed and engines 1 or 2 are not running, the air cycle machine will overheat from lack of cooling air through the heat exchangers.

D. Air Conditioning Master Switch - COND AIR

E. Cabin Temperature - Adjust as desired

While operating the air conditioning system on the ground, the air conditioning shutoff valve will be open. The ground air ejector valve will be open to produce a jetting action to move air through the primary and secondary heat exchangers to produce the necessary cooling.

Flight Operation

Several combinations of ventilating, air conditioning, and pressurizing are available during flight. Ram air ventilation without air conditioning or pressurization may be obtained by placing the air conditioning master switch in the RAM AIR position. Air conditioning without pressurization may be obtained by placing the air conditioning master switch in the COND AIR position and setting the cabin altitude selector at an altitude greater than airplane altitude or turning the cabin manual pressure control counterclockwise to the full DECREASE position. The combination most generally used will be with the air conditioning and pressurization systems operating.

CAUTION

Do not operate the air conditioning system during the time water injection is used. To do so will cause cabin fog and possible damage to the air cycle machine compressor and turbine wheels.

The system is automatic in its operation and will maintain the cabin altitude selected as long as the maximum airplane altitude for the cabin altitude selected is not exceeded. If the maximum airplane altitude for the cabin altitude selected is exceeded, the cabin altitude will be maintained at an 8.6 psi differential. It is best to select a cabin cruising altitude that will give a higher maximum airplane altitude than the planned cruising altitude for the flight. This will prevent cabin altitude fluctuations that would occur during airplane altitude changes when flying in the differential pressure range. During letdown, be sure to select a cabin altitude slightly higher than destination station pressure altitude as this will insure a depressurized cabin during landing.

Airplane Depressurization

For nonemergency airplane depressurization and also during emergencies, where time permits, the following depressurization method should be used:

A. All Personnel - On oxygen

All personnel on board shall begin using oxygen prior to depressurization of the airplane under conditions which require use of oxygen, time permitting.

B. Cabin Manual Pressure Control - Full DECREASE

C. Air Conditioning Master Switch - OFF

The air conditioning master switch must be in the OFF position if it is anticipated that the emergency exit hatches will be removed. If the emergency exit hatches are not to be removed and ventilation air is desired, the air conditioning master switch may be placed in RAM AIR in lieu of OFF. The RAM AIR position of the air conditioning master switch provides a very slight amount of pressurization through the ram air intake making it very difficult to remove the emergency exit hatches.

CAUTION

Before the airplane is completely depressurized, turn off heat to fluid containers such as hot cups, coffee pots, etc. Heating fluids at high altitudes causes them to boil at much lower temperatures and may cause the container to rupture if pressure is not allowed to equalize during depressurization.

D. Left Alternate Pressurization Switch - ON

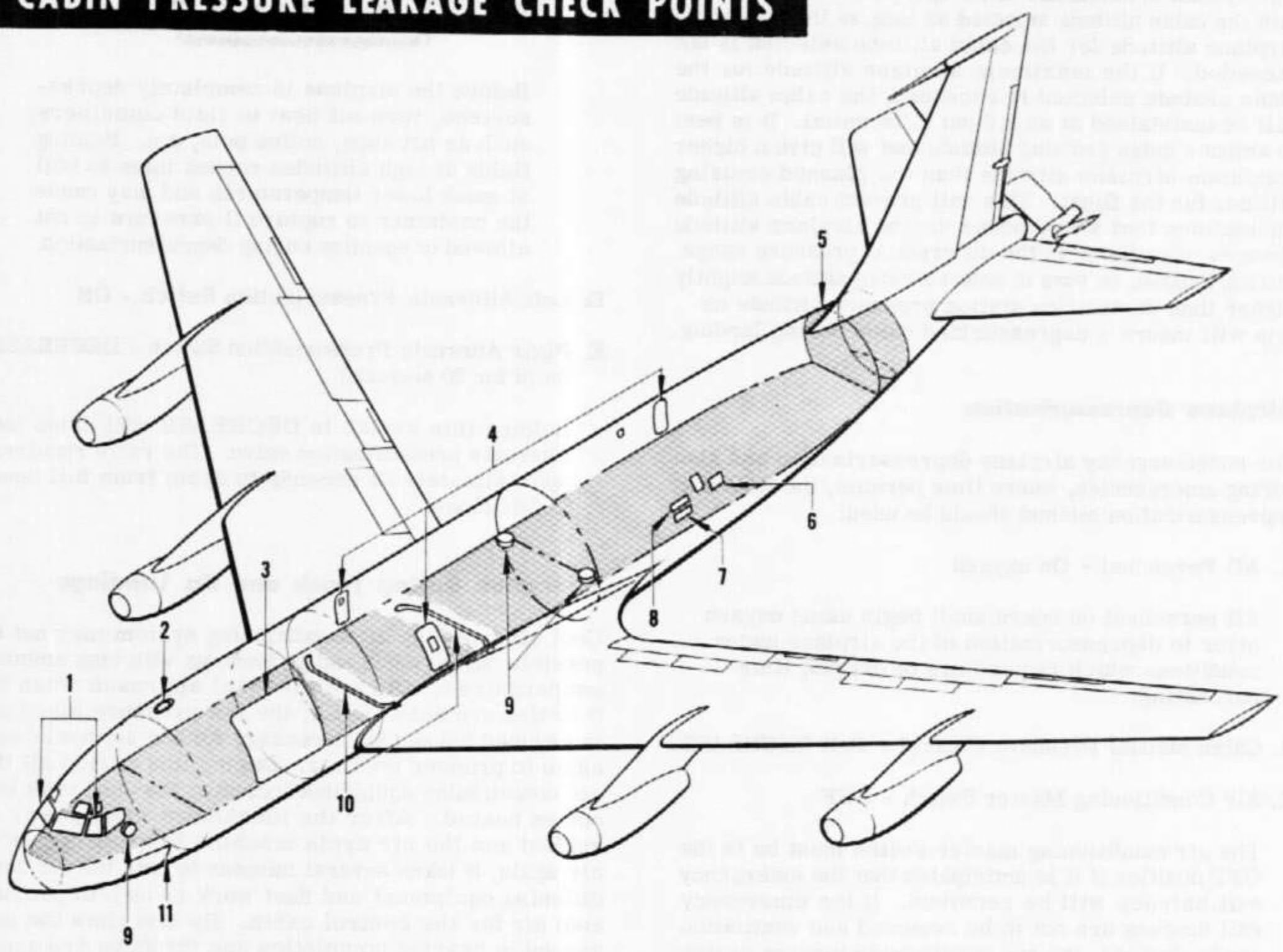
E. Right Alternate Pressurization Switch - DECREASE (hold for 20 seconds)

Holding this switch in DECREASE will close the alternate pressurization valve. The valve requires approximately 20 seconds to cycle from full open to full close.

Operation During Touch and Go Landings

Cool air from the air conditioning system may not be possible during touch and go landings with high ambient temperatures. During the final approach when all throttles are set at IDLE, the low pressure bleed air is reduced below that necessary for the air cycle machine to produce cool air. During this period all the air conditioning equipment including the duct work becomes heated. After the touchdown when power is applied and the air cycle machine is producing cool air again, it takes several minutes to cool the air conditioning equipment and duct work enough to provide cool air for the control cabin. By this time the go-around is nearing completion and throttles are again reduced to IDLE causing the air cycle machine to lose efficiency again. If cool air from the air conditioning system is desired during touch and go landings it will be necessary to operate at least one engine at 90% rpm

CABIN PRESSURE LEAKAGE CHECK POINTS



1 PILOT AND COPILOT SLIDING WINDOWS
2 EMERGENCY CABIN PRESSURE RELEASE DOOR
3 CARGO DOOR
4 EMERGENCY EXIT HATCHES
5 UPPER DECK TANK
6 APU TURBINE EXHAUST PORT
7 APU CABIN AIR INLET PORT
8 APU COMPRESSOR INLET PORT
9 CABIN PRESSURE OUTFLOW VALVE (2 PLACES)
10 CENTER WING TO BODY SEALS
11 CREW ENTRY DOOR

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Figure 4-10

to produce enough bleed air to produce cool air. However, operating one engine at high rpm may be undesirable as it will require longer approaches, thereby reducing the number of landings that can be accomplished in a given period. In this case depressurized flight using ram air for ventilation is recommended for touch and go landings when the ambient temperature is high enough to make the control cabin uncomfortably warm using the air conditioning system.

CABIN AIR CONDITIONING, PRESSURIZING, AND VENTILATING SYSTEMS EMERGENCY OPERATION

To obtain the desired cabin altitude in the airplane pressurized areas, two conditions must be met. First, 9th stage compressor air from the engines must be delivered to the pressurized area in sufficient quantity. Second, this pressurizing air must be vented overboard at the proper rate.

Figure 4-4 shows that engine bleed air can be delivered to the pressurized compartment by either of two routes, the normal pressurization route as shown in solid red, or the alternate route as shown by the broken red. Failure of either the air conditioning shutoff valve or the airflow control valve in the closed position would prevent pressurizing the airplane through the normal airflow route. However, airflow could still be supplied through the alternate route although temperature control would be lost. A failure of either the air conditioning shutoff valve or the airflow control valve in the closed position would

be indicated by no air entering the pressurized area when the air conditioning master switch was placed to COND AIR and the engines operating at sufficient RPM.

If sufficient airflow exists and the airplane is not pressurizing properly, then the problem must be due to the pressurizing air venting overboard at an improper rate, either too rapidly or too slowly. If the air is venting overboard too rapidly, the actual cabin altitude will be higher than selected cabin altitude. If the air is venting overboard too slowly the actual cabin altitude will be lower than the selected cabin altitude. Air venting overboard too rapidly could be caused by excessive leakage around the seals for the crew entry door, cargo door, overwing hatches, aft emergency hatch or the wing to body joints. It could also be caused by the auxiliary power unit ports being left open, an outflow valve stuck in the open position, or a malfunction in the cabin pressure controller. Air venting overboard too slowly causing an over-pressurized condition would most likely be due to a malfunction in the cabin pressure controller.

If the airplane fails to pressurize as desired, proceed as follows: (This procedure may be terminated at any step that restores normal pressurization.)

A. Check for airflow into the pressurized compartment (CP, BO)

   The air vents near the periscopic sextant mount are a convenient place to check for airflow in the control cabin.

B. If there is very little or no airflow present, proceed as follows:

   (1) Air Conditioning Master Switch - Check in COND AIR (CP)

   (2) Engine Bleed Valve Switches and Air Conditioning Crossover Valve Switch - Check OPEN (CP)

   (3) Air Conditioning Circuit Breakers on SBCBP - Set (CP, BO)

   (4) Left Alternate Pressurization Switch - ON (CP)

   (5) Right Alternate Pressurization Switch - INCREASE until sufficient airflow is obtained (CP)

   Airflow from the alternate pressurization valve will be felt sooner in the aft portion of the cargo compartment and the boom operator's compartment.

   (6) Air Conditioning Crossover Valve Switch - CLOSED, if there is still insufficient airflow (CP)

   If airflow is restored, refer to ENGINE BLEED MANIFOLD FAILURE in this Section.

C. If sufficient airflow is present and the airplane is not pressurizing as desired:

   (1) All Hatches and APU Port - Check closed (CP, BO)

WARNING

When checking or reinstalling hatches in flight, the crewmember shall wear a parachute and helmet. Refer to REINSTALLATION OF HATCHES IN FLIGHT for procedures and precautions which must be observed.

   (2) Cabin Manual Pressure Control - Check full INCREASE & OFF (full clockwise) (CP)

   (3) Refer to CABIN PRESSURE CONTROLLER MALFUNCTION in this Section.

Engine Bleed Manifold Failure

Excessive loss of bleed air caused by failure of the engine bleed manifold or any associated valves or equipment may prevent pressurization of the airplane. If the malfunction is limited to one side, i.e., engines No. 1 and 2 or engines No. 3 and 4, the malfunctioning equipment can be isolated by moving the A/C crossover switch to the CLOSE position. If the malfunction occurs on the left side (engines No. 1 and 2) the alternate pressurization valve should be closed; this will reduce the amount of heat received by the cargo compartment and boom operator. If the malfunction is on the right side, the air conditioning pack should be shut down; loss of cooling air will occur, but heat and pressurization will be available through the alternate pressurization valve. Closing the bleed valves on the malfunctioning side of the manifold will prevent possible damage to airplane wing components from escaping bleed air.

CAUTION

If the A/C crossover valve and engine bleed valves 1 and 2 are closed the air conditioning master switch must be placed to OFF immediately prior to landing to prevent overheat and possible damage to the air cycle machine.

Cabin Pressure Controller Malfunction

If the cabin pressure controller should malfunction, it can be isolated from the rest of the pressurization system by moving the cabin pressure test valve handle to the CLOSED position. With the cabin pressure controller inoperative, cabin pressure regulation must be accomplished by use of the cabin manual pressure

control. When using the cabin manual pressure control make small adjustments as the valve is very sensitive and small adjustments can cause large changes in cabin pressure. Manual cabin pressure control will start with the indicator on the cabin manual pressure control at approximately the 6 o'clock position. On airplanes 1▶ 131, cabin pressure differentials between approximately 0.172 and 9.42 psi can be maintained with the cabin manual pressure control. On airplanes 132▶ a constant cabin altitude up to sea level pressure within the safety valve relief limit of 9.42 psi can be maintained with the cabin manual pressure control. Use the following procedure for cabin pressure manual control:

A. Primary Crew Members - On oxygen

Primary crew members will be on oxygen before the pressurization source is changed.

B. Cabin Manual Pressure Control - Rotate toward DECREASE until the cabin manual pressure control takes over cabin pressure control or the full DECREASE position is reached, whichever occurs first.

This action prevents too rapid repressurization.

C. Cabin Pressure Test Valve Handle - CLOSED

All automatic control features, including cabin pressure rate-of-change, are cut out with the handle in the CLOSED position.

D. Cabin Manual Pressure Control - Adjust to desired cabin altitude

WARNING

Too rapid rotation of the cabin manual pressure control toward the INCREASE & OFF position during repressurization, can cause a pressurization jolt that may be harmful or uncomfortable to the ears of all persons aboard.

If the cabin manual pressure control has been rotated to the DECREASE stop (fully CCW), to repressurize, rotate the cabin manual pressure control slowly toward INCREASE & OFF (CW) until a decrease in cabin altitude is observed on the cabin altimeter. Allow cabin altitude to stabilize (approximately 1 to 2 minutes). Rotate cabin manual pressure control in approximately 5 degree increments, allowing cabin altitude to stabilize, until the desired cabin altitude is reached. If the cabin manual pressure control has been rotated toward DECREASE only far enough to take over cabin pressure control, to repressurize, rotate the cabin manual pressure control in approximately 5 degree increments, allowing cabin altitude to stabilize, until the desired cabin altitude is reached. See detail I of figure 4-8 for approximate positions of the DECREASE stop and the INCREASE & OFF stop of the cabin manual pressure control.

ANTI-ICING SYSTEMS

ENGINE ANTI-ICING SYSTEM

The engine anti-icing system is a thermal system using hot bleed air from the high pressure compressor engine bleed system. The primary function of the system is to prevent ice formation on the nose cowl, nose dome and inlet guide vanes. Each engine system is controlled by three valves operated by the engine anti-icing switch. Hot air is directed through left and right engine anti-ice valves on each engine to a ring connected to the hollow inlet guide vanes. After the hot air has passed through the inlet guide vanes it is directed into the nose dome and exhausted on the lower side of the nose dome into the engine inlet. Engine anti-icing regulators control the flow of air according to the temperature of the air flowing around them. A bimetallic coil inside the regulator expands or contracts with a change in anti-icing air temperature to position a disk valve through which the air must flow. The nose cowl anti-ice valve directs hot air into the bottom of the nose cowl where it is mixed with ambient air drawn through a duct from the nose cowl chin scoop. The resulting mixture is at the proper temperature and pressure for use as anti-icing air. The air is then directed around the nose cowl and chin scoop, and vented overboard through holes at the aft end of the nose cowl. Part of the anti-icing air directed into the chin scoop is used to deice the EPR probe in the engine inlet and is vented back into the engine inlet.

Engine Anti-Icing Switch

The engine anti-icing switch (1, figure 4-11) on the anti-icing control panel has ON--OFF positions. The ON position opens the two engine anti-ice valves and the nose cowl anti-ice valve of each engine. The

valves will remain open until the anti-icing switch is moved to the OFF position. Operating power for the two engine anti-ice valves is 28 volt DC through two circuit breakers on T-R BUS NO. 1 marked ANTI-ICE VALVE, ENGINE NO. 4, ENGINE NO. 2 and two circuit breakers on T-R BUS NO. 2 marked ANTI-ICE VALVE, ENGINE NO. 3, ENGINE NO. 1 on the MCBP (figure 1-35, sheet 2). Operating power for the nose cowl anti-ice valve is 28 volt DC through a circuit breaker marked ANTI-ICE CONTROL, NACELLE on T-R BUS NO. 1 of the MCBP (figure 1-35, sheet 2). Control power is 28 volt DC through a circuit breaker marked ANTI-ICE CONTROL, ENGINE on T-R BUS NO. 1 of the MCBP (figure 1-35, sheet 2).

Engine Anti-Icing Indicator Light

The engine anti-icing indicator light (2, figure 4-11) on the anti-ice control panel is a green press-to-test light. The light will illuminate when the engine anti-icing switch is moved to the ON position. Operating power is 28 volt DC through a circuit breaker marked ANTI-ICE CONTROL, ENGINE on T-R BUS NO. 1 of the MCBP (figure 1-35, sheet 2).

ENGINE ANTI-ICING SYSTEM NORMAL OPERATION

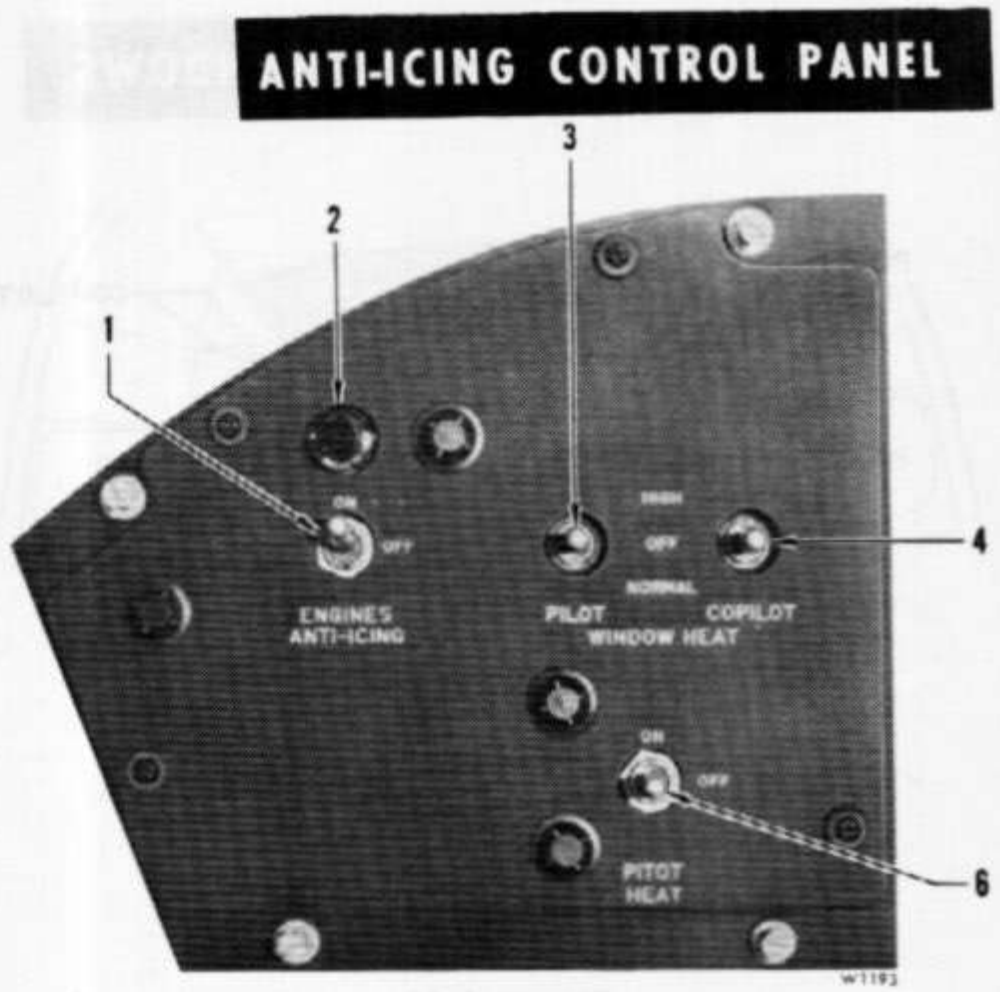
When icing is suspected, place the engine anti-icing switch in the ON position. Try to anticipate engine icing so that the system may be turned on before ice builds up on the engine inlet surfaces. There are no provisions for emergency engine anti-icing.

CAUTION

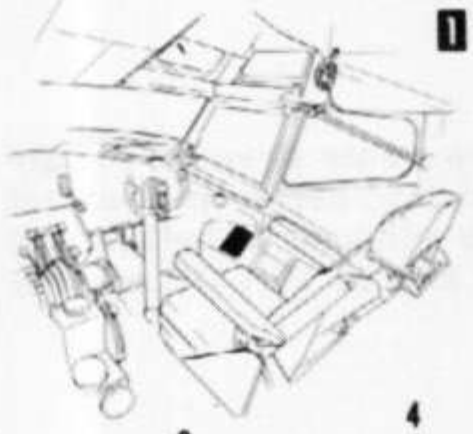
Indiscriminate or prolonged use of engine anti-icing may cause cracking of inlet guide vanes. Anti-icing should be used only as necessary in prevention of icing and not for prolonged periods in dry air. When the possibility of encountering icing conditions no longer exists, engine anti-icing should be turned off.

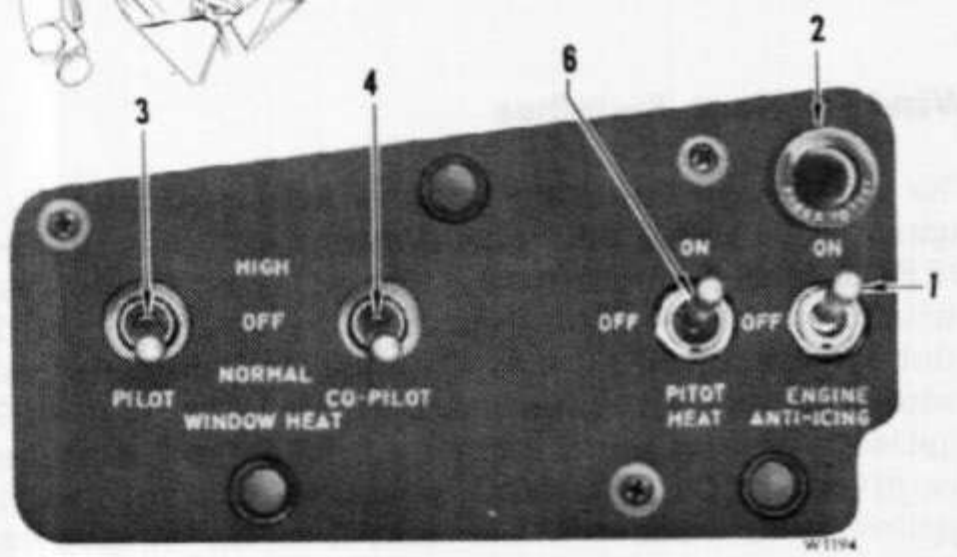
WINDOW ANTI-ICING SYSTEM

Control cabin windows are assigned numbers as shown in figure 4-12. The pilots' four main windows (pilot 1, pilot 2, copilot 1 and copilot 2) are anti-iced by means of electrical window heat. The eyebrow (pilot 4, pilot 5, copilot 4 and copilot 5) and rear windows (pilot 3 and copilot 3) and the three windows in the boom compartment are electrically defrosted. Two types of electrical control systems distribute power to the windows. The pilot's and copilot's 1 and 2 windows are temperature controlled by controller amplifiers and sensing elements. The pilot's and copilot's 3, 4 and 5 windows, and the boom operator's windows, are temperature controlled by thermal switches. Windows pilot 4 and pilot 5 are wired in series and if either window thermal switch opens, both windows will be inoperative until the overheated window cools; the same applies for windows copilot 4 and copilot 5 and the two side windows in the boom



1 ▶ 97





98 ▶

1 ENGINE ANTI-ICING SWITCH (2 PLACES)
2 ENGINE ANTI-ICING INDICATOR LIGHT (2 PLACES)
3 PILOT'S WINDOW HEAT SWITCH (2 PLACES)
4 COPILOT'S WINDOW HEAT SWITCH (2 PLACES)
5 (DELETED)
6 PITOT HEAT SWITCH (2 PLACES)

Figure 4-11

operator's compartment. Movable vents are provided in the boom operator's compartment to direct hot air on the boom operator's windows as required. A shutoff door in the vents in the boom operator's compartment is provided to reduce heat loss during APU operation in cold weather. The navigator's celestial observation windows above the navigator's station are defogged by air from the air conditioning system only. On airplanes 46 ▶ shutoff doors on the

CONTROL CABIN HEATED WINDOWS

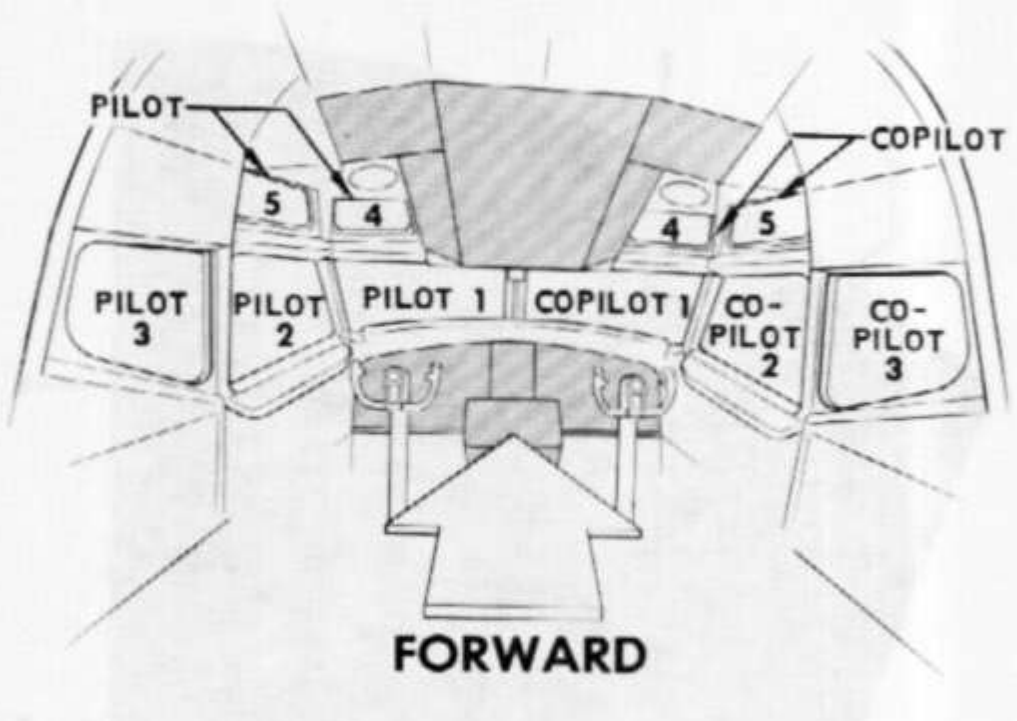


Figure 4-12

celestial observation window vents prevent hot air blast in the navigator's face during periscopic sextant observations. Heating of the windows is by 115 volt AC power with 115 volt AC and 28 volt DC control power.

Window Heat Switches

The pilot's and copilot's window heat switches (3, 4 figure 4-11) on the anti-icing control panel have HIGH--OFF--NORMAL positions. The pilot's window heat switch controls windows numbered pilot 1, copilot 2, pilot 3, pilot 4 and pilot 5. The copilot's window heat switch controls windows numbered copilot 1, pilot 2, copilot 3, copilot 4 and copilot 5. When both switches are placed in the NORMAL position, normal heat is applied to all windows in the control cabin. When these switches are placed in the HIGH position, increased heat is applied to windows numbered pilot 1, pilot 2, copilot 1 and copilot 2 and normal heat is applied to all other heated windows. Operating power for control cabin windows is 115 volt AC through two circuit breakers marked WINDOW ANTI-ICE, NO. 3-4-5 PILOT, PILOT NO. 1 COPILOT NO. 2 on GENERATOR NO. 1 and two circuit breakers marked WINDOW ANTI-ICE, NO. 3-4-5 COPILOT, PILOT NO. 2 COPILOT NO. 1 on GENERATOR NO. 2 of the MCBP (figure 1-35, sheet 3). Control power for pilots' windows 3, 4 and 5 is 115 volt AC through a circuit breaker marked WINDOW ANTI-ICE, CONTROL on GENERATOR NO. 1 and for copilot's windows 3, 4, and 5 through a circuit breaker marked WINDOW ANTI-ICE, CONTROL on GENERATOR NO. 2 of the MCBP (figure 1-35, sheet 3). Control power for pilot 1, copilot 2 windows is through a circuit breaker marked ANTI-ICE CONTROL, PILOT WINDOW on T-R BUS NO. 2 and for pilot 2, copilot 1 windows through a circuit breaker marked ANTI-ICE CONTROL, COPILOT WINDOW, on T-R BUS NO. 1 of the MCBP (figure 1-35, sheet 2). The boom operator's window heat switch (1, figure 4-70) on the BOCBP has ON--OFF positions and controls the window heat for the boom operator's compartment. On airplanes 140▶ the A/R master switch must be ON in order to supply power to the boom operator's window. Control and operating power circuit protection is through circuit breakers marked WINDOW DEFROST on the BOCBP (figure 1-35, sheet 5).

WINDOW ANTI-ICING NORMAL OPERATION

For normal operation during flight, place the pilot and copilot window heat switches in the NORMAL position and place the boom operator's window heat switch in the ON position. In flight, heat will normally be applied continuously to the windows as airflow will prevent the window temperature from reaching the control setting of the sensing elements or thermal switches. During operation at low altitude, high temperature and low airspeeds, the window heat will cycle off when the control setting is reached. There are no ground safety switches in the system; therefore, it should be off if ground operation is unnecessary.

CAUTION

The pilots' window anti-icing system will not be operated when the sliding windows are open. Due to lack of air blast on the windows, they may overheat and possible breakage of the sliding windows could occur.

NOTE

When preparing for descent into extremely cold or adverse weather conditions, if window anti-icing is on NORMAL, it may be desirable to increase window heat to HIGH approximately 20 minutes prior to starting the descent to help prevent window fogging.

WINDOW ANTI-ICING EMERGENCY OPERATION

When the control cabin windows numbered pilot 1, pilot 2, copilot 1 and copilot 2 are not being heated sufficiently, place the pilot and copilot window heat switches in the HIGH position. If necessary, the pilot and co-

pilot window heat switches may be placed in the HIGH position without first warming up in the NORMAL position. See also PRESSURIZATION WITH CRACKED WINDOW, Section III.

CAUTION

Electrically heated windows should be operated at as low a temperature as possible without impairing anti-icing or affecting safety. Excessive temperature reduces service life and contributes to cracking and layer separation.

PITOT HEAD ANTI-ICING SYSTEM

Ice formation on the pitot heads is prevented or removed by an electric heating element in each pitot head. Both pilot and copilot pitot heaters use 115 volt AC. The pilot's circuit receives power through a circuit breaker marked PILOT PITOT STATIC ANTI-ICE on the GENERATOR NO. 3 portion of the MCBP (figure 1-35, sheet 3) and the copilot's circuit receives power through a circuit breaker marked COPILOT PITOT STATIC ANTI-ICE on the GENERATOR NO. 1 portion of the MCBP (figure 1-35, sheet 3).

Pitot Heat Switch

A pitot heat switch (6, figure 4-11) on the anti-icing control panel has ON--OFF positions. This switch controls both pilot and copilot pitot heaters and both pilot and copilot angle of attack transmitter probe heaters.

ANGLE OF ATTACK TRANSMITTER ANTI-ICING SYSTEM

Ice formation on the angle of attack transmitter (20A, figure 1-3) is prevented or removed electrically by a heating element in the external, pressure sensing probe. The case of the transmitter also has a heater. Air flowing through the transmitter is heated by both the probe heater and case heater to keep the interior of the transmitter moisture-free. The case heaters receive 115V AC power through a circuit breaker marked RGA HEATERS on the GENERATOR NO. 3 Section of the MCBP and the individual circuit breakers marked PRB HTR on the FD-109/RGA equipment rack whenever power is on the airplane. The probe heaters receive power through the same breakers, but its application is controlled by operation of the PITOT HEAT switch on the copilot's side panel.

Q-INLET ANTI-ICING SYSTEM

Ice formation on the Q-inlet is prevented or removed by a heating element built into the inlet head. Operating power for the heater is 115 volt AC through a circuit breaker marked Q-INLET HEATER on the GENERATOR NO. 2 section of the MCBP (figure 1-35, sheet 3). Power to the heater is controlled by the Q-inlet heat switch (19, figure 1-17) on the pilots' center instrument panel.

Q-Inlet Heat Warning Light

An amber push-to-test light marked POWER FAILURE illuminates whenever the Q-inlet heat switch is in the ON position and the heater is inoperative or insufficient power is being supplied to the heater. The light (20, figure 1-17) is on the pilots' center instrument panel, adjacent to the Q-inlet heat switch. Operating power for the light is 28 volt DC through a circuit breaker marked Q-INLET HEATER WARN on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2).

Q-Inlet Heat Switch

The Q-inlet heat switch (19, figure 1-17) on the pilots' center instrument panel has ON--OFF positions. With the switch in the ON position, power is supplied to the Q-inlet heater. The switch also actuates a holding relay which prevents the Q-inlet warning light from illuminating provided the heater is operative. When the switch is in the OFF position, there is no power to the system. Operating power is 115 volt AC through a circuit breaker marked Q-INLET HEATER on the GENERATOR NO. 2 section of the MCBP (figure 1-35, sheet 3).

PITOT AND Q-INLET ANTI-ICING OPERATION

In flight, turn the pitot and Q-inlet heat switch to the ON position if icing is suspected. To prevent burning out the heating element, ground operation of the pitot and Q-inlet heaters should be kept to a minimum. Also, see Q-INLET ICING in Section IX.

NOTE

- Avoid areas of known or suspected icing. Inaccurate airspeed readings will result from ice accumulations on or around the pitot heads. The copilot pitot head may be marginal for severe icing conditions and may loose airspeed indication because of pitot head icing; however, the pilot's pitot head has increased anti-icing capacity.
- Loss of Q-inlet heater power could result in an iced-over Q-inlet.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

All electronic equipment used for communications, navigation, and identification is listed in figure 4-13. The airplane has long range HF and short range UHF communications radios. For navigation, there are VOR/ILS, TACAN, and radar navigation sets plus the following navigation aids: marker beacon, search radar set. UHF-ADF, radar beacon, and, on airplanes 346▶, rendezvous beacon. The identification equipment includes the SIF/IFF, radar beacon, and, on airplanes 346▶, rendezvous beacon for use during normal flight conditions. The emergency identification equipment includes one feature of the SIF/IFF. Low and high range radio altimeters are additional pieces of electronic gear. Control panels for the electronic equipment do not illuminate when the respective sets are turned on. Separate light switches control illumination of control panels and indicators. (Refer to LIGHTING EQUIPMENT in this Section.) Figure 4-29 shows the location of all antennas. Each electronic unit that requires fuses has spare fuses in the equipment. Figure 4-29A lists corrective actions for navigation equipment malfunction. See figure 4-29B for electronic cabinet equipment and fuse location.

NOTE

- No transmission will be made on emergency (distress) frequency channels except for emergency purposes to prevent transmission of messages that could be construed as actual emergency messages.

- Radio equipment used for two-way communications have separate transmitters and receivers. When a radio is selected, the receiver operates continuously except for the periods when the transmitter is used. Since the receiver is cutout during transmission, it is not possible to transmit and receive simultaneously on the selected radio.

INTERPHONE (AN/AIC-10, AN/AIC-10A)

The AN/AIC-10A is a modified AN/AIC-10 that uses transistor type amplifiers instead of tube type amplifiers. A large white dot (2, figure 4-14) on an interphone control panel indicates a transistorized unit. The interphone ties all communications facilities together on a common channel. The interphone consists of three groups of basic components: user equipment (headsets), station equipment (control panels, relay assemblies, loudspeakers, and amplifiers), and power equipment (dynamotors). The particular control panel or panels at each station (figure 4-14) determine the facilities available for talking and listening. Regular crew stations have control panels with switching arrangements that permit speech communication between crewmembers, transmission and reception on the liaison and UHF radios, and reception of the signals from the navigation equipment. Stations of limited use have auxiliary interphone installations that limit the user to talking or listening to other crewmembers. The location of all interphone equipment is shown in figure 4-15. The pilot, copilot, navigator, and boom operator each have a control panel with a selector switch, a volume control knob, a NORMAL-AUX LISTEN switch, and five mixer switches. The same type panel is used by the crew instructor on airplanes 10▶ also by the boom operator instructor and the boom operator (at the forward station). The navigator, crew instructor, and on airplanes 98▶ the pilot and copilot each have a panel of additional mixer switches. The loudspeakers are cut-in and out of the interphone system by switches on the loudspeaker and TACAN antenna control panel (13 and 14, figure 4-14, sheet 2) on the pilot's overheat panel. The interphone power equipment on airplanes 1▶97 consists of two dynamotors in the electronics cabinet (11, figure 1-3). The transistorized interphone system on airplanes 98▶ does not require dynamotors for power. The interphone source of power is through two circuit breakers marked INPH on the battery circuit breaker panel (figure 1-35, sheet 1). One of the circuit breakers protects the following interphone stations: emergency, auxiliary, copilot's, navigator's, and boom operator's. The remaining stations receive power through the second circuit breaker. Since there is no switch to turn the interphone on or off, it operates whenever there is 28 volt DC power on the appropriate buses.

Normal-Auxiliary Listen Switch

Each interphone control panel has a NORMAL--AUX LISTEN switch (3, figure 4-14) 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 up (ON) position no other circuit is connected, regardless of the position of the other switches. Placing the left switch down (OFF) 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.

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
INTERPHONE AN/AIC-10 OR AN/AIC-10A	Intercrew communication and use with other radio equipment	All crew members	Intraplane only except when used in conjunction with other equipment	All crew stations. Control panels located at various positions in airplane	No control switches to turn interphone on or off. Operative whenever airplane has electrical power
UHF COMMAND RADIO AN/ARC-34 OR AN/ARC-133V (2 SETS)	Short range, two-way voice communication	Pilots	Line-of-sight. Range varies with altitude in respect to receiving station	Overhead panel	Do not operate both sets on or near the same frequency. AN/ARC-133V radio is required for secure speech operation.
UHF-ADF AN/ARA-25	Receives signals for directional bearing and homing, both air to air and ground to air	Pilots	Line-of-sight. Range depends upon power of transmitting stations and conditions	ADF position on UHF command radio control panel on overhead panel	Used in conjunction with the UHF Command radio (COMM = 1). Requires data from N-1 Compass
LIAISON RADIO AN/ARC-65	Long range, two-way voice communication	Navigator and Pilots	Range dependent upon mode selected, operating frequency and atmospheric condition. Up to several thousand miles	Primary control at navigator's station. Remote control on copilot's side panel	Frequencies can only be preset on navigator's control panel. Either AM or SSB operation
LIAISON RADIO AN/ARC-58	Long range, two-way voice communication	Navigator and Pilots	Range dependent upon mode selected, operating frequency and atmospheric conditions. 4000 NAM average	One on copilot's side panel and another on navigator's forward control console	Either AM or SSB operation
VOR/ILS RECEIVER (2) (VHF-NAV) 51R-6	VOR and ILS localizer	Pilots	Unobstructed line-of-sight (Variable)	Overhead panel	VOR-1 indication on copilot's HSI pointer No. 1; pilot's ADI runway symbol (localizer), HSI pointer No. 2 and CDI; VOR-2 indication on copilot's ADI runway symbol, HSI pointer No. 2 and CDI; pilot's HSI pointer No. 1 and navigator's RMI pointer No. 2

Figure 4-13 (Sheet 1 of 3)

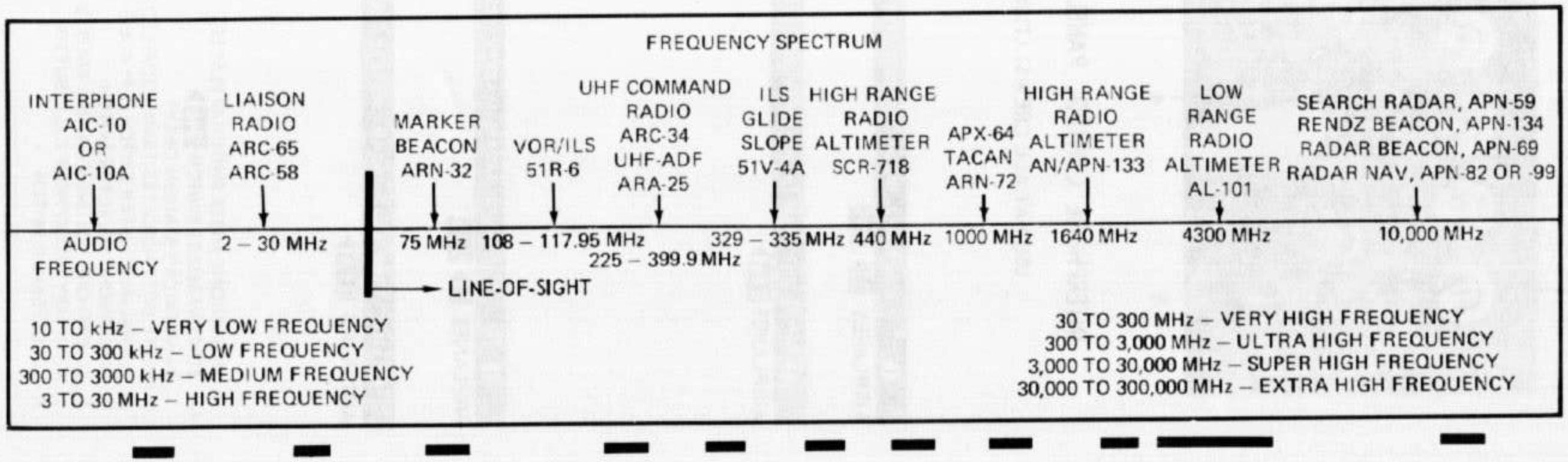
COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT (CONT)

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
GLIDE SLOPE RECEIVER (2) 51V-4A	Indicates glide slope for instrument approaches	Pilots	Short range line-of-sight	NAV 1/NAV 2 control panel on overhead panel	Indication on pilots' HSI and ADI
TACAN (UHF-NAV) AN/ARN-72	UHF radio navigational aid and A/R rendezvous	Pilots	Line-of-sight bearing. Indicator limited to distance - 195 NM	Overhead panel	Bearing indication on pilot's, copilot's, and navigator's RMI, and bearing and course deviation on pilot's and copilot's HSI. Distance displayed on pilot's and copilot's HSI. Requires data from N-1 Compass Air to air range capability
MARKER BEACON RECEIVER AN/ARN-12 OR AN/ARN-32	Receives marker beacon signals	Automatic		Beacon light located on pilots' instrument panels	
RADAR NAVIGATION SET AN/APN-82 1▶97	Aids in Navigation. Used to determine position, ground speed, drift angle	Navigator		Navigator's Radar Control Console	Requires data from N-1 Compass. Combination of AN/APN-81 and AN/ASN-6
RADAR NAVIGATION SET AN/APN-99 98▶	Constant display of position, distance and course to destination, true ground track, ground speed, drift angle, and magnetic variation	Navigator	Indicator displays distance (maximum 999 NAM) to destination	Navigator's Radar Control Console	Pilot also has destination indicator. Requires data from N-1 Compass. Combination of AN/APN-81 and AN/ASN-7
SEARCH RADAR AN/APN-59	Search, navigation, weather and rendezvous radar	Navigator	Up to 240 nautical miles	Navigator's Radar Control Console	Indication on Search Radar Indicators. Requires data from N-1 Compass

Figure 4-13 (Sheet 2 of 3)

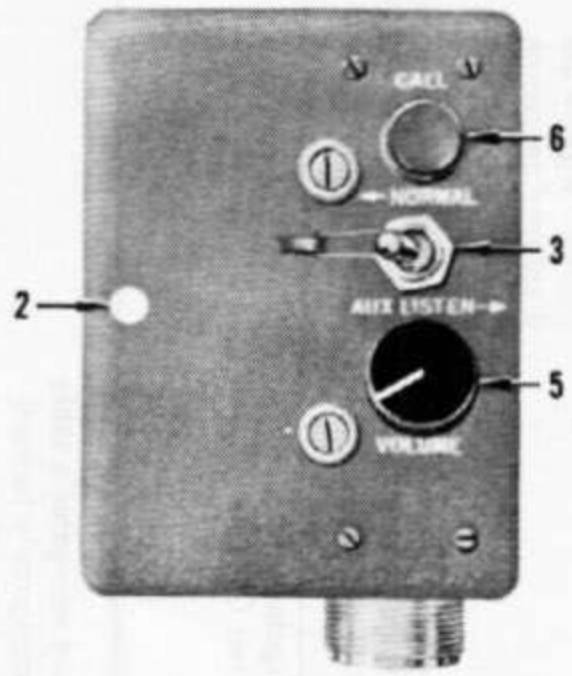
TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
RADAR BEACON AN/APN-69	Send signals to other airplanes for rendezvous	Navigator	Excess of 200 NAM	Navigator's Radar Control Console	Sends signals when triggered by other airplanes. Signals are displayed on search radar on approaching airplanes
RENDEZVOUS BEACON AN/APN-134 346▶	Send signals to other airplanes for rendezvous	Navigator	Up to 200 NAM	Navigator's forward control console	Similar to Radar Beacon AN/APN-69
IFF AN/APX-64	Airplane Identification	Navigator	Line-of-sight	Navigator's Radar Control Console	
RADIO ALTIMETER (HIGH RANGE) SCR-718 1▶547 AN/APN-133 548▶	Indicates distance from airplane to surface	Navigator	0-40, 000 feet 1▶547 0-50,000 feet 548▶	Above navigator's table on navigator's forward control console	
RADIO ALTIMETERS (2) (LOW RANGE) AL-101	Determines terrain clearance from 2500 feet to touchdown	Pilot-Copilot	0 – 2500 feet	Pilot's and co-pilot's instrument panels	Moves pilots' ADI runway symbols vertically and turns on MDA lights
RADAR PRESSURIZING EQUIPMENT AN/ASQ-15	Pressurizes radar sets to provide satisfactory operation at high altitudes	Navigator		Navigator's Radar Control Console	

Figure 4-13 (Sheet 3 of 3)



INTERPHONE CONTROLS (TYPICAL)





INTERPHONE CONTROL PANEL (C-824A)

USED AT ALL CREW STATIONS

INTER VHF NAV2 TACAN MARKER RDR-BCN
AIRPLANES 1 ▶ 3 45

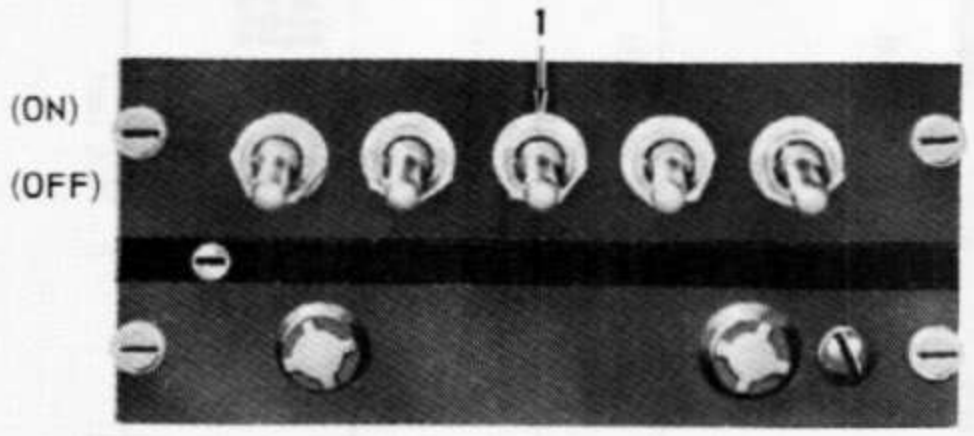
INTER RENDZ VHF NAV2 TACAN MARKER RDR-BCN
AIRPLANES 3 46 ▶

INTER IFF VHF NAV2 TACAN MARKER RDR-BCN
AIRPLANES 1 ▶ 345

INTER IFF VHF NAV2 TACAN MARKER BCN
AIRPLANES 346 ▶

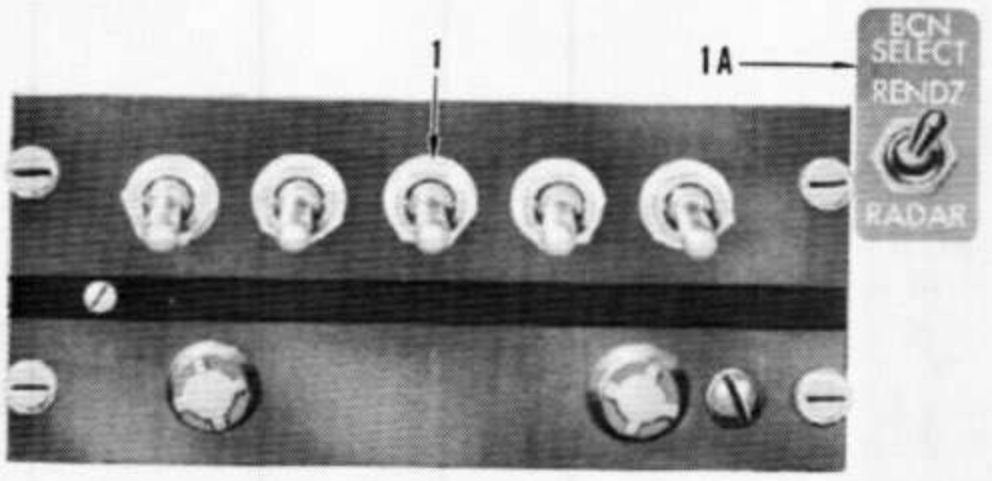
AUXILIARY INTERPHONE CONTROL PANEL (C-823A)

USED AT EMERGENCY AND RIGHT AFT SCANNING STATIONS



INTERPHONE MIXER SWITCH PANEL (C-826)

USED AT PILOT, COPILOT, AND CREW INSTRUCTOR STATIONS



INTERPHONE MIXER SWITCH PANEL (C-826)

USED AT NAVIGATOR'S STATION

1 INTERPHONE MIXER SWITCH (3 PLACES)
1A BEACON SELECT SWITCH 346 ▶ (NAVIGATOR'S STATION ONLY)
2 WHITE DOT (INDICATES TRANSISTORIZED PANEL) (2 PLACES)
3 NORMAL-AUX LISTEN SWITCH (2 PLACES)
4 INTERPHONE SELECTOR SWITCH
5 INTERPHONE VOLUME CONTROL KNOB (2 PLACES)
6 AUXILIARY INTERPHONE CALL BUTTON
7 LOUDSPEAKER SWITCH
8 PRESS-TO-TALK SWITCH
9 MICROPHONE SWITCH
10 INTERPHONE SWITCH (2 PLACES)
11 INTERPHONE-MIKE SWITCH
12 NAVIGATOR'S FOOT MIKE SWITCH
13 COCKPIT LOUDSPEAKER CONTROL SWITCH
14 CARGO COMPARTMENT LOUDSPEAKER CONTROL SWITCH

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Figure 4-14 (Sheet 1 of 2)

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
RADAR BEACON AN/APN-69	Send signals to other airplanes for rendezvous	Navigator	Excess of 200 NAM	Navigator's Radar Control Console	Sends signals when triggered by other airplanes. Signals are displayed on search radar on approaching airplanes
RENDEZVOUS BEACON AN/APN-134 346 ▶	Send signals to other airplanes for rendezvous	Navigator	Up to 200 NAM	Navigator's forward control console	Similar to Radar Beacon AN/APN-69
IFF AN/APX-64	Airplane Identification	Navigator	Line-of-sight	Navigator's Radar Control Console	
RADIO ALTIMETER (HIGH RANGE) SCR-718 1 ▶ 547 AN/APN-133 548 ▶	Indicates distance from airplane to surface	Navigator	0-40, 000 feet 1 ▶ 547 0-50,000 feet 548 ▶	Above navigator's table on navigator's forward control console	
RADIO ALTIMETERS (2) (LOW RANGE) AL-101	Determines terrain clearance from 2500 feet to touchdown	Pilot-Copilot	0 – 2500 feet	Pilot's and co-pilot's instrument panels	Moves pilots' ADI runway symbols vertically and turns on MDA lights
RADAR PRESSURIZING EQUIPMENT AN/ASQ-15	Pressurizes radar sets to provide satisfactory operation at high altitudes	Navigator		Navigator's Radar Control Console	

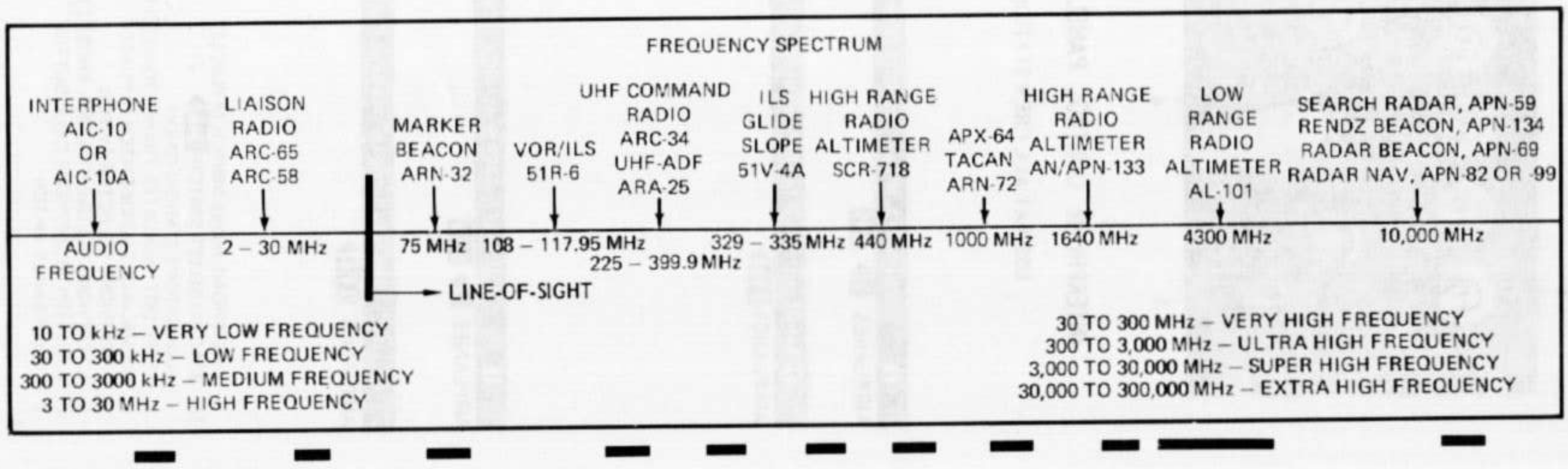
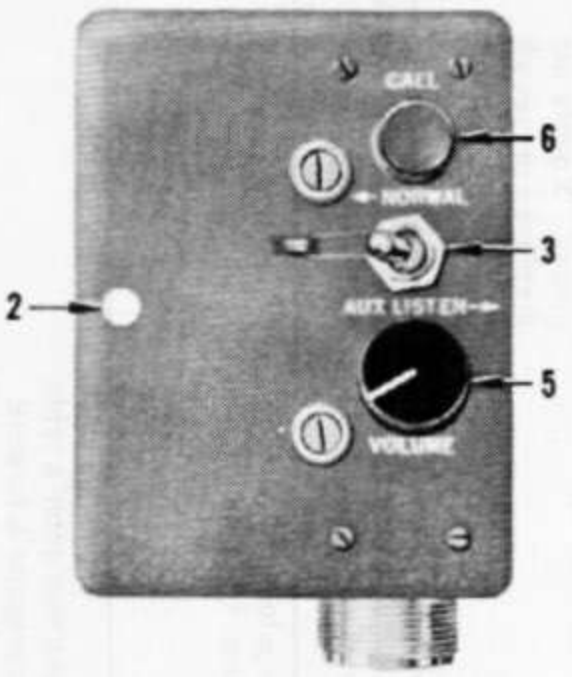


Figure 4-13 (Sheet 3 of 3)

INTERPHONE CONTROLS (TYPICAL)





INTERPHONE CONTROL PANEL (C-824A)

USED AT ALL CREW STATIONS

VHF NAV2 TACAN MARKER RDR-BCN
AIRPLANES 1 ▶ 345

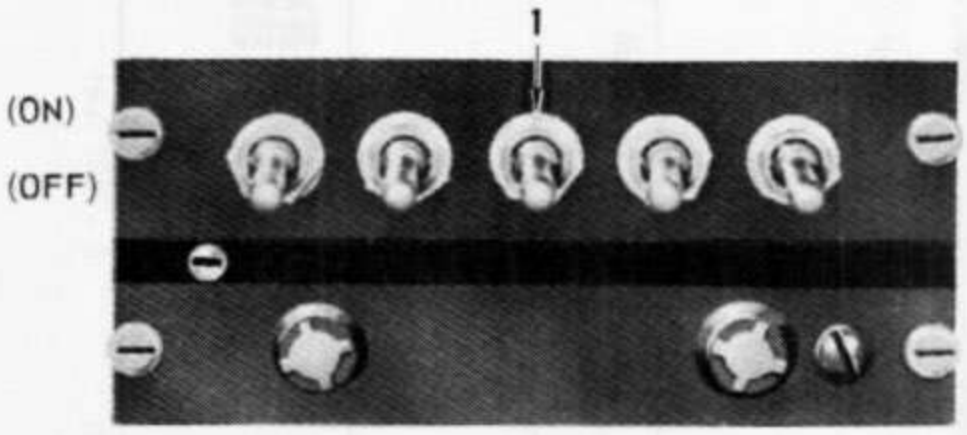
RENDZ VHF NAV2 TACAN MARKER RDR-BCN
AIRPLANES 346 ▶

IFF VHF NAV2 TACAN MARKER RDR-BCN
AIRPLANES 1 ▶ 345

IFF VHF NAV2 TACAN MARKER BCN
AIRPLANES 346 ▶

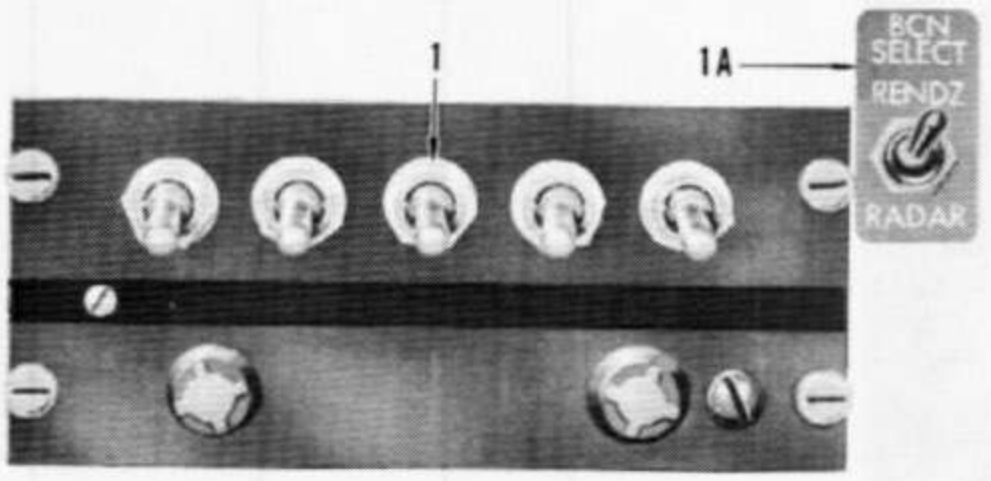
AUXILIARY INTERPHONE CONTROL PANEL (C-823A)

USED AT EMERGENCY AND RIGHT AFT SCANNING STATIONS



INTERPHONE MIXER SWITCH PANEL (C-826)

USED AT PILOT, COPILOT, AND CREW INSTRUCTOR STATIONS



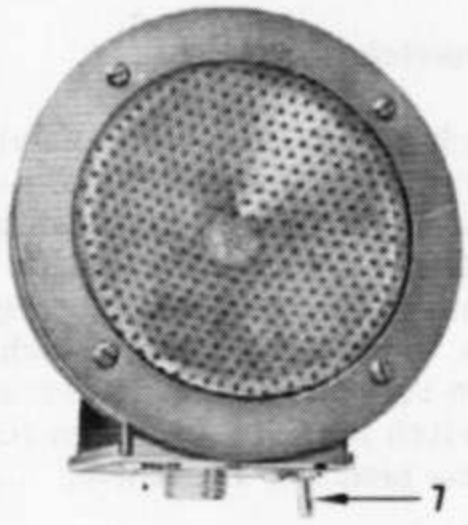
INTERPHONE MIXER SWITCH PANEL (C-826)

USED AT NAVIGATOR'S STATION

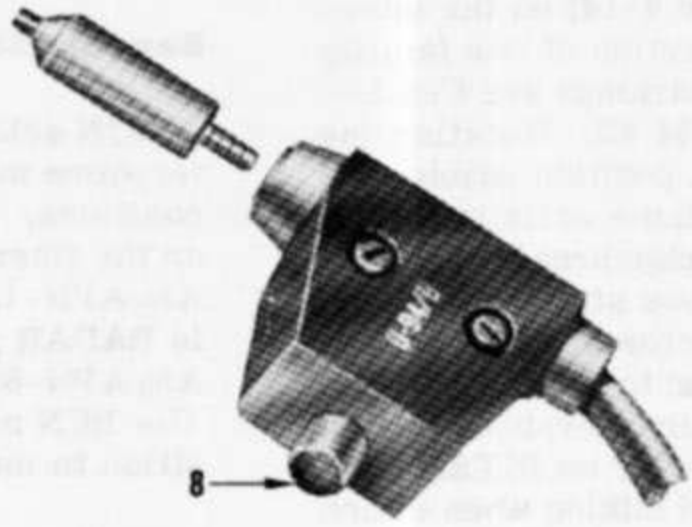
1 INTERPHONE MIXER SWITCH (3 PLACES)
1A BEACON SELECT SWITCH 346 ▶ (NAVIGATOR'S STATION ONLY)
2 WHITE DOT (INDICATES TRANSISTORIZED PANEL) (2 PLACES)
3 NORMAL-AUX LISTEN SWITCH (2 PLACES)
4 INTERPHONE SELECTOR SWITCH
5 INTERPHONE VOLUME CONTROL KNOB (2 PLACES)
6 AUXILIARY INTERPHONE CALL BUTTON
7 LOUDSPEAKER SWITCH
8 PRESS-TO-TALK SWITCH
9 MICROPHONE SWITCH
10 INTERPHONE SWITCH (2 PLACES)
11 INTERPHONE-MIKE SWITCH
12 NAVIGATOR'S FOOT MIKE SWITCH
13 COCKPIT LOUDSPEAKER CONTROL SWITCH
14 CARGO COMPARTMENT LOUDSPEAKER CONTROL SWITCH

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Figure 4-14 (Sheet 1 of 2)



LOUDSPEAKER



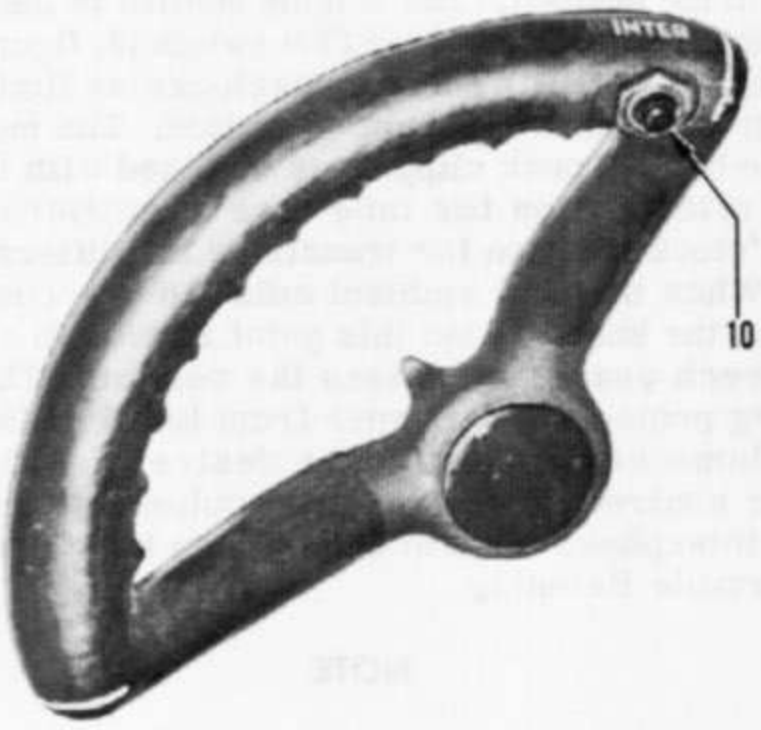
U-94 PLUG CONNECTOR

LOCATED AT NAVIGATOR'S STATION, BOOM OPERATOR'S FORWARD STATION, BOOM OPERATOR INSTRUCTOR'S STATION, AFT SCANNING STATION, AND EMERGENCY STATION



RUDDEVATOR CONTROL STICK

LOCATED AT BOOM OPERATOR'S STATION ONLY



NOSE STEERING WHEEL

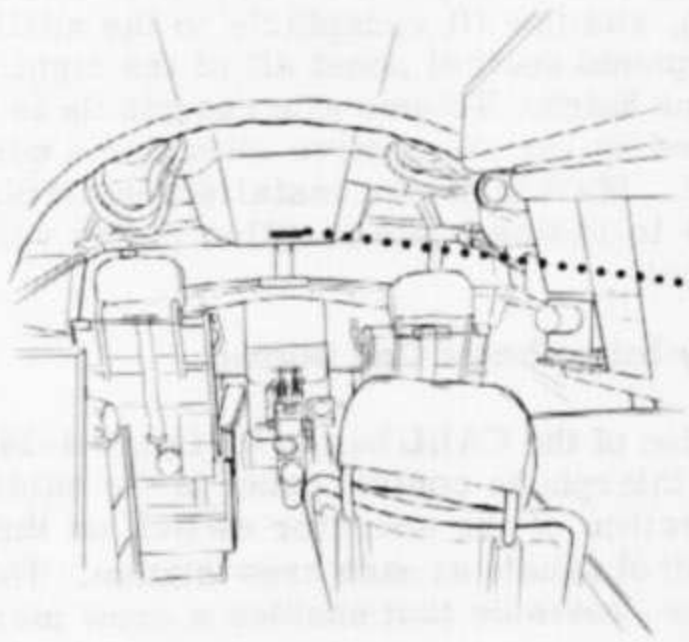
LOCATED AT PILOT'S STATION



CONTROL WHEEL

LOCATED AT PILOTS' STATIONS







LOUDSPEAKER AND TACAN ANTENNA CONTROL PANEL

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F-165
F-166
F-189
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F-4297

Figure 4-14 (Sheet 2 of 2)

Interphone Selector Switch

A rotary selector switch (4, figure 4-14) on the interphone control panel is for the selection of one facility for talking and listening. Switch markings are CALL--INTER--COMM #1--LIA--COMM #2. 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 release to INTER to listen. It is not necessary to use a mike or interphone switch to talk on CALL. Placing the selector on INTER permits listening on the interphone and talking when either the MIKE or INTER switch is depressed. Crew members at other stations have to have their INTER mixer switch on or their selector switch on INTER to be able to hear. The COMM #1 and COMM #2 position allows the user to transmit and receive on the selected UHF radio set. Transmission occurs when the respective mike switch is pressed (whether talking or not). The respective UHF radio control panels are identified with decals COMM #1 and COMM #2. The LIA position allows the user to transmit and receive on the long range liaison radio.

NOTE

- To prevent inadvertent transmission on the UHF or liaison radio set, check the position of the interphone selector switch before pressing a microphone switch.
- The interphone selector switch has six positions, but not all six positions are used. With the switch at a blank position, the user hears the facilities he has selected with the mixer switches but he will be unable to transmit on a radio or talk on the interphone.
- The external interphone receptacle in the nose wheel area is connected in parallel with the interphone control panel at the boom operator's forward station. Consequently, if the interphone selector switch (on the BO's panel) is on a COMM or LIA position and the selected radio is on, speech from this external station will be transmitted on the radio.

Interphone Mixer Switches

Five mixer switches (1, figure 4-14) are on the interphone control panel. Placing a mixer switch ON (up) mixes the audio signal from the respective receiver simultaneously with the receiver selected by the interphone selector switch (4, figure 4-14). This allows the crew member to monitor incoming signals from various equipment without changing the selector switch position. Mixer switch control of reception is affected by the NORMAL-AUX LISTEN switch described in a preceding paragraph. Refer to figure 4-14 for the interphone equipment configuration at each crew station. The navigator, crew instructor on airplanes 10▶, and on airplanes 98▶ the pilot and copilot, each have a panel of five additional mixer switches.

Beacon Select Switch 346▶

A BCN select switch attached to the navigator's interphone mixer switch panel has RENDZ---RADAR positions. In RENDZ position, a tone can be heard on the interphone at the navigator's station when the AN/APN-134 beacon responds to an interrogation. In RADAR position, a tone can be heard when the AN/APN-69 beacon responds to an interrogation. The BCN mixer switch must be in the up (ON) position to monitor the beacons' response.

Interphone Volume Control

The volume control (5, figure 4-14) on each interphone control panel regulates the strength of the signal (volume) to the headset at the user's station but does not regulate the volume of the user's voice going into the interphone system. There is a sidetone feature on the interphone, UHF, and liaison radio sets that enables the user to regulate his speech by hearing his own voice in the headset. The volume control is ineffective when the NORMAL-AUX LISTEN switch (3, figure 4-14) is in AUX LISTEN. The counterclockwise limit of the knob gives minimum volume operation. The maximum volume before peak clipping is obtained with the knob at the midposition for tube type amplifiers or the 9:00 o'clock position for transistor amplifiers (white dot). When there is ambient noise to overcome, advancing the knob beyond this point results in clipping the speech peaks and raises the volume. The peak clipping protects the listener from loud blasts. With the volume control set at the desired position, the volume controls of the various equipment connected to the interphone system should then be adjusted for comfortable listening.

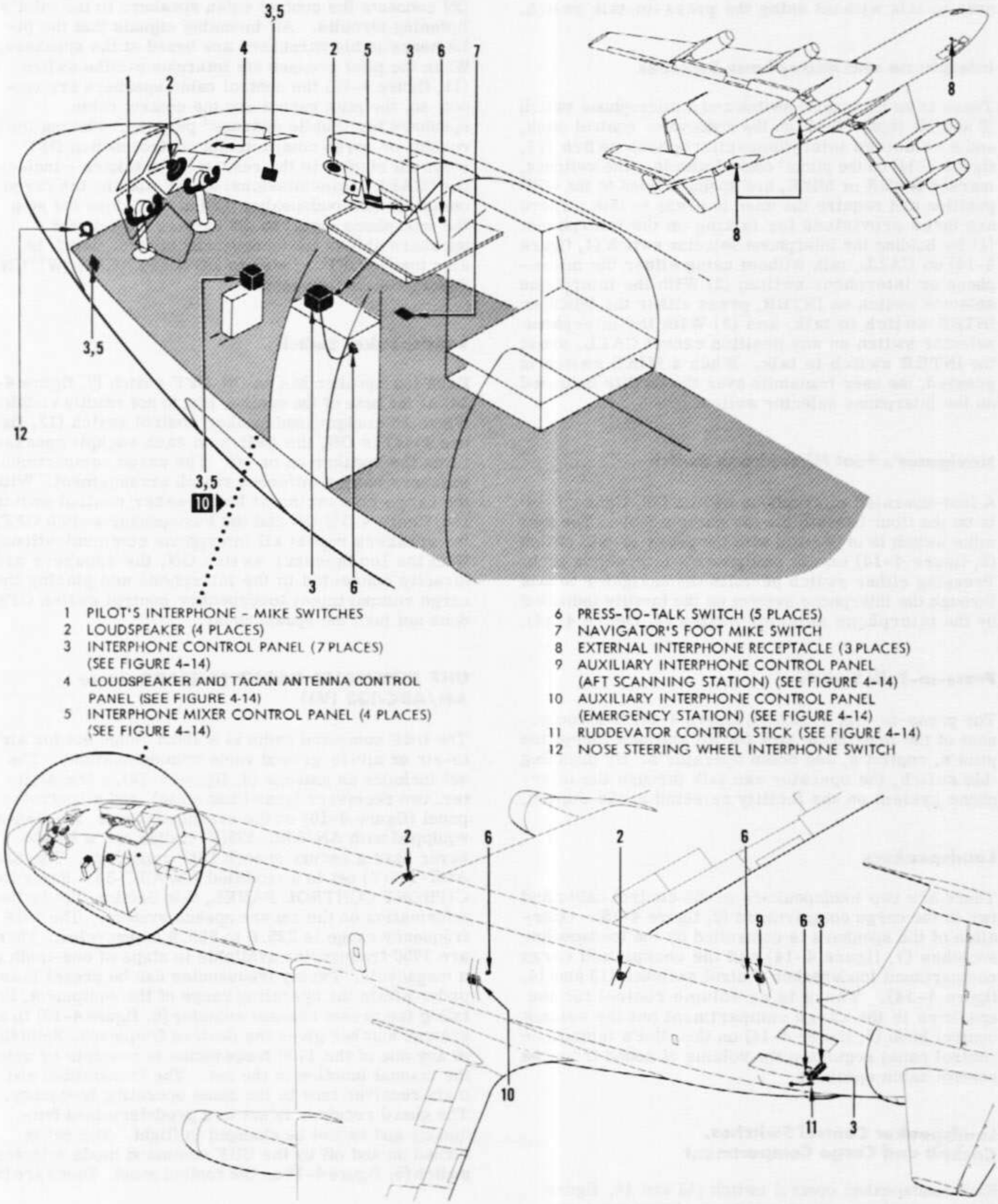
NOTE

The external interphone receptacles (8, figure 4-15) are connected in parallel with the interphone panels inside the airplane. The forward receptacle is connected to the boom operator's interphone control panel at the forward station, the wheel well receptacle to the emergency auxiliary control panel aft of the left overwing hatch, and the aft receptacle to the auxiliary interphone control panel aft of the right rear escape hatch. Volume at a receptacle is controlled by the respective interphone control panel. Markings are installed on airplanes 504▶ to indicate the location of the volume control.

Auxiliary Interphone Call Button

The function of the CALL button (6, figure 4-14) on the auxiliary interphone control panel 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

INTERPHONE EQUIPMENT LOCATION



1 PILOT'S INTERPHONE - MIKE SWITCHES
2 LOUDSPEAKER (4 PLACES)
3 INTERPHONE CONTROL PANEL (7 PLACES) (SEE FIGURE 4-14)
4 LOUDSPEAKER AND TACAN ANTENNA CONTROL PANEL (SEE FIGURE 4-14)
5 INTERPHONE MIXER CONTROL PANEL (4 PLACES) (SEE FIGURE 4-14)
6 PRESS-TO-TALK SWITCH (5 PLACES)
7 NAVIGATOR'S FOOT MIKE SWITCH
8 EXTERNAL INTERPHONE RECEPTACLE (3 PLACES)
9 AUXILIARY INTERPHONE CONTROL PANEL (AFT SCANNING STATION) (SEE FIGURE 4-14)
10 AUXILIARY INTERPHONE CONTROL PANEL (EMERGENCY STATION) (SEE FIGURE 4-14)
11 RUDDEVATOR CONTROL STICK (SEE FIGURE 4-14)
12 NOSE STEERING WHEEL INTERPHONE SWITCH

Figure 4-15

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.

Interphone and Microphone Switches

There is an interphone switch and a microphone switch (9 and 10, figure 4-14) on the ruddevator control stick, and a combined interphone-microphone switch (11, figure 4-14) on the pilots' control wheels. The switches, marked INTER or MIKE, are spring-loaded to the OFF position and require the user to press to talk. There are three provisions for talking on the interphone: (1) By holding the interphone selector switch (4, figure 4-14) on CALL, talk without using either the microphone or interphone switch; (2) With the interphone selector switch on INTER, press either the MIKE or INTER switch to talk; and (3) With the interphone selector switch on any position except CALL, press the INTER switch to talk. When a MIKE switch is pressed, the user transmits over the facility indicated on the interphone selector switch.

Navigator's Foot Microphone Switch

A foot-operated microphone switch (12, figure 4-14) is on the floor beneath the navigator's table. The foot mike switch is in parallel with the press-to-talk switch (8, figure 4-14) on the navigator's interphone jack. Pressing either switch permits the navigator to talk through the interphone system on the facility indicated by the interphone selector switch (4, figure 4-14).

Press-to-Talk Switch

The press-to-talk switch (8, figure 4-14) is a component of the interphone jack for all stations except the pilot's, copilot's, and boom operator's. By pressing this switch, the operator can talk through the interphone system on the facility selected at the station.

Loudspeakers

There are two loudspeakers in the control cabin and two in the cargo compartment (2, figure 4-15). Operation of the speakers is controlled by the loudspeaker switches (7, figure 4-14) and the cockpit and cargo compartment loudspeaker control switches (13 and 14, figure 4-14). There is no volume control for the speakers in the cargo compartment but the volume control knob (5, figure 4-14) on the pilot's interphone control panel regulates the volume of sound from the control cabin speakers.

Loudspeaker Control Switches, Cockpit and Cargo Compartment

Each loudspeaker control switch (13 and 14, figure 4-14) controls a pair of speakers. When the cargo compartment switch is in SPKR ON, both speakers in the cargo compartment reproduce conversation on the interphone channel. Although the speakers are intended for use by the pilot, they repeat all interphone communications. Placing the cockpit switch in SPKR ON connects the control cabin speakers to the pilot's listening circuits. All incoming signals that the pilot hears in his earphones are heard at the speakers. When the pilot presses his interphone-mike switch (11, figure 4-14) the control cabin speakers are cut-out; so, the pilot cannot use the control cabin speakers for "public address" purpose. Placing the cockpit or cargo compartment control switch OFF stops all signals to the respective speakers - including "CALL" transmissions; except placing the cargo compartment loudspeaker switch OFF does not stop the interphone signal to the cargo compartment speakers unless the loudspeaker control switch is also turned OFF. Refer to LOUDSPEAKER SWITCH description in this section.

Loudspeaker Switch

Each loudspeaker has an ON-OFF switch (7, figure 4-14) at the base of the speaker that is not readily visible. When the cockpit loudspeaker control switch (13, figure 4-14) is ON, the switch on each cockpit speaker turns the speaker on or off. The cargo compartment speakers have a different switch arrangement. With the cargo compartment loudspeaker control switch (14, figure 4-14) ON and the loudspeaker switch OFF, the speakers repeat all interphone communications. With the loudspeaker switch ON, the speakers are directly connected to the interphone and placing the cargo compartment loudspeaker control switch OFF does not turn the speakers off.

UHF COMMAND RADIO (AN/ARC-34 or AN/ARC-133 (V))

The UHF command radio is a short range set for air-to-air or air-to-ground voice communications. The set includes an antenna (9, figure 4-29), a transmitter, two receivers (guard and main), and a control panel (figure 4-16) on the overhead panel. Airplanes equipped with AN/ARC-133(V) radios and a KY-28 keyer have a secure speech UHF capability. The AN/ARC-133(V) set is a modified AN/ARC-34. Refer to CIPHONY CONTROL PANEL, this Section, for further information on the secure speech system. The UHF frequency range is 225.0 to 399.9 megacycles. There are 1750 frequencies available in steps of one-tenth of a megacycle. Twenty frequencies can be preset in any order within the operating range of the equipment. Rotating the preset channel selector (6, figure 4-16) to a channel number gives the desired frequency. Selection of any one of the 1750 frequencies is possible by using the manual function of the set. The transmitter and main receiver tune to the same operating frequency. The guard receiver is set to a predetermined frequency and cannot be changed in flight. The set is turned on and off by the UHF command mode selector switch (5, figure 4-16 on the control panel. There are two

UHF sets, referred to as COMM #1 and COMM #2 on appropriate interphone strips and dials. The two sets permit two separate, independent command communications to occur simultaneously. COMM #1 is on the pilot's side of the overhead panel and COMM #2 is on the copilot's side. Since the command radio (or radios) is connected to the interphone, the interphone selector switch and the interphone mixer switch (4 and 1, figure 4-14) must be placed in the appropriate COMM position to receive. The interphone selector switch must be placed in the appropriate COMM position to transmit. The COMM #2 set does not have a direction finding facility (ADF). The 28 volt DC power supply for COMM #1 is through a circuit breaker marked ARC-34 on the SBCBP on airplanes 1▶29. UHF COMMAND on airplanes 30▶97, or No. 1 UHF COMMAND, on airplanes 98▶. The 28 volt DC power for COMM #2 comes through a circuit breaker marked UHF COMMAND NUMBER 2 on the MCBP T-R BUS NO. 1 (figure 1-35, sheet 2).

NOTE

- When a frequency below 225.0 megacycles is selected on the UHF command radio, the radio will either turn itself off or continuously channel. In either case, the radio will be inoperable.
- COMM #1 and COMM #2 should be operated at different frequencies. When both sets are tuned to approximately the same frequency, transmissions from one set may be received in the other set with very loud reception.
- On sets equipped with a transistorized power supply, momentary power interruptions (28 volt DC) may cause the power supply to cease operating. Turning the mode selector switch OFF and then back to MAIN or BOTH will restore power to the receiver.
- Certain line of sight communication and navigation systems may be impaired or inoperative if the attitude of the airplane is such that the antenna is shielded, by airplane structure, from the ground station. This effect applies particularly to SIF, TACAN and UHF. This is to be considered as normal operation. Before a system is written up for malfunctioning, it should be checked with the airplane flying at different attitudes to verify whether or not there is a malfunction.

UHF Command Mode Selector Switch

The rotary selector switch (5, figure 4-16) has four positions: OFF--MAIN--BOTH--ADF. With the switch in the OFF position, the command radio is de-energized. In the MAIN position the set transmits and receives on the selected frequency but the separate receiver for the guard frequency is not heard. BOTH indicates simultaneous reception from both the main and guard receivers. When on ADF, the UHF direction finding set indicates bearing to a station having the selected channel or frequency. Refer to UHF DIRECTION FINDER in this Section. In the ADF position, the guard receiver is not heard and the command radio transmitter can be used; however, using the transmitter interrupts ADF operation. The ADF function is not operable on the COMM #2 control panel.

NOTE

When using the ADF facility, it is normal to have slightly distorted and reduced reception of audio signals.

Manual-Preset-Guard Switch

Frequencies on the UHF command radio can be selected by three methods. A rotary switch marked MANUAL--PRESET--GUARD (3, figure 4-16) is for the selection of one of the three methods. In the MANUAL position, the frequency selector knobs (2, figure 4-16) are used to quickly select an operating frequency without disturbing the preset frequencies. The manually selected frequency appears in the windows across the top of the panel. Preset channels can be checked or changed without disturbing operation on the "manual" operating frequency. The preset channel number is covered when the switch is on MANUAL and a green window covers the words PRESET and GUARD. Rotating the switch to PRESET shifts control of frequency selection to the preset channel selector (6, figure 4-16), removes the cover from the channel indicator (8, figure 4-16), positions covers over the manual frequency indicators 1, figure 4-16), and moves the green window over the words MANUAL and GUARD. In the GUARD position, the transmitter and main receiver operate on a fixed frequency and the guard receiver is inoperative. The fixed frequency can be changed only by removing the control panel. The preset channel number is covered and the words MANUAL and PRESET are covered by the green window when the switch is in GUARD.

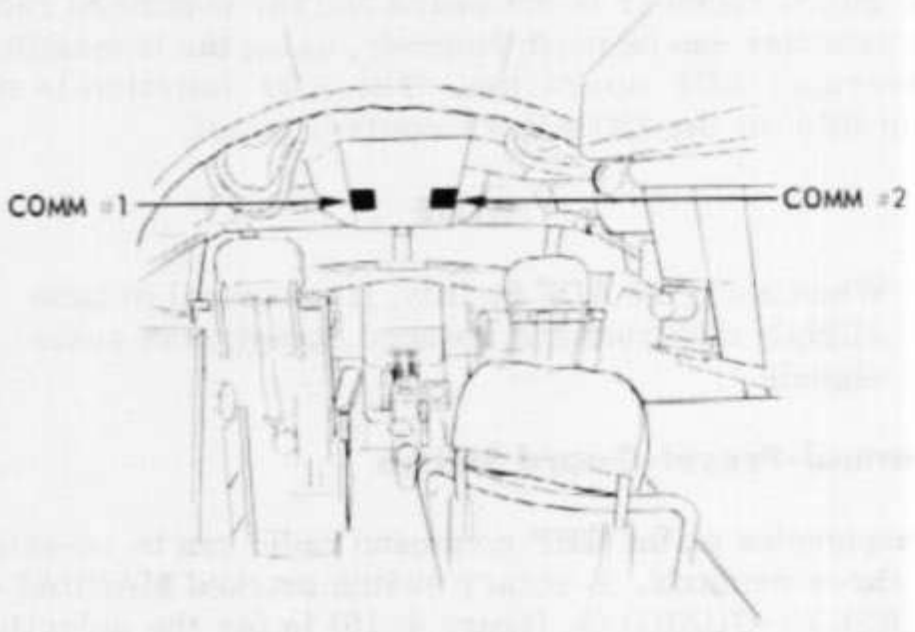
Manual Frequency Selector Knobs

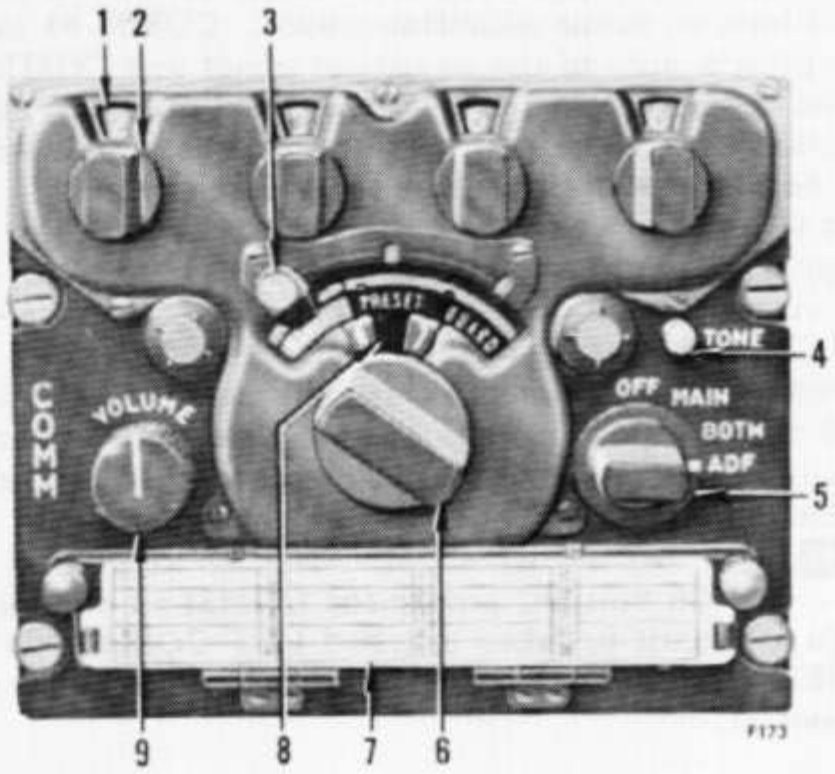
Four knobs (2, figure 4-16), across the top of the control panel, are for the selection of any frequency within the operating range of the equipment. The knobs are effective when the radio is operating and the MANUAL--PRESET--GUARD switch (3, figure 4-16) is in MANUAL. The digits appearing in the windows over the knobs represent the manually selected frequency. The settings of the preset frequencies are not affected by manual operation.

Manual Frequency Indicator

The manual frequency indicator (1, figure 4-16) indicates the operating frequency set up by the frequency selector knobs (2, figure 4-16) when the MANUAL--PRESET--GUARD switch (3, figure 4-16) is on MANUAL.

CONTROL PANEL UHF COMMAND RADIO





1 MANUAL FREQUENCY INDICATOR
2 MANUAL FREQUENCY SELECTOR KNOB
3 MANUAL-PRESET-GUARD SWITCH
4 TONE BUTTON SWITCH
5 UHF COMMAND MODE SELECTOR SWITCH
6 PRESET CHANNEL SELECTOR
7 PRESETTING DRUM COVER AND FREQUENCY CHART
8 CHANNEL INDICATOR
9 UHF COMMAND VOLUME CONTROL KNOB

Figure 4-16

Tone Button Switch

Depressing the tone button (4, figure 4-16) when the UHF command radio is operating causes the set to transmit a continuous tone for direction finding purposes on the selected frequency.

Preset Channel Selector

The preset channel selector (6, figure 4-16) is operative when the MANUAL--PRESET--GUARD switch (3, figure 4-16) is in the PRESET position. To select one of the twenty preset frequencies, refer to the frequency chart at the bottom of the control panel for the corresponding channel number. Then rotate the selector until the channel number appears in the center position above the selector.

UHF Command Volume Control Knob

The volume control knob (9, figure 4-16) adjusts the strength of the signal that both receivers (guard and main) feed into the interphone system. The volume should be adjusted in conjunction with the interphone volume control (5, figure 4-14); however, the volume cannot be reduced below a fixed level.

Channel Indicator

The channel indicator (8, figure 4-16) indicates the preset channel in use. The indicator is visible only when the MANUAL--PRESET--GUARD switch (3, figure 4-16) is in PRESET.

Presetting Drum Cover and Frequency Chart

This cover (7, figure 4-16) conceals the presetting mechanism of the UHF command radio. The frequency chart on the drum cover is a record of the frequency of each channel.

Changing Preset Frequencies

A preset frequency can be changed with the set operating or turned off. To make the change, uncover the presetting mechanism by loosening the screws on the presetting drum cover (7, figure 4-16). Rotate the preset channel selector (6, figure 4-16) so that the number of the channel being preset appears over the arrow at the left end of the slot. Remove the presetting tool from the clip inside the cover. Place the socket-end of the tool over the buttons and push the buttons sidewise to correspond with the desired frequency. Replace the tool and enter the new frequency on the frequency chart.

CIPHONY CONTROL PANEL

The ciphony control panel, (figure 4-16A), is used to control the KY-28 keyer, when the keyer is being used in conjunction with an AN/ARC-133(V) radio to provide UHF secure speech capability. In order to operate in the secure speech mode the airplane must have the following equipment: a KY-28 keyer, an RE-978/ARC relay, and an AN/ARC-133(V) UHF radio set or sets. The KY-28 keyer can be used with either COMM 1 or COMM 2 radio to provide secure speech, as determined by the mode selector

switch on the ciphony control panel. If the KY-28 keyer becomes inoperative or is removed, plain communication can be obtained only by placing the mode selector switch on the ciphony control panel to the PLAIN position. If the RE-978/ARC relay itself fails, the electrical connectors can be moved to a bypass cable built into the base of the keyer. The bypass cable connectors are just outboard of the relay, and are covered by dust caps when not in use. The secure speech system receives 28 volt DC through a circuit breaker marked SECURE VOICE on the T-R BUS NO. 2 section of the MCBP.

WARNING

Simultaneous keying of an unsecure HF or UHF transmitter is prohibited when command 1 or 2 UHF is being used for classified conversation in the same airplane compartment or area.

Power Switch

This switch (5, figure 4-16A) on the ciphony control panel has unmarked ON-OFF positions. The ON (up) position provides power to the KY-28 keyer and allows operation of the secure speech system. The OFF (down) position removes all power from the KY-28 keyer and permits only normal operation of the UHF command radios.

Mode Selector Switch

This three-position rotary switch (6, figure 4-16A) on the ciphony control panel has C/RAD 1--PLAIN--C/RAD 2 positions. The C/RAD 1 position provides secure speech operation on COMM 1 radio, and similarly the C/RAD 2 position provides secure speech operation on COMM 2 radio. The PLAIN position provides normal UHF command radio operation on both UHF radios.

Delay Switch

This switch (1, figure 4-16A) on the ciphony control panel has unmarked ON-OFF positions. When positioned to ON (up) a short delay is provided for use during secure speech operation with a relay radio. The OFF (down) position returns the system to normal undelayed operation.

Zeroize Switch

This switch (7, figure 4-16A) is spring-loaded and guarded to the unmarked OFF (down) position. When moved to the ON (up) position certain circuits in the KY-28 keyer are returned to a zero condition. The OFF (down) position removes power from the zeroize circuits.

C/RAD 1 Indicator Light

This green press-to-test light (2, figure 4-16A) on the ciphony control panel illuminates when the mode selector switch is positioned to C/RAD 1, and indicates that COMM 1 will operate in the secure speech mode.

C/RAD 2 Indicator Light

This green press-to-test light (4, figure 4-16A) on the ciphony control panel illuminates when the mode selector switch is positioned to C/RAD 2, and indicates that COMM 2 will operate in the secure speech mode.

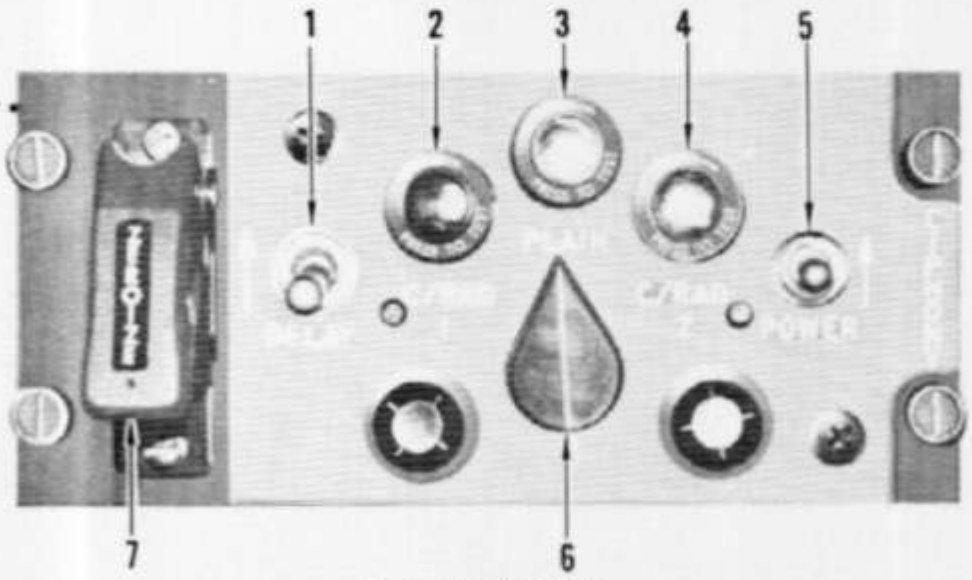
PLAIN Indicator Light

This amber press-to-test light (3, figure 4-16A), on the ciphony control panel, illuminates when the mode selector switch is in PLAIN. This indicates both the COMM 1 and COMM 2 are in the plain mode of operation.



1 DELAY SWITCH
2 C/RAD 1 INDICATOR LIGHT
3 PLAIN INDICATOR LIGHT
4 C/RAD 2 INDICATOR LIGHT
5 POWER SWITCH
6 MODE SELECTOR SWITCH
7 ZEROIZE SWITCH

CIPHONY CONTROL PANEL



C-7213/ARC

Figure 4-16A

LIAISON RADIO (AN/ARC-65 or -65A)

2▶27, 30▶32, 34▶39, 41, 43▶185

The liaison radio operates over a frequency range of 2 to 24 Megahertz giving a total of 44,000 usable frequencies. Control panels are illustrated in figure 4-17. The set permits long range two-way voice communications from airplane to airplane and airplane to ground. The AN/ARC-65 has the capability of single sideband transmission and reception. (Single sideband principles are described under LIAISON RADIO AN/ARC-58 in this Section.) The radio is turned on and off by a control switch on the copilot's liaison radio control panel (2, figure 4-17) on the side panel or by a control switch on the navigator's radio panel (2, figure 4-17) at the navigator's station. Twenty channels may be preset on the navigator's liaison radio control panel and individually selected at either control panel by means of a channel selector switch. A time delay of up to 15 seconds delays operation while the set is tuning after changing channels; therefore, the crewmember operating the set should not expect immediate communication. The receiver is tuned by selecting the desired channel. Transmitter tuning is then automatically completed by using the applicable mike switch. To receive and transmit over the liaison radio, the applicable interphone selector switch must be on LIA. If only listening is desired, the applicable interphone mixer switch must be ON (up). Operating power for the liaison radio is 115 volt AC from GENERATOR NO. 2 of MCBP (figure 1-35, sheet 3) and control power is 28 volt DC from T-R BUS NO. 2 of the MCBP (figure 1-35, sheet 2). Circuit breakers are marked HF LIAISON.

CAUTION

On airplanes with ▶1C18 550◀ (Mark II modulated antiskid brake system), all HF radio transmission should be avoided during taxi, takeoff, and landing roll. Simultaneous keying of an HF radio and the application of the pilot's brakes may generate electronic interference in the antiskid system and result in the brakes "releasing" with temporary loss of the pilot's brakes.

WARNING

- Ground operation of the AN/ARC-65 transmitter is prohibited unless the airplane is at least 200 feet from the following:

  (1) Unloaded weapons or warheads.

  (2) Loaded weapons in an airplane with the bomb bay doors open.

  (3) AGM-28 missiles with warhead compartment doors open, or thruster and squib access door open.

- HF liaison transmissions can cause improper operation and/or failure indications of the FD-109/RGA system while operating in navigation or approach modes. This electromagnetic interference can occur when an HF transmitter is operated at certain subharmonics of the VOR/ILS navigation frequency (3.100 MHz, 15.000 MHz, 23.800 MHz, and 29.999 MHz, approximately .050 MHz about each). The EMI is characterized by the following reactions on the ADI and HSI:

  (1) Navigation, glideslope, and computer flags fluctuate during HF transmissions.

  (2) Movement of glideslope pointer.

  (3) Movement of command bars or bars driven from view.

NOTE

A warm-up time of approximately 10 to 15 minutes is required to obtain optimum performance.

Liaison Radio Control Switch

The control switch (2, figure 4-17) on the copilot's and navigator's liasion radio control panel is marked OFF--ON. The switch permits the operator to turn on and "take control" of the equipment regardless of the setting of the other control switch. Placing one control switch to the ON position causes the other to be electrically returned to the OFF position. With this type of switching arrangement, an OFF position of the switch does not necessarily mean that the equipment is off but is an indication of not having control. With both switches OFF, the equipment is de-energized. The control switch is also a protective device that returns the switch to OFF when there are faults in the equipment. When the operator notices the switch returning to OFF, he should check to see if the other station has taken control or if the radio is malfunctioning.

Channel Selector Switch

This switch (6, figure 4-17) on the navigator's and copilot's liaison radio control panels has channel positions numbered from 1 to 20 providing selection of any of the preset frequencies. Presetting is accomplished using only the navigator's liasion radio control panel.

NOTE

If the channel selector switch is turned too fast, control will not be properly started and channel selection will not proceed.

Channel Selector Indicator

This indicator (5, figure 4-17) is on the copilot's and navigator's liaison radio control panels. It is visible through an illuminated window and indicates the number of the channel in use together with the numbers of the preceding and succeeding channels.

SSB-AME Switch

The SSB-AME switch (10, figure 4-17) is for the selection of one of the two forms of radio communication available: single sideband or amplitude modulation. 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. The noise control (8, figure 4-17) on the pilot's panel is operative when the switch is in SSB.

Power Switch

A two-position switch (7, figure 4-17) is on the navigator's liaison radio control panel. This power switch with HI--LOW positions provides a means of selecting the power output in a 10 to 1 ratio. The HI position will normally be used when maximum range transmissions are desired. The LOW position is used when shorter range transmissions are desired.

CAUTION

Do not change the power switch position while the microphone switch is closed. Arcing and permanent damage to the relays in the receiver-transmitter may result.

Noise Control Knob

A knob (8, figure 4-17) on the navigator's and copilot's liaison radio control panels allows adjustment of the background noise level of the liaison radio receiver during VOICE operation. The knob should be adjusted for best reception of voice signals.

Presetting Drum and Frequency Card

Two presetting drums (4, figure 4-17) are on the navigator's liaison radio control panel. These drums provide a means of manually presetting the frequency of each channel as selected by the channel selector switch. Each drum is protected by a hinged cover. A special tool for the presetting operation is stowed inside the top drum cover. A card on the face of the top drum cover is used to record frequency values of each channel as the presetting operation is accomplished. The preset frequencies for the liaison radio are also recorded on the radio frequency card (8, figure 1-20).

NOTE

If the upper drum cover door is not closed with the knurled knob tight, a door interlock switch will remain open and prevent channelization of the liaison radio.

CW Tune Control

A CW tune control (3, figure 4-17) on the navigator's liaison radio control panel is used to adjust the CW beat frequency when receiving continuous wave signals.

Function Switch

A rotary-type selector switch (9, figure 4-17) on the navigator's liaison radio control panel has FSK--SSB--CW--AME positions. The FSK and CW positions are not operative (FSK is a provision for teletype equipment and CW is a provision for sending and receiving code). The SSB and AME positions are the same as described under SSB--AME SWITCH

Liaison Radio Volume Control

There is a volume control (1, figure 4-17) on the copilot's and navigator's liaison radio control panels. The control adjusts the sound level during voice or CW reception. Only one control is effective at a time; the effective knob is on the panel that has control. Volume is also dependent upon the position of the interphone volume control (5, figure 4-14).

LIAISON RADIO (AN/ARC-58) 1, 28, 29, 33, 40, 42, 186▶

The AN/ARC-58 liaison radio is capable of transmitting and receiving on any one of 28,000 frequencies for long range, two-way voice communication. The frequency range is in the high frequency (HF) band from 2.0 to 29.999 Megahertz. The full range of frequencies is available only on airplanes having a wire antenna (6, figure 4-29). Frequencies below 4 Megahertz may not be obtainable on radios using the probe antenna at the top of the vertical stabilizer. The radio can be operated from either one of two control panels but not from both simultaneously. One control panel is on the copilot's side panel and the other is on the navigator's forward control console. The control panels are identical and have the following controls: control switch, mode selector switch, volume control, and frequency selector knobs. The control switch turns the radio on and "takes control" or turns the radio off. Frequencies are selected by manually positioning the four selector knobs so that the digits of the desired frequency appear on the frequency indicator. The unusually long range (average 4000 NAM) is achieved by using high power and single sideband transmission and reception. 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 contain 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 either the upper sideband, lower sideband, or both sidebands. 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 "synthetic" AM. The mode selector switch permits selection of upper (U) or lower (L) single sideband, amplitude modulation (AM), or both sidebands (TWIN) operation of the radio. When transmitting on AM or TWIN, there is a division of power that results in reduced range. The radio is connected to the interphone; therefore, to transmit and receive on the liaison radio the interphone selector switch and mixer switch (4 and 1, figure 4-14) must be placed in the appropriate LIA position. A "tune" tone is heard over the interphone when a new frequency is selected and continues until the receiver completes tuning and is ready for use. Transmitter tuning is initiated by momentarily pressing a microphone switch. During transmitter tuning, the operator must delay speaking until the tone stops. A microphone switch must be held in the closed position

to transmit. The transmitter is voice-operated and broadcasts only when the operator speaks. A sidetone, the sound of the user's voice in the headset, is an indication of the transmitted signal. If the radio is malfunctioning or inoperative, it may be possible to continue communication by attempting operation at different frequencies or from the other control panel. Due to the high power used by the transmitter, the equipment requires continuous cooling and pressurization. If a cabin altitude of less than 20,000 feet cannot be maintained, the transmitter is inoperative (there is no limitation on monitoring the receiver). The set uses 28 volt DC from T-R BUS NO. 2 of the MCBP (figure 1-35, sheet 2) and 115/200 volt AC from GENERATOR NO. 2 of the MCBP (figure 1-35, sheet 3). Circuit breakers are marked HF LIAISON.

CAUTION

On airplanes with 550 (Mark II modulated antiskid brake system), all HF radio transmission should be avoided during taxi, takeoff, and landing roll. Simultaneous keying of an HF radio and the application of the pilot's brakes may generate electronic interference in the antiskid system and result in the brakes "releasing" with temporary loss of the pilot's brakes.

WARNING

- Ground operation of the AN/ARC-58 transmitter is prohibited unless the airplane is at least 200 feet from the following:

  (1) Unloaded weapons or warheads.

  (2) Loaded weapons in an airplane with the bomb bay doors open.

  (3) AGM-28 missiles with warhead compartment doors open, or thruster and squib access door open.

- HF liaison transmissions can cause improper operation and/or failure indications of the FD-109/RGA system while operating in navigation or approach modes. This electromagnetic interference can occur when an HF transmitter is operated at certain subharmonics of the VOR/ILS navigation frequency (3.100 MHz, 15.000 MHz, 23.800 MHz, and 29.999 MHz, approximately .050 MHz about each). The EMI is characterized by the following reactions on the ADI and HSI:

  (1) Navigation, glideslope, and computer flags fluctuate during HF transmissions.

  (2) Movement of glideslope pointer.

  (3) Movement of command bars or bars driven from view.

- Do not transmit on the AN/ARC-58 liaison radio when the airplane is on the ground and personnel are working on the boom. A high voltage builds up on the boom due to the high power being radiated by the antenna. This voltage will shock anyone that touches the boom.

NOTE

- If a frequency of 3.7, 3.8, 3.9, 7.7, 7.8, 7.9, 15.7, 15.8, or 15.9 Megahertz is selected, the tune tone may not be heard. This indicates that the equipment is not tuning. It will be necessary to move the thousand kHz knob (16, figure 4-17) momentarily to another frequency and return it to the desired frequency to get tuning.

- The frequency for the liaison radio (AN/ARC-58) may not be stable immediately after the radio is turned on. To insure that the frequency is stable for operation of the radio, the following warm-up periods should be observed:

Ambient Air Temperature	Warm-up Time
+30°C (+86°F) and above	7 minutes
0° to 29°C (+32° to 84°F	15 minutes
Below 0°C (+32°F)	20 minutes

- If the operating frequency to be used is the same as that previously selected before turn on, the thousand kilocycle knob should be momentarily rotated to insure proper fine tuning of the system.

- If the ARC-58 fails to tune properly, attempt operation at different frequencies and modes. In particular, change the frequency from the range in use (ranges are 2.0 to 3.6999 MHz, 3.7 to 7.699 MHz, 7.7 to 15.699 MHz, and 15.7 to 29.999 MHz) to one of the other frequency ranges.

- Fault Clearing. When the control switch springs to the OFF position a system fault is indicated. The fault may often be cleared by returning the switch to the ON position. If the switch remains in the ON position, continue with normal operation. If the switch will not remain in the ON position, open and close the three phase circuit breaker to the ARC-58 and then turn the switch to the ON position. This action will sometimes clear the fault.

- On airplanes having a wire antenna for the liaison radio, the wire resonates (makes a whining noise) at airspeeds between 0.6 and 0.7 Mach.

- When the set is turned on or control is transferred from one control panel to the other, it may not be possible to transmit or receive on the selected frequency. This condition is corrected by tuning the thousand KC knob off frequency and back to the desired frequency.
- On airplanes with wire antenna for the liaison radio, low voltage from the T-R units can cause lockout after keying the transmitter. To correct the fault turn the liaison radio OFF momentarily, then ON.

Mode Selector Switch

The position of the mode selector switch (11, figure 4-17) determines the type of signal to be emitted from the transmitter and accepted by the receiver. The switch has four positions: AM--U--L--TWIN. When the switch is on AM, the radio can be used for communicating with aircraft or ground stations that have AM radio equipment. Channel U is for transmission and reception of the upper sideband only. Channel L is for the transmission and reception of the lower sideband only. On TWIN, there is a simultaneous transmission or reception of identical signals on the upper and lower sidebands. The TWIN function will have limited use since it is a provision that makes the set compatible with double-sideband radios currently under development.

NOTE

The TWIN function may be inoperative since there is no requirement for maintaining this mode operational.

The choice of channel U or L will depend on the channel being used by the station with which communication is desired. This usage is based on the channel that has least interference.

Frequency Selector Knobs

The operating frequency of the AN/ARC-58 liaison radio is selected by manually positioning four frequency selector knobs (13, 14, 15 and 16, figure 4-17). Referring to the knobs and dial digits from right to left, the first knob permits selection of one-kilocycle steps through the range of zero to nine. The selected digit appears in the right column of the indicator (12, figure 4-17). The second knob permits selection of ten-kilocycle steps between zero and nine, and the digit appears in the second column. The third knob permits selection of hundred-kilocycle steps between zero and nine, and the digit appears in the third indicator column. The fourth knob permits selection of thousand-kilocycle (megacycle) steps through the range of 2.0 to 29.0 megacycles, and the digit(s) appears in the fourth and fifth column. The total capability is 28,000 channels in one kilocycle steps.

Liaison Radio Volume Control

The function of the volume control (1, figure 4-17) is different from conventional volume controls since rotation of the VOL knob adjusts the sensitivity of the receiver. Full clockwise rotation gives maximum sensitivity. In this position, the receiver can detect and reproduce weak signals that would not be picked up with the knob at lower settings. The knob should be positioned to give the best reception. For weak signals, it will be necessary to position the line on the knob between the one and five o'clock positions; and, for strong signals, some position in the counterclockwise direction will give the best reception. Volume is also dependent upon the position of the interphone volume control knob (5, figure 4-14).

NOTE

Background noise will be heard at all times. If the volume control is turned down to reduce the noise, the sensitivity of the receiver may be lowered too far to pick up communications from distant stations.

Liaison Radio Control Switch

The function of the control switches (2, figure 4-17) on the AN/ARC-58 liaison radio and the AN/ARC-65 liaison radio is identical. Refer to LIAISON RADIO CONTROL SWITCH in this Section.

RADIO NAVIGATION INSTRUMENTS

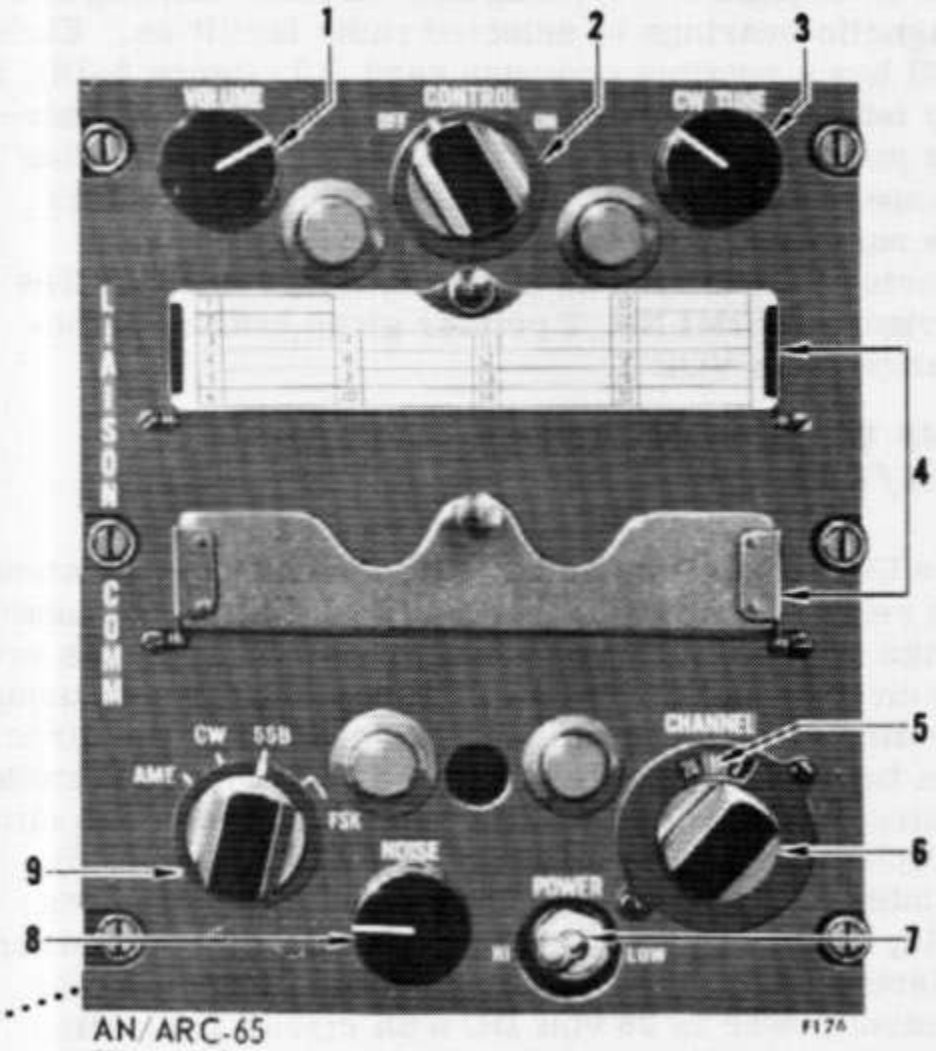
The radio navigation instruments consist of an attitude director indicator (8, figure 1-18 and 4, figure 1-19), a horizontal situation indicator (12, figure 1-18, and 27, figure 1-19), an RMI (21, figure 1-18 and 13, figure 1-19), and a TACAN select switch (7, figure 1-18 and 1, figure 1-19) on each of the pilots' instrument panels. For use of these instruments with the autopilot, see AUTOPILOT SYSTEM in this Section. Also see INTEGRATED DUAL FLIGHT DIRECTOR/ROTATION GO-AROUND SYSTEM, this Section, for use and description of the ADI and HSI.

LIAISON RADIO CONTROL PANELS



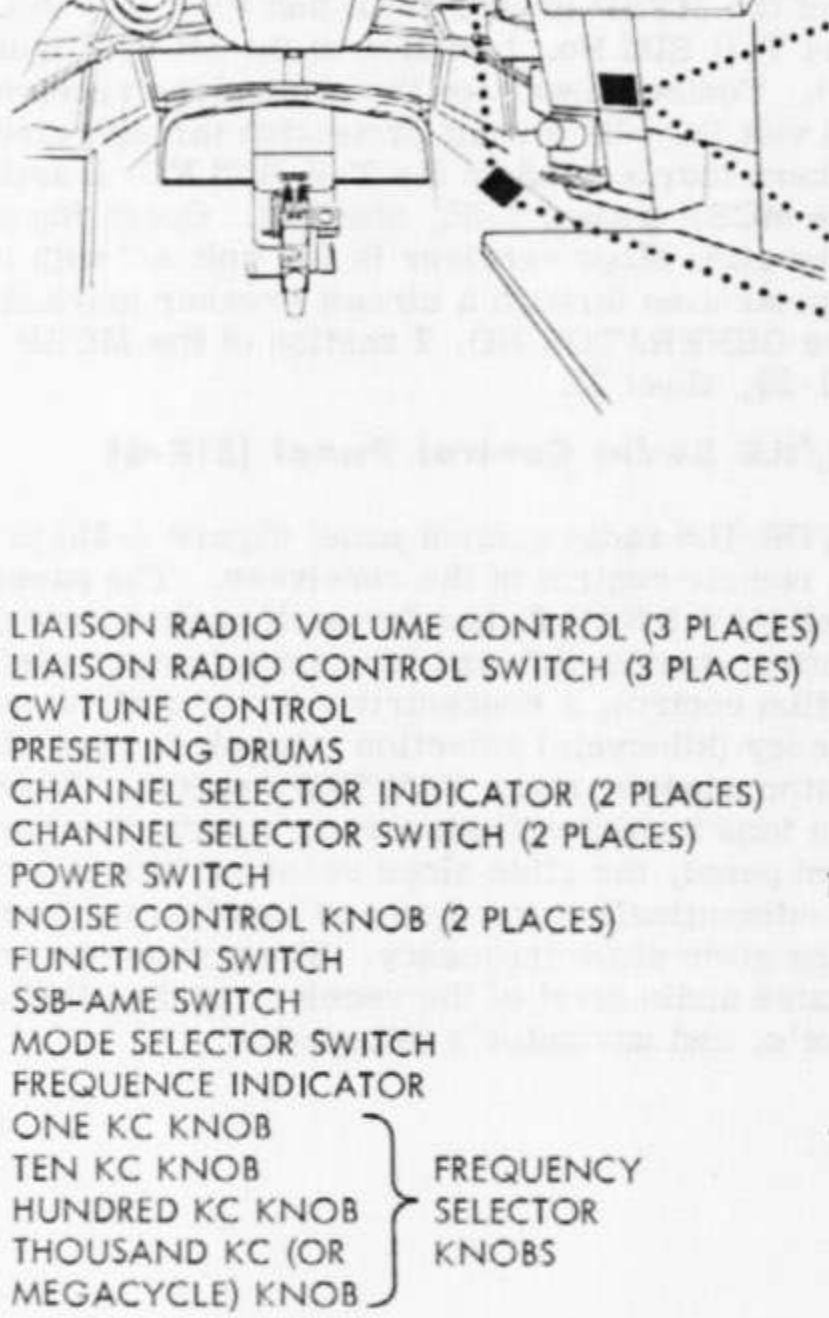
AN/ARC-65
(See text)

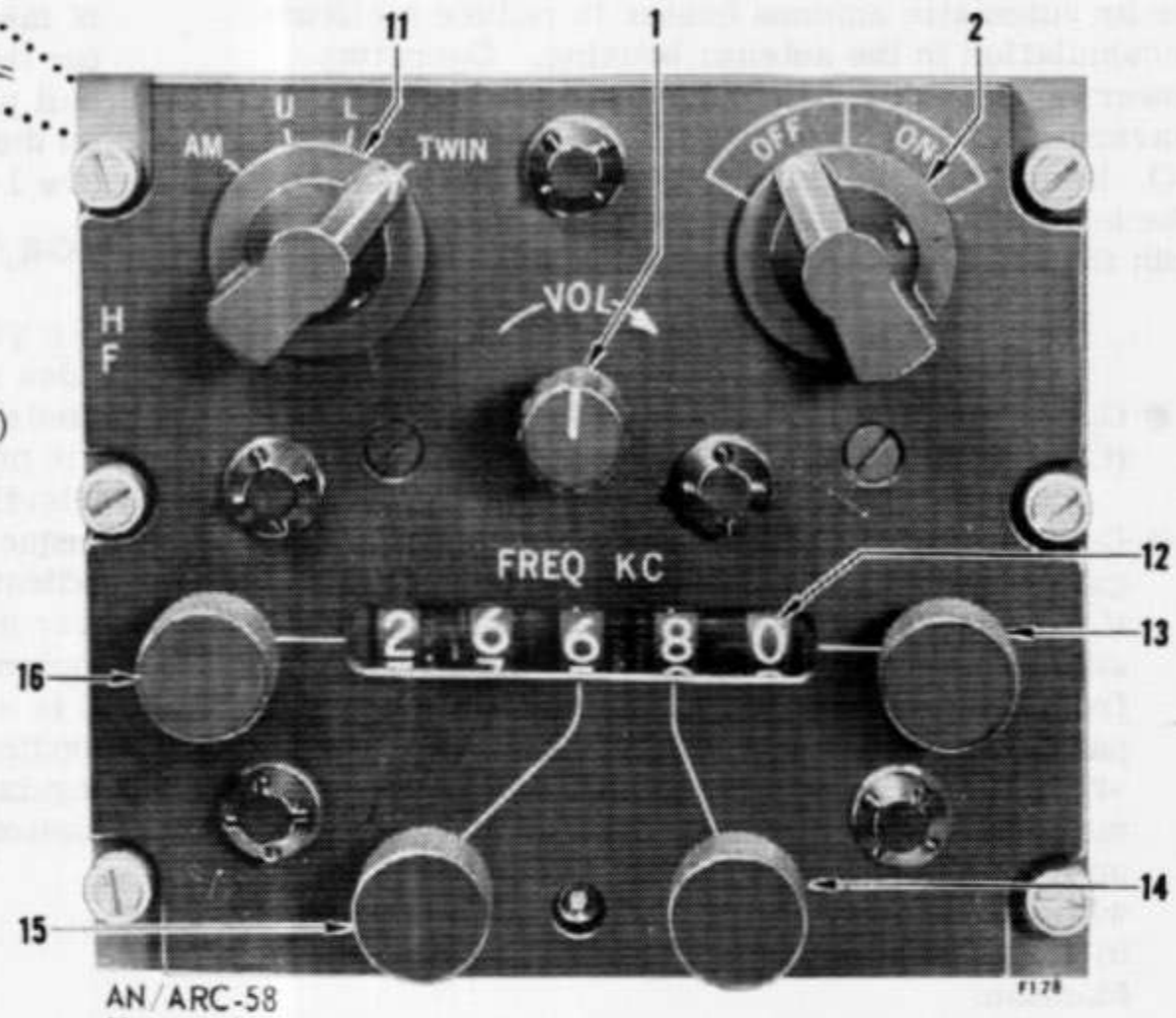
COPILOT'S LIAISON RADIO CONTROL PANEL



AN/ARC-65
(See text)

NAVIGATOR'S LIAISON RADIO CONTROL PANEL





AN/ARC-58
(See text)

COPILOT'S AND NAVIGATOR'S LIAISON RADIO CONTROL PANEL

1 LIAISON RADIO VOLUME CONTROL (3 PLACES)
2 LIAISON RADIO CONTROL SWITCH (3 PLACES)
3 CW TUNE CONTROL
4 PRESETTING DRUMS
5 CHANNEL SELECTOR INDICATOR (2 PLACES)
6 CHANNEL SELECTOR SWITCH (2 PLACES)
7 POWER SWITCH
8 NOISE CONTROL KNOB (2 PLACES)
9 FUNCTION SWITCH
10 SSB-AME SWITCH
11 MODE SELECTOR SWITCH
12 FREQUENCE INDICATOR
13 ONE KC KNOB
14 TEN KC KNOB
15 HUNDRED KC KNOB
16 THOUSAND KC (OR MEGACYCLE) KNOB
} FREQUENCY SELECTOR KNOBS

Figure 4-17

Radio Magnetic Indicator (RMI) (ID-250)

The RMI (figure 4-18) displays airplane heading and magnetic bearings to selected radio facilities. Each RMI has a rotating compass card (13, figure 4-18), a top index (16, figure 4-18), and two numbered bearing pointers (14 and 15, figure 4-18). The rotating compass cards are N-1 or J-4 compass repeaters; the numbered pointers for pilot and copilot give bearing information as shown in figure 4-18A. The navigator's RMI No. 2 pointer gives bearing information from VOR 2.

UHF DIRECTION FINDER (UHF-ADF) (AN/ARA-25)

The UHF direction finder automatically determines the relative bearing of radio signals in the frequency range of 225.0 to 399.9 megacycles. The signals are received by the COMM #1 UHF command radio, using the direction finder antenna. Operation of the direction finder is controlled from the UHF command radio control panel when the UHF command mode selector switch (5, figure 4-16) is on ADF (1, figure 4-18). Pointer No. 2 on each of the pilots' RMI's (figures 1-18, 1-19, and 4-18) shows UHF/DF direction when selected on the UHF command radio mode selector. Control power is 28 volt DC with circuit protection through a circuit breaker, marked ARA-25 UHF HOMING on airplanes 1▶ 29 and UHF HOMING ON airplanes 30 ▶, on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2). Operating power is from the command radio. Provisions are installed for an automatic antenna heater to reduce moisture accumulation in the antenna housing. Operating power is 115 volt AC through a circuit breaker marked ADF ANTENNA HEATER on the GENERATOR NO. 1 section of the MCBP (figure 1-35, sheet 3). The heater is installed and operable only on airplanes with the AS-578C/ARA-25 antenna.

NOTE

- Operation of the command radio transmitter (COMM #1) interrupts ADF operation.
- Certain line of sight communication and navigation systems may be impaired or inoperative if the attitude of the airplane is such that the antenna is shielded, by airplane structure, from the ground station. This effect applies particularly to TACAN, UHF, and AN/APX -25 SIF. This is to be considered as normal operation. Before a system is written up for malfunctioning, it should be checked with the airplane flying at different attitudes to verify whether or not there is a malfunction.

VOR/ILS (VHF-NAV) EQUIPMENT (51R-6 AND 51V-4A)

The 51R-6 navigation system consists of dual VOR receivers (No. 1 and No. 2), dual glide slope receivers, antennas, and a single control panel. The control panel, labeled "NAV 1 NAV 2," is on the pilots' overhead panel (13, figure 1-20). The antennas (8, figure 4-29) are on each side of the vertical fin. Both VOR's use the same antennas. The dual 51R-6 receivers are extended range receivers tunable to ILS localizer, VOR, and some VHF command radio frequencies. The dual 51V-4A glide slope receivers are automatically tuned to the corresponding glide slope frequency whenever the respective VOR receiver is tuned to an ILS localizer frequency. Beam guidance information is presented on the pilot's and copilot's attitude director indicators (8, figure 1-18 and 4, figure 1-19), pilot's and copilot's horizontal situation indicators (12, figure 1-18 and 25, figure 1-19), and the navigator's RMI. See RADIO NAVIGATION INSTRUMENTS in this Section. For use of this equipment with the autopilot, see AUTOPILOT SYSTEM in this Section and INSTRUMENT APPROACHES in Section IX. Power for operation and control of the No. 1 and No. 2 receivers is 28 volt DC through circuit breakers marked VHF NAV No. 1 on the T-R BUS No. 2 section of the MCBP (figure 1-35) and VHF NAV No. 2 on the T-R BUS No. 1 section of the MCBP (figure 1-35). Control power for the glide slope receivers is 28 volt DC with circuit protection through circuit breakers marked ILS on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2). Operating power for the glide slope receiver is 115 volt AC with circuit protection through a circuit breaker marked ILS on the GENERATOR NO. 2 section of the MCBP (figure 1-35, sheet 3).

VOR/ILS Radio Control Panel (51R-6)

The VOR/ILS radio control panel (figure 4-18) provides remote control of the receivers. The panel, labeled NAV 1 NAV 2, has for each radio a concentric power-test switch and frequency (megacycle) selection control, a concentric volume control and frequency (kilocycle) selection control, a channel indicator window, and a NAV TEST switch. Whenever a tone localizer frequency is selected on the control panel, the glide slope receiver (No. 1 or No. 2) is automatically turned on and tuned to a corresponding glide slope frequency. The volume control regulates audio level of the receiver to the pilot's, copilot's, and navigator's interphone.

Power Switch

This switch, operated by the outer skirt knob (11, figure 4-18), controls the application of power to the associated receiver. The test function of the switch is inoperative.

Megacycle Control

This control, operated by the center bar-shaped knob (10, figure 4-18), changes the frequency of operation in one-megacycle steps over the range of the control; this frequency is indicated by the first three digits appearing in the indicator window.

Volume Control

This control, operated by the outer skirt knob (5, figure 4-18), varies the audio gain of the associated receiver.

Kilocycle Control

This control, operated by the center bar-shaped knob (9, figure 4-18), changes frequency of operation in 50-kilocycle steps; this frequency is indicated by the last two digits appearing in the indicator window.

NAV Test Switch

This switch (8, figure 4-18) is inoperative.

TACAN Select Switch

A TACAN select switch (12, figure 4-18) is provided for the pilot (7, figure 1-18) and copilot (1, figure 1-19). When the pilot's or copilot's TACAN select switch is ON (illuminated) TACAN information is displayed on the respective HSI No. 1 (pink) bearing pointer (14, figure 4-18) and TACAN course deviation information on the respective CDI (18, figure 4-18). When the pilot's TACAN select switch is OFF VOR No. 2 bearing information is displayed on the pilot's HSI No. 1 (pink) bearing pointer and VOR/ILS No. 1 course deviation information on the pilot's CDI. When the copilot's TACAN select switch is OFF VOR No. 1 information is displayed on the copilot's HSI No. 1 (pink) bearing pointer and VOR/ILS No. 2 course deviation information on the copilot's CDI. The TACAN select switch is marked with the words TACAN SELECT ON-OFF and illuminates green when depressed on with TACAN selected, and VOR/ILS is selected when the switch is not illuminated.

NOTE

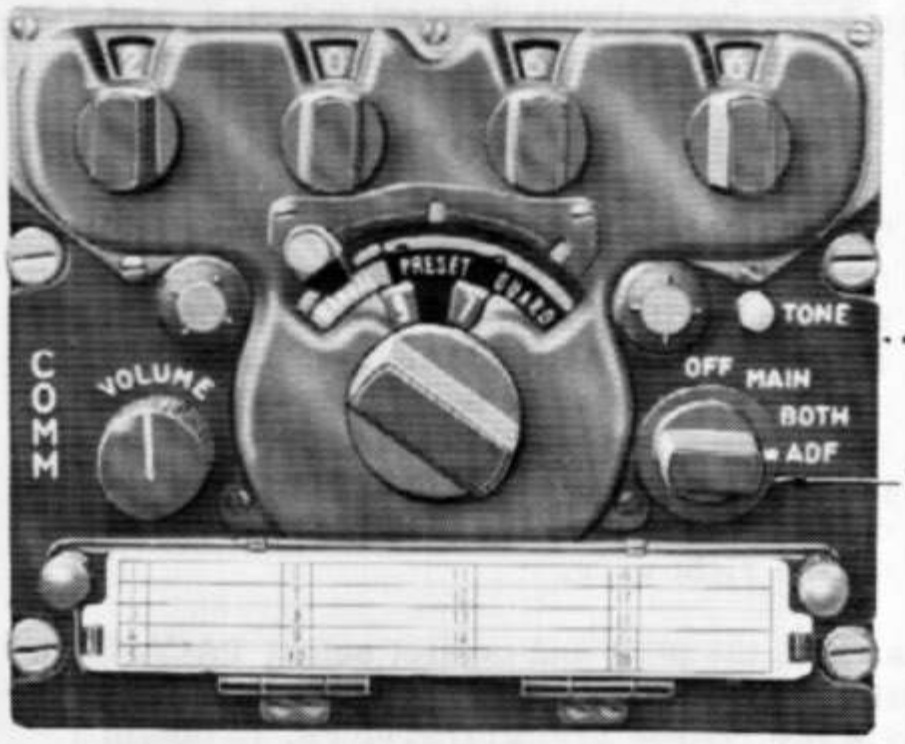
The TACAN select switch will automatically revert to off when the respective FD mode selector switch is turned to an approach mode (APPR AUTO, APPR MAN). If the respective VHF receiver is tuned to a VOR station, the number one (pink) bearing pointer will point to that station. If it is tuned to a localizer frequency, the pink pointer will stow off the right wing.

When both the pilot and copilot select TACAN, the copilot's CDI is controlled by the course set on the pilot's HSI course arrow; therefore, to obtain a proper presentation, the copilot must use his course set knob (19, figure 4-18) to set his course counter (17, figure 4-18) to the same course as set on the pilot's HSI. When only the copilot has selected TACAN, the course set knob and CDI on the copilot's HSI work together.

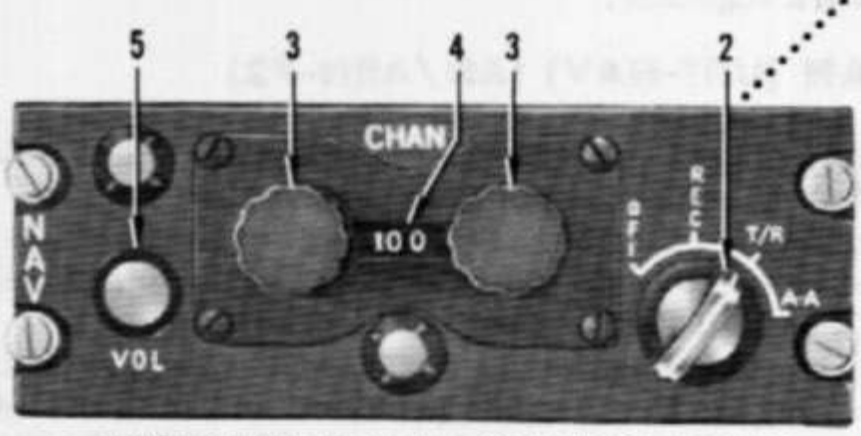
TACAN (UHF-NAV) (AN/ARN-72)

The TACAN set is a receiver-transponder unit which provides bearing and distance information to a selected TACAN station. Bearing information is presented on the course indicators of the HSI's (figure 4-30D) and all RMI's (figure 4-18). Distance information is presented on the RANGE counters of the HSI's. An air to air mode provides an air to air (A/A) range capability only. Refer to RADIO NAVIGATION INSTRUMENTS in this Section. For use of this equipment with the autopilot, refer to AUTOPILOT SYSTEM in this Section and INSTRUMENT APPROACHES in Section IX. The loudspeaker and TACAN antenna control panel on the pilots' overhead panel has a TACAN antenna switch. Twenty-eight volt DC and 115 volt AC power is obtained through circuit breakers marked UHF-NAVIGATION on the T-R BUS NO. 2 and GENERATOR NO. 1 sections of the MCBP (figure 1-35, sheets 2 and 3).

NAVIGATION RADIOS-CONTROLS AND INDICATORS



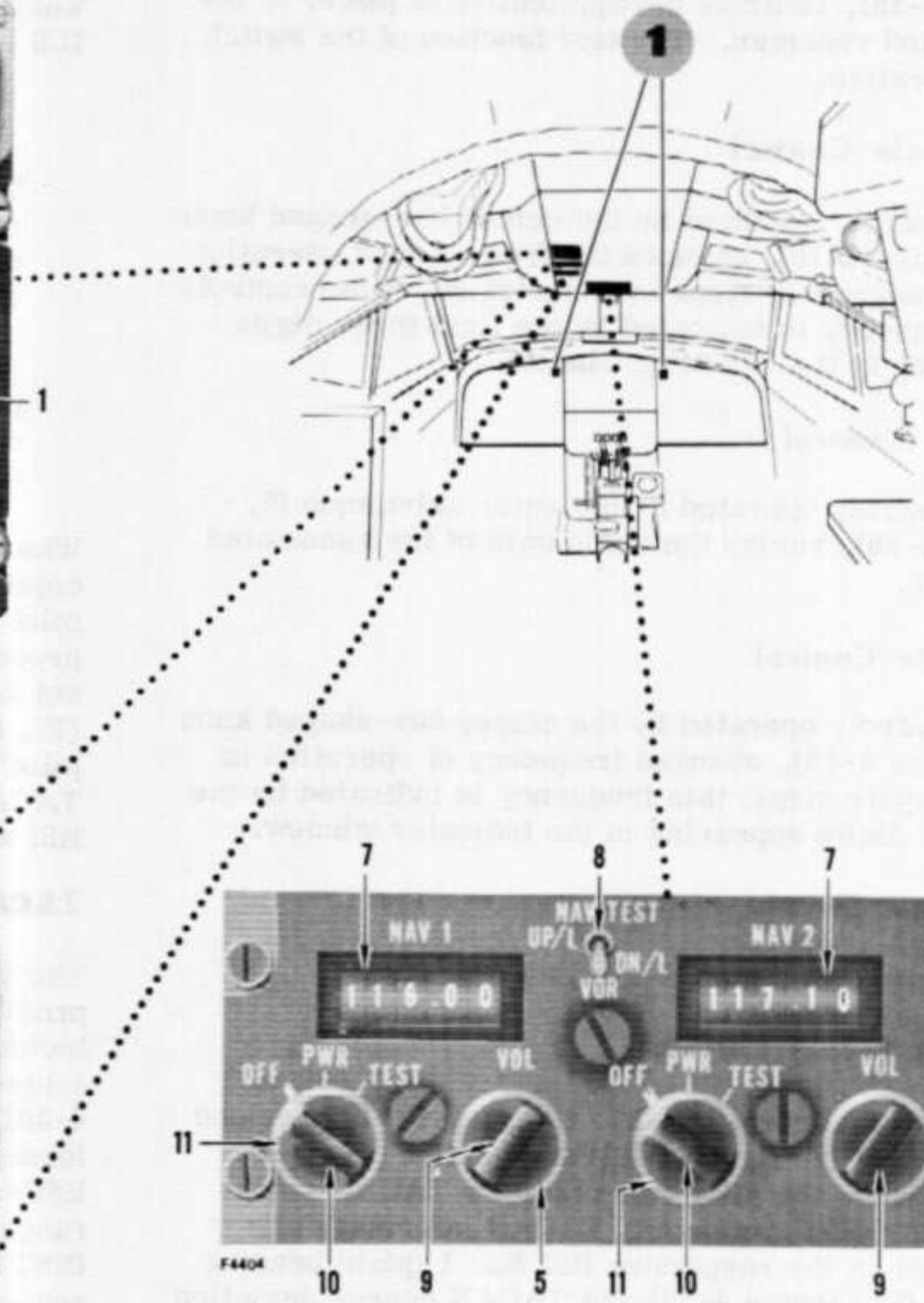
UHF COMMAND RADIO CONTROL PANEL (SEE FIGURE 4-16)



TACAN (UHF-NAV) CONTROL PANEL



LOUDSPEAKER AND TACAN ANTENNA CONTROL PANEL



VOR/ILS (VHF-NAV) PANEL

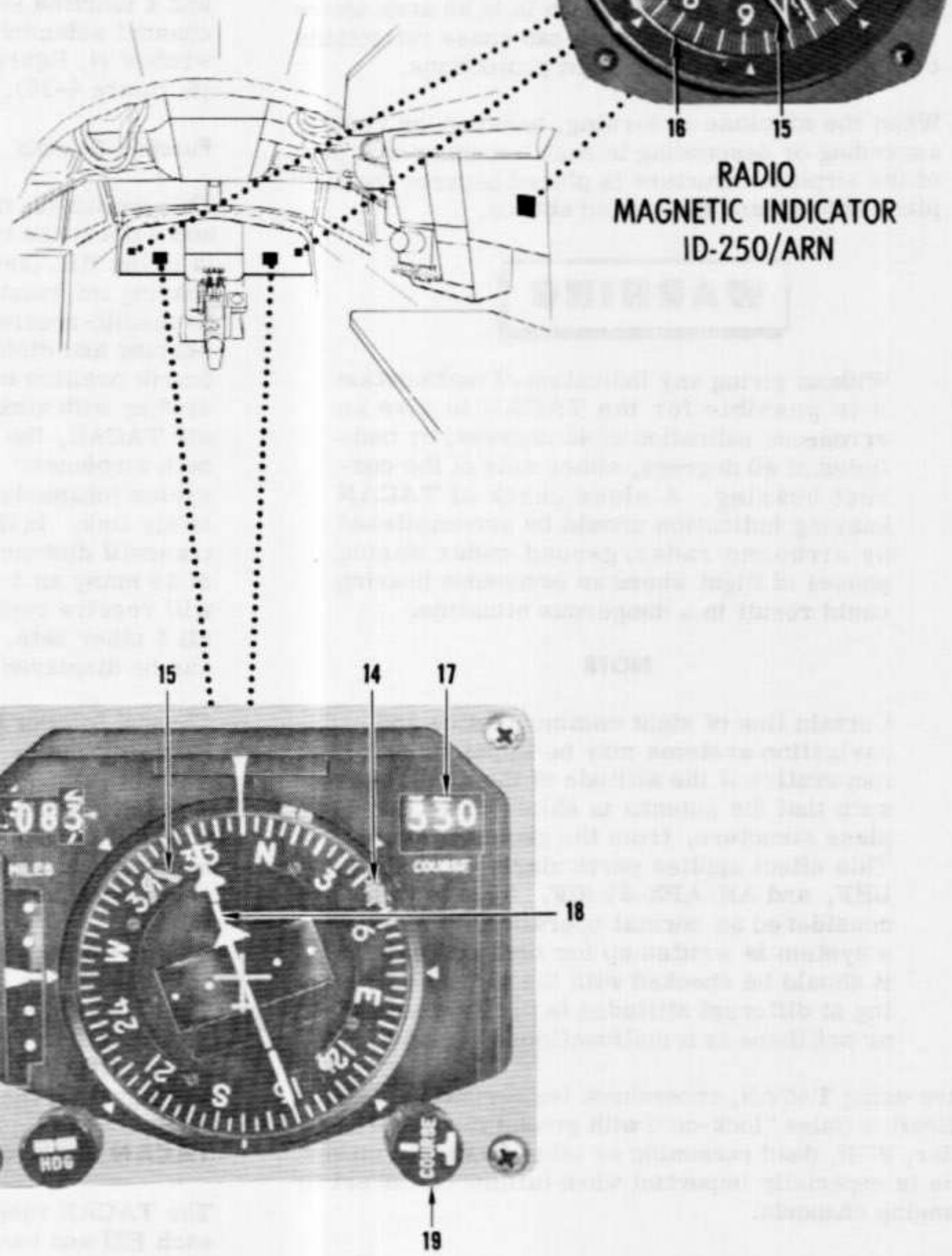


1 TACAN SELECT SWITCH

1 UHF COMMAND MODE SELECTOR SWITCH
2 FUNCTION SELECTOR SWITCH
3 CHANNEL SELECTOR KNOB (2 PLACES)
4 CHANNEL WINDOW
5 VOLUME CONTROL (3 PLACES)
6 TACAN ANTENNA SWITCH
7 FREQUENCY WINDOW (2 PLACES)
8 NAV TEST SWITCH (INOPERATIVE)
9 KILOCYCLE CONTROL (2 PLACES)
10 MEGACYCLE CONTROL (2 PLACES)
11 POWER SWITCH (2 PLACES)
12 TACAN SELECT SWITCH

Figure 4-18 (Sheet 1 of 2)

13 TOP INDEX
14 NO. 1 BEARING POINTER (2 PLACES)
15 NO. 2 BEARING POINTER (2 PLACES)
16 COMPASS CARD (N-1/J-4 REPEATER)
17 COURSE COUNTER
18 COURSE DEVIATION INDICATOR
19 COURSE SET KNOB



RADIO MAGNETIC INDICATOR ID-250/ARN

HORIZONTAL SITUATION INDICATOR (HSI)

Figure 4-18 (Sheet 2 of 2)

Limitations of TACAN

The airborne TACAN system can be expected to lose track under one of the following conditions:

A. When the airplane is below the required altitude for line-of-sight operation.

B. When the airplane is over the ground station within the ground antenna's cone of confusion.

C. When the TACAN ground station is in an area where terrain or other obstructions can cause reflections or interfere with line-of-sight projections.

D. When the airplane is turning, banking, or rapidly ascending or descending in such a manner that part of the airplane structure is placed between the airplane antenna and the ground station.

WARNING

Without giving any indication of malfunction it is possible for the TACAN to give an erroneous indication of 40 degrees, or multiples of 40 degrees, either side of the correct bearing. A close check of TACAN bearing indication should be accomplished by airborne radar/ground radar during phases of flight where an erroneous bearing could result in a dangerous situation.

NOTE

Certain line of sight communication and navigation systems may be impaired or inoperative if the attitude of the airplane is such that the antenna is shielded, by airplane structure, from the ground station. This effect applies particularly to TACAN, UHF, and AN/APX-25 SIF. This is to be considered as normal operation. Before a system is written up for malfunctioning, it should be checked with the airplane flying at different attitudes to verify whether or not there is a malfunction.

When using TACAN, crosscheck for erroneous bearing indication (false "lock-on") with ground radar, airborne radar, VOR, dead reckoning or other available means. This is especially important when turning on the set or changing channels.

A. If a false "lock-on" is suspected, change channels and check for correct "lock-on," then change back to desired channel.

B. If false "lock-on" is still suspected, turn set OFF then ON.

C. If false "lock-on" still occurs, use other navigational equipment or aids.

NOTE

TACAN can be used in an emergency if magnitude and direction of the error are known and compensation is made for the error in TACAN bearing.

TACAN Control Panel

The TACAN control panel (figure 4-18) controls frequency selection and the type of operation. The panel has a function selector switch (2, figure 4-18), two channel selector knobs (3, figure 4-18), a channel window (4, figure 4-18) and a volume control knob (5, figure 4-18).

Function Selector Switch

This switch (2, figure 4-18) energizes the TACAN set and selects the type of operation. When this switch is in the REC(receive) position, the set supplies only bearing information. When this switch is in the T/R (transmit-receive) position, the set supplies both bearing and distance information. The switch has a fourth position marked A/A (air to air). When operating with another airplane equipped with air to air TACAN, the air to air mode must be selected in both airplanes. Two channels separated by 63 megacycles (channels) are required to complete the air to air link. In the air to air mode, the set can transmit distance reply signals to the interrogations of as many as 5 other sets. At the same time, it will receive replies to its own interrogations from all 5 other sets. However, the distance to only one can be displayed on the range indicator.

Channel Selector Knobs and Channel Selector Window

The left channel selector knob (3, figure 4-18) controls the tens and hundreds digit and the right knob controls the unit digit which appear in the channel selector window (4, figure 4-18).

Volume Control Knob

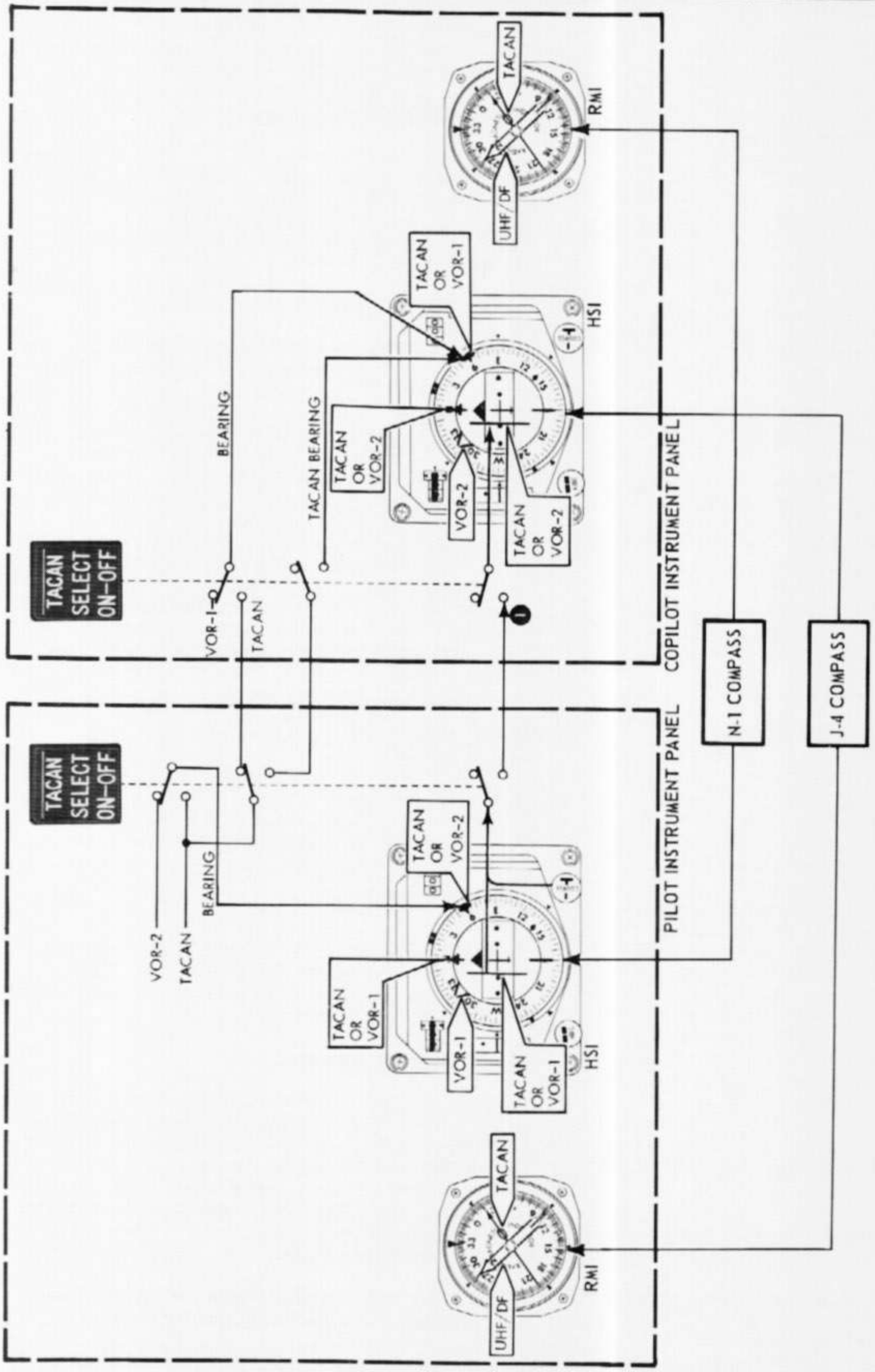
This knob (5, figure 4-18) marked VOL adjusts the audio level to the interphone system. The TACAN mixer switch (1, figure 4-14) must be ON (up) to hear the signal on the interphone.

TACAN Range Counter

The TACAN range counter (1, figure 4-30D) is on each HSI and has an OFF bar. This counter displays slant range distance in nautical miles to the selected TACAN station. The counter is operative when a station is tuned and the function selector switch is in the T/R position. The counter displays the distance to another similarly equipped airplane when operating in the air to air mode.

The OFF bar partially obliterates the TACAN range counter when: (1) the set is searching for correct

RADIO NAVIGATION INSTRUMENT SELECTION



❶ When both the pilot and copilot have selected TACAN, course deviation on the copilot's CDI is controlled only by the pilot's course set knob. For the copilot to see the correct course heading and course deviation presentation, the copilot must set the course arrow on his HSI to the same course as on the pilot's HSI.

Figure 4-18A

distance data, (2) when the set is awaiting a signal from the station, or (3) when the equipment is de-energized. During the search condition, the counters will spin. While awaiting a signal, the counters may remain stationary for as long as 20 seconds before spinning or the OFF flag may disappear, indicating a reliable distance reading.

TACAN Antenna Switch

The TACAN antenna switch (6, figure 4-18) is on the loudspeaker and TACAN antenna control panel and has TOP--BOTTOM positions. When the TACAN function selector switch is in the REC or T/R position, the antenna switch should always be in the BOTTOM position. When the TACAN function selector switch is in the A/A position, the antenna switch is used to select the top or bottom antenna for optimum air to air range determination. Operating power is 28 volt DC through a circuit breaker marked TACAN ANT SEL on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2).

MARKER BEACON RECEIVER (AN/ARN-12 or AN/ARN-32)

A marker beacon receiver is used as a navigational and landing aid. The receiver detects radio signals and delivers aural and visual indication of the received signal to the pilots of the airplane in which it is located. An audio signal is received through the interphone system when the operator positions his interphone mixer switch (1, figure 4-14) to MARKER. Visual identification is by means of the radio marker beacon light (9, figure 1-18 and 8, figure 1-19) on the pilots' instrument panels. The lights will illuminate whenever the airplane is within the radiation pattern of a marker beacon. Control power is 28 volt DC from T-R BUS NO. 2 on the MCBP (figure 1-35, sheet 2). The circuit breaker is labeled ARN-12 MARKER on airplanes 1▶29 and MARKER on airplanes 30▶.

RADAR NAVIGATION EQUIPMENT (AN/APN-82 and -99)

The radar navigation equipment consists of an auto-nav (doppler) radar (APN-81) and a ground position computer (ASN-6) on 1▶97 or a destination computer (ASN-7) on 98▶. Both systems give continuous indications of ground speed, drift angle, airplane position in latitude and longitude, and are independent of visibility and ground based navigational aids. The destination computer (ASN-7) also continuously computes rhumb line course and distance to a selected destination (mercator sailing) and can automatically compute magnetic variation. Both systems may be used for polar navigation by resetting the computer to grid coordinates and by operating the N-1 compass in the gyro mode. The equipment requires 28 volt DC, 28 volt AC and 115/200 volt AC power. Circuit protection is through fuses on the J-608 fuse panel (figure 4-19); however, primary circuit protection is on the MCBP (figure 1-35, sheets 2 and 3). Circuit breaker markings are as follows:

Airplanes 1▶79

LOCATION ON MCBP	MARKINGS
T-R BUS NO. 1 Section (2 breakers 28V DC)	APN-82 RADAR NAVIGATION
28V AC Section (1 breaker)	AN/APN-82
GENERATOR NO. 3 Section (115/200V AC, 5 breakers)	APN-82 RADAR NAVIGATION
GENERATOR NO. 3 Section (115/200V AC, 3 breakers)	APN-82 BLOWER

Airplanes 30▶

LOCATION ON MCBP	MARKINGS
T-R BUS NO. 1 Section (28V DC, 2 breakers)	RADAR NAVIGATION
28V AC Section (1 breaker)	RADAR NAVIGATION
GENERATOR NO. 3 Section (115/200V AC, 5 breakers)	RADAR NAVIGATION
GENERATOR NO. 3 Section (115/200V AC, 3 breakers)	RADAR NAVIGATION BLOWER

Auto-Nav (Doppler) Radar Controls and Indicators (AN/APN-81)

All switches necessary for normal operation are contained on the auto-nav radar control panel. System outputs are presented on the drift angle and ground speed indicators. The unit off or inoperative lights and emergency override switch are on the J-608 fuse panel (figure 4-19, sheet 1).

NOTE

- When two or more airplanes, having doppler radar equipment in operation, are flying in close proximity (formation, A/R rendezvous, and etc.), the signals from one doppler radar (AN/APN-81) can cause interference with the set in the other airplane(s). This interference can make the doppler radar system indications unusable in both airplanes.
- APN-81 doppler system may display erroneous drift and ground speed information with no evidence of malfunction. The validity of data displayed must be verified by comparison with other navigational information, particularly on long oceanic flights.

RADAR NAVIGATION EQUIPMENT-CONTROLS AND INDICATORS

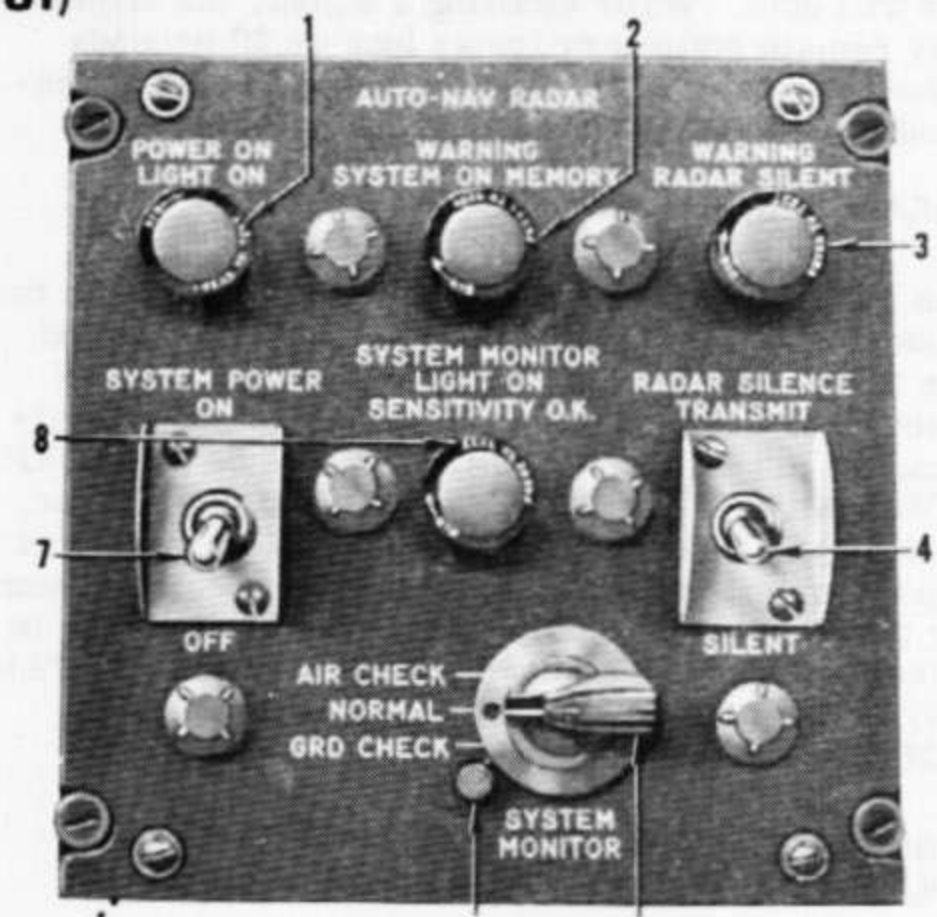
AUTO NAV (DOPPLER) RADAR (AN/APN-81)



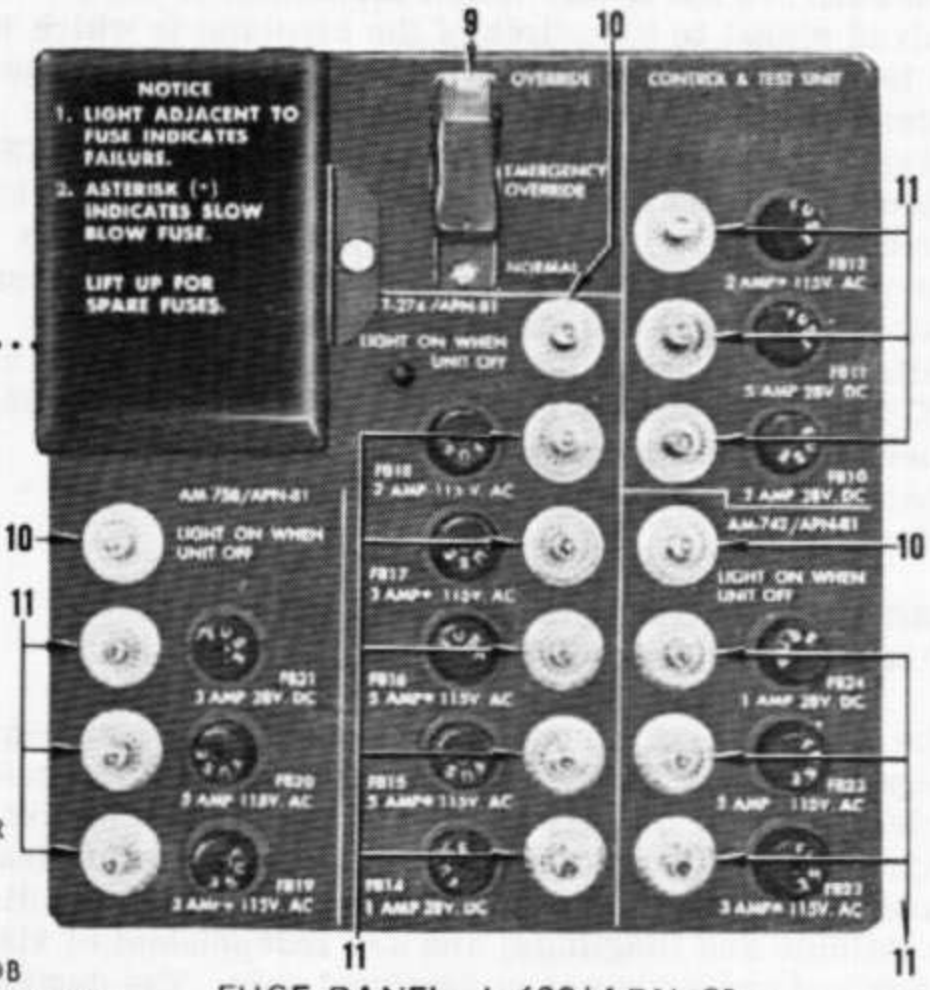
DRIFT ANGLE INDICATOR
ID-342/APN-81



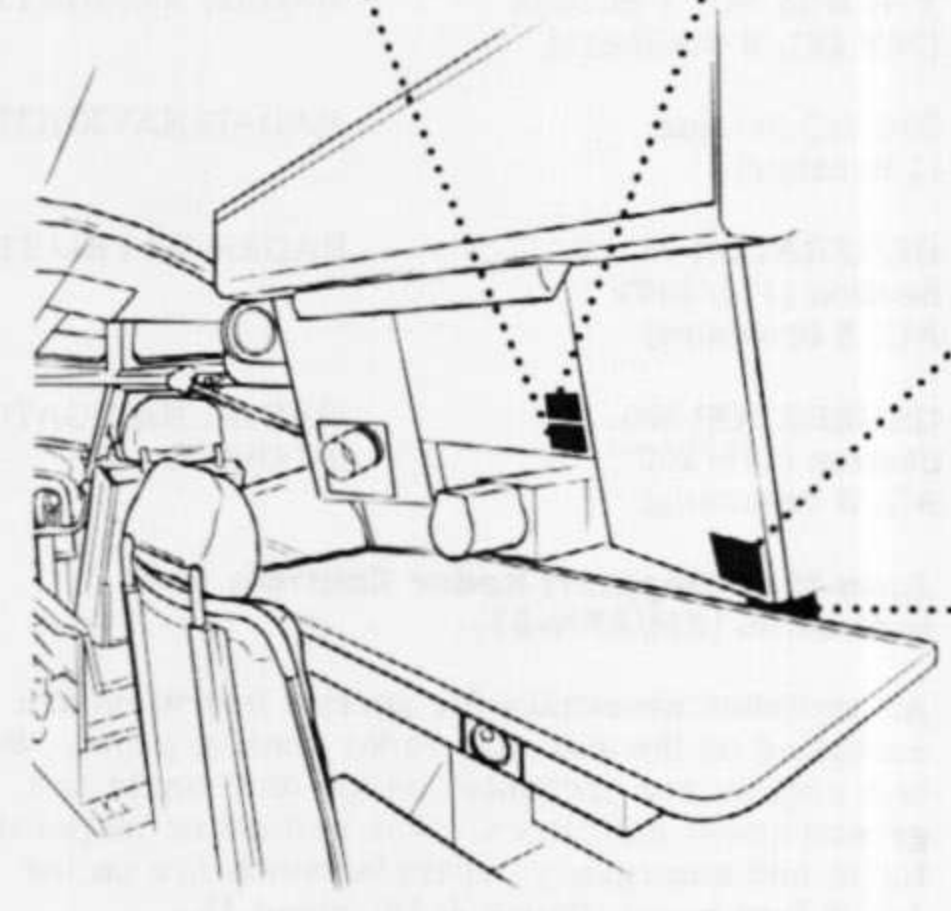
GROUND SPEED INDICATOR
ID-341/APN-81



AUTO-NAV RADAR CONTROL PANEL
C-1416( )/APN-81



FUSE PANEL J-608/APN-81

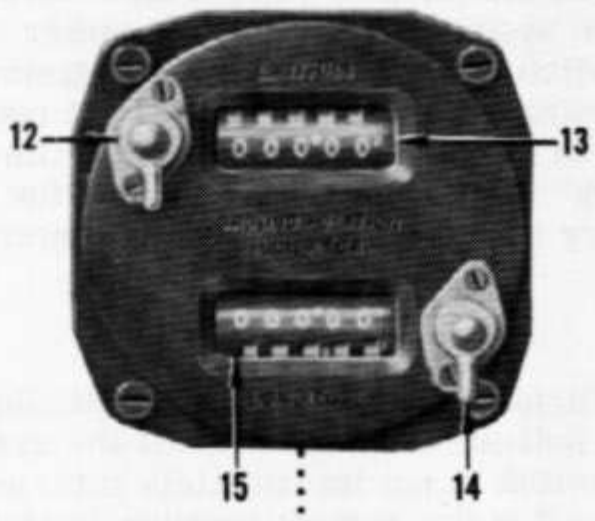


1 POWER-ON LIGHT
2 MEMORY LIGHT
3 RADAR SILENT LIGHT
4 RADAR SILENCE SWITCH
5 SYSTEM MONITOR SWITCH
6 LATCH
7 AUTO-NAV SYSTEM POWER SWITCH
8 SYSTEM MONITOR LIGHT
9 EMERGENCY OVERRIDE SWITCH
10 UNIT OFF OR INOPERATIVE LIGHT (3 PLACES)
11 FUSE FAILURE LIGHT (4 PLACES)
12 LATITUDE SLEW LEVER
13 LATITUDE COUNTER
14 LONGITUDE SLEW LEVER
15 LONGITUDE COUNTER
16 GPI COMPUTER POWER SWITCH
17 WIND DIRECTION DIAL
18 WIND FORCE COUNTER
19 WIND FORCE KNOB
20 VARIATION DIAL
21 VARIATION KNOB
22 WIND DIRECTION KNOB
23 DEPARTURE SWITCH (2 PLACES)
24 FUNCTION SWITCH (2 PLACES)
25 DISPLAY SWITCH
26 LATITUDE WINDOW
27 LONGITUDE WINDOW
28 LATITUDE, LONGITUDE SLEW SWITCHES
29 VARIATION SWITCH
30 VARIATION WINDOW
31 IP CORR BUTTON
32 VARIATION SLEW SWITCH
33 WIND DIRECTION SLEW SWITCH
34 WIND SPEED SLEW SWITCH
35 WIND DIRECTION WINDOW
36 WIND SPEED WINDOW
37 DESTINATION SWITCH
38 DESTINATION STORAGE WINDOWS
39 MODE SELECTOR SWITCH
40 TOP INDEX
41 DISTANCE COUNTERS
42 ROTATING CARD
43 COURSE-TO-DESTINATION POINTER

F-188
F-189
F-193
F-59

Figure 4-19 (Sheet 1 of 2)

NAV COMPUTER (AN/ASN-6) 1▶97



GROUND POSITION INDICATOR
ID-389/ASN-6



GPI COMPUTER POWER PANEL



GPI CONTROL PANEL C-1316/ASN-6

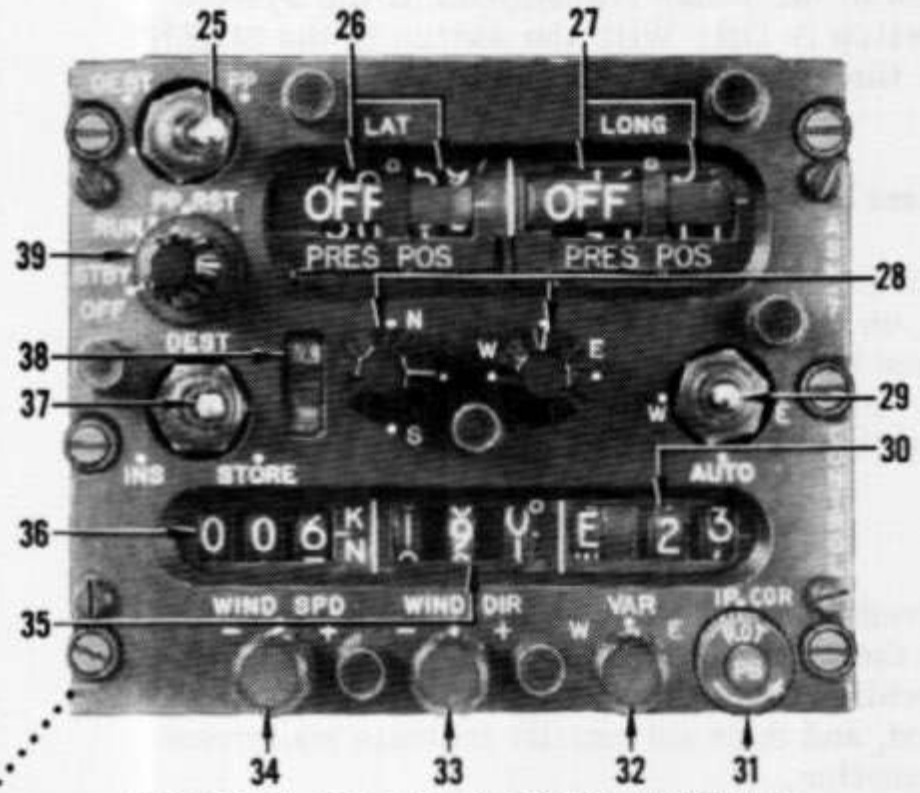


NAV-COMPUTER CONTROL PANEL
C-1196/APN-82

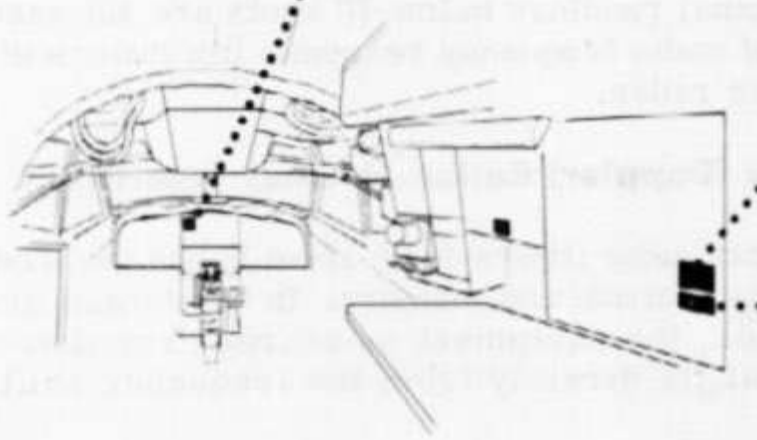
NAV COMPUTER (AN/ASN-7) 98▶



DESTINATION INDICATOR
ID-390A/ASN-7



CONTROL PANEL C-1317( )/ASN-7





NAV-COMPUTER CONTROL PANEL
C-1196/APN-99

F-187
F-190
F-192
F-191
F-195
F-196

Figure 4-19 (Sheet 2 of 2)

Auto-Nav System Power Switch

The system power switch (7, figure 4-19) on the auto-nav radar control panel has ON--OFF positions. This switch energizes the auto-nav radar.

Power-On Light

This light (1, figure 4-19) on the auto-nav radar control panel, illuminates when the system power switch is positioned to ON, indicating that the auto-nav radar set is energized.

Memory Light

The memory light (2, figure 4-19) on the auto-nav radar control panel is marked SYSTEM ON and MEMORY. The light illuminates when the radar navigation set is operating on the memory mode due to one of the following conditions: (1) airplane clearance above terrain of less than 300 feet (or as high as 500 feet depending upon terrain); (2) airplane attitude exceeds the limits of the antenna (excessive roll, pitch, or yaw); (3) the radar silence switch (4, figure 4-19) is in SILENT; (4) loss of return signal over certain types of terrain; or (5) in the event of equipment malfunction. The light is off when the equipment is operating from a normal ground return signal.

Radar Silence Switch

This switch (4, figure 4-19) on the auto-nav radar control panel has TRANSMIT--SILENT positions. With the switch positioned to TRANSMIT, power will be applied to the radar transmitter if the system power switch is ON. With the switch in the SILENT position, the auto-nav radar operates in the memory mode.

Radar Silent Light

This light (3, figure 4-19), marked RADAR and SILENT, on the auto-nav radar control panel, illuminates when the radar silence switch is in the SILENT position. The light is normally OFF when the radar silence switch is in the TRANSMIT position.

NOTE

The radar silent light sometimes illuminates when the system is in memory. This could occur while the antenna attitude limits are exceeded, and does not usually indicate equipment malfunction.

System Monitor Switch

The system monitor switch (5, figure 4-19) on the auto-nav radar control panel has three positions: AIR CHECK--NORMAL--GRD CHECK. This switch and the system monitor light (8, figure 4-19) are used for operationally checking the ground speed measuring circuits of the auto-nav radar. The transmitter must be energized for the switch and light to be operative. Placing the switch in either check position causes the monitor to feed an artificial test signal into the system. When making either check, return the switch to NORMAL when the system monitor light illuminates. If the memory light comes on and remains on for an extended period of time, use the "air check" to determine if the cause for operating on memory is due to equipment malfunction.

NOTE

During inflight operation, errors in latitude and longitude indications will result if the system monitor switch is not immediately returned to NORMAL after the system monitor light illuminates.

System Monitor Light

This light (8, figure 4-19) on the auto-nav radar control panel is used with the system monitor switch. The light provides indication of proper system operation in either AIR CHECK or GRD CHECK position of the system monitor switch. The radar transmitter must be energized for proper indication.

Emergency Override Switch

This switch (9, figure 4-19) on the J-608 fuse panel has OVERRIDE--NORMAL positions. This switch has a guard, safetied to the NORMAL position, and should not be used except in emergencies. In the event a cutout or interlock has opened due to overheat of the equipment, the switch can be positioned to OVERRIDE to bypass the overheat cutout. Continued operation of overheated unit should be avoided. Overheat of the equipment can be detected by noting if any of the unit off or inoperative lights (10, figure 4-19) on the J-608 fuse panel become illuminated.

Drift Angle Indicator

This indicator (figure 4-19) indicates the drift angle output of the auto-nav radar. A scale on the indicator is marked from 0 to 50 degrees drift in LEFT or RIGHT indications; however, antenna rotation is limited to 25 degrees left or right because of airplane structure.

Ground Speed Indicator

The ground speed indicator (figure 4-19) on the navigator's instrument panel displays the ground speed output of the doppler radar. The scale of the ground speed indicator is graduated between zero and 700 knots. Actual readings below 70 knots are not used because of audio frequency response limitations of the doppler radar.

Auto-Nav (Doppler) Radar Normal Operation

The auto-nav radar (figure 4-19, sheet 1) has two modes of operation, normal and memory. In the normal mode of operation, the equipment measures ground speed and drift angle directly from the frequency shift of

radar pulses (doppler effect) reflected from the earth's surface. It also computes wind speed and wind direction using the information (heading and true airspeed) obtained from the N-1 compass and the pitot static system. During periods when radar silence is desired, the system can be switched to the memory mode of operation; or when conditions are such that the radar signal returned from the ground is not usable, the system automatically switches to the memory mode. While in this mode, ground speed and drift angle information are indicated as before, but are computed from the heading, true airspeed, and the remembered wind values. In the memory mode, system accuracy degrades and is only as good as available wind information. See NAV-COMPUTER OPERATION, in this section.

AUTO-NAV RADAR OPERATION:

A. Auto-Nav Power Switch - ON

The power on and memory lights will illuminate.

B. System Monitor Switch - NORMAL

This switch should be left in the NORMAL position except when a system check is being performed. To test the system on the ground, depress the latch (6, figure 4-19) and move the switch to GRD CHECK. (Radar transmit-silent switch must be in transmit and system in memory for proper air and ground check.) If the system operates satisfactorily, the system monitor light will illuminate within a maximum of 9 minutes after the switch has been in either check position. There will be an indication of 95 knots (or a multiple of 95) on the ground speed indicator. The AIR CHECK position may be used with the airplane on the ground or airborne. When airborne, the set has to be operating in memory to make an air check. The switch has to be held in the spring loaded AIR CHECK position until the system monitor light illuminates to give a complete checkout.

C. Radar Silence Switch - TRANSMIT

Radar silent light will be extinguished.

The system will remain in memory until a minimum altitude of 300 to 500 feet above the terrain is reached, and the reflected signal strength is sufficient to maintain the set in normal operation.

If mission requirements dictate radar silence:

D. Radar Silence Switch - SILENT

The memory and radar silent warning lights will illuminate. Wind information must be inserted manually; see NAV-COMPUTER OPERATION, in this Section.

Nav-Computer Controls and Indicators (AN/ASN-6) 1▶97

The ASN-6 GPI computer operates as an automatic navigation computer to give the ground position of the airplane in latitude and longitude. The control panels (figure 4-19, sheet 2) are on the navigator's radar control console.

GPI Computer Power Switch

This switch with ON--OFF positions (16, figure 4-19) energizes the GPI computer when the auto-nav radar system power switch (7, figure 4-19) is ON.

Departure Switch

This switch (23, figure 4-19) on the nav-computer control panel has RUN--STANDBY positions. In the RUN position, signals to drive the latitude and longitude counters are supplied to the ground position indicator. In the STANDBY position, signals to drive the latitude and longitude counters are not connected.

Function Switch

The function switch (24, figure 4-19) on the nav-computer control panel has NORMAL--APN-81 ONLY positions. In the NORMAL position, the radar navigation set (AN/APN-82) operates as a complete navigation system. In the AN/APN-81 ONLY position, the nav-computer is disconnected from the auto-nav radar. The counters will continue to drive on the basis of the last heading input before the switch was placed in the APN-81 ONLY position. The auto-nav radar continues to indicate ground speed and drift angle. The switch has a locking slide plate to prevent inadvertent actuation.

Wind Direction Knob Dial

The wind direction knob (22, figure 4-19) on the GPI control panel is used to manually insert wind data in the computer. The wind direction dial (17, figure 4-19) displays the selected wind value. The wind direction knob is operative when the GPI computer operates independently of the radar set AN/APN-81. Placing the wind force knob (19, figure 4-19) to GND SPD makes the wind direction knob ineffective.

Wind Force Knob

This knob (19, figure 4-19) places wind force data into the radar navigation system. When turned CCW, until the GND SPD flag appears in the WIND FORCE window, the AN/APN-81 radar set in conjunction with the AN/ASN-6 provides automatic navigation. Selecting a wind force value of zero or greater isolates the AN/APN-81 from the system and dead reckoning is performed based upon the positions of the manually set wind and variation knobs.

Wind Force Counter

This counter (18, figure 4-19) on the GPI control panel indicates the wind speed in knots as set by the wind force knob.

Variation Knob And Dial

By manually turning this knob (21, figure 4-19) on the GPI control panel, variation data is set into the computer. The variation dial (20, figure 4-19) displays the value of variation selected. Either magnetic variation, grivation, or convergence may be used as mission requirements dictate. Variation data should be inserted at approximately 1 degree intervals of magnetic variation/grivation/convergence change. Some of the operational configuration of the ASN-6 are:

ASN-6 Coordinates:	N-1 Compass Mode:	Variation Data Input:
Geographic	Magnetic	Magnetic - set manually to airplane position.
Grid	Directional Gyro	Zero degrees
Grid	Magnetic	Grivation - W or E according to airplane position. Manually set and updated.
Geographic	Directional Gyro	Convergence - W or E according to airplane position. Manually set and updated.

Latitude And Longitude Slew Levers

These levers (12 and 14, figure 4-19) on the ground position indicator, are used to slew latitude and longitude values in the ground position indicator.

Latitude And Longitude Counters

These counters (13 and 15, figure 4-19) on the ground position indicator, indicate latitude or longitude position to the nearest minute of arc.

Nav-Computer Controls and Indicators (AN/ASN-7 and -7A) 98▶

The ASN-7 nav-computer operates as an automatic navigation computer to give present position plus course and distance to destination. The control panels (figure 4-19, sheet 2) are on the navigator's radar control console and the associated destination indicator (11, figure 4-43) is on the navigator's instrument panel. An additional destination indicator is on the pilot's center instrument panel (18, figure 1-25). The equipment may be used on flights between two preselected points with a secondary destination available in storage. Processes involved are based upon rhumb line (mercator sailing) navigational concepts. The destination indicators display a maximum of 999 NM and any flights exceeding this distance are divided into legs of this distance or less. The secondary or alternate destination may be selected, stored and inserted into the computer system at any time.

Departure Switch

This switch is not functional in this installation.

Function Switch

The function switch (24, figure 4-19) on the nav-computer control panel has NORMAL--APN-81 ONLY positions. In the NORMAL position, the radar navigation set (AN/APN-99) operates as a complete navigation system. In the APN-81 ONLY position, the nav-computer is disconnected from the auto-nav radar. The counters will continue to drive on the basis of the last heading information input before the switch was placed in the APN-81 ONLY position. The auto-nav radar continues to indicate ground speed and drift angle. This switch has a locking slide plate to prevent inadvertent actuation.

Display Switch

The display switch (25, figure 4-19) has two positions: PP--DEST. The switch is used to select the display in the latitude and longitude windows (26 and 27, figure 4-19). The numbers shown in the windows are the latitude and longitude values used by the computer to solve the direction and distance problem. When the switch is on PP, the coordinates of the present position of the airplane appear in the windows. Flags marked PRES POS also appear in the windows to identify the displayed coordinates. The present position coordinates can be changed with the latitude and longitude slew switches (28, figure 4-19) only when the display switch is on PP and the mode selector switch is on STBY or PP RST. With the ASN-7A computer the present position coordinates can be changed with the IP CORR button. Refer to IP CORR BUTTON in this Section. Placing the display switch on DEST raises the DEST flags and the displayed latitude and longitude values change to show the destination coordinates. The destination coordinates can be changed with the latitude and longitude slew switches only when the display switch is on DEST and the destination switch (37, figure 4-19) is on STORE. Refer to DESTINATION SWITCH in this Section. The display switch is inoperative when the computer exceeds the latitude limit.

Latitude and Longitude Slew Switches

These two knobs (28, figure 4-19) are for selection of latitude and longitude values that the computer uses in solving a navigation problem. Rotating the left knob from the center or off position toward the N

marking changes the latitude input in an increasing northerly direction. The slew rate gradually increases as the line on the knob approaches the N mark. If the original display in the latitude window (26, figure 4-19) was one of North latitude, the degree and minute drums will rotate in a direction to indicate increasing values. If the original latitude display was preceded by an S, the degree and minute drums will rotate to show decreasing values. Rotating the left knob toward S changes the latitude input in an increasing southerly direction. The right knob is used in a similar manner to slew the longitude drums in the longitude window (27, figure 4-19). The slew switches have detents at each extremity of travel to facilitate continued slewing. The latitude and longitude slew switches are inoperative when the mode selector switch (39, figure 4-19) is on OFF or RUN. Operation of the slew switches is also dependent upon the correct positioning of the display switch (25, figure 4-19) and the destination switch (37, figure 4-19). Refer to DISPLAY SWITCH and DESTINATION SWITCH in this Section. In the event the computer stops due to exceeding its latitude limits, the slew switches are used to change the computer data (reduce distance between selected PP and DEST) to place the computer in operation again.

Variation Switch

This three position toggle switch (29, figure 4-19) has W--AUTO--E lettered beneath and is normally left in the AUTO position. In the AUTO position magnetic variation information is continuously displayed in the variation window (30, figure 4-19). The other positions erect the W or E flags of the display and manual variation information (magnetic, grivation, or convergence) may be inserted into the computer by using the variation slew switch (32, figure 4-19) as mission requirements dictate, or in case the automatic variation (AUTO) computer becomes inoperative. Variation data should be manually inserted at approximately 1 degree intervals of magnetic variation/grivation/convergence change. Some of the operational configurations of the ASN-7/7A are:

ASN-7/7A Coordinates:	N-1 Compass Mode:	Variation Data Input:
Geographic	Magnetic	AUTO
Grid	Directional Gyro	Zero degrees - W or E and manually set.
Grid	Magnetic	Grivation - W or E according to airplane position. Manually set and updated.
Geographic	Directional Gyro	Convergence - W or E according to airplane position. Manually set and updated.

Variation Slew Switch

The switch (32, figure 4-19), with W and E positions, is used to manually insert magnetic variation/grivation/convergence data into the position computer as mission requirements dictate, or in lieu of AUTO values. When the knob is turned to W or E, increasing values of W or E magnetic variation/grivation/convergence are inserted into the computer and are visible in the variation window (30, figure 4-19).

IP CORR Button (ASN-7A Only)

A push button with marked IP CORR position (31, figure 4-19) is on the control panel. The knurled knob behind the push button is a guard and must be turned CCW to arm the push button. When the white radial line at the tip of the arrow on the knurled knob is at the 12 o'clock position, the push button is armed. When the line is at any other position, the push button is guarded. Depressing the button after it has been armed does two things: First, it changes the present position coordinates to the same values as the first destination coordinates provided the distance counters indicate less than 99 nautical miles. Second, it inserts the second destination data (that is in storage) into the computer. The IP CORR button is used only when the airplane arrives at a fix over its first destination and the present position coordinates are in error. Pressing the button eliminates the error and starts the computer on the solution of the second destination problem.

NOTE

On airplanes with the ASN-7A control panel installed, the CP-289A destination computer must also be installed, otherwise actuating the IP CORR button will blow a fuse in the computer.

Wind Direction Slew Switch

This switch with -, NEUTRAL, and + positions (33, figure 4-19) is used to manually increase or decrease the value of the wind direction figure, visible in the wind direction window (35, figure 4-19). By turning this knob CW to the + mark, the value increases and, when turning CCW to the - mark, the value decreases. The wind direction slew switch puts wind direction data into the computer only when the function switch (24, figure 4-19) is on NORMAL.

Wind Speed Slew Switch

Wind speed data can be manually placed into the equipment by use of the slew switch (34, figure 4-19). If the knob is moved out of the center or off position towards the + mark, the value of the wind speed figure increases and conversely, if moved to the - mark, it decreases. When the wind speed indication has been slewed past zero, a flag bearing the letters GND SPD appears in the window (36, figure 4-19) and automatic drift information is supplied to the AN/APN-99 system by the auto-nav radar set. The function switch (24, figure 4-19) must be on NORMAL for the computer to receive the input from the AN/APN-81.

Destination Switch

The switch marked DEST (37, figure 4-19) controls the insertion of destination data into the computer. The switch has two positions: INS--STORE. In the STORE position, destination coordinates can be placed into the storage mechanism of the computer. The appearance of the LA and LO flags in the destination storage windows (38, figure 4-19) indicates that destination data is in storage. The coordinates of a destination can be selected with the latitude and longitude slew switches (28, figure 4-19) only when the destination switch is in STORE and the display switch (25, figure 4-19) is on DEST. Placing the destination switch in INS transfers the destination latitude and longitude values into the computer. Once the stored data is inserted, the LA and LO flags disappear. After the primary destination is stored and inserted in the computer, an alternate destination can be stored until course and distance information to the alternate destination is desired. All destination inputs must first be routed to storage. If an attempt is made to place destination data in the computer when the destination switch is in INS, the LA and LO flags will oscillate in and out of view as well as cause deterioration of some computer components.

Mode Selector Switch

This switch (39, figure 4-19) has four positions: OFF--STBY--RUN--PP RST. When the switch is OFF and DC power is available, all power is removed from the nav-computer except for the panel lights. If AC power is available but no DC power, some computer circuits will be energized as long as the AC power is applied. Off flags appear in the latitude and longitude windows and over the distance counters (41, figure 4-19) when the switch is off. Placing the switch on STBY causes the OFF flags to disappear and energizes the computer so that it can warm up and accept information. When the switch is on RUN, the computer starts the computation of navigation data and all counters and indicators display computed or input information. The PP RST (present position reset) function of the switch permits correction of the present position coordinates with the latitude and longitude slew switches. While on PP RST, the computer continues to generate present position solutions which are held in storage

while the display is stopped for resetting and utilizes the new position data when the switch is returned to RUN. The mode selector switch and the system power switch must be out of the OFF position to fully energize the AN/APN-99 system.

Destination Indicator (ID-390/ASN-7)

The pilot's and navigator's destination indicators (18, figure 1-17 and 11, figure 4-43) display navigation data derived by the nav-computer. The indicators display the true ground track of the airplane, the rhumb-line course to destination, and the rhumb-line distance to the destination. The rotating card (42, figure 4-19) is positioned under the fixed top index (40, figure 4-19) to show the true ground track. True ground track is derived from variation, drift, and magnetic heading data. The course-to-destination pointer (43, figure 4-19), is the white-tipped movable pointer, and indicates the rhumb-line course to the selected destination on the rotating card. When this movable pointer is aligned with the top index mark, the airplane is flying a rhumb-line course to the selected destination. The distance to the destination along the rhumb-line course is indicated on the distance counters (41, figure 4-19). Distance can be read to the nearest 0.2 nautical mile. When passing over a destination, the distance counters may be off by as much as 6 NM and the course-to-destination pointer may oscillate. The counters will not necessarily go to zero before the distance starts to build-up as the airplane passes the destination. The distance counters are covered with an OFF flag when the computer is turned off and by a LIMIT flag if the distance limits of the computer are exceeded.

Nav-Computer Operation

The AN/APN-82, on airplanes 1▶97, consists of the AN/APN-81 auto-nav (doppler) radar and the AN/ASN-6 GPI computer. The GPI computer continuously computes and displays the position of the airplane in geographic coordinates. When operating with the radar set, the computer uses ground speed and drift angle information from the radar set plus heading information from the N-1 compass. Variation values are manually added by positioning the variation knob on the GPI control panel. The computer can also be operated independently of the radar set. Operation without the ground speed and drift angle information from the radar set requires: (1) heading information from the N-1 compass, (2) true airspeed from pitot static system, and (3) the manual insertion of wind force, wind direction, and variation information on the GPI control panel. The AN/APN-99, on airplanes 98▶, consists of the AN/APN-81 auto-nav (doppler) radar and the AN/ASN-7 or 7A destination computer. During flight, the system automatically and continuously displays airplane position in geographic coordinates, drift, ground speed, magnetic variation and actual ground track. The rhumb-line course and distance are displayed when the N-1 compass is in the magnetic mode, and the approximate great circle course and distance are displayed when the N-1 compass is in the gyro mode. The system automatically computes drift, ground speed and magnetic variation, receiving heading information from the N-1 compass. Navigation is essentially reduced to alignment of ground track display with required course display. Normal operation is independent of ground-based aids and weather conditions. The radar navigation set has the capability of navigating over polar regions. The only changes required for polar navigation are to set up the computer on grid coordinates and to change the N-1 compass to the gyro mode. The destination computer operates within the approximate limits of 70 degrees N and 70 degrees S latitude. The OFF flag will appear in the latitude window and an OFF flag will cover the distance counters if this latitude limit is exceeded. The LIMIT flag appears over the distance counters if the distance from the present position to the inserted destination exceeds 1000 nautical miles.

NOTE

To place computer in operation after exceeding the latitude limit, the slew switch is used to reduce the mean value of latitude.

Dead Reckoning (Auto-Nav Radar Not Operable)

If the auto-nav radar is in memory because of poor signal return, radar silence requirements or equipment malfunction, the nav-computer may be operated for limited periods of time with the wind values set on GND SPD. The computer remembers the last recorded doppler wind information and resolves the drift angle and ground speed for any given heading from this remembered wind; however, the nav-computer accuracy is only as good as this remembered wind. If more accurate wind information can be obtained from other sources, D/R computer operational accuracy may be improved by manually inserting the new wind values into the respective counters on the computer control panel.

SEARCH RADAR (AN/APN-59)

The search radar set is an airborne radar system that is a navigational and search radar, a weather radar, or a racon (radar beacon) interrogator-receiver. See figure 4-20 for illustrations of the control panel and indicators for this set. When used as a search radar, it displays a visual, map-like scope picture showing cities and smaller terrain features, rivers, islands, shorelines, mountains, and ships at sea. When used as a weather radar, because of increased sensitivity, it displays less substantial objects, such as storm fronts, heavy rainfall, or other turbulent weather features with precipitation. When used for racon navigation, it transmits an interrogating signal and then displays, in plan position, the space-coded identification of the automatic racon reply or replies. The set enables the navigator to see targets or check points on the ground through clouds, fog, overcast or darkness. It enables the navigator to determine accurate ground speeds, ground tracks, and winds under all conditions of visibility. It also permits him to view the entire area within more than 100 miles of

the airplane, depending on altitude. If the system is used by a navigator who understands its capabilities and limitations, it will aid and simplify his job and increase his accuracy and efficiency. Two search radar indicators, the pilots' indicator (6, figure 1-22) and the navigator's indicator (14, figure 4-30) give a short range map-like display with the airplane at the center. The set is turned on and off by use of the search radar function switch (17, figure 4-20) on the search radar control panel. The control panel (8, figure 4-24) is on the navigator's radar control console above the navigator's table. Control power is 28 volt DC from T-R BUS NO. 1 on the MCBP (figure 1-35, sheet 2) and operating power is 115 volt AC from GENERATOR NO. 2 on the MCBP (figure 1-35, sheet 3). The circuit breakers are marked APN-59 SEARCH RADAR on airplanes 1 ▶ 29 and SEARCH RADAR on airplanes 30 ▶.

NOTE

- The APN-59 has a 3 minute time delay which prevents operation of the set until it has warmed up. Therefore, in the event of power interruption or loss, there will be approximately a 3 minute delay in set operation after power has been restored.
- Ice formations on the radome cause the picture to deteriorate noticeably and it will be necessary to tilt the antenna to obtain a better picture.
- 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).

Search Radar Function Switch

This switch (17, figure 4-20) on the search radar control panel is used to energize the system and select a system function. The switch has OFF--STDBY--SEARCH--BEACON--WARN positions. The OFF position removes all power from the system except for dial illumination and fuse box supply. In STDBY all system circuits are energized except the transmitter. In SEARCH, the system is activated for the SEARCH function. This function supplies a continuous scan over a large area for the purpose of target pickup and identification. Since the system is a navigational radar, the target which it was designed to display is nothing less than the full terrain lying beneath the airplane, with its physical features clearly defined and cultural features identifiable. In the SEARCH function, the system presents a plan view of the underlying terrain and water, with indications of cities, towns, railroads, airfields, bridges, and other cultural features identifiably displayed on the land return, and islands and ships displayed in the water areas. Shorelines, rivers, lake outlines, mountains and other shadows, and other geographical features are prominently identifiable. The result of this function is a radar counterpart of the standard charts for the area. In the BEACON position, the search radar transmits pulses which cause operation of the radar beacon in other airplanes or at ground stations. (See RADAR BEACON in this Section.) Operation with radar beacons (racons) is a specialized navigational function of the system. Such beacons transmit pulse-coded signals on a specific and separate frequency when triggered by the radar-pulse transmission of the system within its normal frequency band. The system therefore does not operate as an echo-receiver, and no map appears on the PPI screen. Instead, groups of bars, spaced according to the code identification of the responding racons, are displayed at the range and azimuth of the beacon location. These groups are easily read on the PPI at shorter ranges, but tend to blend together at farther ranges. Therefore, a range delay circuit in the indicator permits the start of the 30 mile sweep to be delayed any required distance up to 210 miles, so that, for instance, the portion of range between 210-240 miles may be displayed expanded across the entire screen. This results in an expanded presentation of the racon return, facilitating both identification and range determination. Due to the considerable distortion caused by this expansion, range delay is rarely useful for any function other than beacon identification beyond 100 miles. In the WARN position, the system is activated for the warning function. Warning, as the term is used in radar, implies a scan over distant areas for the purpose of primary target pickup. On shorter ranges, of the system, it means weather warning since this is the function which is used to isolate and explore nearby storm areas. Since maximum sensitivity is required for this function, definition of targets is permitted to be less than optimum on ranges shorter than 50 miles. The increased sensitivity of the system in the warning function and on long range search emphasizes returns of weather phenomena. The more insubstantial targets formed by areas of disturbed weather with precipitation, such as storm fronts, squall lines, and nearby areas of heavy precipitation in water form are displayed as bright but indistinct returns. The operator's experience in identification of such areas and manipulation of the controls to verify his identification is important. Most areas of disturbed weather will be clearly defined when the SEARCH function is used.

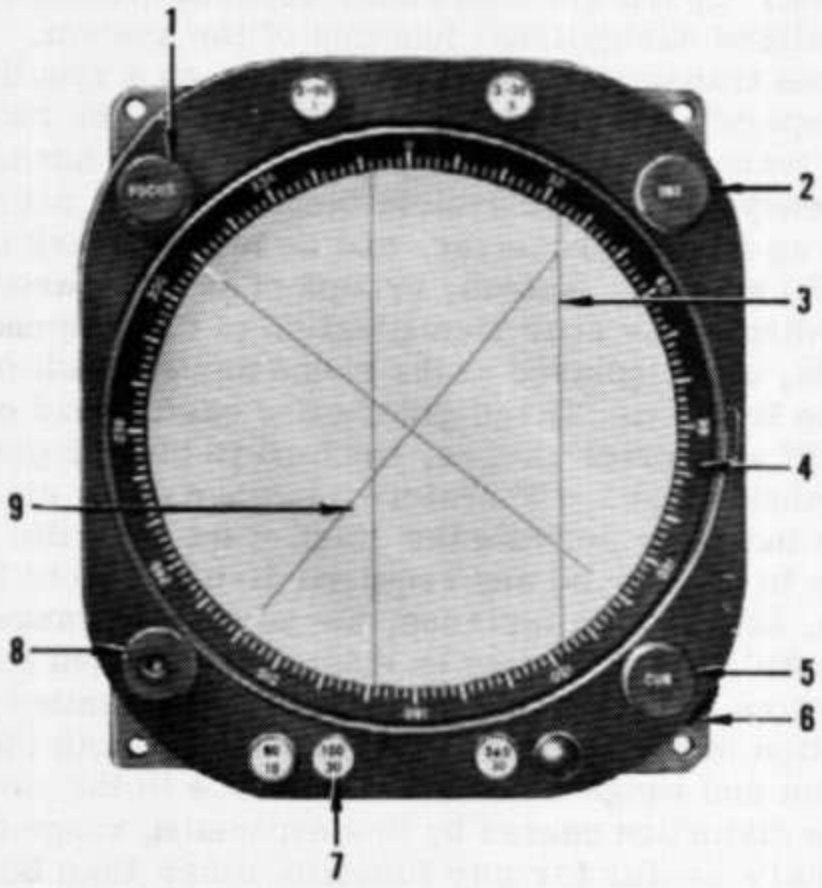
WARNING

Before placing the function switch in SEARCH, BEACON, or WARN, make sure that all personnel are clear of the antenna radiation pattern. Avoid directing the energy beam toward inhabited structures, personnel groupings, or areas where airplanes are being serviced with fuel. (See figure 4-21.)

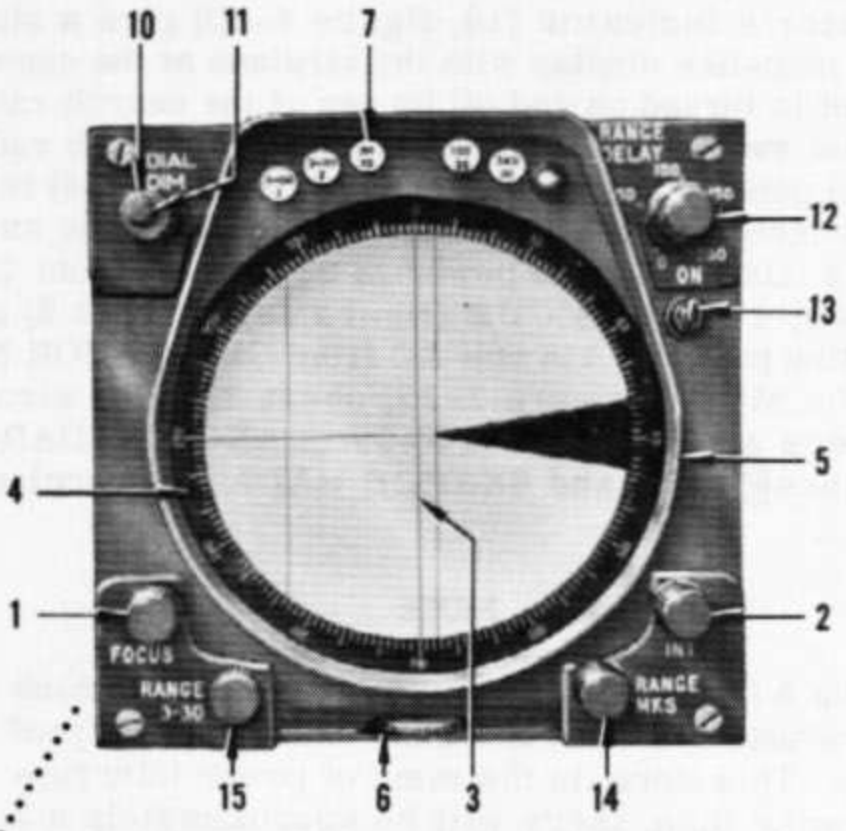
Gain Control

The GAIN control (20, figure 4-20) on the control panel is used to adjust the receiver gain. As the control is turned clockwise, the contrast ratio of the presentation is increased.

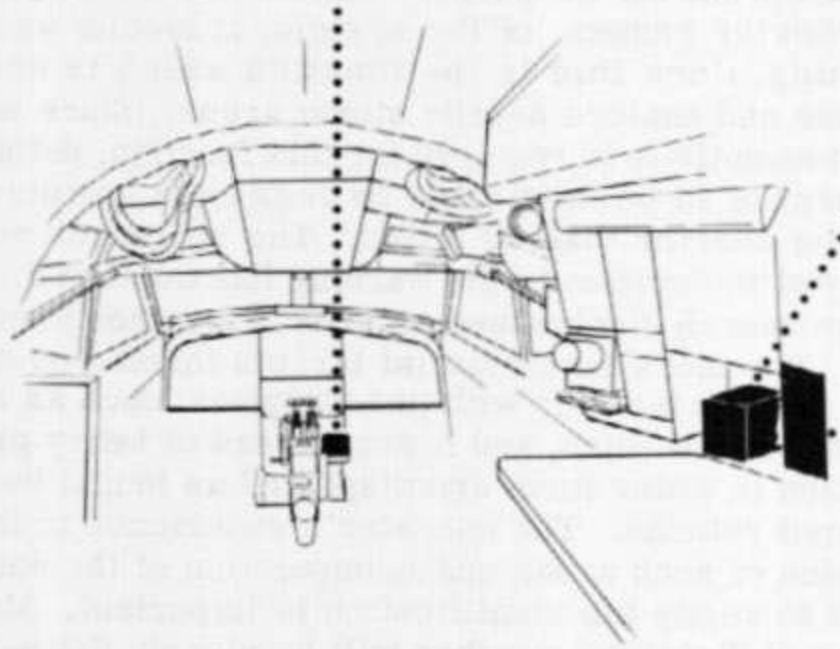
SEARCH RADAR CONTROLS AND INDICATORS



PILOTS' SEARCH RADAR INDICATOR



NAVIGATOR'S SEARCH RADAR INDICATOR





SEARCH RADAR CONTROL PANEL

1 FOCUS CONTROL (2 PLACES)
2 INTENSITY CONTROL (2 PLACES)
3 RETICLE (2 PLACES)
4 AZIMUTH RING (2 PLACES)
5 CURSOR CONTROL (2 PLACES)
6 RETICLE GEAR (2 PLACES)
7 RANGE INDICATOR LAMP (2 PLACES)
8 S--R SWITCH
9 CURSOR
10 DIAL DIM SWITCH
11 HEADING MARK INTENSITY CONTROL (SOME AIRPLANES)
12 RANGE DELAY CONTROL
13 RANGE DELAY SWITCH
14 RANGE MARKS CONTROL
15 RANGE 3-30 CONTROL
16 TEST METER
17 SEARCH RADAR FUNCTION SWITCH
18 HEADING SELECT VERNIER
19 HEADING SELECT CONTROL
20 COARSE GAIN CONTROL
21 FINE GAIN CONTROL (SOME AIRPLANES)
22 STC KNOBS
23 FTC SWITCH
24 IAGC SWITCH
25 PATT SWITCH
26 STAB SWITCH
27 BEARING SWITCH
28 TILT CONTROL
29 SCAN SWITCH
30 TEST METER SWITCH
31 RANGE (NM) SWITCH

F-197
F-198
F-199

Figure 4-20

RADIATION HAZARD AREA

NOTE

The radiation hazard area shown is around the search radar antenna. Accidental entry into the hazard area does not result in injury. It is only through prolonged exposure that the possibility of danger exists.

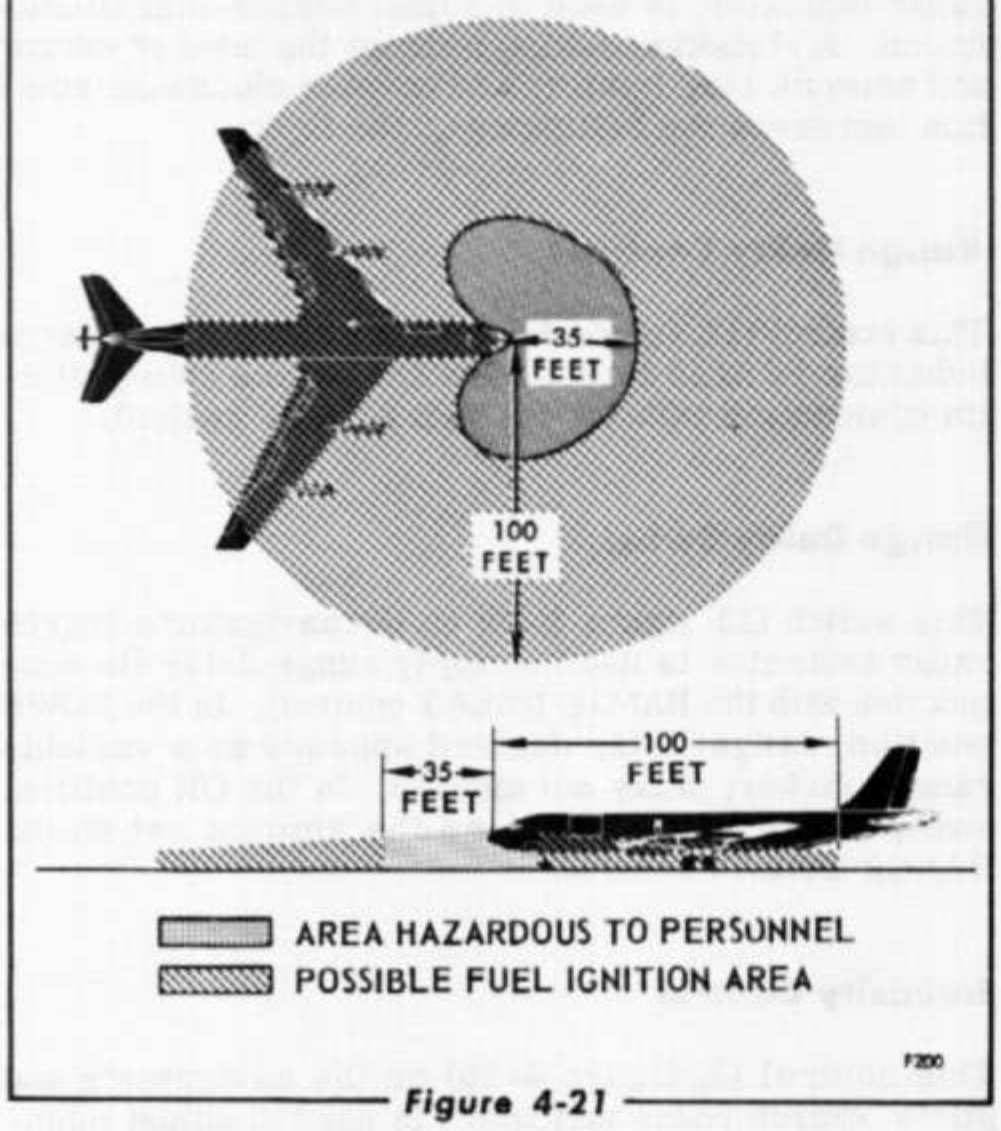


Figure 4-21

Range (NM) Switch

This switch (31, figure 4-20) on the search radar control panel is used to select the range for PPI. The switch has 3-30/1--3-30/5--50/10--100/20--240/30 positions. In the 3-30/1 position, PPI range is continuously variable by RANGE 3-30 control, between 0-3 and 0-30 miles, with 1 mile range marks. In the 3-30/5 position, PPI range is continuously variable by RANGE 3-30 control between 0-3 and 0-30 miles, with 5 mile range marks. In the 50/10 position PPI range is 0-50 miles with 10 mile range marks. In the 100/20 position, PPI range is 0-100 miles with 20 mile range marks. In the 240/30 position PPI range is 0-240 miles, with 30 mile range marks.

Scan Switch

The SCAN switch (29, figure 4-20) on the search radar control panel is used to select the type of antenna scan. The switch has L--OFF--R--PPI--SECTOR positions. In the L position, the antenna rotates counterclockwise at 12 rpm. In the OFF position, the antenna is stationary. In the R position, the antenna rotates clockwise at 12 rpm. In the PPI position, the antenna rotates clockwise at 12 or 45 rpm. In the SECTOR position, the antenna scans back and forth across the lubber line of the airplane.

Patt (Pattern) Switch

This switch (25, figure 4-20) on the search radar control panel is used to select the type of radar beam. The switch has PENCIL--FAN positions. In the PENCIL position, the radiated beam is narrow both vertically and horizontally. In the FAN position, the radiated beam is fan shaped vertically and narrow horizontally.

Heading Select Control

The heading select control (19, figure 4-20) on the search radar control panel, marked HDG SEL, orients the PPI display when the bearing switch (27, figure 4-20) is in STAB. The control has ten degree increments from 0 to 360 degrees with one degree increments shown on the heading select vernier (18, figure 4-20). With the control set on zero, the N-1 compass stabilizes the PPI orientation on magnetic North and the heading marker indicates the magnetic heading of the airplane. However, the control can be used to add any arbitrary angle to magnetic North (such as drift correction or for offset flying). Setting the control to the value of local variation stabilizes the display on true North. Placing the control to the magnetic heading of the airplane duplicates the PPI display obtained with the REL position of the bearing switch.

STC (Sensitivity Time Control) Knobs

The STC control (22, figure 4-20) on the search radar control panel is used to reduce gain on short range returns, and preserve more uniform contrast across display. The control consists of two concentric knobs: one is knurled and the other is hexagonal. When the hexagonal knob is rotated clockwise it acts to reduce the level of signals reflected from targets near the airplane. The range over which brilliance is reduced increases with clockwise rotation of the knurled knob. In the extreme counterclockwise position of the knurled knob, the STC is cut off.

FTC (Fast Time Constant) Switch

The FTC switch (23, figure 4-20) on the search radar control panel is used to break up large signal areas of uniform intensity on the PPI. Use of this control in the UP position will sometimes increase the definition of complex targets such as cities, or short range detailed targets such as airfields. When the switch is in the DOWN position, PPI display is unaffected.

IAGC (Instantaneous Automatic Gain Control) Switch

This switch (24, figure 4-20) on the search radar control panel is used to reduce gain with strong returns. When the switch is in the UP position, brightness of strong returns is reduced. In the DOWN position PPI display is unaffected.

STAB (Antenna Stabilization) Switch

The STAB switch (26, figure 4-20) on the search radar control panel controls the servo system that stabilizes the antenna reflectors. The reflectors are stabilized so that changes in airplane attitude will not affect the map presentation. In the UP (on) position, the vertical axis of the reflectors is stabilized perpendicular to the earth for all antenna positions, despite airplane pitch or roll. Mechanical stops restrict antenna movement in the pitch and roll axes. The stops are set for 12 degrees nose down, 15 degrees nose up, and 30 degrees of right and left roll. When the switch is DOWN (off), the antenna rotates about a vertical axis that is locked perpendicular to the airplane deck plane. The STAB switch should be in the UP (on) position at all times during flight except: (1) for operations requiring a locked vertical axis for the antenna for reference purposes (such as determination of terrain clearance), (2) when stabilization equipment is malfunctioning.

Bearing Switch

The bearing switch (27, figure 4-20) on the search radar control panel is used to select PPI reference azimuth (in conjunction with the heading select control). The switch has STAB and REL positions. In the STAB position, PPI top center is magnetic North plus heading select position. In the REL position, PPI top center is airplane heading.

Tilt Control

This control (28, figure 4-20) on the search radar control panel is used to control tilt of the radar beam. The beam tilts from 10 degrees above horizontal to 15 degrees below horizontal.

Test Meter Switch

This switch (30, figure 4-20) on the search radar control panel, when used, provides readings of selected circuits for operating tests on the test meter. The switch has LINE--MAG--MIXER 1--MIXER 2--AFC 1--AFC 2 positions. In the LINE position, line voltage is displayed on the test meter. In the MAG position, magnetron current is displayed on the test meter. In the MIXER 1 position, MIXER 1 crystal current is displayed on the meter. In the MIXER 2 position, MIXER 2 crystal current is displayed on the meter. In the AFC 1 position, AFC 1 crystal current is displayed on the meter. In the AFC 2 position, AFC 2 crystal current is displayed on the test meter. The switch should be left in the MAG position during normal operation to prevent the additional load (required to operate the meter) from affecting critical control circuits.

Dial Dim Switch

This switch (10, figure 4-20) on the navigator's search radar indicator, is used to adjust cursor-dial illumination. A clockwise setting reduces the level of cursor and azimuth ring lighting and counter clockwise rotation increases the brilliancy of the light.

Range Delay Control

This control (12, figure 4-20) on the navigator's search indicator is used to set distance before sweep start (in conjunction with the RANGE DELAY switch).

Range Delay Switch

This switch (13, figure 4-20) on the navigator's search radar indicator is used to apply range delay (in conjunction with the RANGE DELAY control). In the DOWN position, range-delay desired appears as a variable range marker; delay not applied. In the ON position, sweep delay is the same as the amount set on the RANGE DELAY control.

Intensity Control

This control (2, figure 4-20) on the navigator's and pilots' search radar indicators is used to adjust intensity of PPI trace for best signal visibility and contrast.

Range Marks Control

This control (14, figure 4-20) on the navigator's search radar indicator is used to adjust intensity of range marks. Counterclockwise setting of the control makes the range marks invisible. Clockwise rotation makes the marks appear and grow brighter.

Reticle

The reticle (3, figure 4-20) on the navigator's and pilot's search radar indicators will facilitate offset-track flying. The reticle shifts sidewise when the reticle gear is turned.

Reticle Gear

A reticle gear (6, figure 4-20) on each search radar indicator moves the reticle sidewise.

Range 3-30 Control

This control (15, figure 4-20) on the navigator's search radar indicator is used to set extent of short-range or delayed sweep. At extreme counterclockwise position, the radius of PPI is 3 miles and increases with clockwise rotation to a maximum of 30 miles.

Focus Control

The focus control (1, figure 4-20) on the navigator's and pilot's search radar indicators is used to adjust focus of sweep spot. The trace line blurs to either side of the proper control setting.

S—R (Bearing) Switch

This switch (8, figure 4-2) on the pilot's search radar indicator is used to select slaved (S) or relative PPI orientation for pilot's indication. When the switch is turned, either an "S" or "R" will appear in a circular indicator on the switch knob. If an "S" appears, the pilot's PPI presentation is the same as that displayed on the navigator's search radar indicator. If an "R" appears, the pilot's PPI top center is the airplane heading regardless of the navigator's search radar indicator PPI display.

Test Meter

The test meter (16, figure 4-20) on the control panel provides readings of selected circuits for operating tests.

Cursor

The cursor (9, figure 4-20) on the pilot's search radar indicator is used to indicate azimuths of targets (on the azimuth ring). When rotated, by use of the CURSOR gear, to split a target blip, the end of the crosshair indicates azimuth on the azimuth ring.

Cursor Control

The cursor control (5, figure 4-20) on the navigator's and pilot's search radar indicators is used to rotate the cursor through 360 degrees.

Range Indicator Lamp

These lamps (7, figure 4-20) on the navigator's and pilot's search radar indicators indicates range of PPI display.

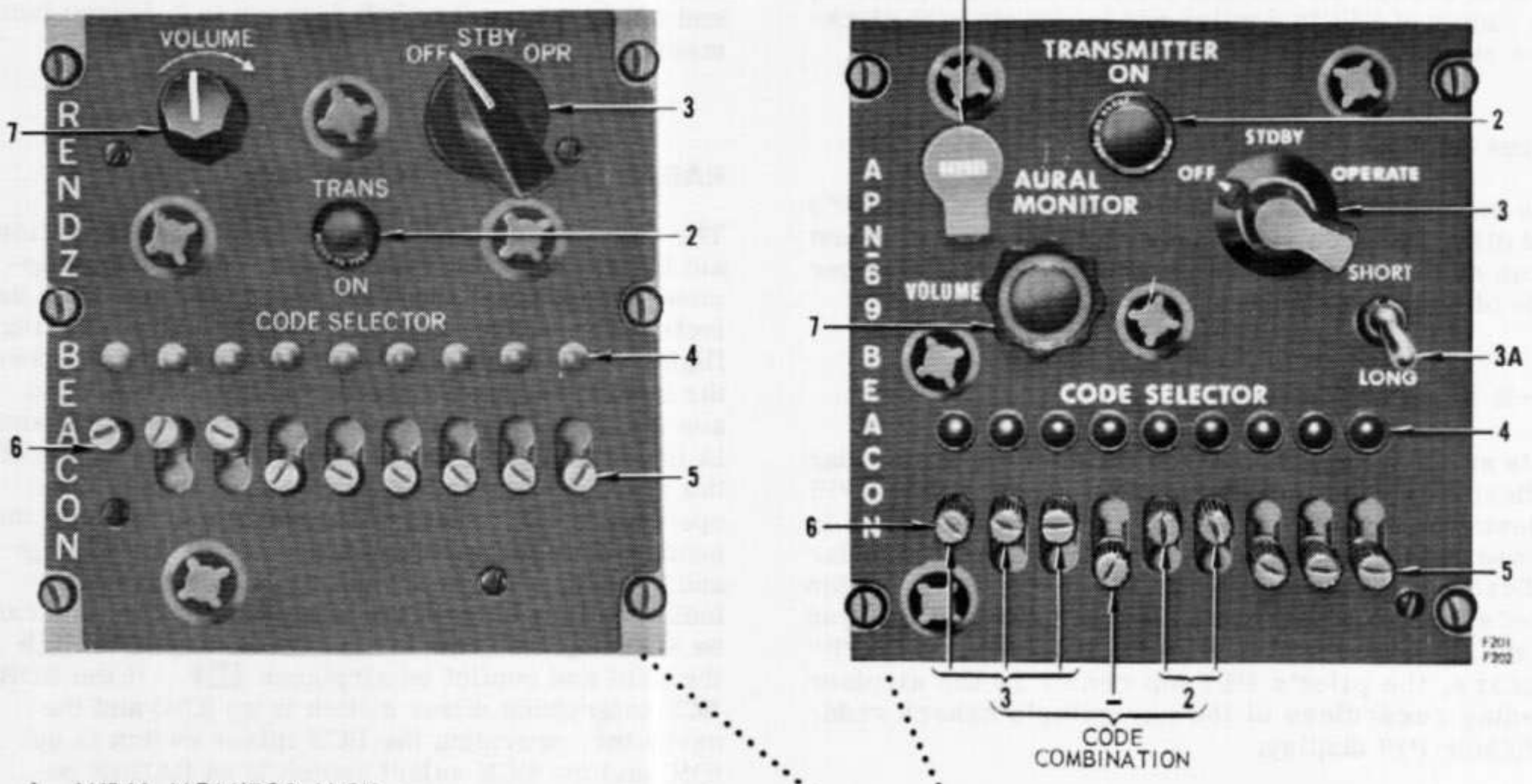
Azimuth Ring

The azimuth ring (4, figure 4-20) on the navigator's and pilots' search radar indicators allows the operator to read azimuth of targets. The ring is stationary and marked from 0 to 360 degrees in 2 degree increments.

RADAR BEACON (AN/APN-69)

The radar beacon is used primarily as a navigational aid for air refueling rendezvous. 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. The tone can be heard by the crew instructor on airplanes 10▶, the pilot and copilot on airplanes 98▶, if the RDR-BCN interphone mixer switch is up (ON) and the navigator, providing the BCN mixer switch is up (ON) and the BCN select switch is in RADAR position. 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 up (ON) to give three successive pulses, the fourth knob must be down (OFF) 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 4-22. (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 master power switch and is operative when the transmitter-on light is illuminated. Operating power is 115 volt AC through one circuit breaker on GENERATOR NO. 3 of the MCBP (figure 1-35, sheet 3). Control power is 28 volt DC through one circuit breaker on T-R BUS NO. 1 of the MCBP (figure 1-35, sheet 2). The circuit breakers are marked APN-69 RADAR BEACON on airplanes 1▶ 29 and RADAR BEACON on airplanes 30▶.

BEACON CONTROL PANELS



1 AURAL-MONITOR JACK
2 TRANSMITTER-ON INDICATOR LIGHT (2 PLACES)
3 MASTER POWER SWITCH (2 PLACES)
3A PULSE WIDTH SWITCH
4 CODE SELECTOR INDICATORS (2 PLACES)
5 CODE SELECTOR SWITCHES (2 PLACES)
6 COMMON CODE SELECTOR (2 PLACES)
7 VOLUME KNOB (2 PLACES)

Figure 4-22

NOTE

- The radar beacon may trigger itself occasionally which will be indicated on the interphone by an intermittent click or buzz. When the beacon is triggered by a radar set whose antenna is scanning, a buzz will be heard in the headset at the scanning frequency of the radar antenna. This scanning frequency will be quite low, sometimes as low as four scans per minute. If the radar is not scanning but is directed on the beacon, a tone of approximately 300 cycles per second will be heard.
- To avoid over-loading the radar beacon transmitter, do not insert more than six code elements - including the first (stationary) element. Over-loading the transmitter may blow a fuse on the R/T unit in the tail compartment (which is inaccessible during flight).

Master Power Switch

The master power switch (3, figure 4-22) 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 4-22) 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.

Pulse Width Switch

The pulse width switch (3A, figure 4-22), on the radar beacon panel has LONG-SHORT positions. Use of this switch allows the radar beacon to accept either of two different pulse width interrogation signals. The LONG (bomber) position is the normal position for operation of the radar beacon. Placing the switch in the SHORT (fighter) position enables the system to accept interrogation pulses from fighter airplanes.

Common Code Selector

A common code selector (6, figure 4-22) 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.

Radar Beacon Volume Knob

A volume knob (7, figure 4-22) on the radar beacon control panel adjusts the volume of the beacon tone into the interphone system. The volume of the tone is also controlled by the interphone volume control knob (5, figure 4-14).

Transmitter-On Indicator Light

A green indicator light (2, figure 4-22), marked TRANSMITTER ON, is on the radar beacon control panel. When the master power switch is turned to OPERATE, and a three-minute warm up period has elapsed, the green press-to-test TRANSMITTER ON indicator light illuminates indicating that the radar beacon is ready for automatic operation. The navigator's panel lights (6, figure 4-43) control the brilliance of this indicator light.

Code Selector Indicators

Nine code selector indicators (4, figure 4-22) are on the bottom of the radar beacon control panel. The navigator's panel lights (6, figure 4-43) control the brilliance of the indicators. Each code selector switch (5, figure 4-22) controls its respective indicator. The indicators, when illuminated, indicate the presence of a code element inserted in the beacon response.

Aural Monitor Jack

A jack (1, figure 4-22) on the radar beacon control panel is used for test purposes. The jack is not used by the flight crew.

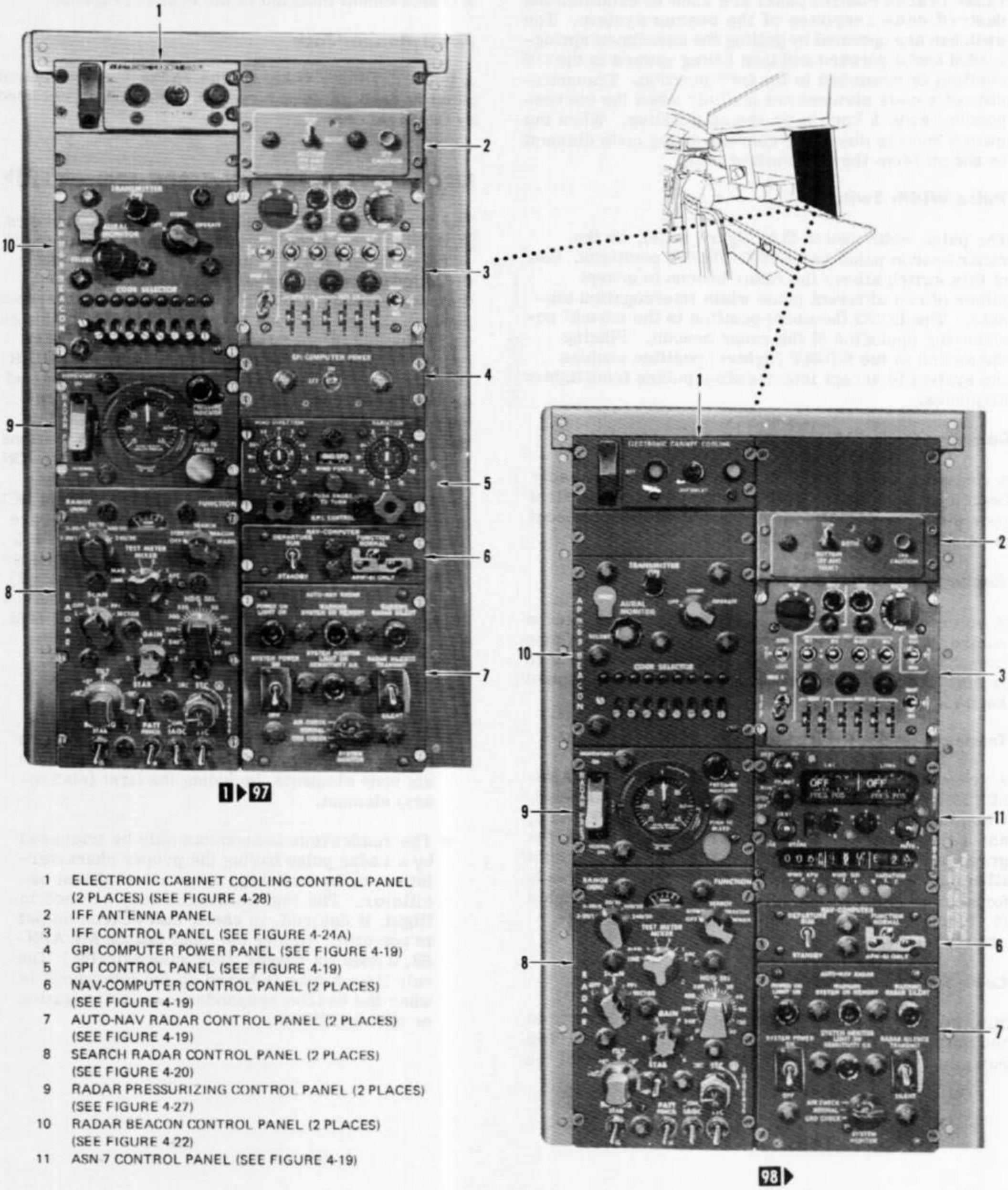
RENDEZVOUS BEACON (AN/APN-134) 346▶

The rendezvous beacon on airplanes 346▶ (airplanes 483▶ have provisions for the installation of AN/APN-135 equipment but the receiver-transmitter and directional coupler are not installed) is similar to the radar beacon AN/APN-69. The major difference between the two beacons is the operating frequencies. The principle of operation and the function of each control is the same for both sets. Refer to RADAR BEACON in this Section for general information and description of each control. When the beacon responds to an interrogation, a tone can be heard on the pilot's, copilot's, and crew instructor's stations providing the RENDZ interphone mixer switch is ON (up) and at the navigator's station, providing the BCN interphone mixer switch is up (ON) and the BCN select switch is in the RENDZ position. There are 52 usable codes available. Operating power is 115 200 volt AC through three circuit breakers on GENERATOR NO. 2 of the MCBP (figure 1-35, sheet 3) marked RENDEZVOUS BEACON. Control power is 28 volt DC through one circuit breaker on T-R BUS NO. 2 of the MCBP (figure 1-35, sheet 2) marked RENDEZVOUS BEACON.

NOTE

- Due to the limitations of the scope presentation on the receiver's radar, do not insert more than six code elements, including the first (stationary) element.
- The rendezvous beacon can only be triggered by a radar pulse having the proper characteristics, or by switching on an internal test oscillator. The test oscillator may be used in flight, if desired, to check that beacon output is operative. (Unlike the radar beacon AN/APN-69, it does not trigger itself automatically.) The only time a tone is heard on the interphone is when the beacon responds to an interrogation or test oscillation.

NAVIGATOR'S RADAR CONSOLE



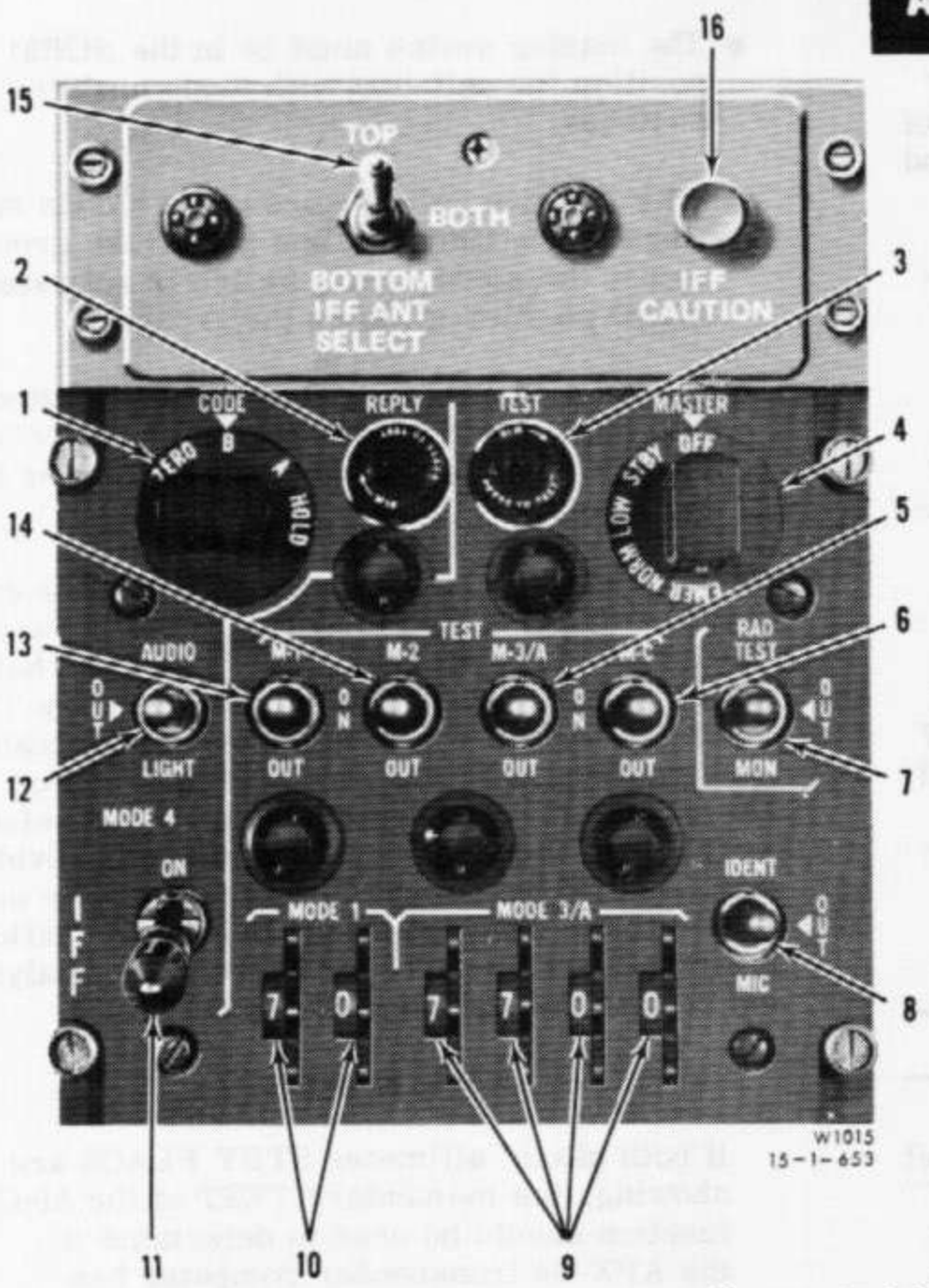
1 ELECTRONIC CABINET COOLING CONTROL PANEL (2 PLACES) (SEE FIGURE 4-28)
2 IFF ANTENNA PANEL
3 IFF CONTROL PANEL (SEE FIGURE 4-24A)
4 GPI COMPUTER POWER PANEL (SEE FIGURE 4-19)
5 GPI CONTROL PANEL (SEE FIGURE 4-19)
6 NAV-COMPUTER CONTROL PANEL (2 PLACES) (SEE FIGURE 4-19)
7 AUTO-NAV RADAR CONTROL PANEL (2 PLACES) (SEE FIGURE 4-19)
8 SEARCH RADAR CONTROL PANEL (2 PLACES) (SEE FIGURE 4-20)
9 RADAR PRESSURIZING CONTROL PANEL (2 PLACES) (SEE FIGURE 4-27)
10 RADAR BEACON CONTROL PANEL (2 PLACES) (SEE FIGURE 4 22)
11 ASN 7 CONTROL PANEL (SEE FIGURE 4-19)

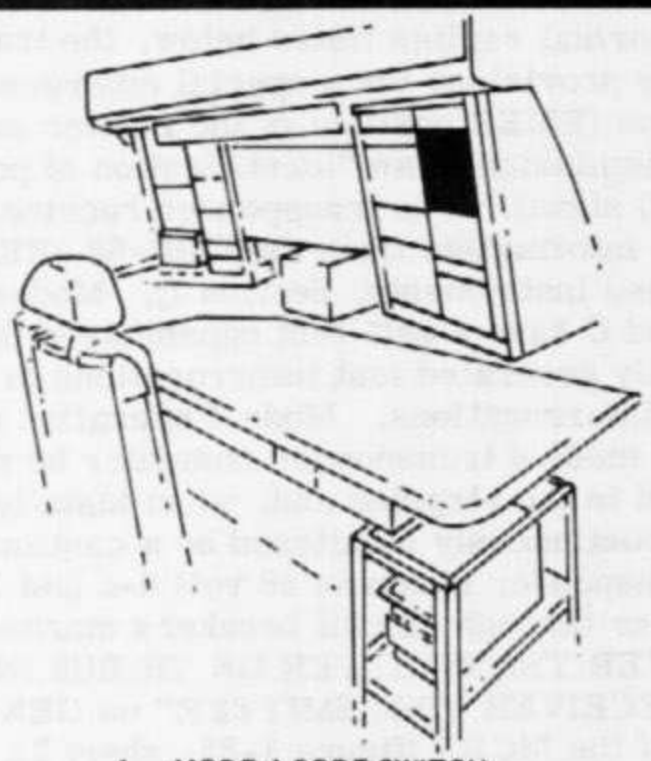
F-207
F 208

Figure 4-24

All data on pages 4-57 and 4-58, including figure 4-23 (Deleted)

AN/APX-64 IFF RADAR CONTROL PANELS





1. MODE 4 CODE SWITCH
2. MODE 4 REPLY LIGHT
3. TEST LIGHT
4. MASTER SWITCH
5. MODE 3/A ENABLING SWITCH
6. MODE C ENABLING SWITCH
7. RAD TEST/MON SWITCH
8. IDENT/MIC SWITCH
9. MODE 3/A CODE SELECTORS
10. MODE 1 CODE SELECTORS
11. MODE 4 ON/OUT SWITCH
12. MODE 4 AUDIO/LIGHT SWITCH
13. MODE 1 ENABLING SWITCH
14. MODE 2 ENABLING SWITCH
15. IFF ANTENNA SWITCH
16. IFF MODE 4 CAUTION LIGHT

Figure 4-24A.

SIF/IFF TRANSPONDER SET AN/APX-64 (AIMS)

NOTE

AIMS includes the features of and is derived from:

- Air traffic control radar beacon system (ATCRBS)
- IFF (SIF)
- MK 12 IFF
- System

The transponder set AN/APX-64 (AIMS) provides for Mark X IFF with selective identification feature (SIF), automatic altitude reporting, and Mark XII (Mode 4) encrypted IFF. The transponder set is the airborne portion of a two-way link between the airplane and ground radar installations. The ground radar station sends an interrogation signal which is received by the airplane; the airplane transponder (reply system) then replies with coded signals which are received on the ground and displayed on the radar scope as unique identification and altitude sig-

nals. The ground station may interrogate in more than one mode. However, the transponder will only reply in those modes that are enabled. In addition to the normal replies listed below, the transponder contains provisions for a special emergency mode of operation (EMER position of the master switch), and for transmission of an "identification of position" (IDENT) signal. The transponder receives coded altitude information from the CPU-66 altitude computer (see Instruments, Section I). Modes 1, 2, 3/A, and C have a self-test capability with either internally generated test interrogations or ground station interrogations. Mode 4 operation requires that the mode 4 transponder computer be physically installed in the airplane and, when installed, operation is continuously monitored by a caution light. The transponder receives 28 volt d-c and 118-volt a-c power through circuit breakers marked "IFF RECEIVER TRANSMITTER ON TR BUS NO. 1" and "IFF RECEIVER TRANSMITTER" on GENERATOR NO. 1 of the MCBP (figure 1-35, sheet 2). The IFF test set is provided 28 volt d-c power from a circuit breaker marked "TRANSPONDER TEST SET" on TR BUS NO. 2 of the MCBP. The mode 4 computer is provided power by the transponder.

The interrogation and reply modes are as follows:

INTERROGATION	REPLY
MODE 1	Any one of 32 possible codes, as set on IFF panel
MODE 2	Any one of 4096 possible codes, as set on APX-64 transponder
MODE 3/A	Any one of 4096 possible codes, as set on IFF panel
MODE C	Standard ATC code for altitude reporting
MODE 4	As determined by mode 4 transponder computer

AN/APX-64 IFF Transponder Set Controls

MASTER SWITCH. The master switch (4, figure 4-24A) is a rotary switch with OFF--STBY--LOW--NORM--EMER positions. In OFF position, all power is removed from the set. STBY position places the transponder in warmup condition. Warm-up requires approximately 3 minutes. LOW position places the transponder in operation with reduced receiver sensitivity. NORM position results in operation with normal receiver sensitivity. EMER position causes automatic transmission of emergency reply signals when interrogated by mode 1, mode 2, or mode 3/A. The switch must be pulled out to turn to OFF or EMER.

NOTE

- The master switch must be in the NORM position for self-test with mode enabling switches.
- OFF position will zeroize mode 4 code settings at any time in flight and on the ground unless the mode 4 code switch is activated to HOLD position while on the ground.
- The mode 4 code switch must be activated to the HOLD position a minimum of 15 seconds prior to the removal of electrical power from the aircraft.

MODE ENABLING SWITCHES. Four mode enabling switches (13, 14, 5, and 6, figure 4-24A) are marked "M-1," "M-2," "M-3/A," and "M-C" and have positions of OUT-ON--TEST with momentary TEST position. The OUT position prevents the transponder from replying to interrogation signals in that mode. The ON position enables operation in the selected mode. The momentary TEST position provides for a self-test of the selected mode. When the switch is held to the TEST position, test interrogations are generated, the transponder response is analyzed, and results are indicated by the test light.

NOTE

If both pilots' altimeter STBY FLAGS are showing, the momentary TEST of the M-C function should be used to determine if the APX-64 transponder computer has failed.

TEST LIGHT. A green press-to-test test light (3, figure 4-24A) illuminates when the transponder is responding correctly to mode 1, 2, 3/A, or C interrogations. Source of interrogations is controlled by the mode enabling switch TEST positions or by the RAD TEST/MON switch.

RAD TEST/MON SWITCH. The RAD TEST/MON switch (7, figure 4-24A) has three positions marked RAD TEST--OUT--MON and is spring-loaded from RAD TEST to OUT. RAD TEST position is not used by the flight crew. MON position enables the test light to monitor modes 1, 2, 3/A, and C replies generated by the transponder to ground interrogations This switch must be positioned to OUT when using the mode enabling switch TEST positions.

IDENT/MIC SWITCH. The IDENT/MIC switch (8, figure 4-24A) provides for special identification features which are of use to the air traffic controller. The switch has three positions marked IDENT--OUT--MIC and is spring-loaded from IDENT to OUT position. Momentarily actuating the switch to the IDENT position initiates the identification response. When the switch is placed in the MIC position, identification response is initiated whenever the pilot's

or copilot's microphone trigger switch is depressed provided the command radio is on and the interphone selector is in the respective COMM position. The response will continue for 30 seconds after the IDENT/MIC switch or the trigger switch is actuated and consists of a double reply, depending upon which modes are enabled.

NOTE

The proper mode enabling switch must be turned on (to match the interrogation mode) to allow identification operation.

CODE SELECTORS. Mode 1 code selectors (10, figure 4-24A) are eight-position thumbwheel type selectors with integral indicators. The first digit selector is numbered from 0 thru 7, and the second digit selector is numbered from 0 thru 3. A total of 32 mode 1 code combinations is available. Mode 3/A code selectors (9, figure 4-24A) are eight-position thumbwheel type selectors with integral indicators numbered from 0 thru 7. The mode 3/A selectors allow selection of any base eight code from 0000 to 7777, for a total of 4096 different codes. Mode 2 and mode 4 codes are preset.

MODE 4 ON/OUT SWITCH. The mode 4 on/out switch (11, figure 4-24A) has two positions marked ON--OUT. With the transponder functioning, mode 4 operation is selected by placing the switch to ON. Transponder functioning is controlled by the master switch for mode 4 as for other modes. Placing the mode 4 on/out switch to OUT disables mode 4 operation. Accidental selection of OUT is prevented by the switch design, which requires the operator to pull out on the toggle lever before it can be moved to the OUT position.

MODE 4 CODE SWITCH. The mode 4 code switch (1, figure 4-24A) has four positions marked HOLD--A--B--ZERO. Positions A and B select the preset code for the present and succeeding code period, respectively. ZERO position will zeroize both code settings at any time airplane power is on and the master switch is in any position other than OFF. Inadvertent selection of ZERO is prevented by switch design which requires that the knob be pulled out before it can be turned to ZERO. Both code settings normally will be zeroized when power is turned off after the airplane has landed. The code settings can be retained by momentarily placing the mode 4 code switch in the spring-loaded HOLD position while the airplane is on the ground. The HOLD function is controlled by the landing gear safety switches and requires transponder power to remain on for at least 15 seconds to mechanically latch the code settings.

NOTE

Once the mode 4 HOLD has been activated on the ground, aircraft power loss or SIF/IFF master switch OFF does not cause loss of the code. If the mode 4 HOLD switch has been activated, the code must be zeroized upon flight termination or alert uncocking.

MODE 4 AUDIO LIGHT SWITCH. The mode 4 audio light switch (12, figure 4-24A) has three positions marked AUDIO--OUT--LIGHT. In the LIGHT position, the mode 4 reply light indicates when replies are transmitted. In the AUDIO position, an audio signal in the applicable crewmember's headset indicates interrogations are being received and illumination of the mode 4 reply light indicates when replies are transmitted. The audio signal is controlled by a separate mixer switch channel on the navigator's interphone panel. In the OUT position, both light and audio indications are inoperative.

MODE 4 REPLY LIGHT. The mode 4 reply light (2, figure 4-24A) is a green press-to-test light controlled by the mode 4 audio/light switch.

IFF MODE 4 CAUTION LIGHT. The amber IFF mode 4 press-to-test caution light (16, figure 4-24A) is located on the IFF antenna switch panel. The caution light illuminates whenever an inoperative mode 4 capability is detected, provided that (1) the mode 4 transponder computer is installed, (2) airplane power is on, and (3) the master switch is not OFF. Specific discrepancies monitored by the caution light are:

- Mode 4 codes zeroized. Computer door must be closed firmly in one continuous motion or zeroize will result.
- Transponder failure to reply to proper interrogation.
- Automatic self-test function of the computer reveals a faulty computer.

To attempt correction when the caution light is illuminated, reposition the master switch to NORM (if in STBY or LOW), check that the mode 4 on/out switch is ON, and check that the proper A or B code has been selected.

NOTE

Since power for the caution light is routed through the mode 4 transponder computer, this unit must be physically installed in the airplane to render the caution light operative.

IFF ANTENNA SWITCH. A three-position IFF antenna switch (15, figure 4-24A) on the navigator's radar console allows selection of TOP, BOTH, BOTTOM IFF antennas. When the IFF antenna switch is positioned to BOTH, the transponder alternates between antennas.

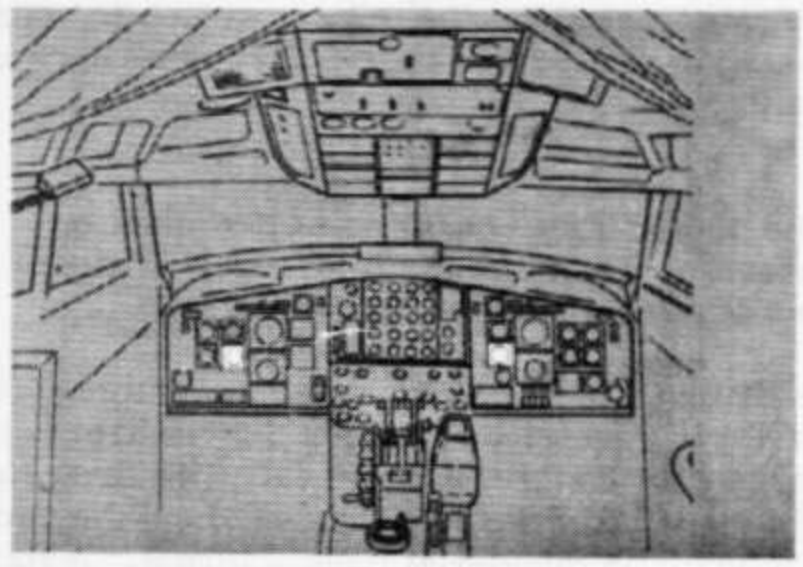
Normal Operation

Normal operation is as follows:

1. Position master switch to STBY for warmup. Warmup requires approximately 3 minutes.
2. Set mode 1 and mode 3/A code selectors as briefed.
3. Position IFF antenna switch to BOTH.
4. Position IDENT/MIC switch to OUT.
5. For system self-test:
   a. Position master switch to NORM.

LOW RANGE RADIO ALTIMETER





CONTROL/INDICATOR		FUNCTION
1	MINIMUM DECISION ALTITUDE (MDA) LIGHT	Will illuminate when the airplane descends to the exact altitude (and below) indicated by the minimum altitude index. Light may be dimmed by turning clockwise.
2	MASK	Hides the pointer when airplane is more than 2500 feet above terrain.
3	MINIMUM ALTITUDE INDEX	A movable index positioned by the minimum altitude knob to the altitude, read against the circular scale, at which further airplane descent would illuminate the MDA light.
4	WARNING FLAG	Will appear in the upper right corner of the indicator when the altitude information is unreliable. **NOTE** Disregard warning flags above 2500 feet as false flag indications may occur.
5	POINTER	Used to indicate airplane altitude on the circular scale.
6	MINIMUM ALTITUDE KNOB	Used to set the position of the minimum decision altitude index.
7	INDICATOR DIAL (SCALE)	A circular scale, calibrated in hundreds of feet, linear from -20 to +500 feet and increasingly compressed from 500 to 2500 feet.
8	TEST BUTTON	Used to self-test the system to ensure proper operation. Depress test button; if system is operating properly, the warning flag will appear and pointer will indicate 100 feet. When the test button is released, the pointer will move completely around the dial to a maximum position behind the mask (will remain behind the mask if airborne above 2500 feet), then return to appropriate altitude (if below 2500 feet). Pointer should return to 0 if on the ground.

Figure 4-25

b. Position RAD TEST/MON switch to OUT.
c. Momentarily hold each mode enabling switch to TEST, then return to OUT. Illumination of test light for each mode indicates satisfactory operation. If test function inoperative, determine status of SIF approach control if possible.

6. Position master switch to LOW or NORM as desired.
7. Position mode enabling switch to ON as briefed.
8. Position RAD TEST/MON switch to OUT or MON as desired.
9. Perform mode 4 operations as briefed. The navigator will actuate the mode 4 code switch to the HOLD position after the mode 4 computer has been encoded.
10. To turn off equipment, position master switch to OFF.

Emergency Operation

For emergency operation, pull outward on the master switch and rotate to the EMER position. Modes 1, 2, and 3/A are automatically enabled. The set will respond to modes 1 or 2 interrogations with the reply code determined by the mode 1 and mode 2 code selectors followed by three sets of pulse pairs. Mode 3/A reply code will be 7700, regardless of the position of the mode 3/A code selectors, and will be followed by three sets of pulse pairs.

LOW RANGE RADIO ALTIMETER SYSTEM

Two low range radio altimeter systems (figure 4-25) are installed for independent inputs to the pilot's and copilot's flight director systems. Each low range radio altimeter indicates terrain clearance from an altitude of 2500 feet to touchdown and also furnishes altitude data to the respective flight director system. The pilot's low range radio altimeter indicator is located on the pilot's instrument panel and furnishes altitude data to the pilot's flight director system. The copilot's low range radio altimeter indicator is located on the copilot's instrument panel and furnishes altitude data to the copilot's flight director system. Each low range radio altimeter performs the following functions:

a. Indicates terrain clearance (7, figure 4-25) 0 to 2500 feet.

NOTE

The radio altimeter indicates absolute altitude only and should not be used as the primary decision height altitude indication except for published radio altitude approaches.

b. Turns on the minimum decision altitude (MDA) light on the respective altimeter indicator (1, figure 4-25) and ADI (1, figure 4-30C). The minimum decision altitude, at which the MDA lights come on, is set by the minimum decision altitude control knob (6, figure 4-25) and indicated by the minimum decision altitude index (3, figure 4-25).

c. At 200 feet of terrain clearance, a trip signal from the low range radio altimeter starts the ADI runway symbol to move up in a vertical direction to simulate airplane vertical clearance above the terrain when tuned to a localizer frequency. At touchdown, the runway symbol will be deflected full upward to indicate zero altitude (airplane on runway).

d. Furnishes altitude reference signals to the respective flight director system, which changes at 200 feet (radio altitude) the pitch signal gain to the command bars (8, figure 4-30C) during an ILS approach. This programmed gain decreases the pitch command deflection of the command bars as the glide slope beam narrows below 200 feet.

e. Performs continuous self-monitoring at all altitudes (4, figure 4-25), and has a pushbutton self-test feature (8, figure 4-25).

f. Provides altitude data to the flight director comparator monitor where the measured altitude between both low range radio altimeters is continuously compared when the FD mode selector is in APPR AUTO or APPR MAN to check for out-of-tolerance conditions.

The system has no ON--OFF function and is on any time power is applied to the airplane. Operating power is 115 volt AC through circuit breakers marked RDO ALT on the FD/RGA circuit breaker panels (figure 1-35).

HIGH RANGE RADIO ALTIMETER (SCR-718 OR AN/APN-133)

The high range radio altimeter (figure 4-26) is used for determining height above terrain. Airplanes 1 ▶ 547 have the SCR-718 radio altimeter operating in the 440 MC frequency band. The nominal range for the SCR-718 radio altimeter is 0 to 40,000 feet. Airplanes 548 ▶ have the AN/APN-133 radio altimeter operating in the 1640 MC frequency band. The nominal range for the AN/APN-133 radio altimeter is 0 - 50,000 feet in an unpressurized cabin and up to 65,000 feet in a pressurized cabin. The maximum altitude for either altimeter depends on the reflecting terrain; therefore, some lower altitude may be the practical limit. Controls and an indicator are on the face of the set and are identical for both the SCR-718 and AN/APN-133. The altimeter (18, figure 4-30) is located above the navigator's table at the navigator's station. The set is

HIGH RANGE RADIO ALTIMETER





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

F-210

Figure 4-26

turned on and off by the use of a REC. GAIN knob (6, figure 4-26) on the altimeter. Operating power is 115 volt AC through one circuit breaker on GENERATOR NO. 1 of the MCBP (figure 1-35, sheet 3), marked SCR-718 ALTIMETER on airplanes 1▶ 29 and ALTIMETER on airplanes 30▶.

WARNING

Do not rely on the radio altimeter to provide accurate terrain clearance when flying over areas covered by large depths of snow and ice. The frequency of this radio altimeter is such that the radio waves produced can penetrate the surface of snow and ice fields, therefore, indicating a greater terrain clearance than that actually existing.

NOTE

- Except in emergency, the SCR-718 radio altimeter equipment will be used only over broad ocean areas starting not less than 50 miles off shore unless the restriction is specifically waived by Headquarters USAF. Ground operational preflight is authorized if mission dictates use of equipment. Check current FLIP documents for areas in which additional restrictions are placed on the use of the SCR-718.

- 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 causes interference with the radio altimeter in the other airplane(s). The interference makes the altitude indications unusable.

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 size of the circular trace.

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.

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 illuminate when the components of the set are energized.

RADAR PRESSURIZING EQUIPMENT (AN/ASQ-15)

The pressurizing equipment pressurizes the search radar (AN/APN-59), the radar beacon (AN/APN-69) and the navigation radar set (AN/APN-81), to provide satisfactory operation at high altitudes. The control panel is shown in figure 4-27. The equipment is controlled by a switch on the radar pressurizing control panel (9, figure 4-24) on the navigator's radar control console. Pressure, supplied by an electric pump, is maintained at the proper level (±1.5 psi at the high and low of normal) by a pressure operated switch when the control switch is in the NORMAL ON position. A light on the pressurizing control panel illuminates when the pressurizing pump is operating. If the pressure switch malfunctions and pressure exceeds 34 inches Hg, the system should be returned to normal pressure by depressing a PUSH TO BLEED button on the panel. If the reverse is true and the equipment is underpressurized as indicated by a pressure of less than 30 inches Hg, the pressure should be increased to the proper value by holding the control switch in the MOMENTARY ON position. Operating power is 115 volt AC through two circuit breakers on GENERATOR NO. 1 of the MCBP (figure 1-35, sheet 3). The circuit breakers are marked ASQ-15 PRESSURIZING KIT on airplanes 1▶29 and PRESSURIZING KIT on airplanes 30▶.

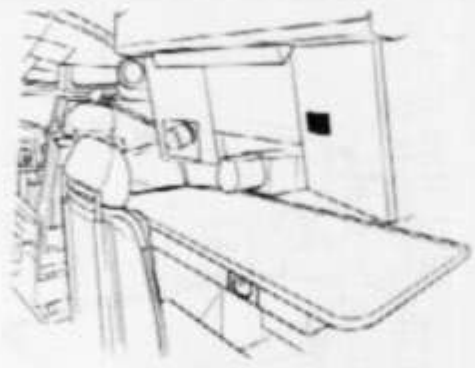
Control Switch

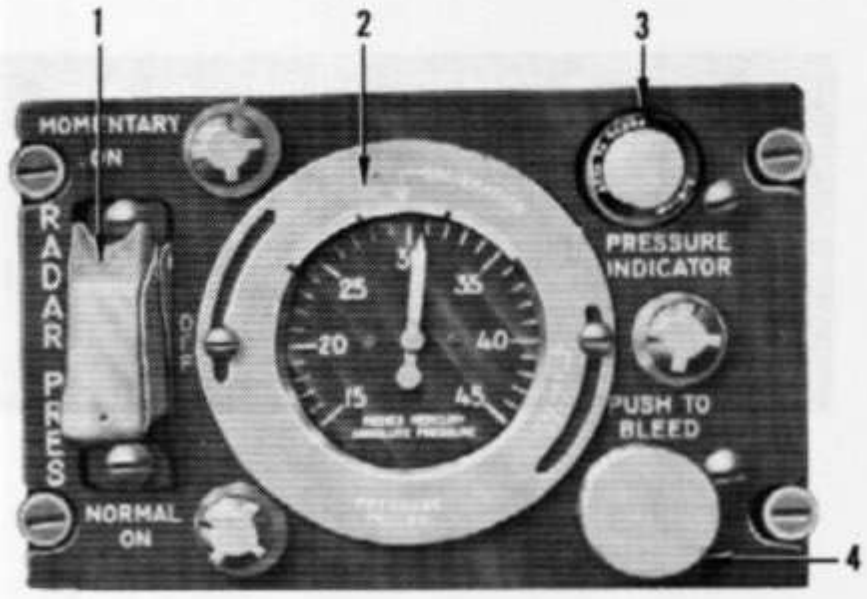
This switch (1, figure 4-27) on the radar pressurizing control panel has MOMENTARY ON--OFF--NORMAL ON positions. The switch, guarded to the NORMAL ON position, controls operation of the connected air system. With the switch in the NORMAL ON position, intermittent operation of connected equipment is automatic with results indicated on the control panel. Switch positions MOMENTARY ON and OFF are used for testing and emergency.

Bleed Valve Knob

A knob (4, figure 4-27) 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 CONTROL PANEL





1 CONTROL SWITCH
2 RADAR PRESSURE GAGE
3 PRESSURE INDICATOR LIGHT
4 BLEED VALVE KNOB

F 211

Figure 4-27

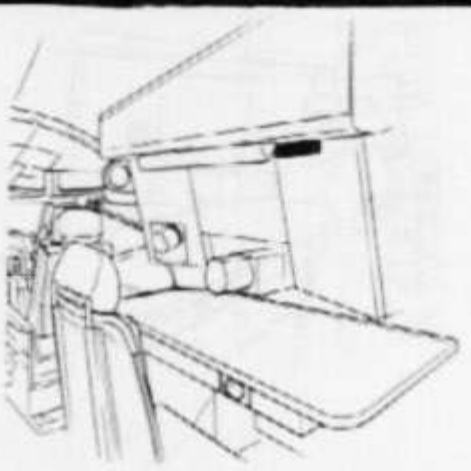
Pressure Indicator Light

A green indicator light (3, figure 4-27) on the radar pressurizing control panel, when illuminated, indicates that the compressor is operating.

Radar Pressure Gage

A radar pressure gage (2, figure 4-27) 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.

ELECTRONIC CABINET COOLING CONTROL PANEL





1 ELECTRONIC CABINET COOLING SWITCH
2 ELECTRONIC CABINET COOLING OVERHEAT WARNING LIGHT

F-212

Figure 4-28

ELECTRONIC CABINET COOLING SYSTEM

An electronic cabinet cooling system provides adequate cooling for electronic units mounted in the electronic cabinet (11, figure 1-3). The system is turned on and off by use of a switch (1, figure 4-28) on the electronic cabinet cooling control panel. The control panel for the system (1, figure 4-24) is on the navigator's radar control console. The system has a blower and an airflow detector to facilitate and indicate adequate cooling of the equipment mounted in the electronic cabinet. The blower is capable of exhausting 800 cubic feet of air per minute from the electronic cabinet. The airflow detector is used to indicate when flow of cooling air circulating in the electronic cabinet is inadequate by illuminating a warning light on the control panel. Airflow detector power is 28 volt AC through one circuit breaker, marked ELECTRONIC RACK BLOWER IND on the MCBP (figure 1-35, sheet 3). Operating power is 115/200 volt AC through three circuit breakers, marked BLOWER ELECTRONIC CABINET, on GENERATOR NO. 2 of the MCBP (figure 1-35, sheet 3).

Electronic Cabinet Cooling Switch

This switch (1, figure 4-28) on the control panel has ON--OFF positions. With power on the airplane and the switch in the OFF position, the electronic cabinet cooling warning light (2, figure 4-28) will be on. When the switch is placed to ON and power is on the airplane, the blower will start circulating air to cool the equipment in the electronic cabinet and the warning light should extinguish within 20 seconds. With the switch in the OFF position, no cooling will be available and the overheat light will be illuminated.

CAUTION

Electronic equipment in the electronic cabinet will tend to overheat after only a few minutes of operation. Whenever any of this equipment is to be utilized, the electronic cabinet cooling power switch should be positioned to ON.

Electronic Cabinet Cooling Overheat Warning Light

This light (2, figure 4-28) on the control panel will illuminate if cooling air circulating in the electronic cabinet is inadequate or the blower is not operating.

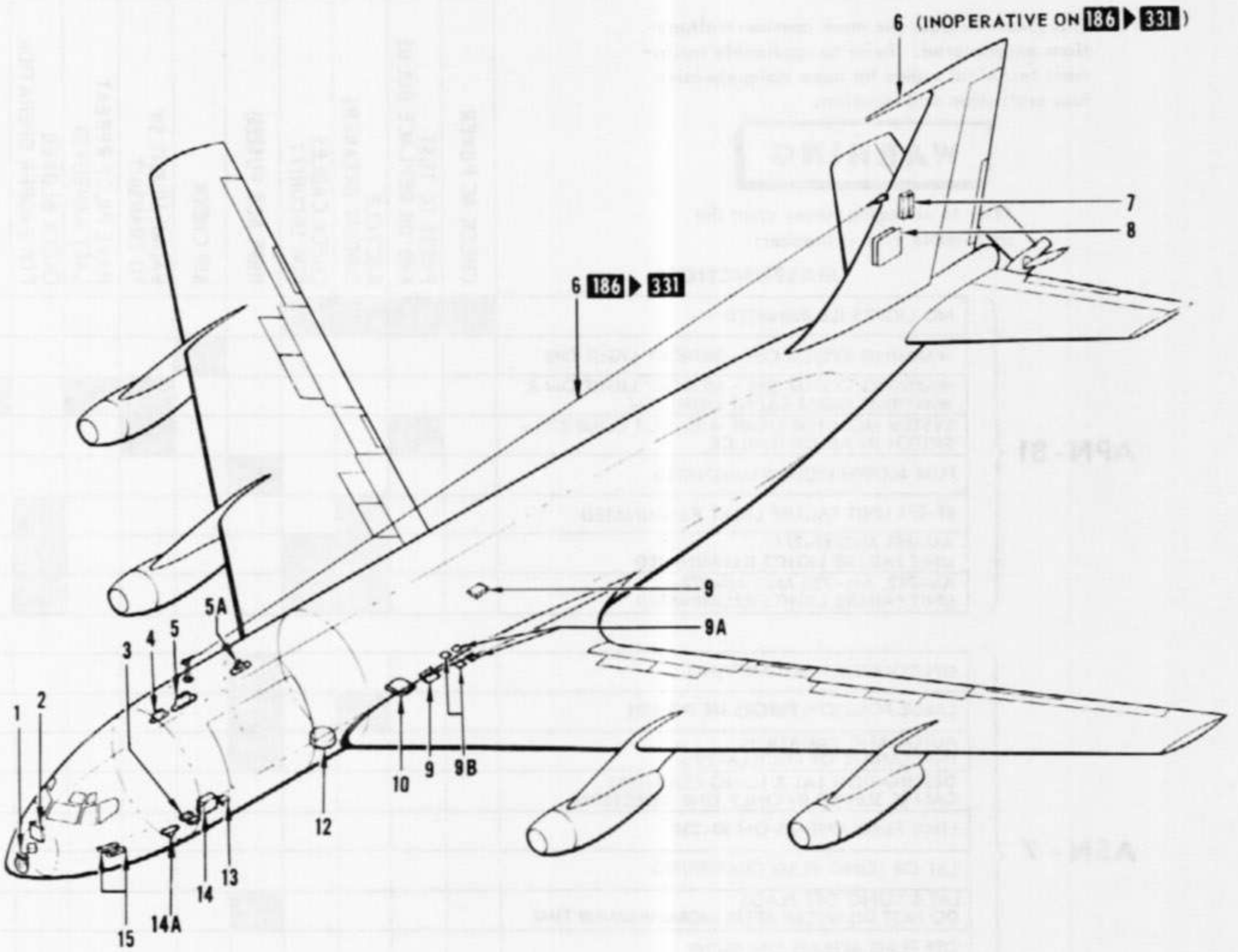
CAUTION

In the event an overheat condition (blower failure) of the electronic equipment exists, as determined by illumination of the electronic cabinet overheat warning light, serious damage to the equipment may occur. If this condition exists, the sets in question should be immediately turned OFF. Emergency cooling may be obtained by removing the cabinet doors. During this condition only critically needed electronic equipment should be operated.

INTEGRATED DUAL FLIGHT DIRECTOR/ ROTATION GO-AROUND SYSTEM

The integrated dual flight director/rotation go-around (FD/RGA) system (figure 4-30A) consists of a dual flight director subsystem, dual angle of attack rotation go-around subsystem, comparator warning monitor and attitude system warning monitor. The dual flight director systems, in conjunction with vertical gyros, VOR/LOC, TACAN and glide slope receivers and compass systems, provide the pilot and copilot with a display of airplane attitude, heading and position. The system also provides a visual display of steering commands which the pilot follows to attain and hold any desired attitude, altitude, heading and

ANTENNA LOCATIONS (TYPICAL)



1 SEARCH RADAR
2 GLIDE SLOPE RECEIVER
3 AFT HIGH RANGE RADIO ALTIMETER
4 TACAN (TOP)
5 RENDEZVOUS BEACON 346 ▶
5A IFF (TOP)
6 LIAISON RADIO (2 PLACES)
7 RADAR BEACON
8 VOR/ILS (VHF-NAV) RADIO
9 UHF COMMAND RADIO (2 PLACES)
9A LOW RANGE RADIO ALTIMETER (AFT)
9B LOW RANGE RADIO ALTIMETER (FORWARD)
10 MARKER BEACON
11 DELETED
12 UHF-ADF
13 TACAN (BOTTOM)
14 RADAR NAVIGATION
14A IFF (BOTTOM)
15 FORWARD HIGH RANGE RADIO ALTIMETER

Figure 4-29

NAVIGATION EQUIPMENT MALFUNCTION CHART

NOTE

This chart includes the more common malfunctions encountered. Refer to applicable equipment technical orders for more comprehensive fuse protection and location.

WARNING

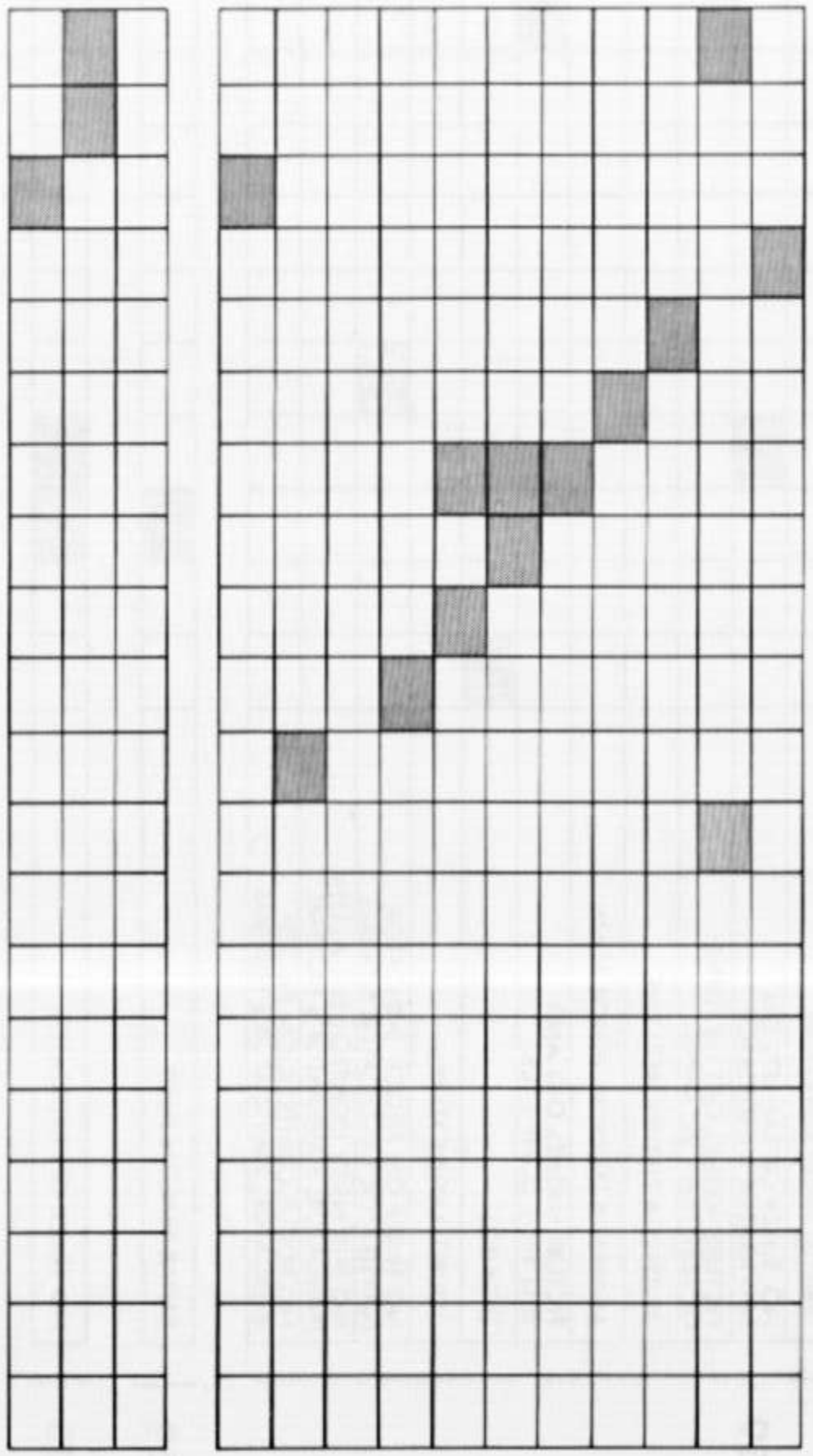
Prior to changing fuses, open the applicable circuit breakers.

	MALFUNCTION	ACTION: CHECK AC POWER	PRESS TO TEST AND/OR REPLACE BULBS	RECYCLE CIRCUIT BREAKERS	CHECK CABLES FOR SECURITY	REPLACE FUSE(S)	AIR CHECK	RADAR SILENT SW TO TRANSMIT	HAVE PILOT REPEAT LAST MANEUVER	CHECK BLOWER FOR PROPER OPERATION	TURN POWER SW OFF & ON
APN-81	NO LIGHTS ILLUMINATED	■	■	■	■						
	WARNING SYSTEM ON - MEMORY LIGHT ON						■				
	WARNING SYSTEM ON - MEMORY LIGHT ON & WARNING RADAR SILENT LIGHT ON							■	■		■
	SYSTEM MONITOR LIGHT WILL NOT COME ON - SWITCH IN AIR OR GND CK		■					■			
	FUSE BLOWN LIGHT ILLUMINATED					■					
	RT-274 UNIT FAILURE LIGHT ILLUMINATED			■						■	
	AM-758 AND RT-274 UNIT FAILURE LIGHTS ILLUMINATED			■	■					■	
	AM-742, AM-758 AND AM-274 UNIT FAILURE LIGHTS ILLUMINATED			■	■					■	
ASN-7	GPI COUNTERS NOT MOVING					ITEMS 18, 49					
	LARGE POSITION ERRORS IN THE GPI			■		ITEM 10					
	AUTOMATIC VARIATION INACCURATE OR OSCILLATING					ITEM 47					
	DESTINATION LAT & LONG COUNTERS CAN BE SLEWED IN ONLY ONE DIRECTION										
	LIMIT FLAG APPEARS ON ID-390										
	LAT OR LONG FLAG CHATTERING										
	LAT & LONG OFF FLAGS DO NOT DISAPPEAR AFTER NORM WARMUP TIME					ITEM 18					
	OFF FLAG APPEARS ON ID-390										
	ID-390 COMPASS CARD WILL NOT ROTATE AS N-1 COMPASS ROTATES					ITEM 46					
	IP CORR BUTTON INOPERATIVE										
	ABOVE ACTIONS DO NOT CORRECT PROBLEM(S)										
ASN-6	GPI COUNTERS NOT MOVING			■		ITEM 18					
	LARGE POSITION ERRORS IN GPI			■		ITEM 10					
	ABOVE ACTIONS DO NOT CORRECT PROBLEM(S)										

NOTE

References to items in the chart correlate with the information contained in figure 4-29B.

Figure 4-29A (Sheet 1 of 4)



CHECK FOR CORRECT VARIATION
COMPARE READOUT DIALS CP-188
SWITCH TO APN-81 ONLY MODE
POSITION DISPLAY SW TO PP
SET VARIATION MANUALLY
SLEW DEST LAT IN OPPOSITE DIRECTION
SLEW PP TOWARD DEST UNTIL FLAG DISAPPEARS
POSITION DEST SW TO STOR POS
DECREASE PP OR DEST LAT UNTIL MEAN LAT IS LESS 70°
PLACE MODE SELECTOR SW TO STBY OR RUN
FLY TOWARD OR SLEW PP UNTIL DIST IS LESS THAN 99
COMPARE READOUT DIALS ON CP-221
CHANGE BEARING SW TO REL
CHANGE RANGE SETTING
MOVE STAB. SW TO DOWN POSITION
ROTATE RANGE 3/30 CONT CCW
TURN RANGE DELAY SW OFF
USE 240/30 AND BEACON FUNCTION
NO CORR ACTION POSSIBLE
USE SECTOR SCAN

Figure 4-29A (Sheet 2 of 4)

NAVIGATION EQUIPMENT MALFUNCTION CHART (CONT)

WARNING

Prior to changing fuses, pull the applicable circuit breakers.

	MALFUNCTION	ACTION: CHECK AC POWER	PRESS TO TEST AND/OR REPLACE BULBS	RECYCLE CIRCUIT BREAKERS	CHECK CABLES FOR SECURITY	REPLACE FUSE(S)	AIR CHECK	RADAR SILENT SW TO TRANSMIT	HAVE PILOT REPEAT LAST MANEUVER	CHECK BLOWER FOR PROPER OPERATION	TURN POWER SW OFF & ON
APN-59	NO POWER TO APN-59	■		■							
	TESTMETER GIVES NO READING IN LINE POSITION	■		■							
	TESTMETER BELOW NORMAL IN LINE, FLUCTUATES IN MAG	■									
	NO SWEEP, TESTMETER READS NORMAL				■	F-101 F-104					
	NO SWEEP, TESTMETER READS NORMAL IN LINE, HAS PULSATING CRYSTAL CURRENT				■	F-103					
	NO SWEEP, TESTMETER INDICATES IN LINE POSITION ONLY				■	F-102					
	NO SWEEP, NO TESTMETER READINGS				■	F-105					
	NO SWEEP, TESTMETER NORMAL										
	ERRATIC SWEEP ROTATION										
	NO SWEEP OR TARGETS ON NAVIGATOR'S INDICATOR				■						
	PICTURE WASHES OUT IN TURNS OF LESS THAN 30° BANK										
	ANTENNA TILT INOPERATIVE										
	ANTENNA STUCK IN PENCIL BEAM										
	PICTURE WASHES OUT AND WILL NOT COME BACK										■
	SPOKING	■									
	DOUBLE RANGE MARKS										
	NO SWEEP ON PILOTS' INDICATOR, NAVIGATOR'S INDICATOR NORMAL					F-2001 F-2002					
	NO INTENSITY CONTROL ON PILOTS' INDICATOR, NAVIGATOR'S NORMAL										
	NO FOCUS CONTROL ON PILOTS' INDICATOR, NAVIGATOR'S NORMAL										
APN-69	RADAR BEACON INOP			■							
APN-133	NO TRACE ON INDICATOR			■	■						
ASQ-15	RADAR PRESSURIZATION INOPERATIVE			■							
SCR-718	NO TRACE ON INDICATOR			■	■	■					

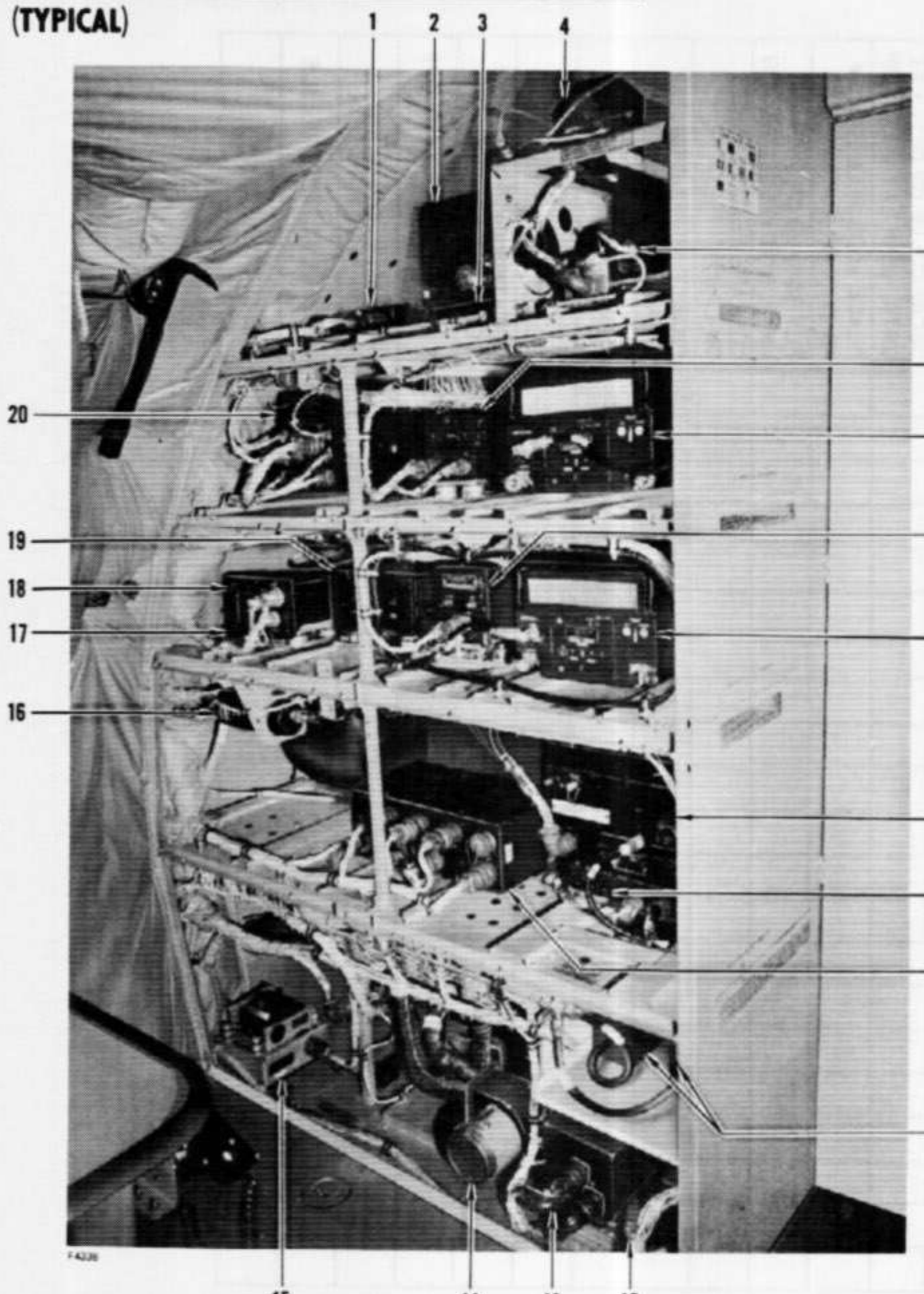
Figure 4-29A (Sheet 3 of 4)

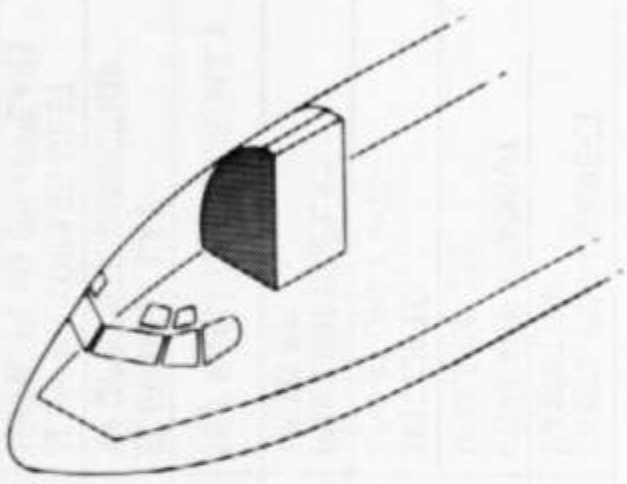
	CHECK FOR CORRECT VARIATION
	COMPARE READOUT DIALS CP-188
	SWITCH TO APN-81 ONLY MODE
	POSITION DISPLAY SW TO PP
	SET VARIATION MANUALLY
	SLEW DEST LAT IN OPPOSITE DIRECTION
	SLEW PP TOWARD DEST UNTIL FLAG DISAPPEARS
	POSITION DEST SW TO STOR POS
	DECREASE PP OR DEST LAT UNTIL MEAN LAT IS LESS 70°
	PLACE MODE SELECTOR SW TO STBY OR RUN
	FLY TOWARD OR SLEW PP UNTIL DIST IS LESS THAN 99
	COMPARE READOUT DIALS ON CP-221
	CHANGE BEARING SW TO REL
	CHANGE RANGE SETTING
	MOVE STAB. SW TO DOWN POSITION
	ROTATE RANGE 3/30 CONT CCW
	TURN RANGE DELAY SW OFF
	USE 240/30 AND BEACON FUNCTION
	NO CORR ACTION POSSIBLE
	USE SECTOR SCAN

Figure 4-29A (Sheet 4 of 4)

ELECTRONIC CABINET EQUIPMENT

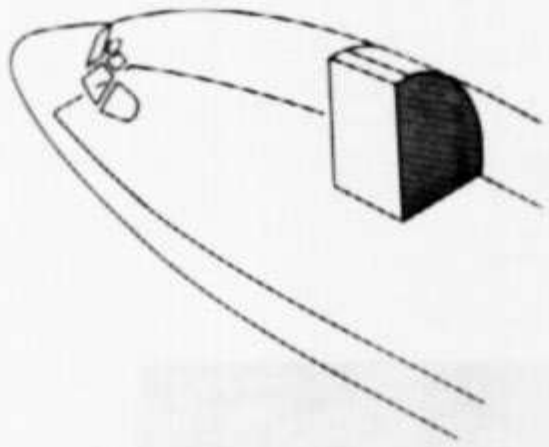
(TYPICAL)

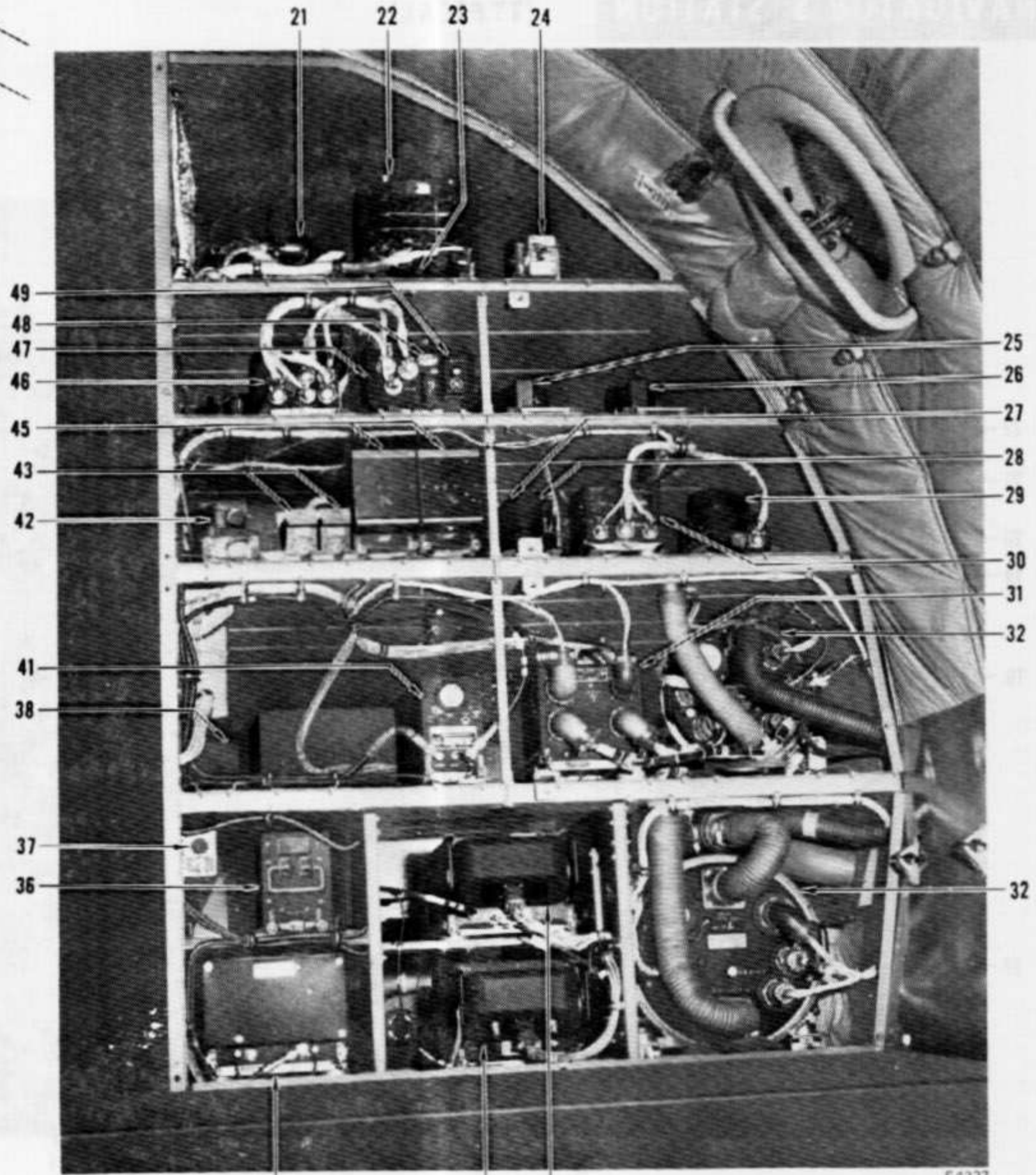




1 AUTOPILOT TRIM COUPLER AMPLIFIER
2 AUTOPILOT DUAL CHANNEL COUPLER
3 COUPLER FUSES (1 ACTIVE, 1 SPARE)
4 AUTOPILOT MACH CONTROL
5 AUTOPILOT ALTITUDE CONTROL
6 N-1 COMPASS ME-1 AMPLIFIER
7 COMMAND RADIO (AN/ARC-34) RECEIVER-TRANSMITTER (2 PLACES)
8 ELECTRONIC CONTROL AMPLIFIER, AM-608/ARA-25
9 IFF TRANSPONDER (AN/APX 64)
10 TRANSPONDER CIRCUIT BREAKERS
11 RADAR NAVIGATION JUNCTION BOX, AN/APN-81
11A FLIGHT DIRECTOR ALTITUDE CONTROLLER
12 SEARCH RADAR AMPLIFIER, AN/APN-59
13 RADAR NAVIGATION AMPLIFIER, AN/APN-81
14 LIAISON RADIO BLOWER
15 VERTICAL GYRO CONTROL, AN/APN-81
16 RADAR NAVIGATION TRUE AIRSPEED COMPUTER
17 RADAR NAVIGATION PRESENT POSITION COMPUTER AMPLIFIER
18 AMPLIFIER FUSES (2 ACTIVE, 2 SPARE)
19 RADAR NAVIGATION PRESENT POSITION COMPUTER
20 N-1 COMPASS AMPLIFIER

***Figure 4-29B** (Sheet 1 of 2)*





21 AUTOPILOT VERTICAL GYRO
22 AUTOPILOT MAIN AMPLIFIER
23 AMPLIFIER FUSES (1 ACTIVE, 1 SPARE)
24 AUTOPILOT TEST RECEPTACLE
25 PILOT'S ATTITUDE GYRO
26 COPILOT'S ATTITUDE GYRO
27 N-1 COMPASS SLAVING CONTROL (BEHIND J-4)
28 J-4 COMPASS SLAVING CONTROL
29 J-4 COMPASS GYRO
30 J-4 COMPASS AMPLIFIER
31 RADAR NAVIGATION COMPUTER
32 RADAR NAVIGATION AMPLIFIER (2 PLACES)
33 LIAISON RADIO TRANSMITTER
34 LIAISON RADIO RECEIVER
35 TACAN RECEIVER-TRANSMITTER
36 TACAN COUPLER
37 TEST EQUIPMENT POWER RECEPTACLE
38 FD-109 RATE GYRO (2)
39 (DELETED)
40 (DELETED)
41 LIAISON COUPLER CONTROL AN/ARC-58
42 MARKER BEACON AN/ARN-32
43 GLIDE SLOPE RECEIVER 51V-4A
44 (DELETED)
45 VHF-NAV RECEIVER 51R6
46 DESTINATION COMPUTER AN/ASN-7
47 MAGNETIC VARIATION COMPUTER AN/ASN-7 (2 ACTIVE AND 2 SPARE FUSES) (BEHIND AMPLIFIER)
48 DESTINATION AMPLIFIER AN/ASN-7
49 AMPLIFIER FUSES (3 ACTIVE, 3 SPARE)

***Figure 4-29B** (Sheet 2 of 2)*

NAVIGATOR'S STATION (TYPICAL)



1 NAVIGATOR'S STOWAGE CABINET
2 NAVIGATOR'S LIGHT SHIELD
3 NAVIGATOR'S LIAISON RADIO CONTROL PANEL (SEE FIGURE 4-17)
4 NAVIGATOR'S INSTRUMENT PANEL (SEE FIGURE 4-43)
5 NAVIGATOR'S LIGHT CONTROL PANEL
6 NAVIGATOR'S RADAR CONTROL CONSOLE (SEE FIGURE 4-24)
7 CUP DISPENSER
8 HOT CUPS (2 PLACES)
9 PERISCOPIC SEXTANT STOWAGE CABINET
10 NAVIGATOR'S OXYGEN HOSE
11 NAVIGATOR'S TABLE
12 MAP BIN
13 ASH TRAY
14 SEARCH RADAR INDICATOR (SEE FIGURE 4-20)
15 NAVIGATOR'S INTERPHONE CONTROL PANEL (SEE FIGURE 4-14)
16 NAVIGATOR'S TABLE DRAWER
17 NAVIGATOR'S SEAT (SEE FIGURE 4-80)
18 HIGH RANGE RADIO ALTIMETER (SEE FIGURE 4-26)
19 NAVIGATOR'S OXYGEN REGULATOR PANEL (SEE FIGURE 4-37)
20 NAVIGATOR'S FORWARD CONTROL CONSOLE
21 LOUDSPEAKER (SEE FIGURE 4-14)
22 BLACKOUT CURTAIN

F-214

Figure 4-30

course in all phases of instrument flight. For approaches, two radio altimeter systems are installed to provide information for height above the ground and, if a radio altimeter approach altitude is published, may be used as the primary indication for decision height. The dual rotation go-around system provides wings level and pitch commands for takeoff, initial climb, and go-around phases of flight. The angle-of-attack indications are provided for all phases of flight and a speed deviation indication is provided for approaches. Operating power of 115 volt AC and 28 volt DC is supplied to the integrated dual flight director/rotation go-around system through circuit breakers on the FD-109/RGA equipment rack (figure 4-30B).

FD MASTER POWER SWITCHES (With TCTO 879)

Two toggle switches (4A and 4B, figure 4-30B) are located on the forward side of the FD-109/RGA equipment rack. The switches are marked FD NO. 1 MASTER and FD NO. 2 MASTER and control the application of power to the pilot's and copilot's FD -109/RGA systems, respectively.

FD-109/RGA POWER-OFF LIGHTS (With TCTO 879)

Two lights (21A, figure 1-18 and 11A, figure 1-19) are located one each on the pilot's and copilot's flight instrument panels. Each light will illuminate when the FD master power switch for the respective FD-109/RGA system is turned to OFF position.

NOTE

The copilots FD-109/RGA power-off light will not press-to-test unless the copilots flight and side panel rheostat is out of the full OFF position. Brightness of this light (press-to-test function only) is controlled by this rheostat. The normal warning function is not affected by this rheostat.

FLIGHT DIRECTOR SYSTEM

Two independent flight director systems are installed. Only one system is described in the succeeding paragraphs and differences in system equipment are noted. The flight director system consists of the following primary equipment: attitude director indicator, horizontal situation indicator, flight director controls, roll computer, pitch computer, altitude controller, instrument amplifier, TACAN coupler, and warning monitor circuits. Annunciators on the flight instrument panel display the mode of operation selected. Inputs from systems external to the flight director system are provided from VOR/LOC, TACAN and glide slope receiver systems, N-1 or J-4 compass system, low range radio altimeter system, rotation go-around system and vertical gyro. The N-1 compass system provides heading reference for the pilot's flight director system and the J-4 compass system provides heading reference for the copilot's flight director system. See figure 4-18A for radio navigation data flow.

Attitude Director Indicator (ADI)

The attitude director indicator (ADI) displays airplane attitude and command information by means of a symbolic, three-dimensional, forward view display. Airplane attitude is displayed by the relationship of a stationary delta-shaped airplane symbol relative to the movable attitude tape. The attitude tape is colored blue above the white horizon line and black below the horizon line to represent the sky and ground, respectively. White lines representing degrees of pitch attitude are shown on the attitude tape. The tape moves to give 360 degrees of roll presentation and provides pitch indication from 90 degrees up to 90 degrees down. The pitch tape degree scale is expanded to provide a clearly visible pitch presentation.

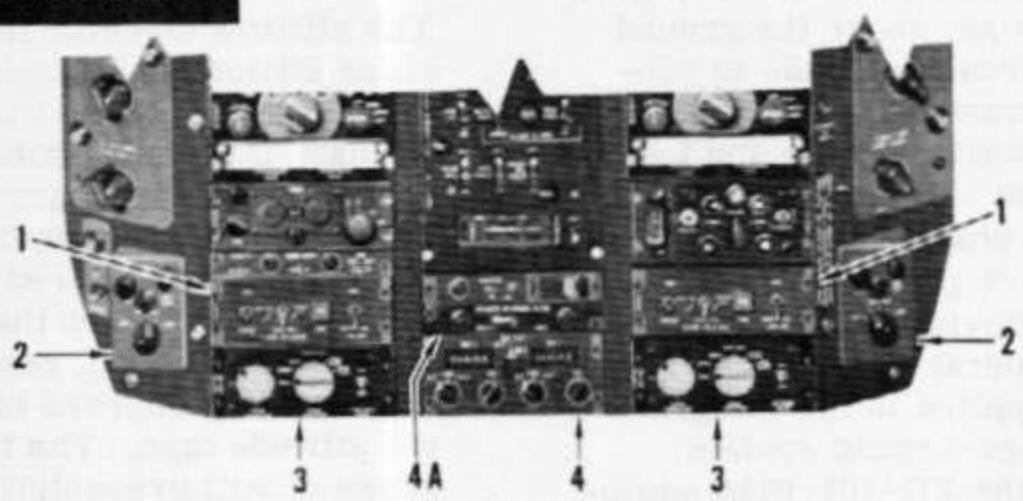
NOTE

- While airborne the pitch attitude tape is subject to pitch error resulting from acceleration and deceleration. When the airplane is flying in a level attitude, the error will temporarily appear as a climb indication after a period of forward acceleration and as a dive indication after a period of deceleration. On the ground during takeoff (weight on wheels), this error is reduced by a pitch erection cutout circuit.

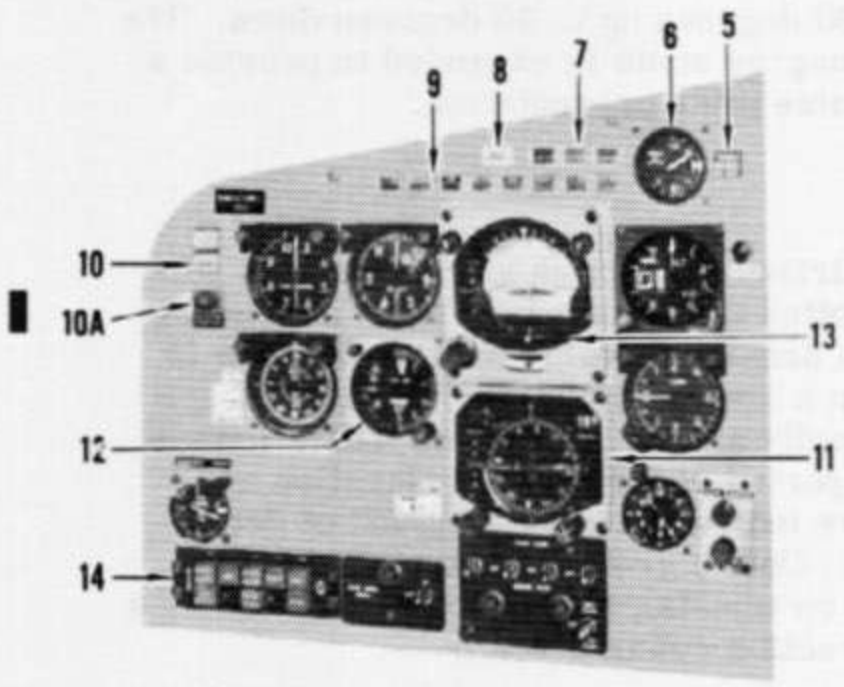
- The pitch erection cutout circuit is installed for each vertical gyro. This circuit operates only during takeoff roll and decreases gyro error during takeoff acceleration to approximately 1/2 degrees or less. The pitch erection circuits are cut out when number three throttle is advanced for takeoff and reconnected after liftoff through weight-on-wheels switching.

Bank indices on the attitude director indicator show 10, 20, 30, 45 and 60 degrees right and left bank attitudes. Computed pitch and roll commands are displayed by the command bars. The command bars move up or down and roll right or left to command changes required in airplane pitch and/or bank to attain the desired attitude for the mode selected. When the delta-shaped airplane symbol is aligned with the command bars the command has been satisfied. Pitch commands displayed by the command bars are: manual pitch, altitude hold, glide slope, and rotation go-around (RGA) system commands. The RGA system commands are: takeoff rotation, initial climb, and go-around. Bank commands are: heading hold, VOR or TACAN course tracking, and localizer beam tracking. Refer to figure 4-30C for description and function of controls and indicators on the attitude director indicator.

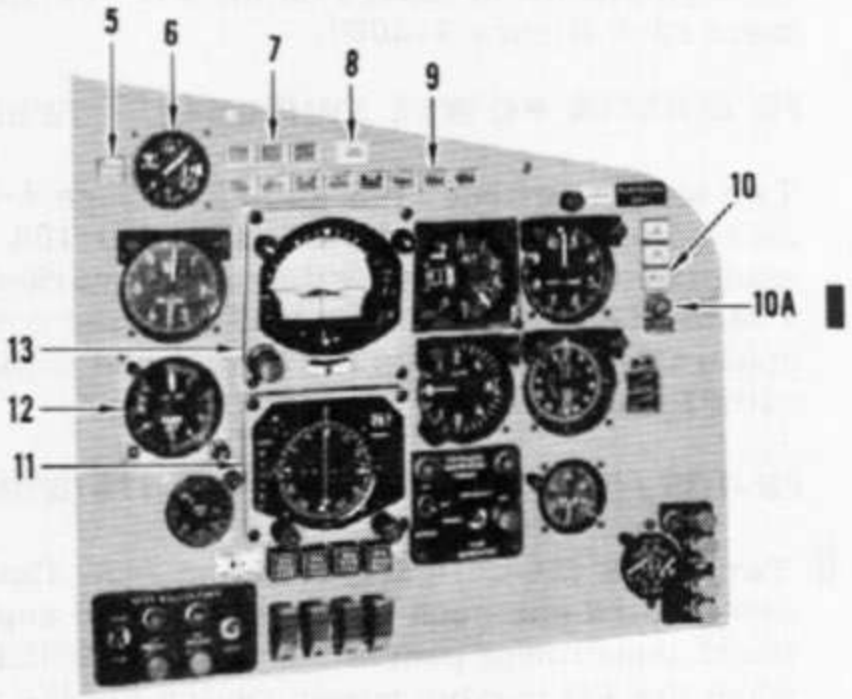
FD/RGA EQUIPMENT LOCATION



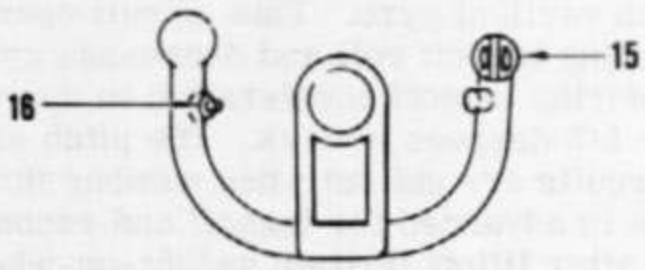
OVERHEAD PANEL



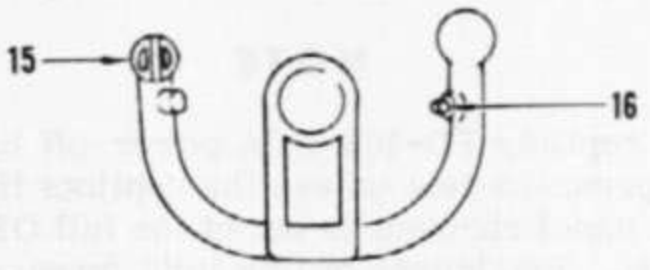
PILOT'S FLIGHT INSTRUMENT PANEL



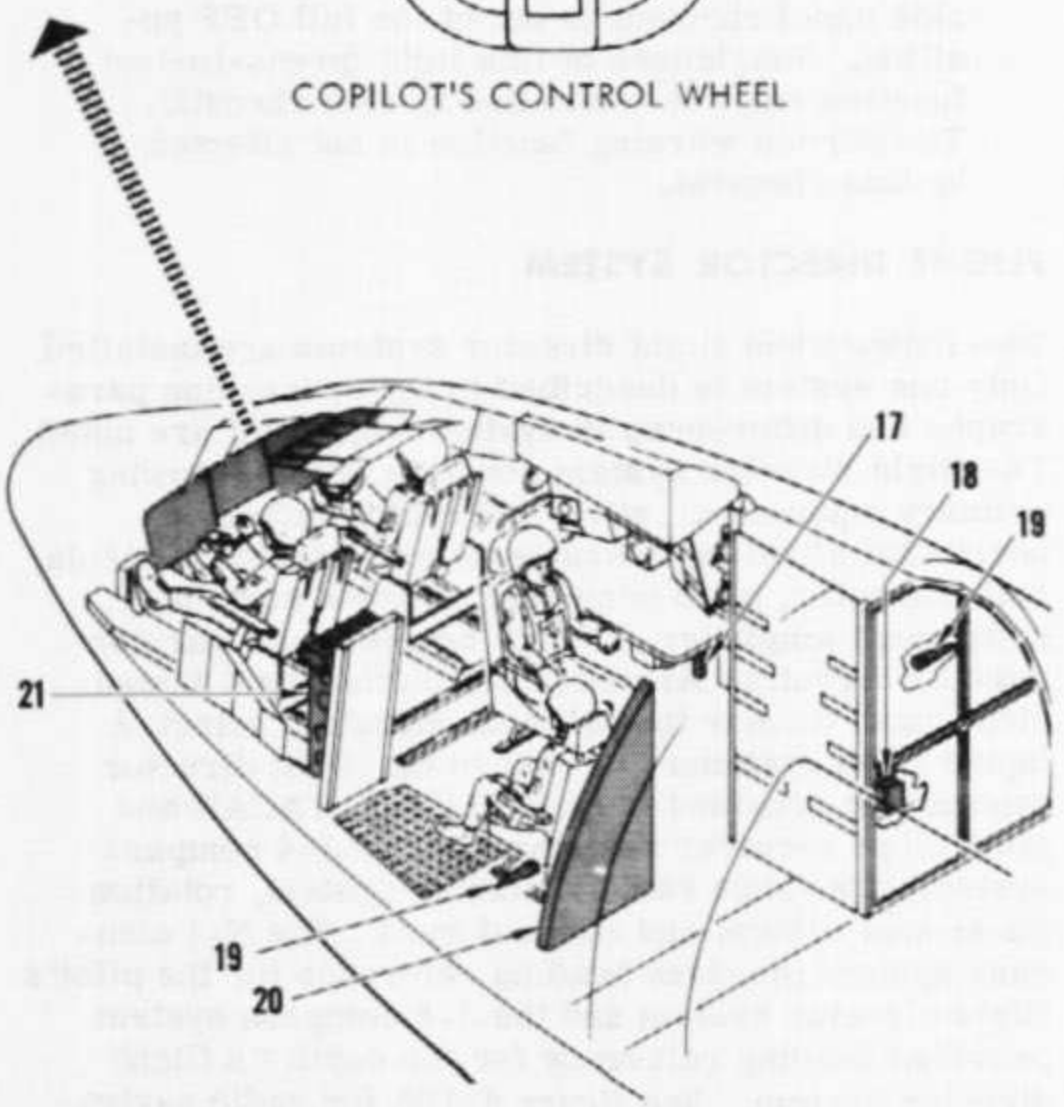
COPILOT'S FLIGHT INSTRUMENT PANEL



PILOT'S CONTROL WHEEL



COPILOT'S CONTROL WHEEL

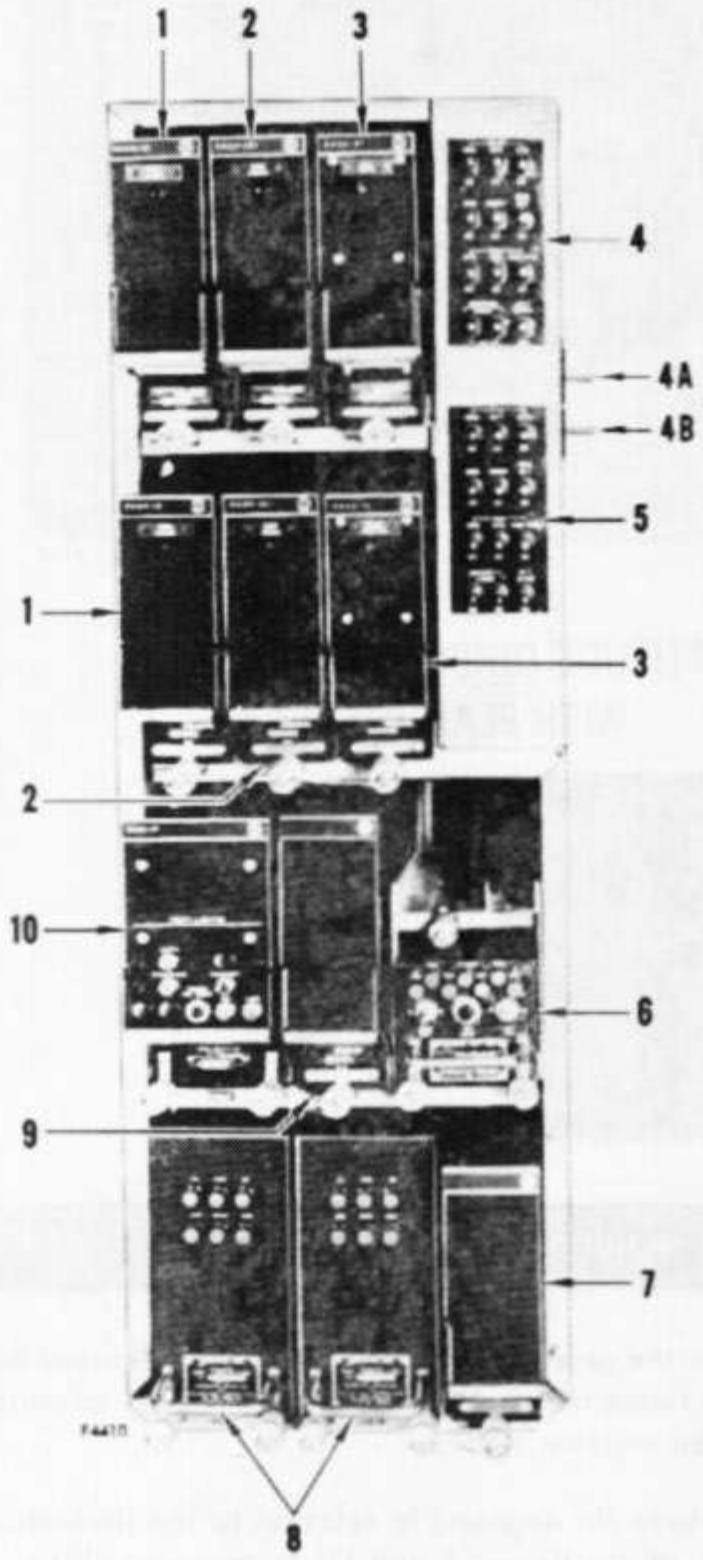


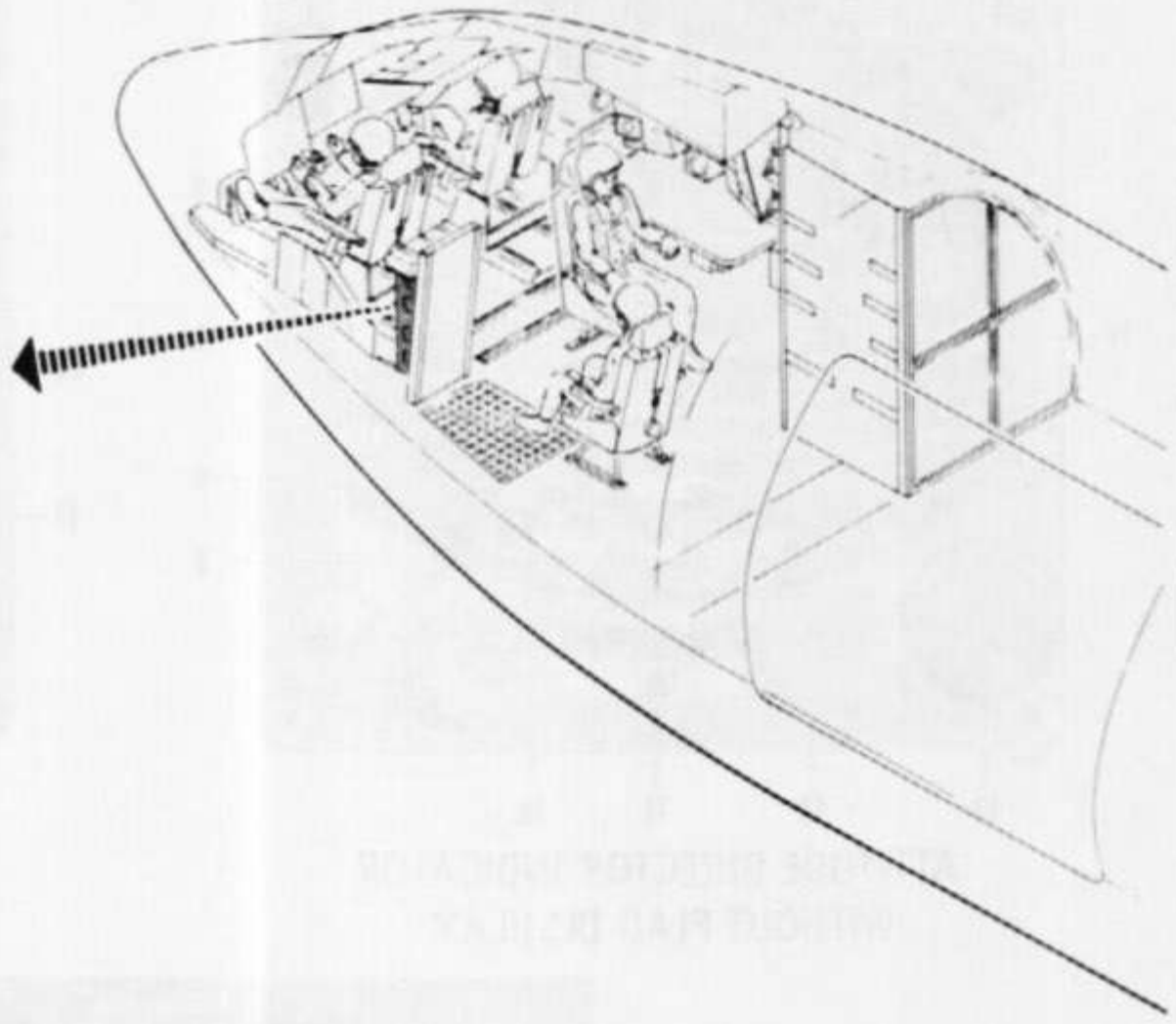
1 RGA CONTROL PANEL (2 PLACES)
2 FLIGHT DIRECTOR ANNUNCIATOR DIMMER CONTROL PANEL (2 PLACES)
3 FLIGHT DIRECTOR CONTROL PANEL (2 PLACES)
4 VHF NAVIGATION CONTROL PANEL
4A DUAL REMOTE HEADING SLEW SWITCH
5 TACAN SELECT SWITCH (2 PLACES)
6 ANGLE OF ATTACK INDICATOR (2 PLACES)
7 ATTITUDE WARNING INDICATORS (2 PLACES)
8 COMPARATOR WARNING SWITCH/INDICATOR (2 PLACES)
9 FD/RGA SYSTEM ANNUNCIATORS (2 PLACES)
10 RGA FAIL OPERATIVE LIGHT (2 PLACES)
10A FD-109/RGA POWER-OFF LIGHT (WITH IC10 8179)
11 HORIZONTAL SITUATION INDICATOR (2 PLACES)
12 LOW RANGE RADIO ALTIMETER (2 PLACES)
13 ATTITUDE DIRECTOR INDICATOR (2 PLACES)
14 COMPARATOR WARNING MONITOR PANEL
15 HEADING SLEW CONTROL (2 PLACES)
16 RGA/AP PUSHBUTTON SWITCH (2 PLACES)
17 COPILOT'S INSTRUMENT POWER PANEL
18 TACAN COUPLER
19 ANGLE OF ATTACK TRANSMITTER PROBES (2 PLACES)
20 MAIN CIRCUIT BREAKER PANEL
21 FD-109/RGA EQUIPMENT RACK

Figure 4-30A

FD-109/RGA EQUIPMENT RACK

(COVERS REMOVED)

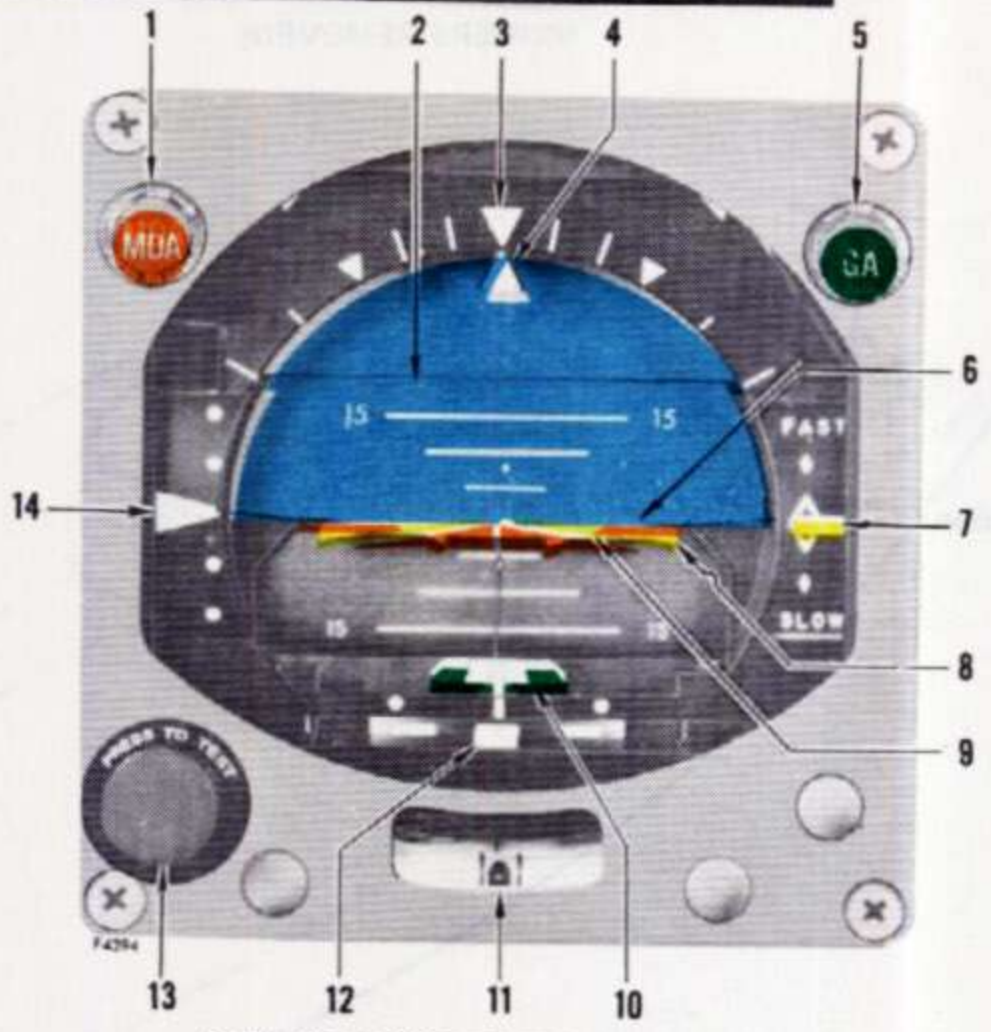




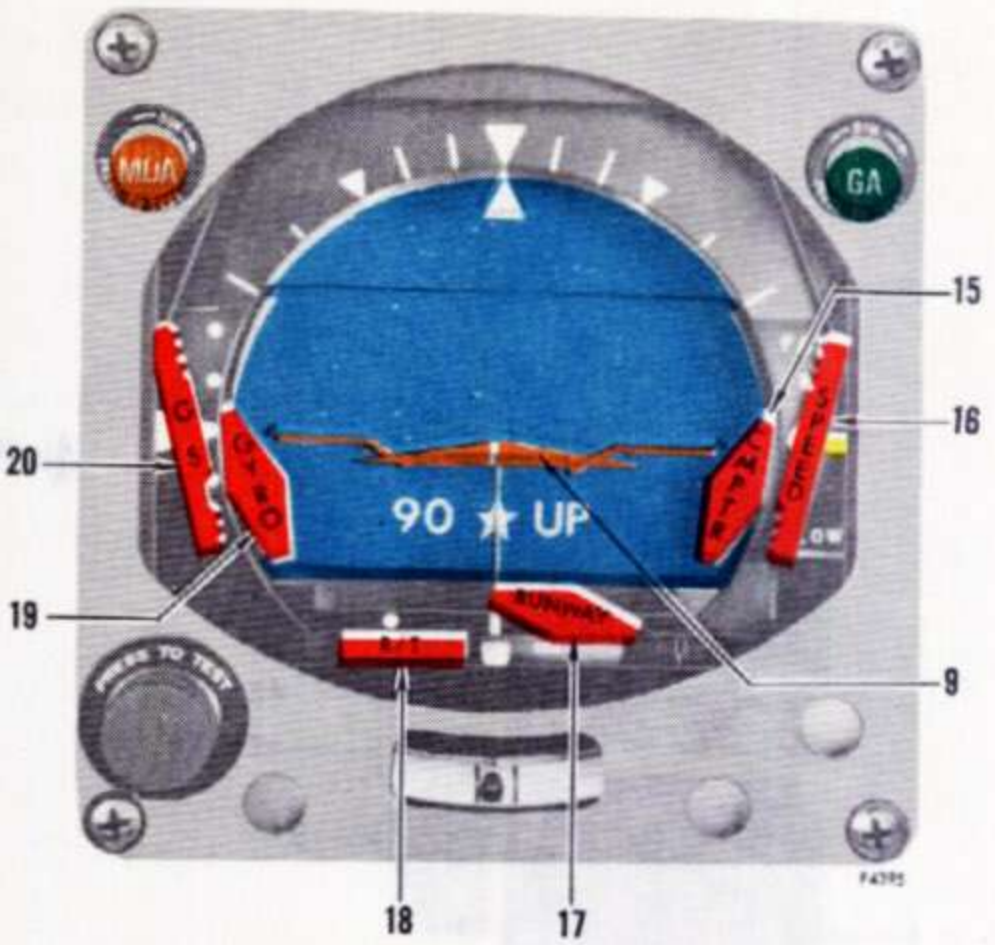
1 ROLL COMPUTER 562R-1E (2 PLACES)
2 PITCH COMPUTER 562P-1E1 (2 PLACES)
3 INSTRUMENT AMPLIFIER 344C-1K (2 PLACES)
4 PILOT'S FD/RGA CIRCUIT BREAKER PANEL
4A FD NO. 2 MASTER POWER SWITCH (WITH TLTO 879)
4B FD NO. 1 MASTER POWER SWITCH (WITH TCTO 879)
5 COPILOT'S FD/RGA CIRCUIT BREAKER PANEL
6 RGA INTERFACE UNIT 599K-1
7 REMOTE SLEW COUPLER 161E-7B
8 RGA COMPUTERS
9 MAJORITY LOGIC ATTITUDE COMPARATOR 54W-4
10 WARNING MONITOR 54W-1F

Figure 4-30B

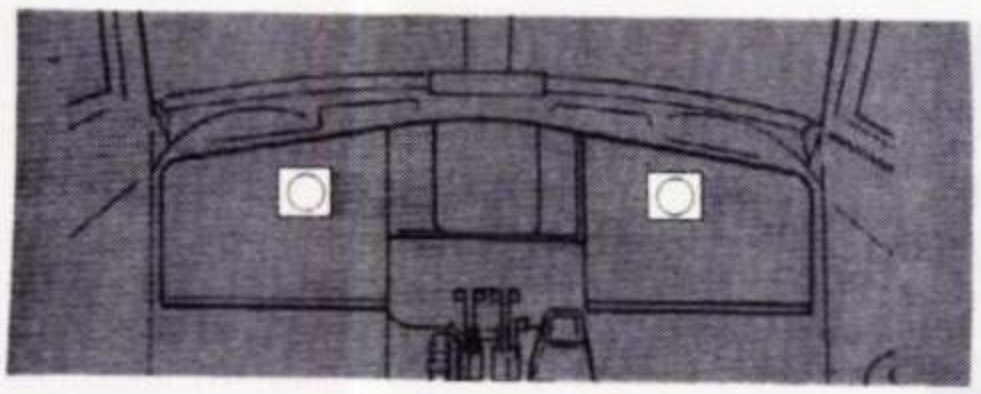
ATTITUDE DIRECTOR INDICATOR



ATTITUDE DIRECTOR INDICATOR
WITHOUT FLAG DISPLAY



ATTITUDE DIRECTOR INDICATOR
WITH FLAG DISPLAY



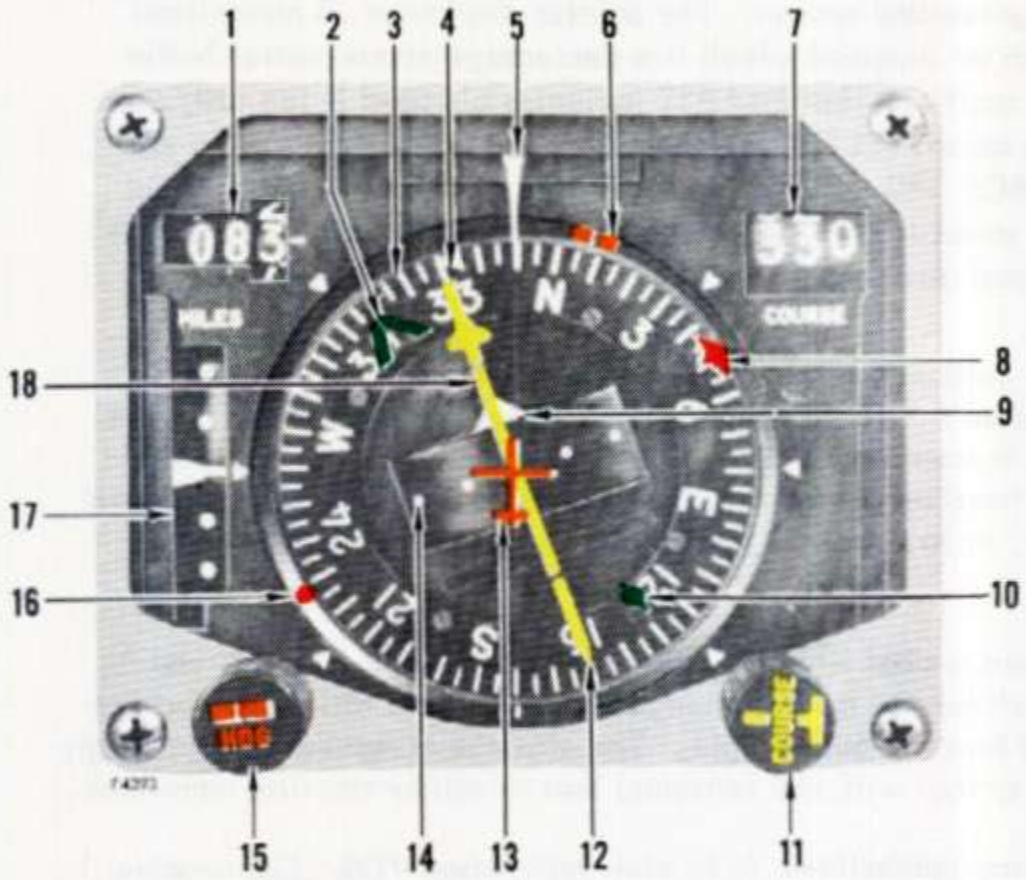
CONTROL/INDICATOR		FUNCTION
1	MDA (MINIMUM DECISION ALTITUDE) INDICATOR	Lights when the airplane reaches the preset minimum altitude (as selected by MDA index control knob on low range radio altimeter (figure 4-25), at which the landing or go-around decision must be made.
2	PITCH TAPE	Indicates the airplane pitch attitude (in degrees) in relation to the horizon. Pitch tape is marked as follows: White line at 5 and 10 degrees up; white dot at 8 degrees up; white line and number at 15 degrees up; number and the word UP at 30 UP, 50 UP, 70 UP and 90 UP; white line at 5, 10 and 20 degrees down; white line and number at 15 degrees down; white line, number and word DOWN at 30 DOWN, 50 DOWN, 70 DOWN and 90 DOWN.
3	ROLL SCALE	Reference scale to measure the airplane bank attitude (through 360 degrees). The scale is marked at 10, 20, 30, 45 and 60 degree increments.
4	BANK INDICATOR	Indicates on the roll scale the degree of airplane bank angle.
5	GA (GO-AROUND) INDICATOR	Lights when the system is in the RGA go-around mode.
6	HORIZON BAR	Represents the earth horizon.

Figure 4-30C (Sheet 1 of 2)

	CONTROL/INDICATOR	FUNCTION
7	SPEED DEVIATION POINTER	Indicates airplane airspeed deviation from the desired approach speed computed by rotation go-around system. The pointer displays a .6 normalized AOA and commands an airspeed which is a percentage above initial buffet depending on flap position. Bar on FAST indicates airspeed is too fast; correct by decreasing speed. SLOW indicates airspeed is too slow. Is in view only when APPROACH SPD DEV switch (4, figure 4-30J) on the rotational go-around control panel is ON. Operates independently from ADI attitude and steering command display.
8	COMMAND BARS	Displays computed bank and pitch steering commands based on the mode of operations selected on the flight director control panel (figure 4-30E). The command bars roll to command a right or left bank for capturing and maintaining a selected heading or radio course; and move up or down to command a climb or descent, or to command corrections to hold altitude or track a glideslope beam.
9	AIRPLANE SYMBOL AND ATTITUDE REFERENCE BARS (2 PLACES)	A fixed delta-shaped symbol which represents the airplane. The attitude reference bars which extend from the symbol provide basic attitude reference when the command bars are out of sight. The airplane is maneuvered to snugly align the airplane symbol with the command bars to satisfy steering commands.
10	RUNWAY SYMBOL	Represents the runway centerline. Is in view only when VOR/LOC receiver is tuned to a localizer frequency. Moves laterally to indicate deviation from the localizer beam and, at 200 feet to zero, moves vertically to indicate radio altitude above the terrain. The lateral deviation scale represents an expanded portion of the horizontal situation indicator course deviation scale. The single dots to left and right of symbol represent approximately 1-1/4 degrees of displacement to left or right respectively, of localizer beam. Vertical movement of runway symbol is controlled by radio altimeter system.
11	SLIP INDICATOR	Indicates airplane slip or skid.
12	RATE-OF-TURN INDICATOR	Displays rate of turn of the airplane about the yaw axis. Single needle-width displacement shows a 1-1/2 degree per second rate of turn. Double needle-width displacement (needle aligned with bar) shows a standard 3 degree per second rate of turn.
13	PRESS TO TEST BUTTON	When pressed will cause the attitude display to indicate a right climbing turn of approximately 10 degrees climb and approximately 20 degrees right bank. GYRO and CMPTR flags will appear and command bars will move up out of view.
14	GLIDE SLOPE POINTER	Indicates the degree of vertical displacement from the glide slope beam. Pointer is in view only when VOR/LOC receiver is tuned to a localizer frequency. Dots on scale represent approximately 1/4 degree and 1/2 degree displacement above or below glide slope beam center.
15	CMPTR (COMPUTER) FLAG	Indicates the command bars display is not reliable. Except for power failure command bars will move up out of view when flag appears.
16	SPEED FLAG	Indicates the speed deviation pointer display is not reliable. Turning APPROACH SPD DEV switch off will remove speed flag and deviation pointer from view.
17	RUNWAY FLAG	Indicates the runway symbol display is not reliable.
18	R/T (RATE-OF-TURN) FLAG	Indicates the rate-of-turn display is not reliable.
19	GYRO FLAG	Indicates a failure in the vertical gyro or attitude circuits.
20	GS (GLIDE SLOPE) FLAG	Indicates glide slope pointer is not reliable. Appears on loss of glide slope signal or glide slope receiver malfunction. Out of view when VOR/LOC receiver is tuned to a VOR frequency.

Figure 4-30C (Sheet 2 of 2)

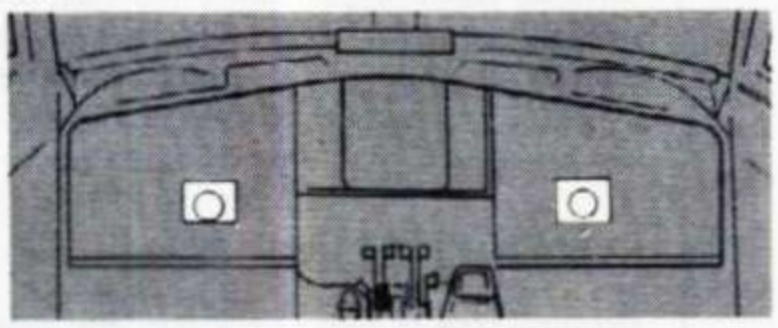
HORIZONTAL SITUATION INDICATOR



HORIZONTAL SITUATION INDICATOR
WITHOUT FLAG DISPLAY



HORIZONTAL SITUATION INDICATOR
WITH FLAG DISPLAY



CONTROL/INDICATOR	FUNCTION
1. RANGE COUNTER	Digital readout of TACAN slant range in nautical miles graduated in 1/2 mile increments through use of the marks between the miles digits. Distance is available in either VOR or TACAN operation.
2. NO. 2 BEARING POINTER (HEAD)	Indicates bearing to tuned radio navigation station (See figure 4-18A.)
3. AZIMUTH CARD	Compass information (pilot, N-1; copilot, J-4).
4. COURSE ARROW (HEAD)	Set to a magnetic heading corresponding to a desired VOR, TACAN or localizer course by rotating the COURSE set knob. Arrow rotates with the compass card as airplane heading changes.
5. LUBBER LINE	Compass and airplane heading are read on azimuth card under lubber line.
6. HEADING MARKER	Indicates the compass heading as selected by the HDG knob or remote slew control (figure 4-30E). The heading marker rotates with the compass card as the airplane heading changes. The difference between actual heading and selected heading is shown by the displacement of the heading marker in relation to the lubber line.
7. COURSE COUNTER	Displays a digital readout of course as selected by the course set knob and indicated by the course arrow (head).
8. NO. 1 BEARING POINTER (HEAD)	Indicates bearing to tuned radio navigation station (See figure 4-18A.)

Figure 4-30D (Sheet 1 of 2)

	CONTROL/INDICATOR	FUNCTION
9	TO-FROM POINTER	Indicates direction to radio station along the course selected by the COURSE knob. Out of view when a localizer frequency is selected.
10	NO. 2 BEARING POINTER (TAIL)	Indicates reciprocal (180°) heading of No. 2 bearing pointer head when read against azimuth card.
11	COURSE SET KNOB	Used to set the course arrow and course counter to the desired VOR, TACAN or localizer course.
12	COURSE ARROW (TAIL)	Indicates reciprocal course of course arrow head when read against azimuth card.
13	MINIATURE AIRPLANE	Represents airplane and displays airplane position and direction to the selected course. When the airplane symbol is pointed toward the course deviation indicator, the airplane is headed towards the selected course; and when the airplane symbol is on the course deviation indicator, the airplane is on the selected course (CDI aligned with course arrow).
14	COURSE DEVIATION SCALE	Indicates deviation from radio beam center. Dots on scale represent approximately 1-1/4 degrees and 2-1/2 degrees to either side of localizer beam center or 5 degrees and 10 degrees to either side of VOR or TACAN beam center.
15	HEADING (HDG) SET KNOB	Adjusts the heading marker to the desired heading. When knob is pulled out, marker is controlled by HSI knob; pushing the knob in provides remote control by the slew control.
16	NO. 1 BEARING POINTER (TAIL)	Indicates reciprocal heading of No. 1 bearing pointer head when read against azimuth card.
17	GLIDE SLOPE SCALE	The dots above and below the center mark each indicate approximately 1/4 degree deviation.
18	COURSE DEVIATION INDICATOR (CDI)	Represents the center line of selected TACAN, VOR or localizer course and indicates deviations from radio beam center. The CDI rotates with the compass card as the airplane heading changes.
19	HEADING FLAG	Out of view when the compass system is functioning properly. In view indicates a failure of compass system. All heading display and command information must be considered unreliable.
20	NAV (NAVIGATION RADIO) FLAG	Out of view when VOR/LOC or TACAN receiver is operating properly. In view indicates course deviation indicator is not reliable.
21	GS (GLIDE SLOPE) FLAG	Out of view during VOR or TACAN operation. In view during localizer operation and glide slope receiver malfunctions or when glide slope signal is unreliable. Covers the glide slope pointer and scale to prevent accidental acceptance of faulty indications.
22	GLIDE SLOPE POINTER	Displays airplane deviation from the center of the glide slope beam. Pointer deflection above the center reference mark indicates that the glide slope beam is above the airplane. Deflection below indicates the glide slope beam is below the airplane.
23	MASK	Covers miles counter when TACAN receiver is not on or is not tuned.

Figure 4-30D (Sheet 2 of 2)

Horizontal Situation Indicator (HSI)

The horizontal situation indicator (figure 4-30D) displays heading, course, bearing, range and glide slope information. A fixed miniature airplane in the center of the instrument represents the airplane. The airplane heading is indicated on a rotating azimuth card under the lubber line at the top center of the instrument. The heading marker on the outer edge of the azimuth card is set by the heading set knob on the lower left corner of the HSI or by the slew control on the flight control wheel (figure 4-30E). The course display in the center of the azimuth card consists of a course arrow (head and tail), course deviation indicator (center of course arrow), to-from indicator and course deviation scale (dots). The course display is integrated within the instrument and rotates 360° to any course selected by the course set knob. The course display also rotates with the azimuth card thus providing airplane position relative to course regardless of the airplane heading. The centerline of a selected TACAN or VOR/LOC course is represented by the course deviation indicator (CDI) and when the CDI is centered (aligned with course arrow) indicates the airplane is on the selected course.

NOTE

The radio navigation course (VOR or TACAN) to be presented on the course display is controlled by the TACAN select switches on the pilot's and copilot's flight instrument panels. Refer to TACAN SELECT SWITCH, this Section.

The bearing pointers on the HSI provide bearings to selected VOR or TACAN stations. Number one (pink) pointer provides either VOR or TACAN bearing (as selected by TACAN select switch), and number two (green) pointer displays only VOR bearing. Refer to figure 4-18A for pointer presentation.

NOTE

The VHF-NAV receivers (51R-6) have special circuits which "stow" their respective bearing pointers off the right wing of the miniature airplane symbol when tuned to localizer frequencies.

The digital counters in the upper left corner of the HSI provide a readout in slant range to the selected TACAN station. This range is presented on both the pilot's and copilot's horizontal situation indicators when the TACAN receiver is tuned to a ground station regardless of TACAN select switch selection. The glide slope pointer and scale on the left side of the HSI displays airplane position relative to the glide slope beam. The glide slope pointer receives raw information from the glide slope receiver.

Flight Director Control

Three controls are provided on the flight director control panel (figure 4-30E) to control operation of the flight director/rotation go-around system. The controls consist of a mode selector switch, a pitch command knob and an altitude hold switch. The mode selector switch (2, figure 4-30E) is the primary control and selects the mode of operation for the flight director system. The modes of operation are RGA, GYRO, HDG, NAV/LOC, APPR AUTO, and APPR MAN. Except for the GYRO mode, the ADI command bars will be in view to display commands which, if followed, will cause the airplane to attain and maintain the desired attitude and position for the mode selected. The RGA mode is an overriding mode and pressing the RGA button (5, figure 4-30E) on the control wheel causes the mode selector to automatically move to RGA position. Refer to FLIGHT DIRECTOR SYSTEM OPERATION, this Section, for operation in each mode.

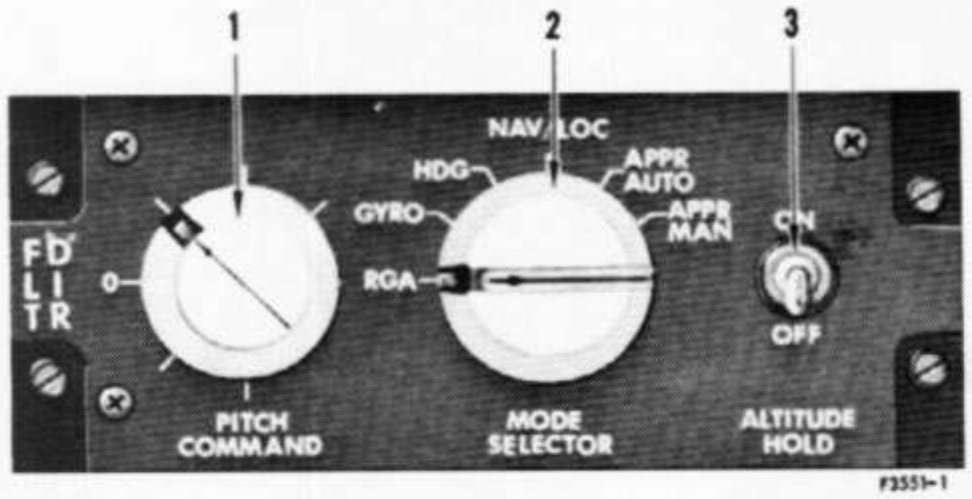
The pitch command knob and altitude hold switches are used in conjunction with the mode selector switch when in HDG, NAV/LOC or APPR AUTO (before glide slope capture) mode. The pitch command knob (1, figure 4-30E) is used to manually set the ADI command bars at any desired climb or descent pitch angle within the limits of 15 degrees climb or 10 degrees dive. The pitch command knob is inoperative when the altitude hold switch is engaged or when the mode selector is set to RGA, GYRO or APPR MAN mode. In APPR AUTO mode the pitch command knob becomes inoperative when the glide slope is captured. Scale markings are provided at zero (0), 5, 10 and 15 degrees pitch up and 5 and 10 degrees pitch down.

NOTE

The pitch scale markings on the flight director control panel are approximate and may not agree exactly with the pitch angle indicated by the ADI command bars.

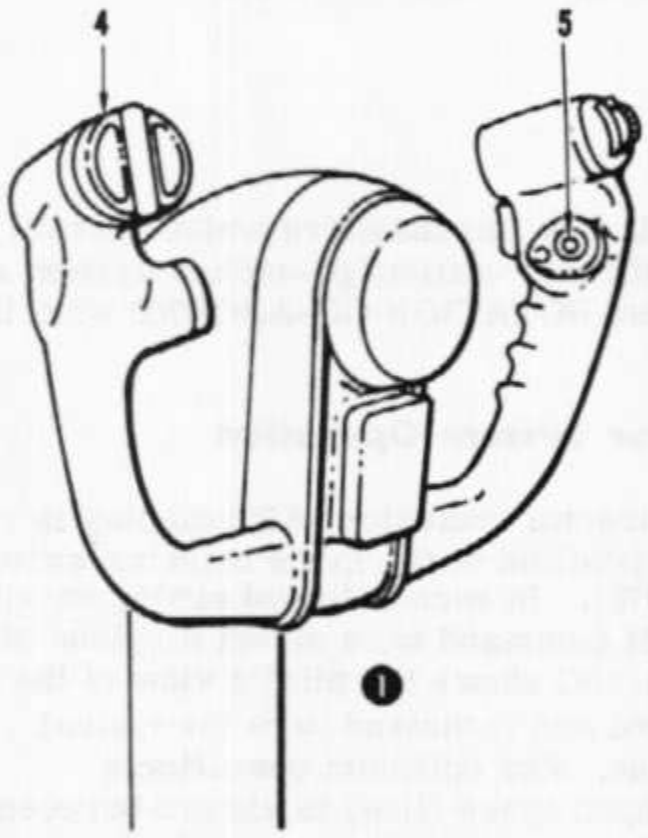
The altitude hold switch (3, figure 4-30E) is used when it is desired to maintain a specific altitude. Placing this switch ON engages the altitude hold mode and pitch commands, displayed by the ADI command bars, are referenced to a barometric altitude. The command bars command a climb or descent to maintain the barometric altitude sensed at the time the altitude hold mode was engaged. The altitude hold switch is inoperative and automatically moves to OFF position when the mode selector is set to RGA, GYRO or APPR MAN mode. In APPR AUTO mode the altitude hold switch disengages automatically when the glide slope is captured.

FLIGHT DIRECTOR CONTROLS

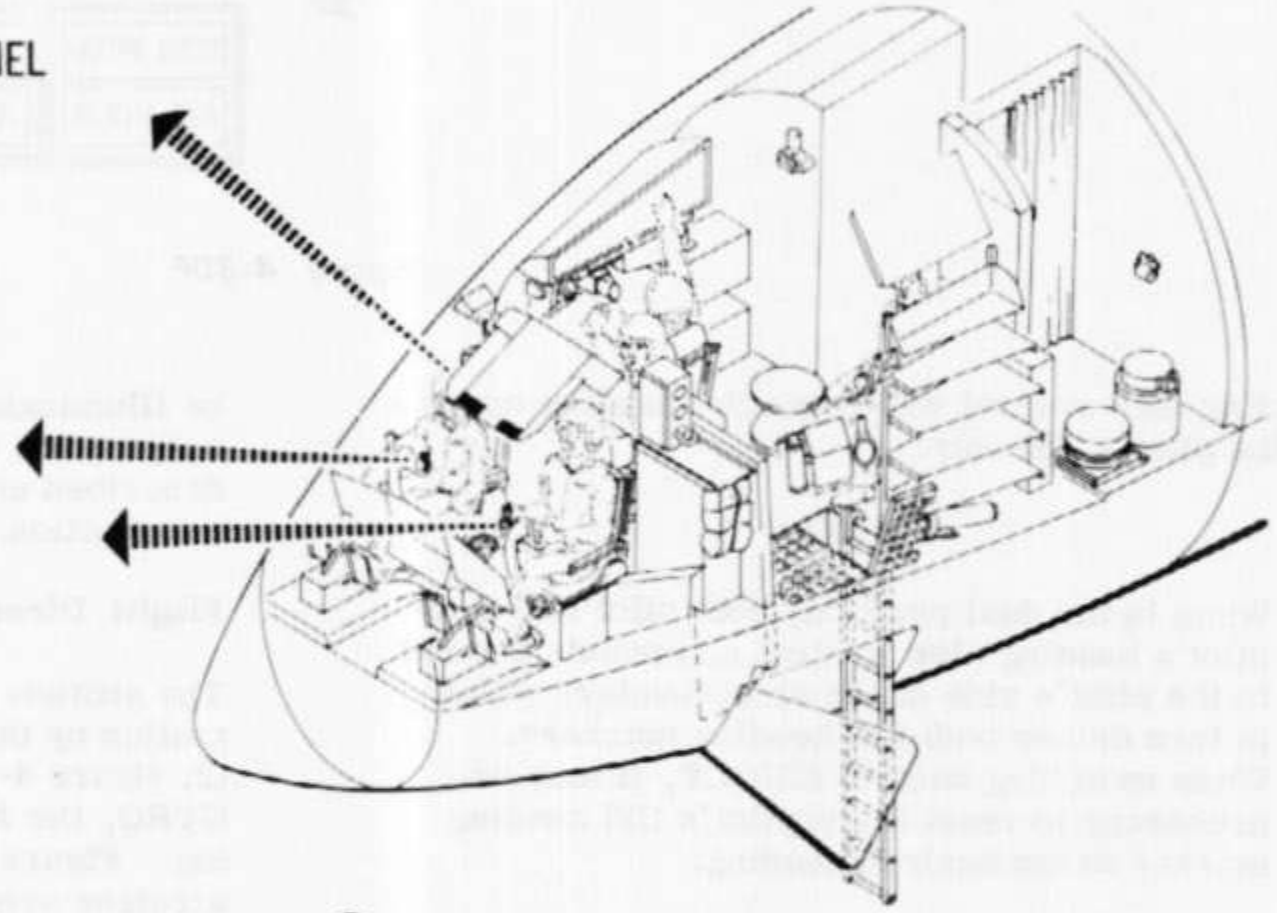


FLIGHT DIRECTOR CONTROL PANEL

1 PITCH COMMAND KNOB
2 MODE SELECTOR SWITCH
3 ALTITUDE HOLD SWITCH
4 HEADING SLEW CONTROL
5 RGA/AP PUSHBUTTON SWITCH



CONTROL WHEEL (TYPICAL)



❶ Copilot's left control wheel grip shown; pilot's control wheel has controls on right control wheel grip.

Figure 4-30E

Heading Slew Control

A heading slew control (4, figure 4-30E) is located on each flight control wheel. The slew control provides remote control of the heading marker on the HSI when the heading set knob is pushed in. Pressing the control to the right or left moves the HSI heading marker to the right or left, respectively. Momentary depression (1/2 second or less) of the control will cause the heading marker to move in one degree steps. If continuous pressure is applied on the control, the heading marker will move, after a slight pause, at a variable fast rate of slew until the control is released. The speed at which the heading marker moves is proportional to the amount of pressure on the heading slew control.

NOTE

The heading slew control incorporates a memory circuit which is not affected by pulling out the heading set knob. This circuit will cause the heading marker to move to the last position set by the slew control when the heading set knob is pushed in for remote control. Actuation of the heading slew control will reprogram the memory circuit regardless of the position of the heading set knob.

Dual Remote Heading Slew Switch

A dual remote heading slew switch (14, figure 1-20) is on the pilots' overhead panel and has SINGLE--DUAL positions. In DUAL position, actuation of either pilots' heading slew control will move the heading marker on both pilot's and copilot's HSI. When in the SINGLE position, actuation of the pilot's

FLIGHT DIRECTOR SYSTEM ANNUNCIATORS

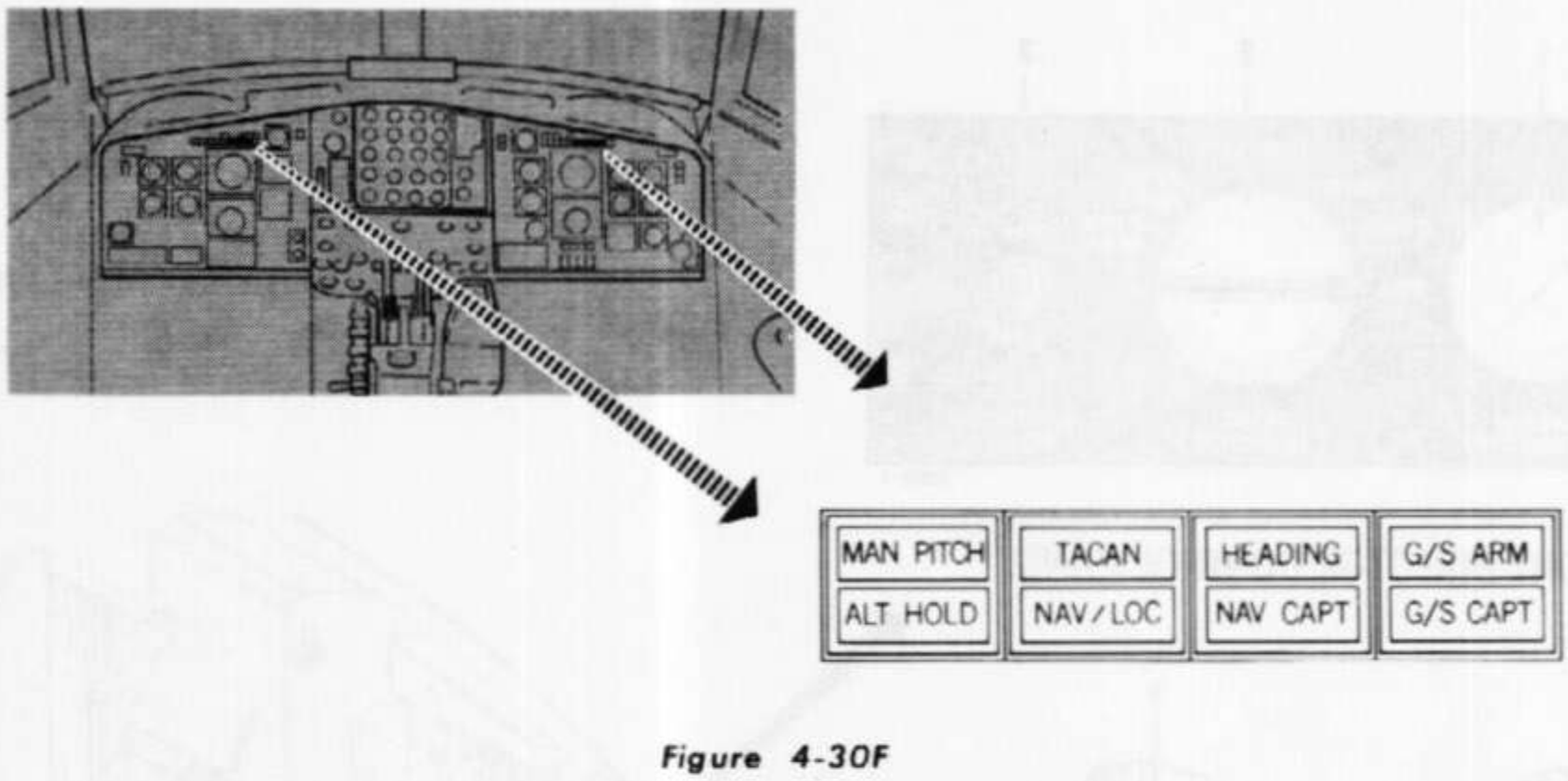


Figure 4-30F

heading slew control will move the heading marker on the pilot's HSI only.

NOTE

When in the dual position, both pilot's and copilot's heading slew control commands are fed to the pilot's side of the slew coupler, which in turn drives both HSI heading markers. When switching back to SINGLE, it may be necessary to reset the copilot's HSI heading marker to the desired heading.

RGA Pushbutton Switch

A RGA pushbutton switch (5, figure 4-30E) is located on each control wheel. The RGA pushbutton switch is actuated to provide information to the ADI command bars from the RGA system. Refer to ROTATION GO-AROUND SYSTEM, this Section.

Flight Director System Annunciators

The flight director system annunciators (figure 4-30F) are located on the flight instrument panel above the attitude director indicator. The flight director annunciators are aligned horizontally in a double row and provide a visual indication of steering information being displayed by the ADI command bars. Annunciators are aligned vertically to provide an "either/or" display; that is, either one annunciator or the other will light when that mode of operation is selected. As an example, if the mode selector switch is in HDG, NAV/LOC, or APPR AUTO before glide slope capture, either MAN PITCH or ALT HOLD will be illuminated. The annunciators which operate in conjunction with the rotation/go-around system are described under ROTATION GO-AROUND SYSTEM, this Section.

Flight Director System Operation

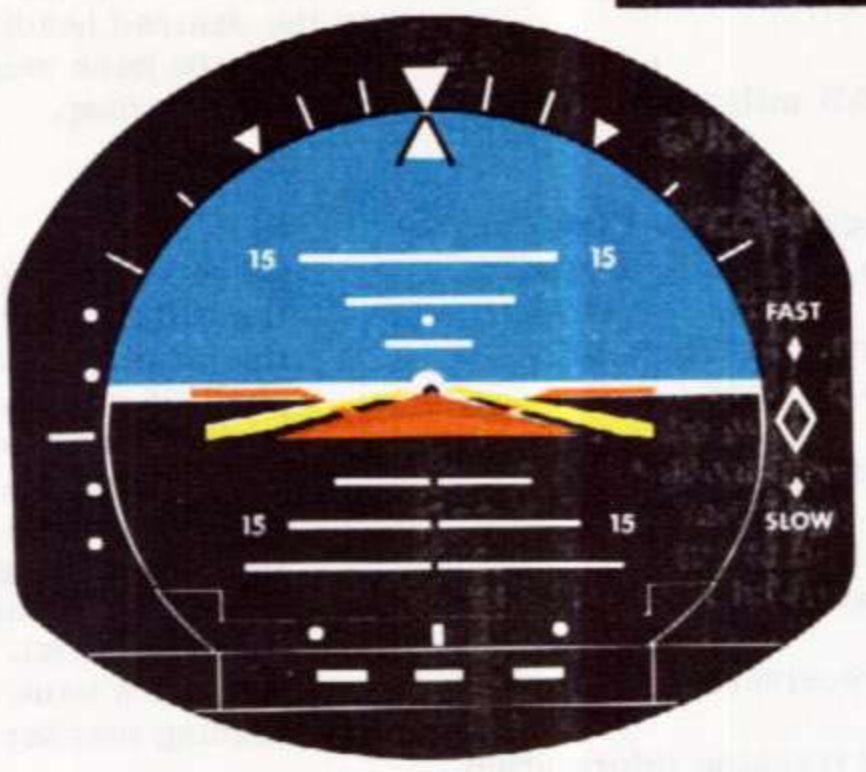
The attitude director indicator (ADI) display is controlled by the position of the mode selector switch (2, figure 4-30E). In each selected mode, except GYRO, the ADI command bars direct airplane steering. Figure 4-30G shows the pilot's view of the airplane symbol and command bars for typical flight conditions. For optimum operation a definite, thin open space (line) is viewed between the command bars and airplane symbol when steering commands are satisfied. The open area will widen or disappear as pitch attitude changes or command bars move to provide a new pitch command. Roll (heading correction) commands are seen as unbalanced line width, the low command bar side representing the direction of the turn command. Banking the airplane toward the low command bar until the lines on both sides appear equal satisfies the bank command.

The horizontal situation indicator (HSI) display is not affected by the mode selector switch position but is controlled by radio receiver, course arrow and heading marker selections. The HSI presents the following display in all flight director modes of operation:

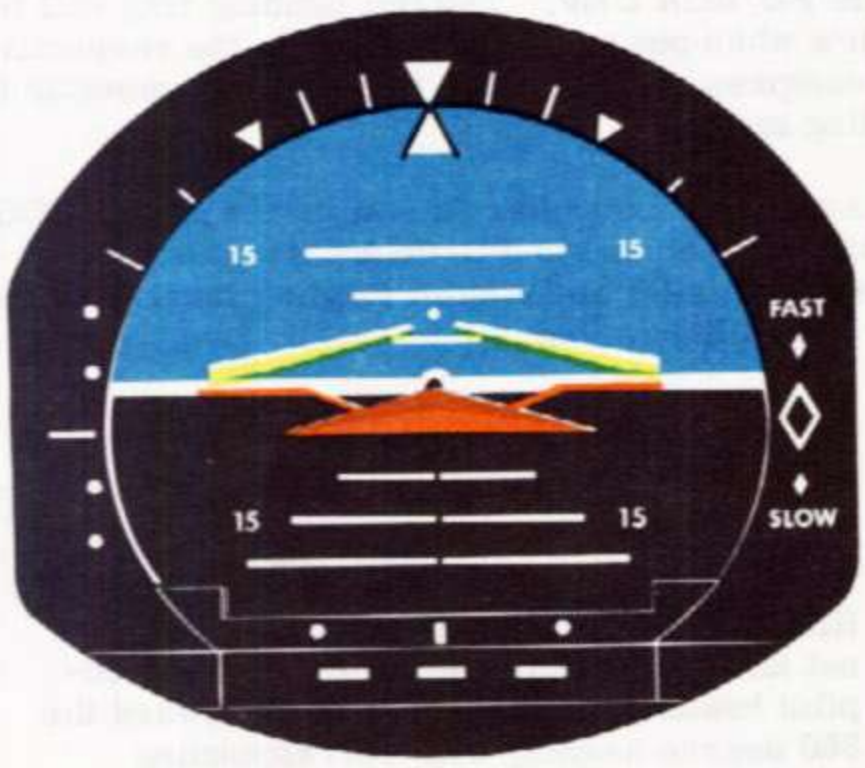
a. Azimuth card displays compass heading.

b. Course deviation indicator displays radio beam deviation (TACAN, VOR or localizer).

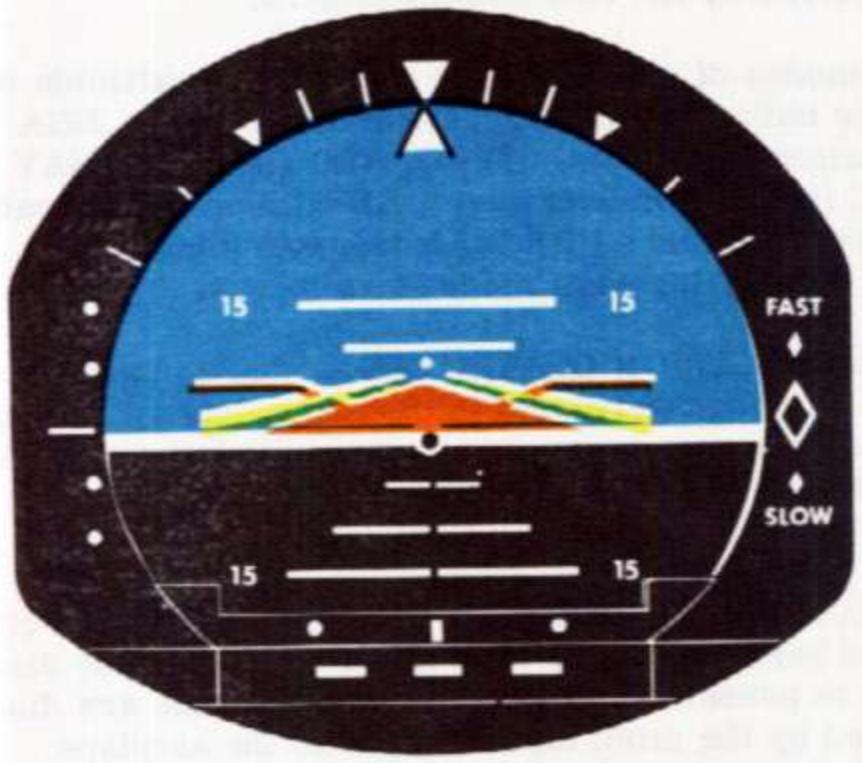
COMMAND BARS PRESENTATION



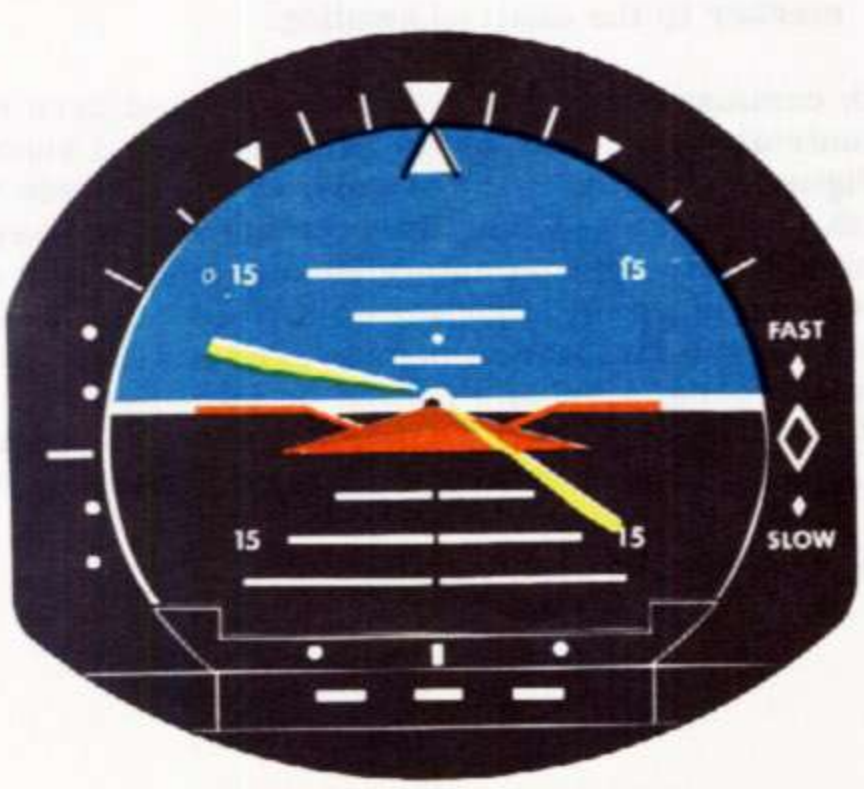
LEVEL FLIGHT
(COMMAND SATISFIED)



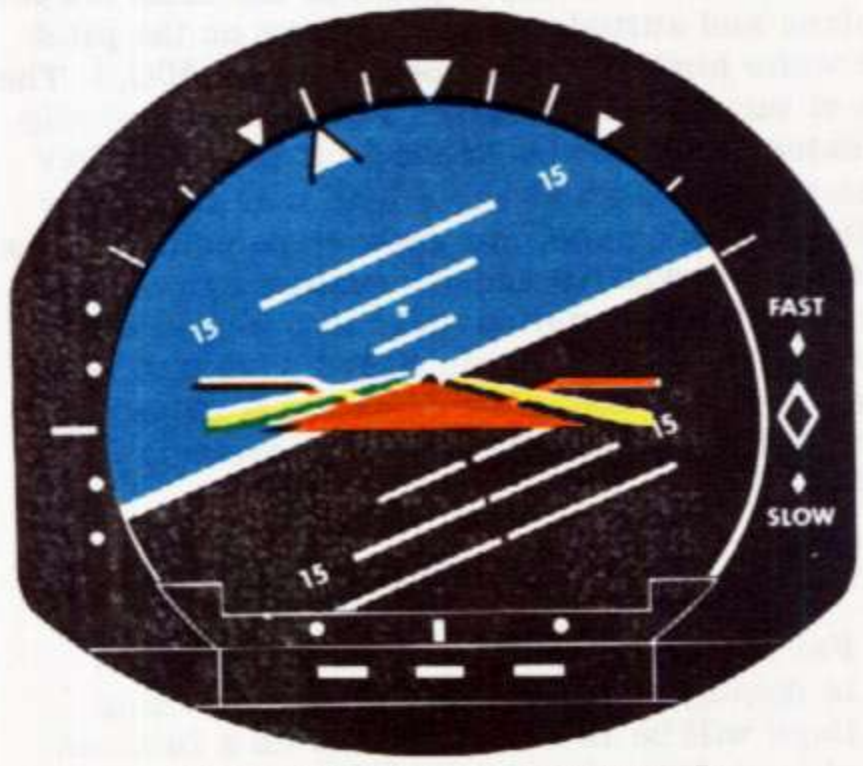
CLIMB COMMAND



CLIMB COMMAND SATISFIED



RIGHT BANK COMMAND



BANK COMMAND SATISFIED

T 4407

Figure 4-30G

c. Glide slope pointer displays glide slope beam deviation (out of view if radio receiver not tuned to localizer frequency).

d. Miles counter reads out TACAN miles if TACAN receiver is on and tuned.

e. To-from indicator shows direction to the VOR or TACAN station selected on the course arrow.

f. The two bearing pointers indicate bearings to TACAN/VOR navigation radio stations.

g. HEADING flag monitors condition of the compass system.

h. NAV flag monitors selected navigation receiver.

i. GS flag monitors glide slope receiver.

Since the HSI displays heading and tracking information in all modes, it can be used as a primary navigation instrument and as a cross reference for bank commands displayed by the ADI command bars.

Six modes of operation are provided for attitude director indicator display. These modes are: RGA (rotation go-around), GYRO, HDG (heading), NAV/LOC (navigation/localizer), APPR AUTO (approach automatic), and APPR MAN (approach manual). The display for each mode is as follows:

RGA (ROTATION GO-AROUND). The command bars display wings-level and pitch commands as computed by the rotation go-around system. Refer to ROTATION GO-AROUND SYSTEM, this Section.

GYRO. In the GYRO mode of operation the ADI command bars are out of view and a basic attitude display is presented. Pitch and bank attitude are displayed by the pitch tape relative to the airplane symbol. Roll angle is displayed by the bank indicator against the roll scale. A level flight condition shows the forward center point of the delta shaped airplane and attitude reference bars on the pitch tape white horizon line. (See figure 4-30G.) The rate of turn indicator shows rate of turn and slip indicator displays slip or skid. If the VHF NAV radio receiver is tuned to a localizer frequency while in GYRO mode, the glide slope pointer shows glide slope deviation and the runway symbol displays localizer deviation and radio altimeter altitude (200 feet to zero). Speed deviation pointer will indicate fast/slow deviation if selected. Refer to ROTATION GO-AROUND system, this Section.

NOTE

For all modes the basic attitude function is displayed as in GYRO mode. Warning flags will be in or out of view as a function of system mode and navigation receiver tuning. If a subsystem or sensor is not in use, its flag will be out of view.

HDG (HEADING). The HDG mode is a manual mode of operation in which the HSI heading marker is set to the desired heading and the ADI command bars display the bank required to attain and maintain the selected heading.

NOTE

When switching heading marker control from the HSI heading set knob to the slew control, the heading marker will move to the last position programmed into the memory circuit by the slew control. Actuation of the slew control will program the memory circuit regardless of the position of the heading set knob although there will be no associated movement of the heading marker if the heading knob is out. The command bars will indicate a bank toward the new heading if the heading marker moves.

The remote slew coupler is designed with single power supply through the pilot's HDG circuit breaker on the FD/RGA CBP. The HSI heading flag will be in view when power is interrupted to the respective HSI compass system. The flag does not monitor the heading marker.

When airplane ac power is lost or the pilot's HDG circuit breaker on the FD/RGA CBP is popped/pulled, both pilot and copilot heading marker remote slew capability is lost.

NOTE

When ac power is restored and/or the pilot's HDG circuit breaker is reset with the HDG set knob in Remote (in), both pilot and copilot heading markers will move toward the 360 degree heading with corresponding bank command on the ADI command bars. It will then be necessary to slew the heading marker to the desired heading.

Pitch commands displayed by the command bars may be controlled manually by the pitch command knob (1, figure 4-30E) or automatically by the altitude hold switch (3, figure 4-30E). The command bars may command up to approximately 30 degrees of bank and 15 degrees of pitch depending on turn or pitch required. If the airplane is manuevered to follow the command bars, a smooth rollout on the selected heading will result. After rollout, minor deviations will be immediately indicated by the command bars and, if followed, will maintain the airplane on the selected heading.

NAV/LOC (NAVIGATION/LOCALIZER). The NAV/LOC mode provides a combination heading and radio navigation mode of operation. Selection of NAV/LOC mode from HDG mode displays HSI heading marker inputs to the ADI command bars and arms the flight director system for radio beam capture. The radio course signals are provided by either the TACAN or VHF NAV, (VOR/LOC) receiver. Selection of TACAN or VOR/LOC is controlled by the TACAN select switch (figure 4-18A) on the flight instrument panel.

Course selection is made on the HSI using the course set knob (11, figure 4-30D). Prior to capture of the radio course the pilot may select any intercept heading desired and the command bars will display commands to follow the selected heading. When the radio course is captured (intercept capture angle should be 90 degrees or less) the flight director system switches from heading hold to tracking computation and the command bars direct flight along the selected course. The command bars will command up to approximately 30 degrees of bank on intercepting the course depending on intercept angle, and if followed, will provide a smooth roll-out on course. Capture point of a TACAN or VOR radial is approximately 5 degrees displacement, inner dot on the HSI course deviation scale. Capture point of a localizer course is approximately 2.5 degrees, outer reference dot. In NAV/LOC mode, crosswind correction is automatically computed after radio course capture. Pitch commands displayed by the ADI command bars are controlled, as in HDG mode, by the pitch command knob or altitude hold switch.

NOTE

The position of the course arrow should not be changed after radio course capture except over a VOR or TACAN station and the course change is 10 degrees or less. Select HDG mode to established a new intercept angle if the course change is more than 10 degrees or whenever a new frequency is selected on the navigation receiver.

In NAV/LOC mode, the command bars will display commands to follow a localizer course (LOC submode) when the VOR/LOC receiver is tuned to a localizer frequency. Heading commands to intercept the course are controlled and displayed as in the navigation (NAV) submode. The glide slope pointer and runway symbol will appear on the ADI when the localizer frequency is tuned; however, glide slope information will not be provided to the command bars. Pitch commands are still controlled by the pitch command knob or altitude hold switch.

NOTE

The flight director system incorporates a fixed angle intercept feature in the event course capture is lost. This feature can be selected by placing the mode selector switch to APPR MAN and then back to NAV/LOC or APPR AUTO. The system computations will then provide a fixed angle intercept command display of approximately 30 degrees to the selected course.

APPR AUTO (APPROACH AUTO). The APPR AUTO mode provides command bars display for intercepting and tracking a localizer beam and glide slope path. When the VOR/LOC receiver is tuned to the localizer frequency and APPR AUTO is selected the flight director system is armed for localizer capture. The system operates as in HDG mode prior to localizer capture and at the capture point the system is armed for glide slope capture, the command bars will command a bank (up to 30 degrees) to turn onto the selected localizer course. The intercept heading is set on the HSI heading marker and can be any heading which will intercept the course at an angle of 90 degrees or less. The pitch commands displayed by the command bars are controlled by the pitch command knob or altitude hold switch until glide slope capture. After glide slope capture the system automatically switches to glide slope tracking (if selected, altitude hold switch moves to OFF) and computes the pitch attitude required to command flight on the glide slope. Gain programming is provided in the system to compensate for the gain increase of the glide slope beam during the approach. On a signal from the radio altimeter system at 200 feet radio altitude, the gain of the glide slope command signals reduces to provide a smooth command bars display for close-in glide slope tracking.

In the APPR AUTO mode, the runway symbol on the attitude director indicator appears when the localizer is tuned and provides lateral and vertical displacement display for the low approach. As the runway is approached, the runway symbol will move up toward the airplane symbol to indicate descent from 200 feet to touchdown. At touchdown the runway symbol will be at the base of the airplane symbol. Raw glide slope displacement is displayed by the glide slope pointers on both the ADI and HSI when the localizer is tuned and glide slope signals are received. The glide slope pointers show the actual displacement from the glide slope beam and are used as a reference for glide slope capture.

APPR MAN (APPROACH MANUAL). To engage the system in APPR MAN mode, it is necessary to depress the mode selector switch to turn it to APPR MAN. After APPR MAN is selected the mode selector switch must be positioned to one of the other modes to reset the push-to-turn mechanism. The APPR MAN mode provides an immediate localizer and glide slope capture display. The command bars will show the bank, and climb or descent required to track the localizer and glide slope beams. A fixed course intercept angle of 30 degrees will be commanded if course displacement is beyond localizer capture point. The vertical commands to capture the glide slope will be displayed up to the pitch limit of the command bars. The pitch command knob and altitude hold switch do not function in APPR MAN mode. The ADI and HSI display function is the same in APPR MAN mode as APPR AUTO mode after localizer and glide slope capture. Glide slope gain programming in APPR MAN mode is the same as APPR AUTO mode.

Flight Director Annunciator Functions

The annunciator display on the flight instrument panel provides the pilot with an annunciation of system mode of operation. Refer to figure 4-30H for correct annunciator display for each mode selection.

NOTE

The annunciators must be checked after changing mode selection or during automatic mode switching to determine if the system is in the correct mode.

ROTATION GO-AROUND SYSTEM

The dual rotation go-around system operates in conjunction with the flight director systems (RGA mode) to provide takeoff and go-around pitch steering commands on the pilot's and copilot's ADI command bars display. The RGA system computers use pitch, angle of attack, longitudinal acceleration, elevator and flap position to compute the takeoff and go-around pitch steering commands. Flap-compensated angle of attack information from the RGA angle of attack indicators is presented on the respective ADI speed deviation pointer when selected. Primary components of each RGA system are: angle of attack indicator, angle of attack transmitter (probe), longitudinal accelerometer, RGA computer, RGA control unit and warning monitor circuits. An RGA interface unit integrates the flap position and angle of attack functions of the dual system and monitors RGA system equipment. RGA system annunciators are installed on the pilots' flight instrument panels to display the selected mode of operation.

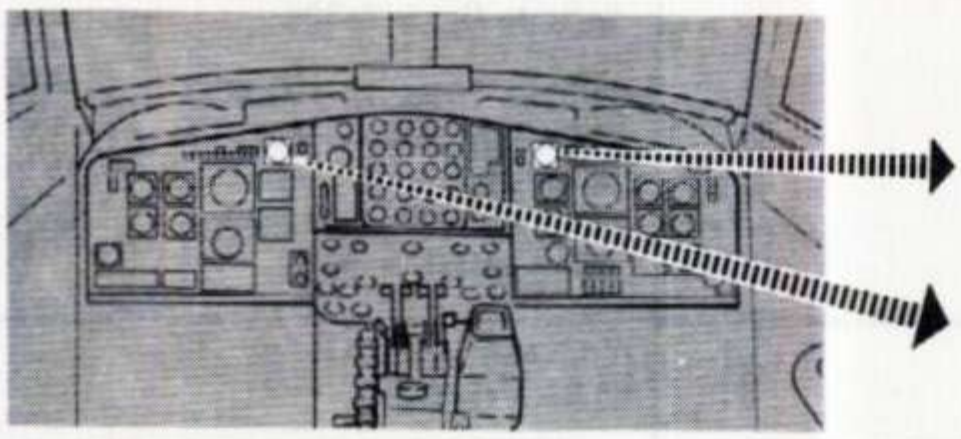
The RGA system has a stall avoidance feature which is automatically activated in certain flight conditions. If the AOA reaches 0.9 ± 0.01, a strong nosedown signal is sent to the command bars to keep the airplane away from stall. This signal overrides all other inputs to the computer. It must be emphasized that the AOA limiter (stall fence) is a stall avoidance feature and not a stall prevention feature of the system. There are no design conditions for the RGA system in which this "stall fence" would be reached since the RGA pitch commands normally keep the AOA below the AOA limit, but there are a few remote conditions in which the limiter might be needed. These are: Sudden large vertical wind shears; insufficient thrust available to maintain flight; early rotation; actuation of RGA switch after rotation has begun; RGA computer malfunction; and selection of RGA mode during airplane deceleration prior to takeoff.

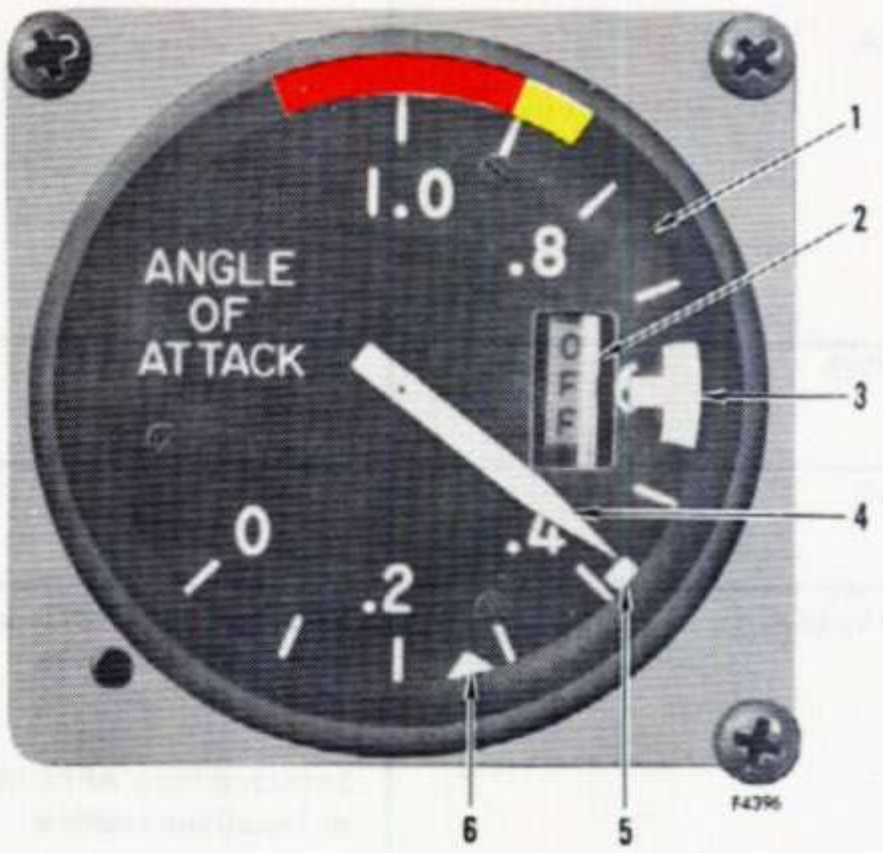
FLIGHT DIRECTOR ANNUNCIATOR CHART

SELECTED MODE	CONDITION	ANNUNCIATION
RGA		Refer to figure 4-30K. NOTE: Either T/O ARM or G/A ARM annunciator will be on when in any mode other than RGA and RGA power switch is on.
GYRO		T/O ARM or G/A ARM (RGA SYSTEM)
HDG		MAN PITCH or ALT HOLD HEADING
NAV/LOC	Selected from HDG; before VOR, TACAN or localizer capture	MAN PITCH or ALT HOLD TACAN or NAV/LOC HEADING
	Selected from APPR MAN; before VOR or localizer capture	MAN PITCH or ALT HOLD NAV/LOC
	After VOR, TACAN or localizer capture	MAN PITCH or ALT HOLD TACAN or NAV/LOC NAV CAPT
APPR AUTO	Selected from HDG; before localizer capture	MAN PITCH or ALT HOLD NAV/LOC HEADING
	Selected from APPR MAN; before localizer glide slope capture	MAN PITCH or ALT HOLD NAV/LOC
	After localizer capture and before glide slope capture	MAN PITCH or ALT HOLD NAV/LOC NAV CAPT G/S ARM
	After glide slope capture	NAV/LOC NAV CAPT G/S CAPT
APPR MAN		NAV/LOC NAV CAPT G/S CAPT

Figure 4-30H

ANGLE OF ATTACK INDICATOR





1 INDICATOR SCALE
2 POWER OFF FLAG
3 APPROACH INDEX
4 ANGLE OF ATTACK POINTER
5 MAXIMUM ENDURANCE INDEX
6 MAXIMUM RANGE INDEX

CAUTION ZONE (APPROACHING BUFFET)
BUFFET/STALL ZONE

Figure 4-30-I

Angle of Attack Indicator

The angle of attack indicator (figure 4-30-I) presents a display of angle of attack which is indicated in percent of lift by the pointer on a zero to 1.0 scale. The 0 (zero) position on the scale represents the zero lift reference angle of attack (angle of attack for zero G flight) and the maximum scale reading of 1.0 represents an angle of attack which produces a lift condition between initial buffet and stall. This method of displaying angle-of-attack information is referred to as "Normalized AOA." The normalized AOA reading is electrically shifted as flaps are lowered from 0 to 20 degrees and 20 to 30 degrees (flap compensation) to correct the zero lift angle of attack for flap position. Flap compensation is not provided to shift the 1.0 AOA or the 0 (zero) AOA when flaps are lowered 30 to 40 or 40 to 50 degrees. This results in a slight variation in percent above stall or initial buffet as flaps are lowered and AOA index is held constant. Index markings on the indicator scale show approximate normalized angles of attack in a clean configuration for maximum range and maximum endurance and for a .6 normalized AOA approach. The approach index (.6 normalized AOA) indication is amplified, dampened, and then repeated on the attitude director indicator fast/slow speed deviation pointer when this selection is made. See APPROACH SPEED DEVIATION SWITCH, this section. A slow indication on the speed deviation pointer means the airspeed is slower than .6 AOA approach speed.

NOTE

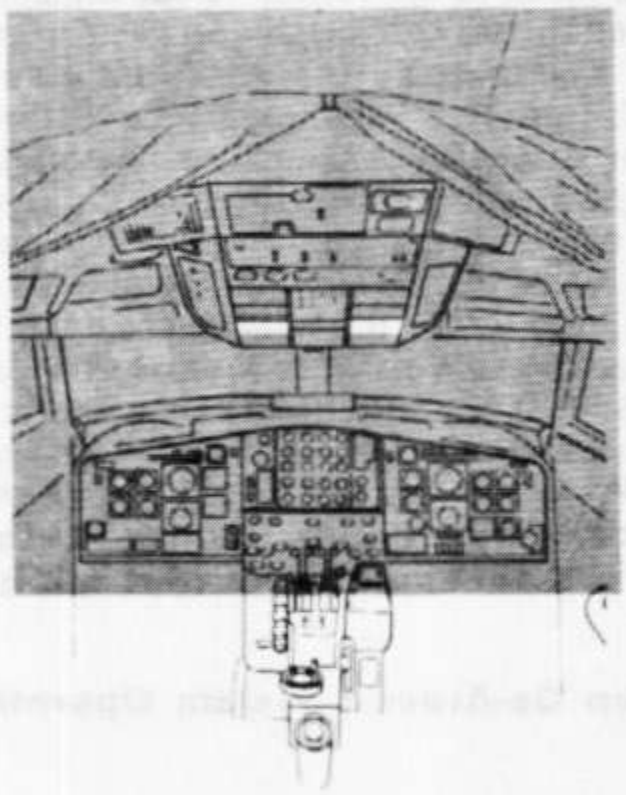
The pilot's and copilot's angle of attack indicators operate independently of each other and will indicate different readings when the airflow around the angle of attack probes varies as in a sideslip.

Rotation Go-Around System Control

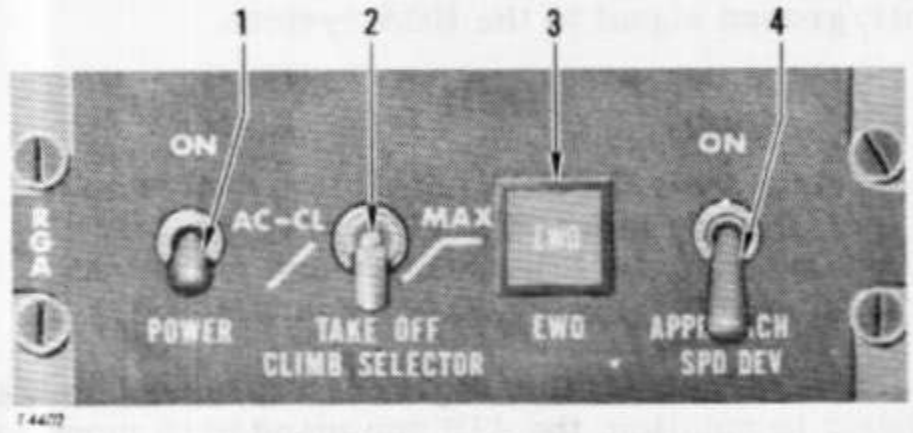
Two control panels, one for each RGA system, are on the pilots' overhead panel. Each panel (figure 4-30J) contains the following controls: RGA power switch, takeoff climb selector switch, EWO switch/indicator, and approach speed deviation switch.

RGA Power Switch

The RGA power switch (1, figure 4-30J) controls power to the RGA system components which provide vertical steering information to the ADI command bars. Power to the angle of attack indicator and speed deviation pointer is provided from another source and is not affected by the RGA power switch position.



ROTATION GO-AROUND CONTROL PANEL



1 RGA POWER SWITCH
2 TAKEOFF CLIMB SELECTOR SWITCH
3 EWO SWITCH/INDICATOR (SOME AIRPLANES)
4 APPROACH SPEED DEVIATION SWITCH

Figure 4-30J

Takeoff Climb Selector Switch

The takeoff climb selector switch (2, figure 4-30J has two positions marked AC-CL and MAX. In either AC-CL or MAX position the command bars will display an initial climb (rotation) command of 8.5 degrees pitch up for 20 degrees of flaps or 8 degrees pitch up for 30 degrees of flaps.

The AC-CL (accelerated climb) position selects the accelerated climb profile computations for display by the ADI command bars. In this position the ADI command bars direct a wings-level accelerated climb to flap retraction speed and then direct a wings-level climb which compensates for loss of lift during flap retraction. The AC-CL takeoff climb switch position may be used with wet or dry engine operation. The climbout flight path charts for the AC-CL selection are predicated on the loss of an engine during takeoff.

The MAX (maximum climb) position of the takeoff selector switch will command a constant speed (climbout speed) profile as depicted in the flight manual climbout flight path charts for normal operation 3-engine and EWO operation 4-engine.

NOTE

Since the constant speed maximum climb command is normally less than the flap retraction speed, the command bars display must be ignored when the appropriate altitude is reached for acceleration to flap retraction speed.

EWO Switch/Indicator (Some Airplanes)

The EWO (emergency war order operation) switch/indicator (3, figure 4-30J) operates in conjunction with the takeoff climb selector switch AC-CL position. Depressing the EWO switch indicator with AC-CL climb profile selected provides a four-engine, wet or dry, accelerated climb profile for the ADI command bars display.

WARNING

If installed, the EWO switch/indicator will not be used.

Approach Speed Deviation Switch

The approach speed deviation switch (4, figure 4-30J) controls selection of the ADI speed deviation pointer (7, figure 4-30C) display. Placing this switch ON causes the speed deviation pointer to appear and display fast/slow indications derived from the angle of attack indicator approach reference. Positioning the switch off (down) removes the ADI speed deviation pointer from view.

RGA/AP Pushbutton Switch

The RGA pushbutton switch (5, figure 4-30E), when depressed, provides either a takeoff or go-around command bars display. The type of display presented depends on whether the airplane is on the ground or in-flight. A weight-on-wheels switch provides an air/ground signal to the RGA system.

NOTE

Activating the RGA pushbutton switch automatically moves the FD mode selector switch to the RGA position and moves the approach speed deviation switch to off.

When the RGA pushbutton switch is depressed on takeoff prior to rotation, the ADI command bars move to a wings-level climb attitude of 8.5 degrees with 20 degrees flaps or 8 degrees with 30 degrees flaps. After rotation the attitude commands are computed and vary according to the climbout profile selected.

NOTE

If both FD mode selector switches are in RGA position, depressing either the pilot's or co-pilot's RGA pushbutton switch will cause the takeoff rotation command to be displayed on both pilots' attitude director indicators.

During approach, when the RGA pushbutton switch is depressed, a wings-level climb attitude of 7 degrees will be displayed by the ADI command bars. Once the RGA pushbutton switch is depressed for either takeoff or go-around additional actuation of the switch has no effect. The flight director mode selector switch must be rotated to another position to reset the RGA system and change the command bars display.

NOTE

The weight-on-wheels input signal to the RGA system determines the RGA mode of operation, takeoff or go-around, and arms the system accordingly. When the RGA pushbutton switch is depressed, the mode previously armed is then selected to provide commands to the command bars. This mode of operation is retained until the flight director mode selector switch is rotated to a position other than RGA.

The RGA pushbutton switch is combined with the autopilot disengage button. When the RGA/AP pushbutton switch is actuated with the RGA power switch in ON, the above RGA system functions will occur. Regardless of the position of the RGA power switch, actuation of the RGA/AP pushbutton will result in the autopilot being disengaged (if engaged). See AUTOPILOT, this Section.

RGA Annunciators

The RGA annunciators (figure 4-30K) display RGA system mode of operation. Four annunciators are provided for takeoff mode and two for go-around mode. The takeoff mode annunciators are T/O ARM, ACC CLIMB,T/O MAX and EWO. Either the T/O ARM or G/A ARM annunciator is illuminated when the flight director mode selector (2, figure 4-30E) is in any mode except RGA and the RGA power switch is ON. If the airplane is on the ground (weight-on-wheels), the T/O ARM annunciator will be on; when airborne the G/A ARM annunciator is on. The ACC CLIMB, T/O MAX and EWO annunciators indicate the takeoff climb selector switch (2, figure 4-30J) and EWO switch (3, figure 4-30J) selections. Refer to figure 4-30K for annunciation when the flight director mode selector switch is in RGA position.

Rotation Go-Around System Operation

Takeoff and Initial Climb

The FD/RGA system controls (FD mode selector and RGA pushbutton switch) must be operated in the correct sequence to obtain a command bars display for takeoff and prevent a malfunction indication. For takeoff the correct sequence is:

1. Set both FD mode selectors to RGA position.

NOTE

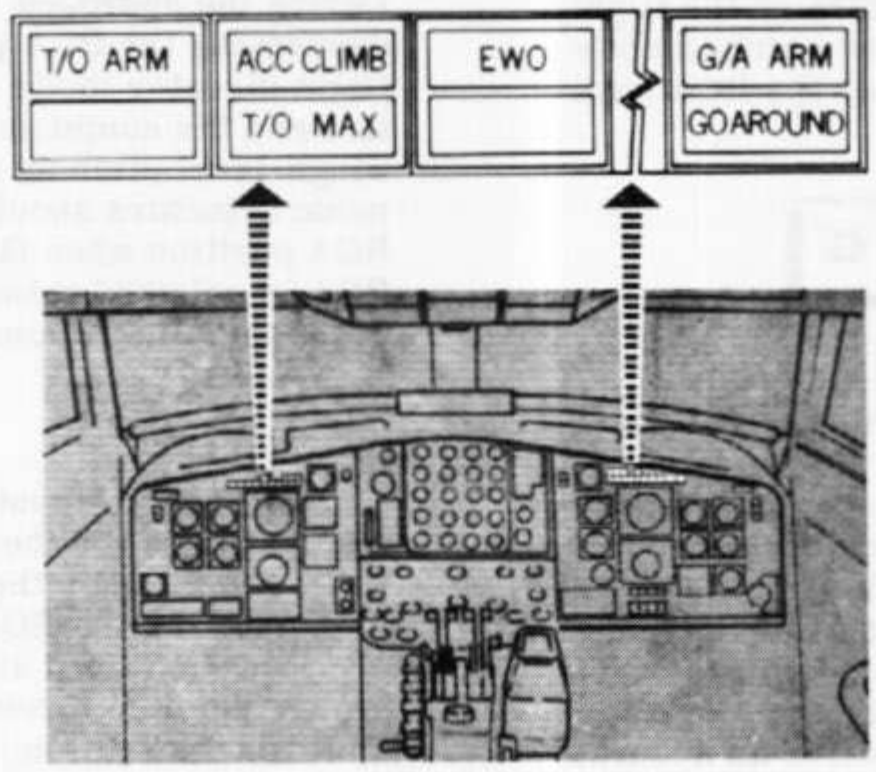
- Do not set FD mode selectors to RGA position while accelerating, decelerating or turning the airplane while taxiing.
- If neither of the FD mode selectors is in RGA position and the RGA pushbutton switch is actuated while on the ground (weight-on-wheels) the CMPTR flag will appear and the respective command bars will drive out of view. To rearm the system turn both FD mode selectors to another mode, turn both RGA power switches to OFF momentarily then ON to reset the RGA system. Reselect RGA manually for takeoff.

2. Depress RGA pushbutton switch just prior to rotation (within 10 knots).

NOTE

- The RGA rotation steering commands are not displayed by the ADI command bars until the RGA pushbutton switch (5, figure 4-30E) is actuated.
- If the RGA button is inadvertently depressed prior to starting takeoff roll, it will be necessary to move both flight director mode selectors to another position and back to RGA to rearm the system for takeoff.

RGA SYSTEM ANNUNCIATORS



MODE	CONDITION	ANNUNCIATION
RGA	BEFORE RGA PUSHBUTTON ACTUATION:	
	WEIGHT-ON-WHEELS	ACC CLIMB or T/O MAX
	WITH EWO	ACC CLIMB EWO
	AIRBORNE	G/A ARM (COMMAND BARS GO OUT OF VIEW)
	AFTER RGA PUSHBUTTON ACTUATION:	
	WEIGHT-ON-WHEELS AND AFTER LIFTOFF	ACC CLIMB or T/O MAX
	WITH EWO	ACC CLIMB EWO
	AIRBORNE (AFTER G/A ARM)	GO AROUND
ALL OTHER MODES	WEIGHT-ON-WHEELS	T/O ARM
	AIRBORNE	G/A ARM

Figure 4-30K

The rotation go-around system is armed for the takeoff when the airplane is on the ground, the RGA power switch (1, figure 4-30J) is ON and the flight director mode selector switch (2, figure 4-30E) is in RGA position. The takeoff climb selector switch and EWO switch/indicator (2 and 3, figure 4-30J) are set for the desired climb profile prior to lineup on the runway and the ADI command bars checked for a zero attitude (level) command display.

During takeoff roll the ADI command bars will indicate command for level flight (RGA mode prior to RGA pushbutton actuation). Just prior to reaching rotation speed (V_{ROT}) (within 10 knots), both RGA pushbutton switches are depressed to establish the most accurate zero pitch attitude reference for the RGA system pitch computations. (Depressing both RGA buttons ensures correct display for both pilot and copilot.) The RGA system then determines the initial climb attitude, based on the pitch attitude reference at RGA pushbutton actuation, and the

climb (rotation) command is displayed by the command bars. Thus, to establish an accurate pitch attitude reference, forward pressure on the flight control wheel must be sufficient to maintain nose wheel contact with the runway when the RGA pushbutton switch is depressed.

WARNING

Airplane rotation will not be delayed in order to actuate RGA pushbutton switch.

The rotation (initial climb) pitch command displayed by the command bars for all takeoff modes is 8.5° with 20 degrees flaps or 8° with 30 degrees of flaps. The ADI command bars represent true pitch attitude as determined by the 8.5° or 8° angle measurement from the zero attitude at RGA pushbutton switch actuation and, if followed, will provide an accurate rotation and climb attitude for takeoff.

WARNING

If for some reason neither of the RGA pushbutton switches is depressed prior to rotation, the command bars will not display the rotation (climb) command. In this condition if one of the RGA switches is actuated during rotation, the ADI command bars will display an excessive climb for takeoff flare. Example: RGA switch depressed at 5° pitch up during rotation, command bars would initially display a climb command of approximately 13 degrees and would result in over rotation if followed.

NOTE

If the RGA switch is not actuated or is actuated after rotation is started, ignore the ADI command bars and rotate to 8 to 9 degrees climb attitude on the ADI pitch tape.

Two seconds after the airplane pitch attitude changes 4 degrees during rotation, RGA computer programming is started and the command bars display the computed climb commands. These commands are introduced through a smoothing period to eliminate abrupt changes. The computed commands displayed by the ADI command bars in the climb after takeoff are based on the selected profile set on the takeoff climb selector switch (2, figure 4-15). For a MAX profile the angle of attack indicator may be used as a reference and will indicate .7 to .8 after takeoff flare at 4-engine climbout speed and up to .86 at 3-engine climbout speed.

Go-Around

During the approach when a go around is required, depressing the RGA pushbutton switch will cause the flight director mode selector to move to RGA position and the command bars will display a 7 degree, wings-level pitch up (climb) command. The FD mode selectors should not be manually set to the RGA position when G/A ARM mode is present. If RGA is selected manually on either FD mode selector the respective command bars will drive out of view.

NOTE

- The RGA system uses vertical gyro pitch inputs for the go around command; therefore, when the decision to go around is made, the RGA pushbutton switch should be actuated at a constant airspeed, just prior to throttle advance and airplane acceleration. This will minimize the longitudinal acceleration errors input to the RGA computer and provide a more accurate go around command display.
- During a go around and prior to actuating the RGA pushbutton switch, if the airplane contacts the runway and weight-on-wheels switch is activated, the FD mode selectors will move to the RGA position and the RGA system will revert from G/A ARM mode to the takeoff mode. The ADI command bars would then command rotation and a climb profile if the RGA pushbutton switch is depressed just prior to V_{ROT}.
- It is possible that an inadvertent touchdown or touch and go landing may not actuate the weight-on-wheels switch. In this event the ADI command bars will display a 7 degree climb go around command when the RGA switch is depressed. The G/A ARM annunciator would remain on for this condition until RGA pushbutton actuation; at which time GO AROUND annunciator would come on.

WARNING

When the airplane touches down and weight-on-wheels switch is not activated, airplane acceleration will cause pitch error in the attitude director indicator pitch tape and command bars. This error will vary (1/2 to 2 degrees) and appear as a climb indication.

Computed pitch commands are displayed by the ADI command bars after the initial go around command to compensate for changing thrust and loss of lift during flap retraction. The computed commands provide a smooth go around with minimum loss of altitude and optimum rate of climb. After reaching the desired missed approach climb attitude, the flight director mode selector may be switched to another mode and pitch commands may be controlled either by the pitch command knob or altitude hold switch.

ANNUNCIATOR AND FLIGHT DIRECTOR DIMMER CONTROLS

The dimmer controls for the annunciators and flight director instrument lighting are on the pilots' overhead panel. Dimmer switches are provided for each FD/RGA system. The ANN DIM switch (9B, figure 4-34) is a five position switch that provides step dimming control for the annunciator lamps, TACAN select switches, green attitude warning lights and the vertically aligned indicators on the side of the pilots' flight instrument panels. The extreme dim position does not completely extinguish the lamps. The F/D DIM control (9C, figure 4-34) dims the lighting for the ADI, HSI, and radio altimeter when rotated counterclockwise. The ANN TEST switch (9A, figure 4-34) is located on the FD dim control panel and when depressed, will cause all FD/RGA system annunciators to illuminate. The red and green attitude warning indicators will also illuminate when the ANN TEST switch is depressed.

FD/RGA WARNING MONITOR INDICATORS

The warning monitor indicators (figure 4-30L) for the FD/RGA system consist of warning flags, comparator warning monitor indicators, attitude warning indicators, and RGA fail operative warning lights. Refer to figures 4-30C and 4-30D for flag display.

Warning Flags

The FD/RGA warning flags are "positive monitoring," that is, the proper operating voltage must be present to keep the associated flag out of view. Generally, if a flag is displayed and the source affected by the particular flag is being used to compute steering commands, the ADI command bars will be driven from view. Three flags which do not cause the command bars to be driven from view are RUNWAY, R/T

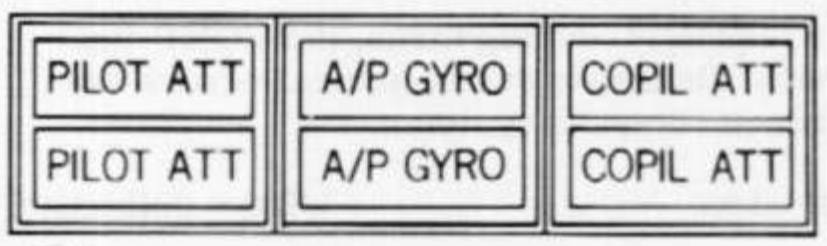
FD/RGA SYSTEM WARNING MONITOR INDICATORS



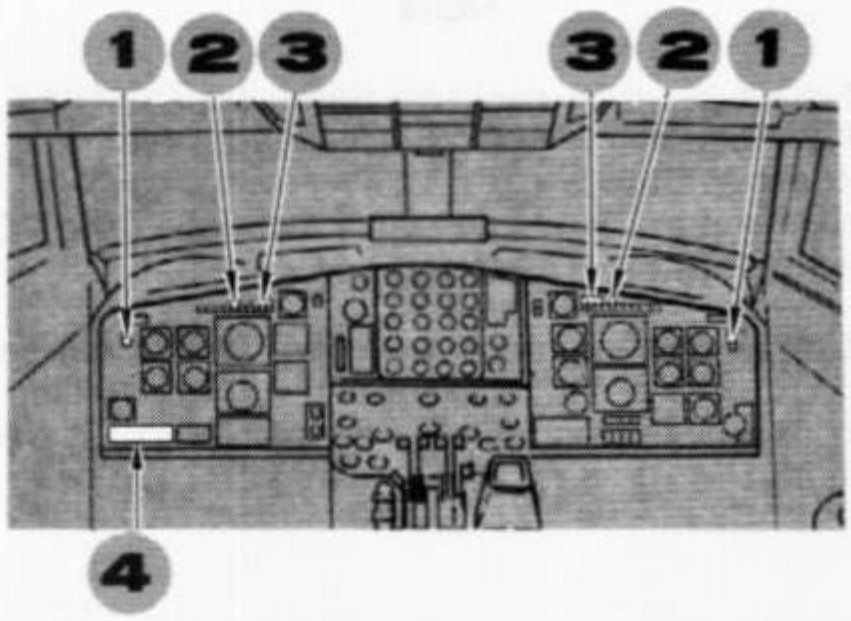
1 RGA FAIL OPERATIVE INDICATOR

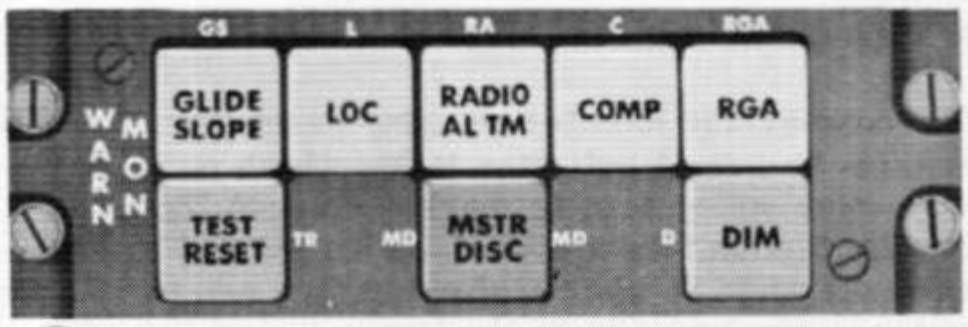


2 COMPARATOR WARNING SWITCH/ INDICATOR



3 ATTITUDE WARNING INDICATORS





4 COMPARATOR WARNING MONITOR PANEL

F3550

Figure 4-30L

and SPEED. Refer to figure 4-30M for command bars display, flight director modes affected and corrective action for each warning flag. If a flag appears for a subsystem which is providing steering information to the flight director computer, both the subsystem flag and the CMPTR flag will appear in view and the command bars will be driven out of view. When only the CMPTR flag appears, the command bars remain in view. This condition indicates a failure in power to the computer.

Comparator Warning Monitor Indicators

The comparator warning monitor indicators (figure 4-30L) continuously monitor subsystems of the pilot and copilot FD/RGA systems, namely: glide slope, localizer, radio altimeter, compass, and RGA system. When a differential error between corresponding systems exceeds a predetermined limit, warning lights on the comparator warning monitor panel and COMPAR WARNING lights above the pilot's and copilot's attitude director indicators will illuminate. The following is the differential error (wings level) at which a warning indication will appear:

Subsystem	Differential Error
RGA (pitch)	3 degrees
Compass	6 degrees (before localizer capture) 3 degrees (after localizer capture)

NOTE

Frequently, during turns, the COMP light may illuminate due to normal errors between compass systems.

Glide slope	1/2 dot deflection
Localizer	1/3 dot deflection

Radio Altimeter:

Altitude	Differential Error
0 feet	5 feet
495 feet	27 feet
505 feet	55 feet
1000 feet	152 feet
1500 feet	227 feet
2000 feet	305 feet
2500 feet	382 feet

The comparator monitor warning panel (figure 4-30L) contains five fault indicator lights which monitor the respective subsystem as marked on each light. All five fault indicators are dual-bulb units and are normally off when no comparator warning exists. Three switch/indicators are on the lower row of the comparator warning monitor panel. The TEST RESET and DIM switch/indicators have green lenses and remain illuminated when power is on the dual FD/RGA system. The MSTR DISC (master disconnect) switch/indicator is red and is lighted when any subsystem warning indicator illuminates or the power supply to the comparator warning monitor circuits fails. Both the COMPAR WARNING switch/indicators (figure 4-30L) located above the pilot's and copilot's ADI's illuminate anytime the MSTR DISC switch/indicator illuminates.

The TEST RESET switch/indicator has two functions. In the TEST function, when the button is held depressed, error voltages are injected into all subsystem monitoring channels; all comparator monitor warning indicators, MSTR DISC indicator, pilots' COMPAR WARNING indicators and red attitude warning indicators should illuminate. When the TEST RESET button is released, all warning indicators should extinguish and green attitude warning indicators illuminate.

NOTE

Both RGA power switches must be ON to test the RGA comparator warning indicator.

The RESET function of the switch permits a subsystem indicator or attitude warning indicator to be extinguished after the fault has been corrected. If the TEST RESET button is not depressed after a warning indication, the subsystem or attitude warning indicator will remain illuminated even though the fault no longer exists. If the TEST RESET switch is depressed and the subsystem or attitude warning indicator remains illuminated, a fault still exists.

Depressing the master disconnect switch/indicator or either one of the comparator warning switch/indicators extinguishes the MSTR DISC and COMPAR WARNING switch/indicators unless the warning indication was caused by power failure in the warning monitor circuits. The COMPAR WARNING switch/indicators will not dim and must be turned off when illuminated due to a subsystem malfunction. In the event of another subsystem malfunction, the COMPAR WARNING and MSTR DISC switch/indicators will again illuminate.

NOTE

If the subsystem corrects itself, the COMPAR WARNING and MSTR DISC indicators will go off automatically but the subsystem indicator will remain illuminated until the TEST RESET switch/indicator is depressed.

The DIM switch/indicator, when depressed, dims all the indicators on the comparator monitor warning panel. If depressed again the indicators will return to bright.

WARNING FLAGS AND CORRECTIVE ACTION

FLAG IN VIEW DUE TO AN UNUSABLE CONDITION	COMMAND BARS DISPLAY	FLIGHT DIRECTOR MODES AFFECTED	CORRECTIVE ACTION
CMPTR	In view	All modes	Disregard command bars and use other FD/RGA System
GYRO	Out of view	All modes	Use other FD/RGA system
HEADING	Out of view	All modes	Use other FD/RGA system
NAV	Out of view	NAV/LOC APPR AUTO APPR MAN	Use HDG, RGA, or GYRO modes
GS	Out of view	APPR AUTO APPR MAN	Use HDG, RGA, GYRO or NAV/LOC modes
RUNWAY	In view	None	Disregard runway symbol display
R/T	In view	None	Disregard rate of turn display
SPEED	In view	None	Disregard speed deviation display or set APPROACH SPD DEV switch on RGA control to OFF

Figure 4-30M

Attitude Warning Indicators

The attitude warning indicators (figure 4-30L) consist of three sets of indicators which monitor the pilot's vertical gyro (PILOT ATT) autopilot gyro (A/P GYRO) and copilot's vertical gyro (COPIL ATT). The attitude warning indicators are arranged in two rows and duplicate displays are installed on the pilots' flight instrument panels. Each gyro is monitored by two indicators (top and bottom) similarly marked. The bottom indicators have green lenses and are illuminated continuously when there is no warning. The intensity of the green illumination is controlled by the ANN DIM switch. When an attitude gyro system fails, the green indicator is turned off and a non-dimmable red indicator directly above the green indicator is illuminated.

NOTE

- If two gyros fail or exceed tolerances, all three red attitude warning indicators will illuminate. In this condition the TEST RESET switch/indicator will not reset the operating gyro warning indicator if the two gyros remain out of tolerance. The operating gyro must be determined by checking the attitude director indicators for a GYRO flag and/or abnormal indication.

- It is possible that a red attitude warning indicator may illuminate due to a momentary out-of-tolerance condition. If this occurs after a previous gyro failure (one red light on), all three red attitude warning indicators will illuminate. Depressing the TEST RESET switch/indicator in this condition will reset the green attitude warning indicators for the operating gyros.

RGA Fail Operative Indicator

Two RGA FAIL OPERATIVE indicators (figure 4-30L) are installed, one on each flight instrument panel, to indicate a failure of either one of the angle-of-attack transmitters. The inoperative angle-of-attack transmitter will be cut out of the RGA system and the operating angle-of-attack transmitter will provide signals to both pilot's and copilot's RGA systems. The operating angle-of-attack transmitter will provide satisfactory RGA system performance unless the airplane is in a sideslip.

NOTE

Both RGA FAIL OPERATIVE indicators will remain on when one angle-of-attack transmitter fails (TEST RESET switch will not reset). If the second angle-of-attack transmitter fails in RGA mode, the CMPTR flag appears and command bars will drive out of view.

INTEGRATED FD/RGA SYSTEM OPERATION

The integrated dual flight director/rotation go-around system provides controls and instruments so that either pilot or copilot can manually fly the airplane through use of his own instrument display. The RGA subsystem, although capable of providing independent command bars displays, is integrated for takeoff and go-around operation in order to provide the same command information to each pilot; therefore, it is recommended that both FD/RGA systems be in the RGA mode for takeoff and go-around. Recommended operating procedures are listed in the following text. Several illustrations are provided to show the instrument panel display and control position for particular phases of operation.

FD/RGA System Preflight

The following checks are recommended if a more comprehensive preflight of the FD/RGA system is desired for pilot's checkout or familiarization.

1. RGA Power Switch - ON (P, CP)

   Check T/O ARM annunciator on and climb select switch in MAX.

2. Warning Lights and Annunciators - Check (P, CP)

   a. Press TEST RESET switch and hold - Check COMPAR. WARNING lights, comparator monitor warning lights and red attitude warning lights on.

   b. Release TEST RESET switch - All warning lights go out, attitude warning lights return to green.

   c. FD Annunciator TEST button - Depress and hold, check annunciators then release.

      Check all annunciators on pilot's and copilot's panels illuminated, both red and green attitude warning lights illuminate. Check annunciators except T/O ARM off and attitude warning lights green when TEST button is released.

3. FD HDG Mode - Checked (P, CP)

   Set flight director mode selector to HDG. Command bars should appear. Check T/O ARM, MAN PITCH and HEADING annunciators on. Slew heading marker to either side of the lubber line. Command bars should command a turn in the proper direction. Set heading marker under lubber line and check for level flight command. Rotate pitch command control throughout full range. Command bars should follow to indicate proper climb and descent commands for corresponding pitch command settings. Set command bars to 6 to 8 degree pitchup position. Turn altitude hold switch to ON and check that command bars move to the aircraft symbol, MAN PITCH annunciator off and ALT HOLD annunciator on. All other FD annunciators should remain the same.

4. ADI - Checked (P, CP)

   Depress ADI press to test button and check for a display of approximately 20 degrees right bank, 10 degrees climb; GYRO and COMPTR flags appear; command bars drive out of view. Check appropriate red attitude warning light on and respective T/O ARM annunciator OFF. Press TEST RESET to reset attitude warning light to green.

   NOTE

   Do not depress pilot's and copilot's ADI TEST buttons at the same time or all red attitude warning lights will illuminate.

5. FD NAV/LOC Mode - Checked (P, CP)

   Set course arrow to place CDI 3 to 4 degrees from center. Set flight director mode selector to NAV/LOC and check T/O ARM, ALT HOLD, NAV/LOC or TACAN, NAV CAPT annunciators on. Command bars should display a command to intercept the selected course.

   NOTE

   With both TACAN select switches on, the copilot's HSI will show same CDI deviation and TO/FROM indication as pilot's HSI regardless of copilot's course arrow position.

6. RGA Mode - Checked (P, CP)

   Set flight director mode selector to RGA. Command bars should indicate a wings-level zero pitch command and T/O MAX annunciators on. Either pilot or copilot actuate RGA switch and check that both ADIs indicate proper rotation commands.

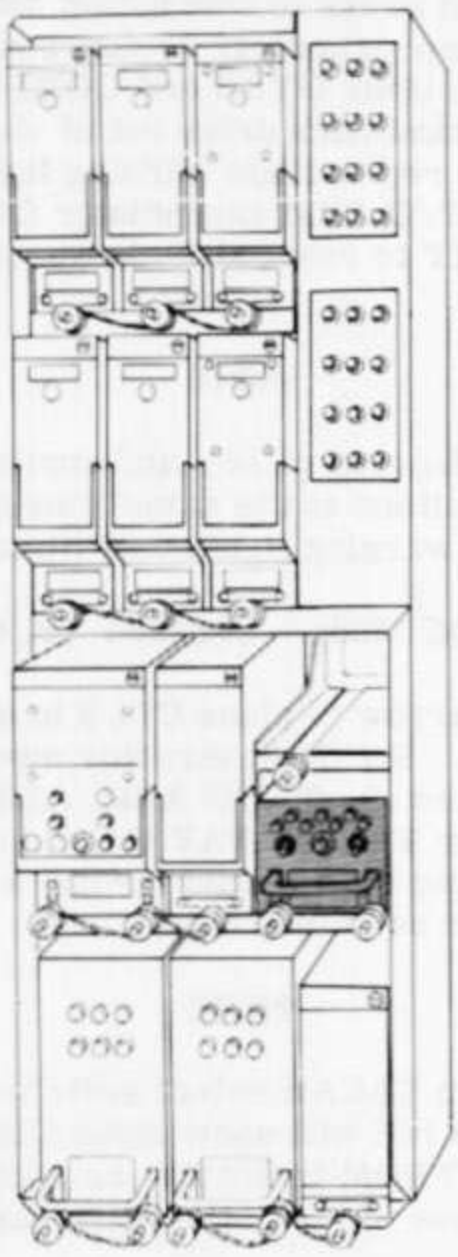
7. FD Mode Selector - GYRO (P, CP)

   Set mode selector switch to GYRO for taxiing.

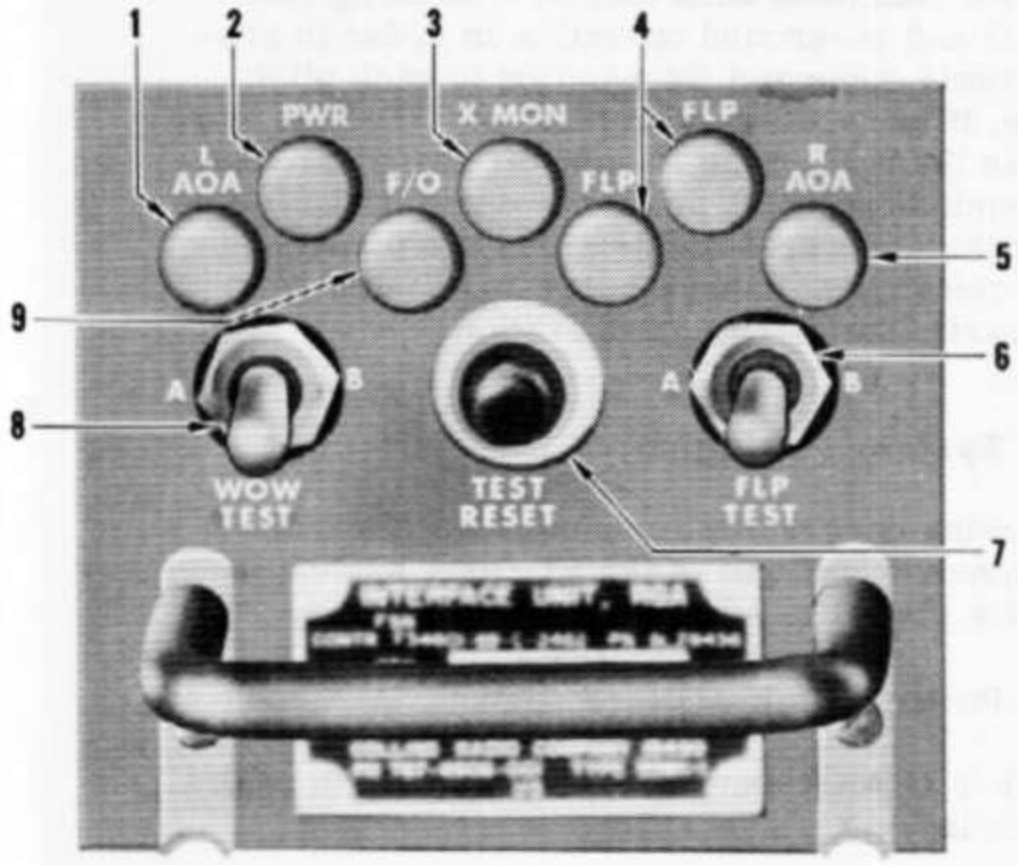
8. Radio Altimeter - Checked (P, CP)

   Press the TEST button on the radio altimeter and check altitude pointer moves to 100 feet and flag appears. Release TEST button and check that altitude pointer moves clockwise behind the mask and then returns to zero altitude indication. Flag goes out of view. Vary MDA index above and below zero and check MDA lights on ADI and radio altimeter illuminate above zero and extinguish below zero. Set MDA index below zero to extinguish MDA lights.

RGA INTERFACE UNIT



FD-109/RGA EQUIPMENT RACK

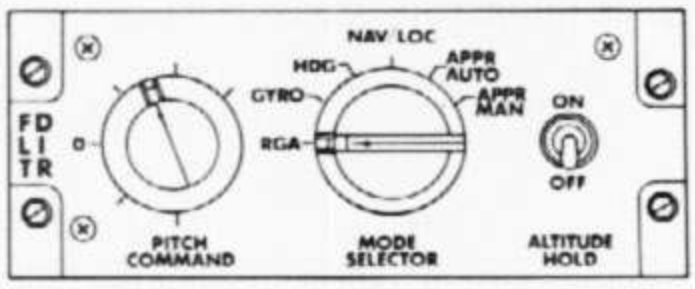


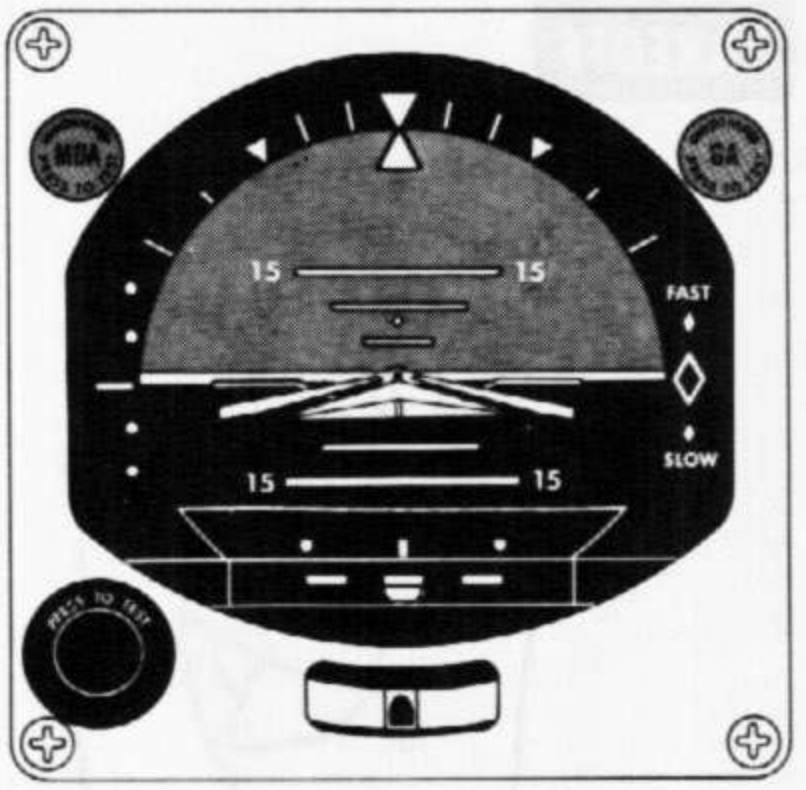
1 LEFT ANGLE-OF-ATTACK MONITOR
2 RGA SYSTEM POWER MONITOR
3 WARNING LIGHT FOR VERTICAL STEERING CROSS MONITOR
4 FLAP POSITION MONITOR
5 RIGHT ANGLE-OF-ATTACK MONITOR
6 FLAP TEST SWITCH
7 TEST SWITCH
8 WEIGHT-ON-WHEELS (WOW) TEST SWITCH
9 FAIL OPERATIVE MONITOR

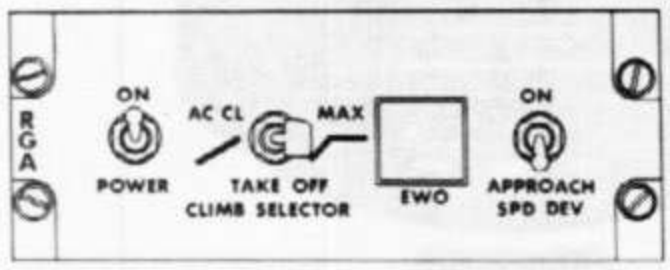
Figure 4-30N

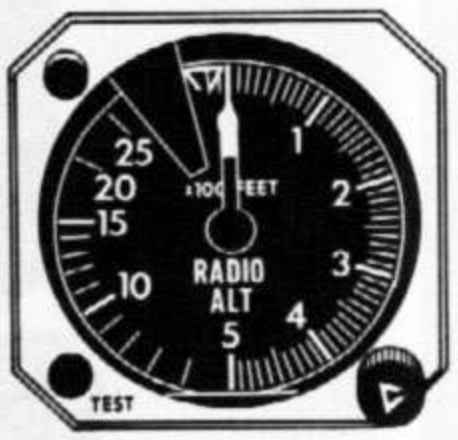
BEFORE TAKEOFF











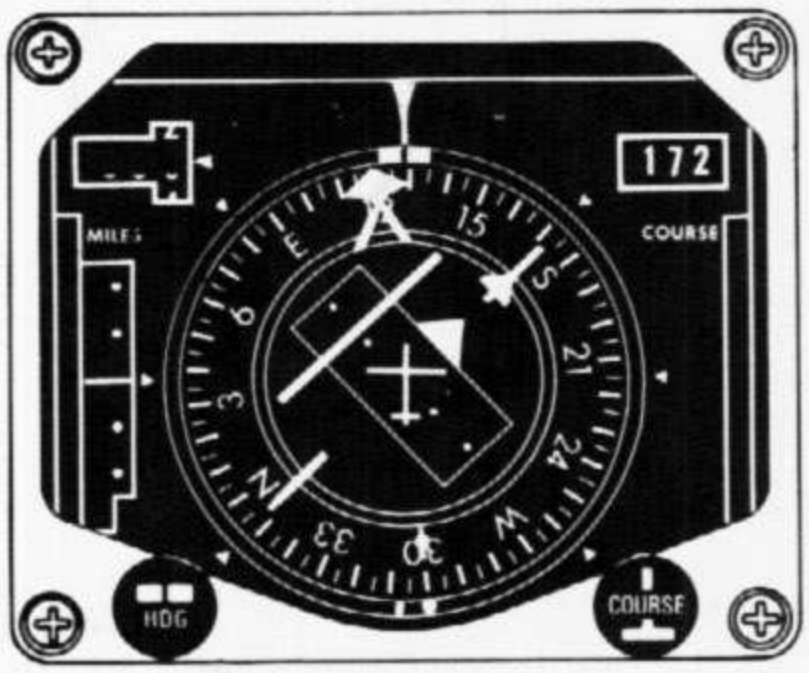




Figure 4-30-O

Before Takeoff (Figure 4-30-O)

The BEFORE TAKEOFF illustration shows the airplane lined up on the runway with all FD/RGA controls in the proper position for the takeoff using the MAX position for the rotation and climbout commands.

Takeoff (Figure 4-30P)

The TAKEOFF illustration shows command bars display after RGA pushbutton is actuated and before airplane rotation.



Figure 4-30P

After Takeoff-Climb (Figure 4-30Q)

THE AFTER TAKEOFF-CLIMB illustration shows a typical departure using a VOR radial. Check annunciators for correct indication. (Refer to figures 4-30H and 4-30K.) Set the manual pitch command knob for optimum climb command display for the climb to cruise altitude.

NOTE

The APPROACH SPD DEV switch is operable with the RGA power switch OFF; however, since the ADI speed deviation pointer operates only in relation to optimum pattern/approach airspeeds, the speed pointer will not provide valid indications for other flight conditions.

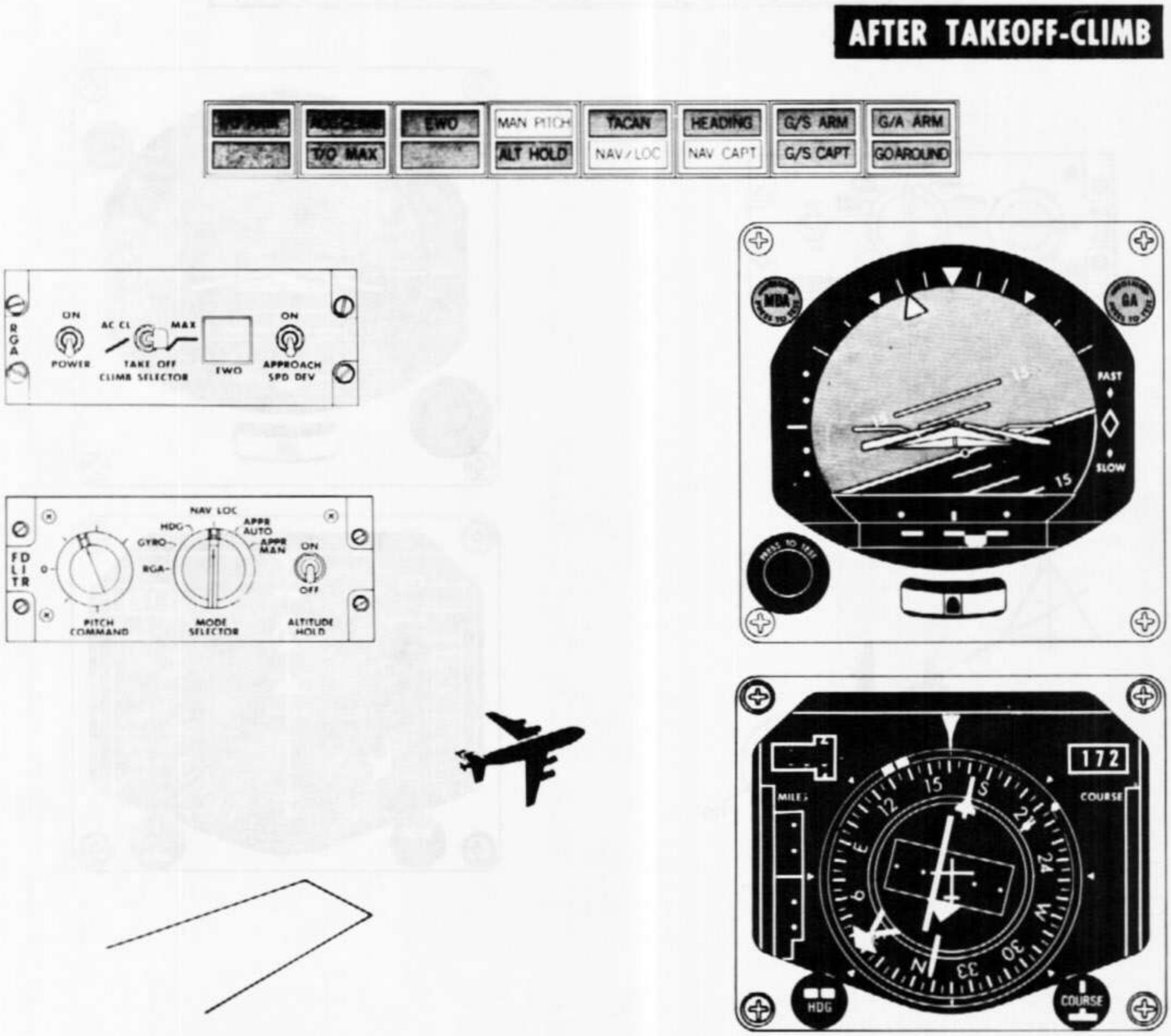


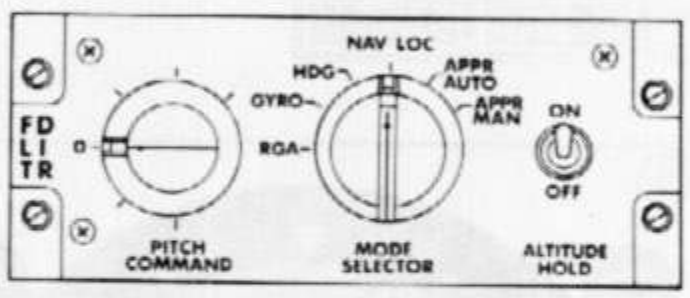
Figure 4-30Q

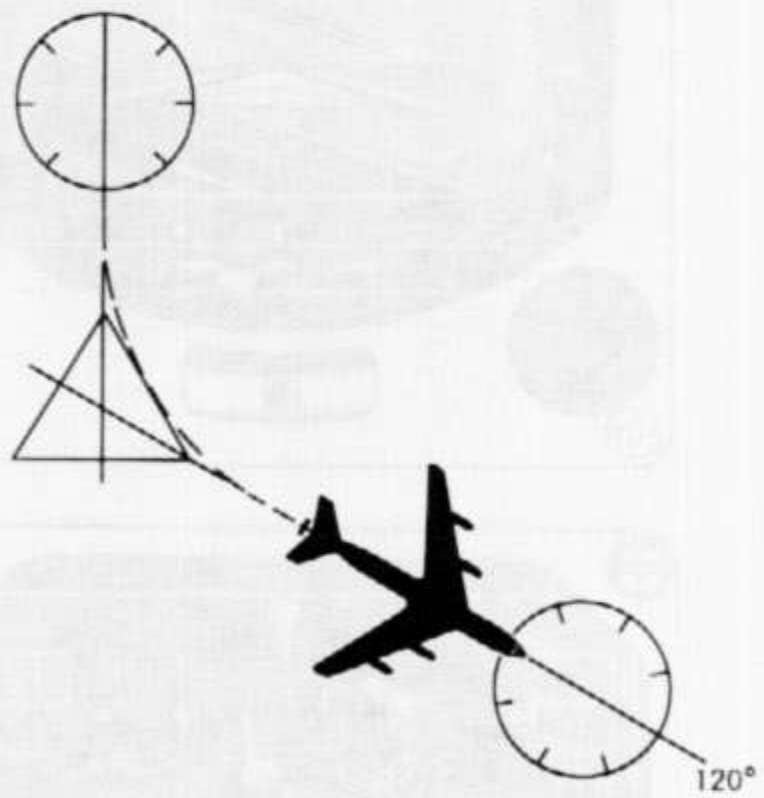
Climb and Level Off

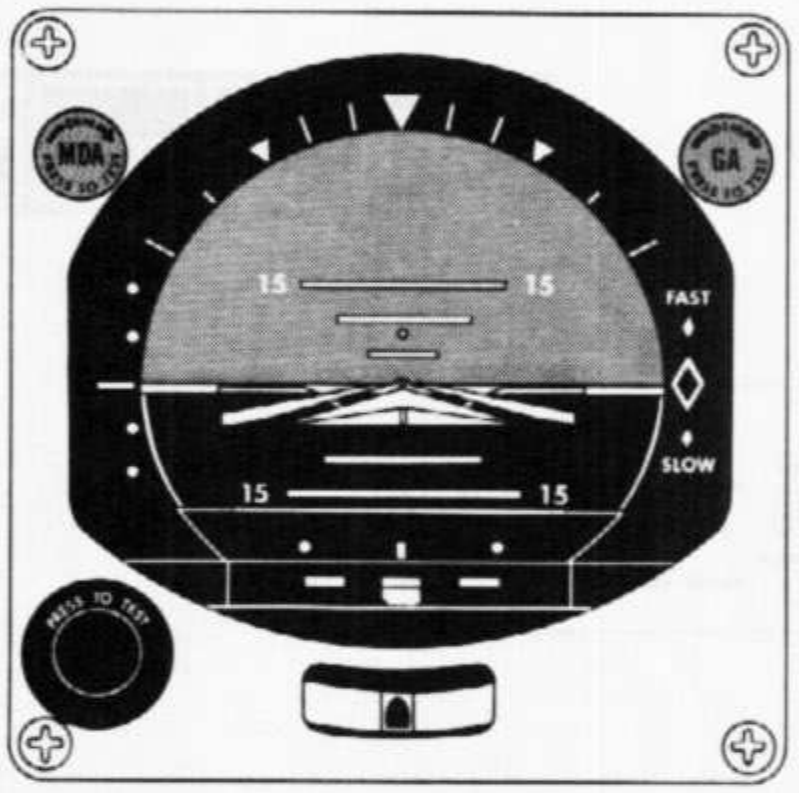
Follow the command bars during climb after setting the optimum pitch attitude. If heading vectors are being provided by air traffic control, HDG mode should be used until a radio course capture is desired. Reset course arrow if a new departure course is assigned and after switching to NAV/LOC mode, check annunciators for correct mode. Upon reaching cruise altitude, perform level-off, then adjust pitch command knob to align command bars with airplane symbol.

CRUISE-ON COURSE









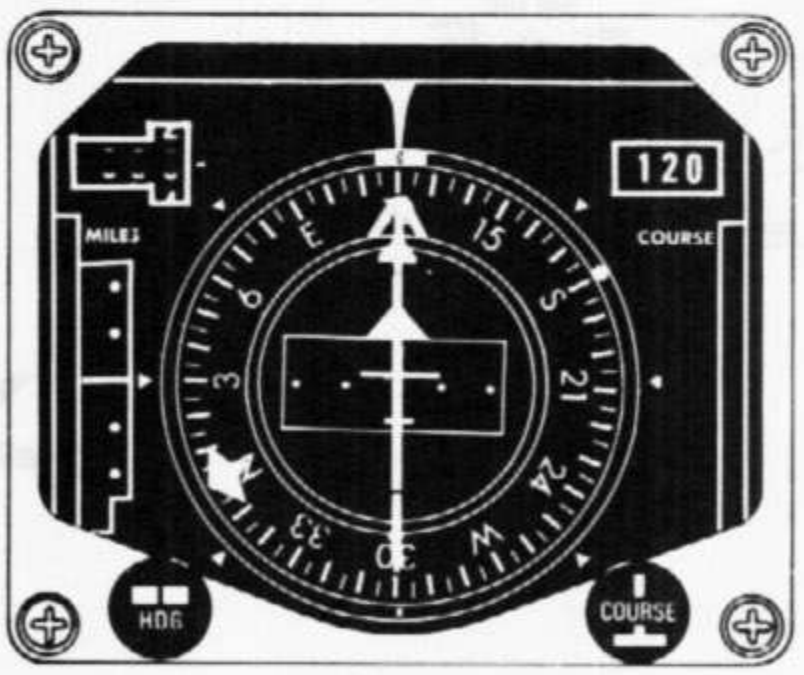


Figure 4-3UR

Cruise (Figures 4-30R and 4-30S)

A typical cruise configuration is shown in the CRUISE-ON COURSE illustration. If flight is to be maintained at a particular barometric altitude, set the FD altitude hold switch ON. Command bars will display commands to maintain the cruise altitude. Enroute climb or descent commands may be obtained any time by turning the altitude hold switch OFF and rotating the pitch command knob up or down for desired climb or descent attitude. The command bars automatically provide crosswind correction for course tracking when in NAV/LOC mode. If HDG mode is selected for cruise navigation, crosswind correction must be determined and the heading marker set to allow for wind drift.

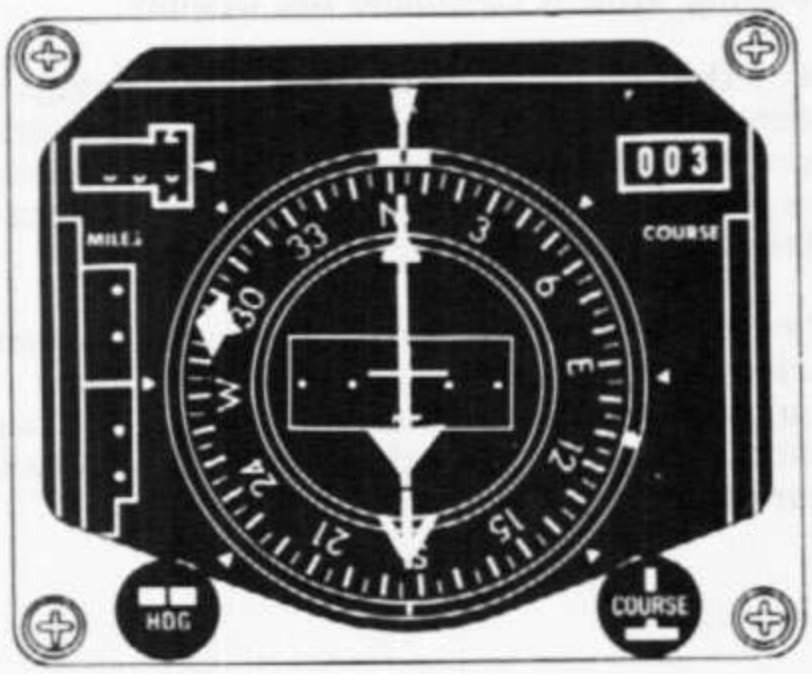
NOTE

Always set the flight director mode selector to HDG or GYRO before changing radio frequency to a new station or switching radio navigation receivers (VOR - TACAN).

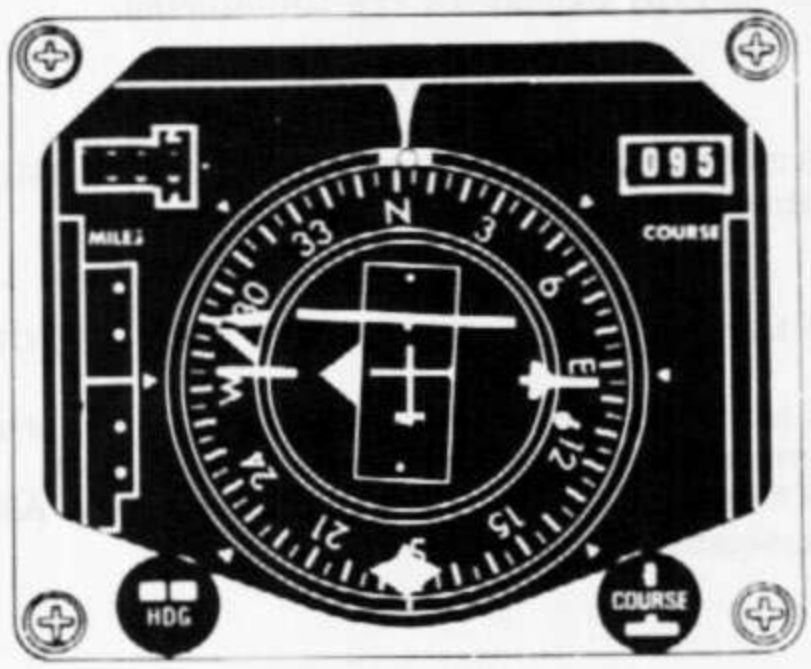
Station passage is indicated on the HSI when the first FROM indication is displayed on the TO/FROM pointer (VOR) or the range indication stops decreasing (TACAN). The ADI command bars will continue to provide course tracking commands during station passage. If the new course to be followed is more than 10 degrees from present course, rotate the FD mode selector to HDG, set the new course and then reset to NAV/LOC mode. Set the heading marker to desired intercept heading and the command bars will provide commands to intercept and capture the new course.

During cruise the angle-of-attack indicator can be used to maintain an optimum angle of attack for maximum range or maximum endurance. The index markings on the angle-of-attack indicator provide a pointer reference for maximum range and maximum endurance. Experience with the angle-of-attack pointer position will aid the pilot in establishing and maintaining best flight angle-of-attack for other cruise conditions.

CRUISE-POSITION FIX



PILOT'S HSI



COPILOT'S HSI

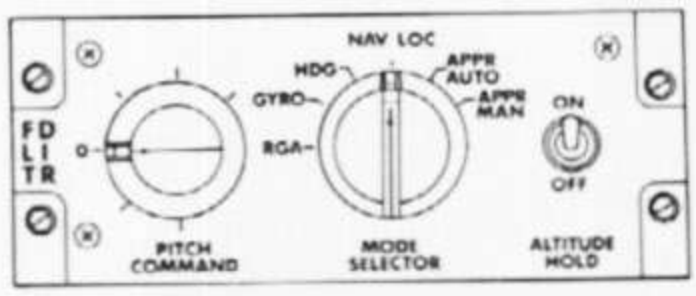
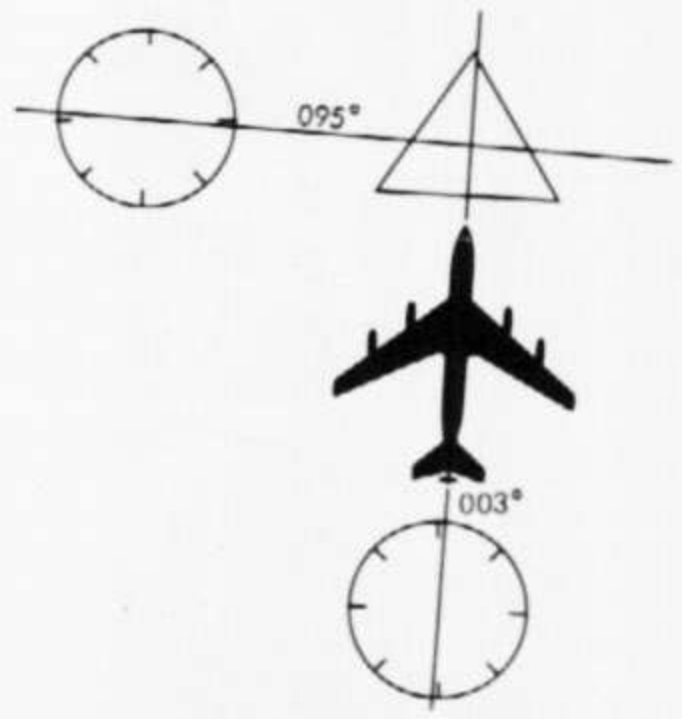


Figure 4-30S



Descent

Enroute descent and penetration procedures are performed using normal instrument procedures. Heading and course following can be accomplished by selecting the respective mode. The manual pitch command control is set for the desired descent command attitude indication, either prior to or after initiating descent. When level-off altitude is reached, the FD altitude hold switch can be turned on for level flight commands.

During cruise or descent both RGA power switches may be turned on. If a check of the RGA go-around function is desired perform the following steps:

A. RGA Power Switch - ON (P, CP)

Check G/A ARM annunciator is illuminated.

B. FD Mode Selector - As desired, other than RGA (P, CP)

C. RGA/AP Pushbutton Switch - Actuate (P, CP)

When RGA pushbutton switch is actuated, the command bars should display approximately 7 degrees pitch up command and FD mode selector will move to RGA position. Check GO AROUND and ADI GA indicators are illuminated.

NOTE

Actuation of the RGA pushbutton switch will disconnect the autopilot (if engaged).

D. FD Mode Selector - HDG or NAV/LOC (P, CP)

Set mode selector in HDG or NAV/LOC to provide command bars display for the descent. GO AROUND and GA indicators go off and G/A ARM annunciator illuminates.

Holding (Figure 4-30T)

For a command bars display for holding, perform the following:

A. Select HDG on FD mode selector, tune navigation receiver to desired station and set HSI course arrow to inbound course. The CDI now represents the inbound course and, when centered, indicates the airplane is on the selected inbound course.

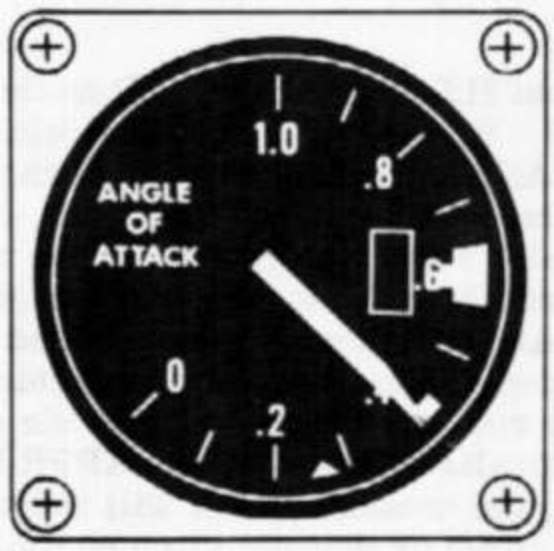
B. Slew heading marker to heading required to maintain inbound course. The heading marker must be set to provide commands to maintain the CDI centered while inbound. If automatic tracking of the inbound course is desired, the mode selector switch must be placed in NAV/LOC position after approximately 90 degrees of inbound turn is completed.

C. When the airplane reaches the holding point, the heading marker should be moved approximately 90 degrees in direction of turn to provide a bank command toward the outbound heading. As the turn progresses, continue to slew the heading marker to the outbound heading. If crosswind correction is required, move heading marker to compensate for the crosswind.

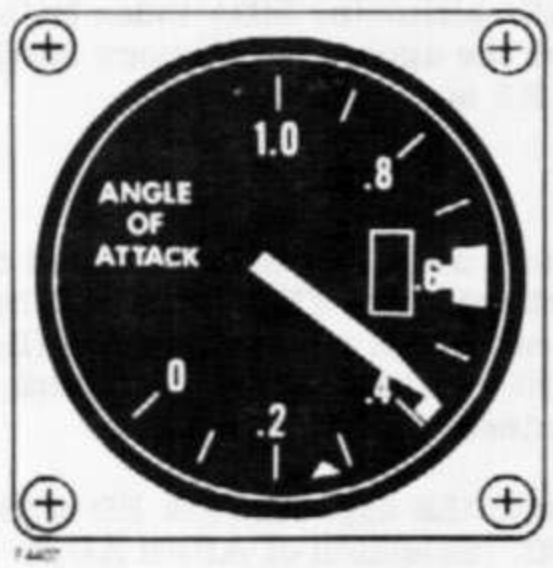
For holding without command bar display:

A. Set FD mode selector to GYRO, tune navigation receiver to desired station and set HSI course arrow to inbound course. Follow indications on the HSI to center the course deviation indicator. Maintain the CDI centered while inbound.

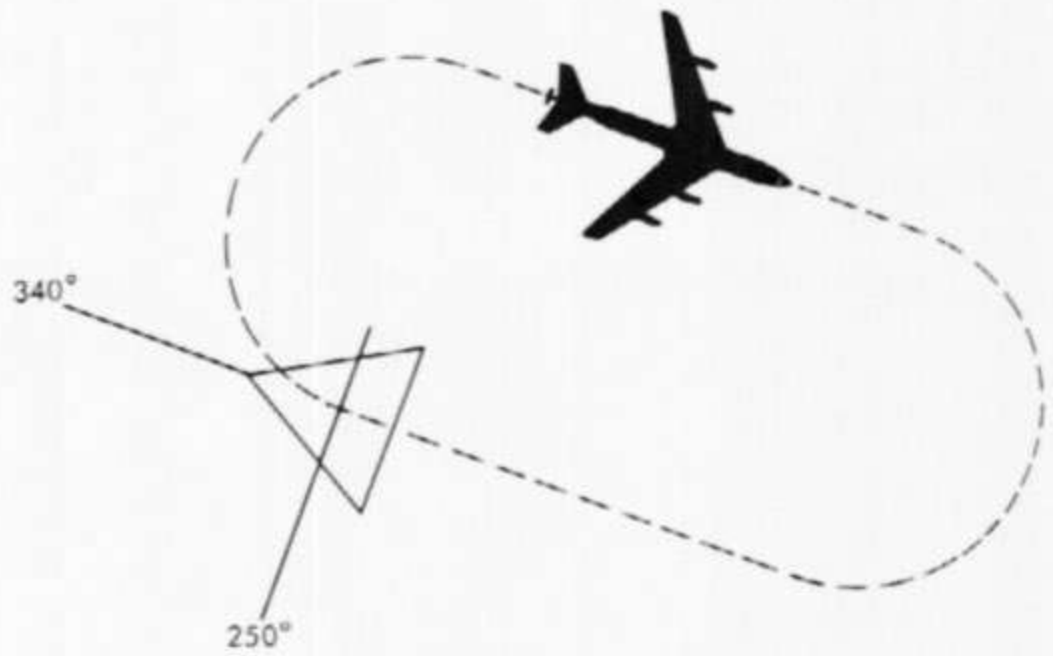
B. Slew the heading marker to the outbound heading prior to starting the turn from the inbound course to provide a reference for the outbound holding leg. Set correction for crosswind as required.



ANGLE OF ATTACK INDICATION
FOR STRAIGHT AND LEVEL



ANGLE OF ATTACK INDICATION
FOR TURNS



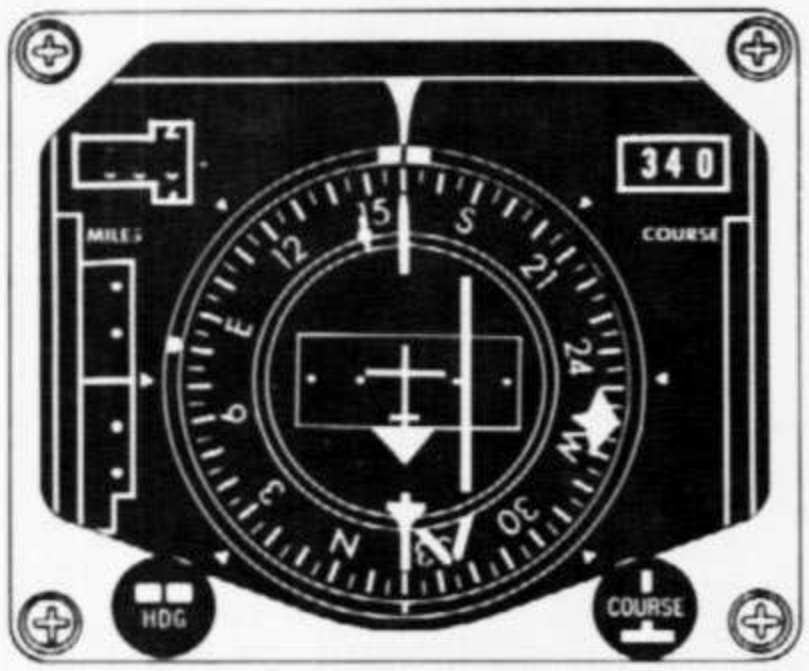


Figure 4-30T

ILS Approach (Figures 4-30U and 4-30V)

Two modes, APPR AUTO and APPR MAN, are provided for making an ILS approach. The APPR AUTO mode provides an approach with automatic capture of the localizer and glide slope beams. The APPR MAN mode bypasses the automatic capture feature and immediately provides commands to fly to the localizer and glide slope beams. For an ILS approach complete the following steps:

A. Ensure RGA power switch is on to arm the RGA system for go-around (G/A ARM annunciator illuminated).

B. Check speed deviation pointer on ADI is in view and indicates correct deviation. When angle of attack indicator pointer shows a reading lower than .6 (approach speed index), the speed deviation pointer should indicate FAST. If angle-of-attack pointer is reading higher than .6, then speed deviation pointer should indicate SLOW.

C. Rotate the mode selector switch to HDG and tune the VOR/LOC navigation receiver to the desired localizer frequency.

NOTE

It is necessary to tune both the pilot's and copilot's navigation receivers to the localizer frequency to provide correct comparator monitor warning indication (LOC, RADIO ALT, GLIDE SLOPE).

ILS Approach (Cont)

D. Set course arrow to inbound course and check CDI and ADI runway symbol for proper indication to the localizer beam.

E. Set the radio altimeter MDA index to the minimum altitude for the approach (decision height) when a published RA approach is used.

NOTE

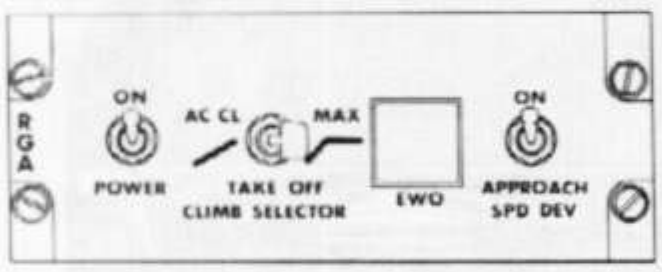
The radio altimeter may be tested during descent using the TEST button. The MDA index can be set any time during flight when the destination approach minimum is determined.

For an automatic ILS approach set FD mode selector to APPR AUTO. Selection of APPR AUTO arms the FD system for capture of the localizer and glide slope beams. If the airplane is not within capture range of the localizer, the command bars will display commands to the heading set on the heading marker (NAV/LOC and HEADING annunciators on). As the localizer beam is approached, the NAV CAPT annunciator will illuminate (HEADING annunciator goes off) to indicate localizer capture and the command bars will display a bank to intercept the localizer course. The G/S ARM annunciator will come on at localizer capture to show the system is armed for glide slope capture.

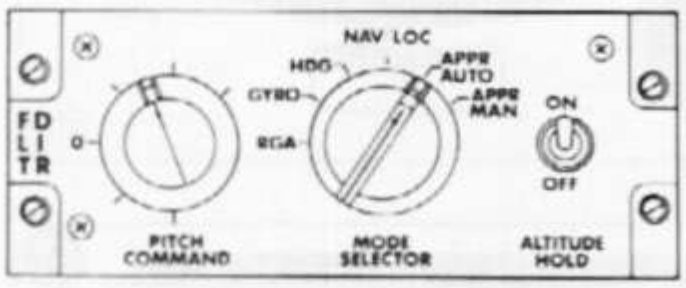
For a manual ILS approach set FD mode selector to APPR MAN. When the FD mode selector is moved to APPR MAN, immediate capture of the localizer and glide slope is indicated (NAV LOC, NAV CAPT and G/S CAPT annunciators on). If the airplane is not close enough to the localizer for capture, the command bars will display a bank based on a fixed 30 degree angle intercept. After reaching capture position the command bars will provide commands to follow the localizer beam. When APPR MAN mode is selected, the command bars will indicate an immediate climb or descent pitch command to the glide slope beam. The pitch command display may be as much as 15 degrees up or 10 degrees down, depending on the airplane position relative to the glide slope beam.

ILS APPROACH (APPR AUTO)















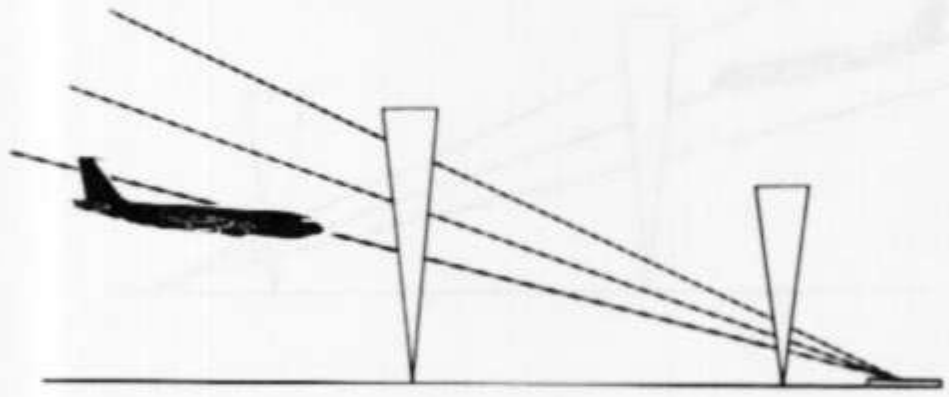
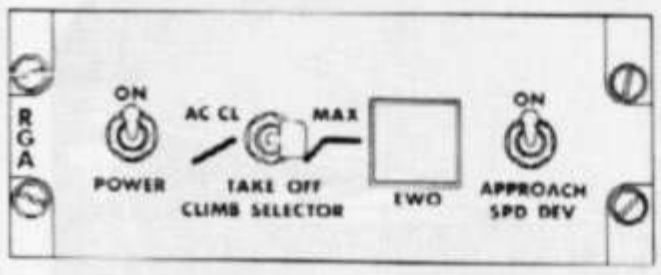
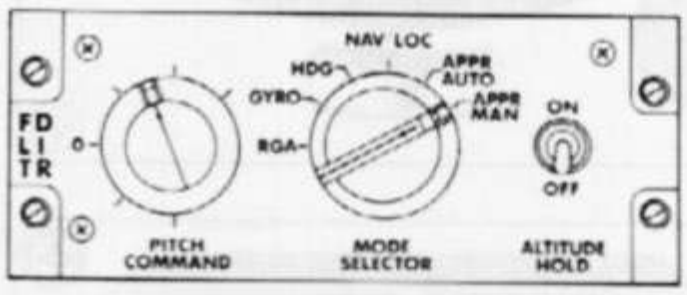


Figure 4-30U

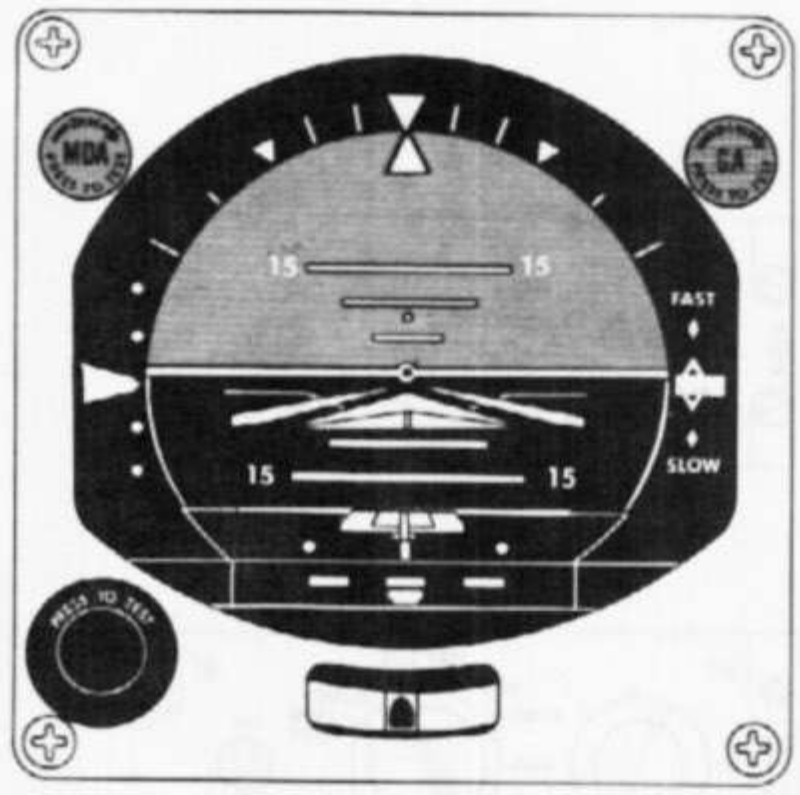
ILS APPROACH (APPR MAN)

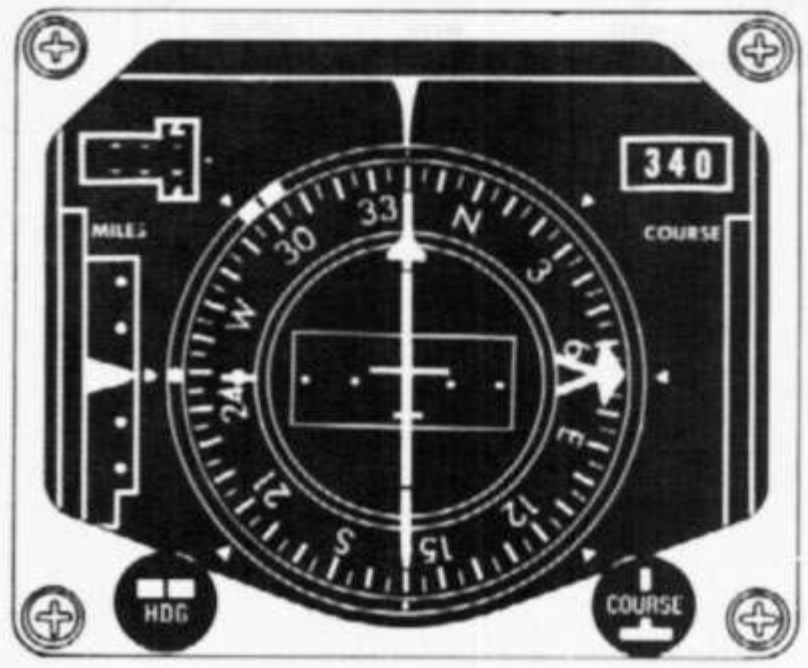


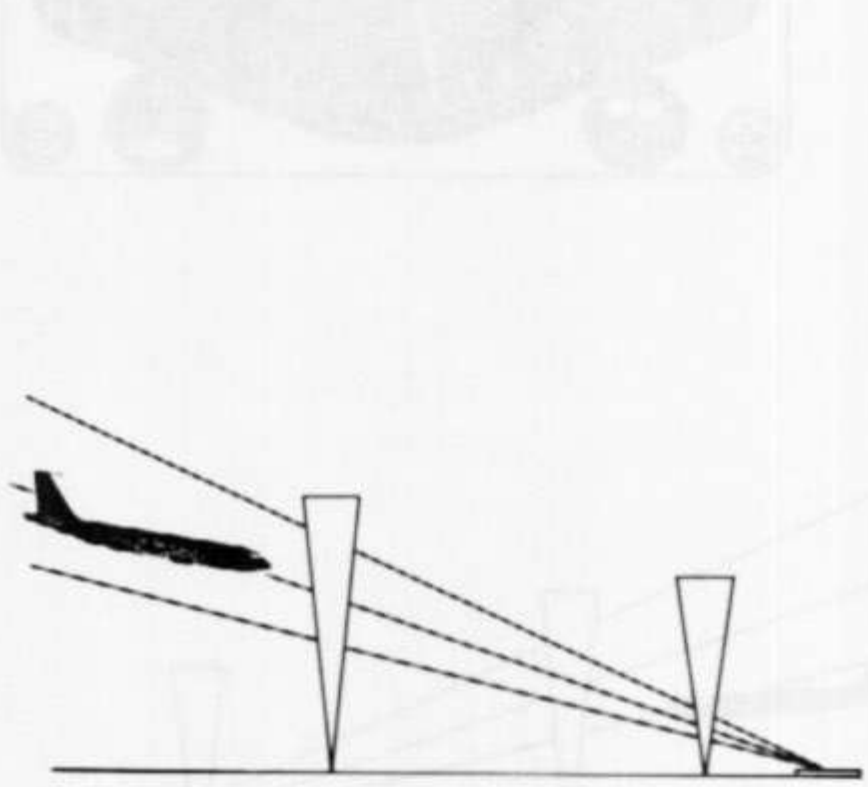












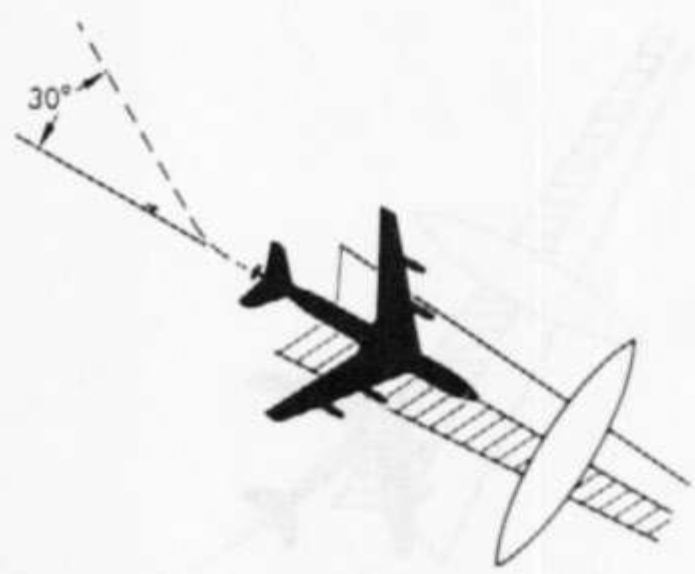


Figure 4-30V

In the ILS APPROACH (APPR AUTO) illustration the instruments and controls are displayed for after localizer capture and before glide slope capture. The altitude hold switch is set ON to provide level flight commands, but will automatically switch off when the glide slope is captured. The manual pitch command knob is preset for the missed approach climb after the altitude hold switch is positioned ON. Glide slope capture will also prevent the selected manual pitch command from being displayed by the command bars. The heading marker can be slewed to the missed approach heading after localizer capture when the NAV CAPT annunciator comes on. The speed deviation pointer, runway symbol, glide slope pointer and radio altimeter are crosschecked during the approach as aids to command bars presentation. As the minimum decision altitude is approached, the attitude director indicator displays all the information needed by the pilot for precision tracking of the ILS and, in addition, provides an altitude reference (runway symbol) from 200 feet to touchdown. The MDA indicator will illuminate when the airplane reaches the decision altitude which was preset on the radio altimeter MDA index prior to the approach.

In the ILS APPROACH (APPR MAN) illustration the airplane is positioned on the localizer and glide slope. The command bars display is followed to touchdown as in APPR AUTO mode. If desired, after selecting APPR MAN mode, the manual pitch command control and heading marker can be set for missed approach.

NOTE

The APPR MAN mode is provided for use during close-in approaches when immediate commands to the localizer and glide slope are desired. If selected prior to reaching a position where localizer or glide slope signals are strong enough to prevent appearance of a warning flag, the command bars will drive out of view.

Localizer Backcourse Approach (Figure 4-30W)

The flight director system does not provide commands for a back course approach; therefore, the localizer backcourse approach is flown with the FD mode selector in either GYRO or HDG. In HDG mode, the pilot manually controls the heading and pitch inputs to the command bars for use in the approach. Always set the course arrow to the published inbound front course to provide directional indications on the horizontal situation indicator to avoid reversed CDI indications.

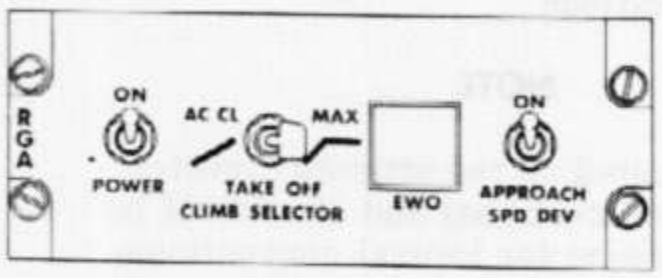
NOTE

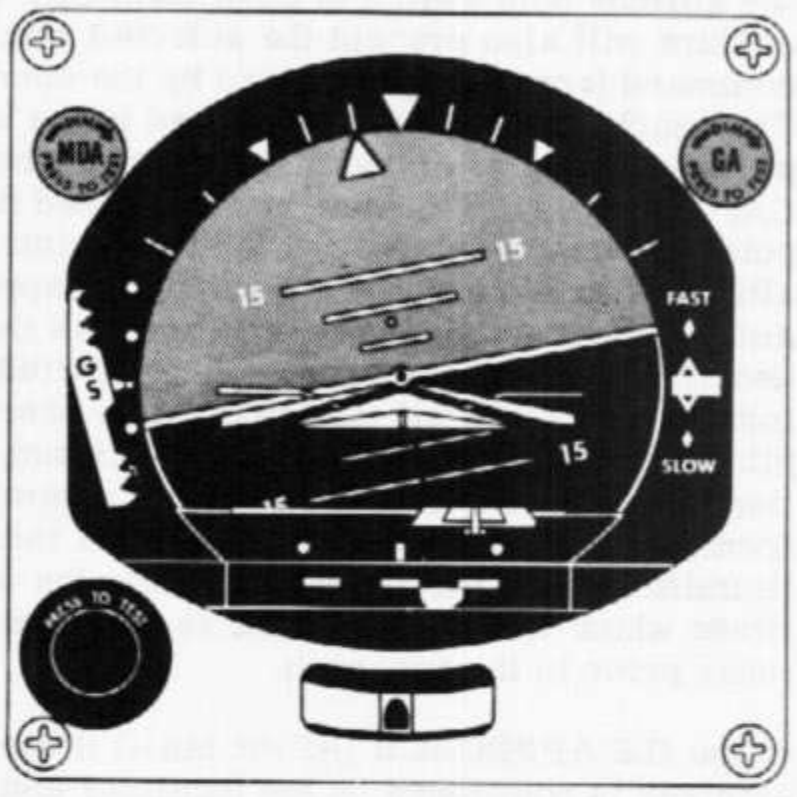
The runway symbol on the attitude director indicator is nondirectional and should not be used as a reference for lateral corrections.

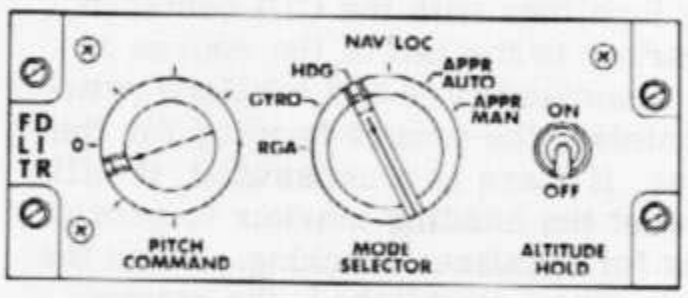
In HDG mode, intercept the backcourse using the heading marker for intercept angle desired and, when established on the localizer with the CDI centered, set the heading marker to the tail of the course arrow. Keeping the command bars and airplane symbol aligned will maintain the proper heading for the approach. However, if there is a crosswind, it will be necessary to reset the heading marker to provide correct commands for localizer tracking. When the desired rate of descent is established, the manual pitch command knob may be adjusted to align the command bars with the airplane symbol; this will provide pitch commands to maintain the desired rate of descent. The radio altimeter can be used as a reference for the minimum altitude if the approach terrain permits. The MDA index should be preset to the minimum altitude for the approach and when this altitude is reached, the MDA indicator will illuminate.

LOCALIZER BACKCOURSE APPROACH

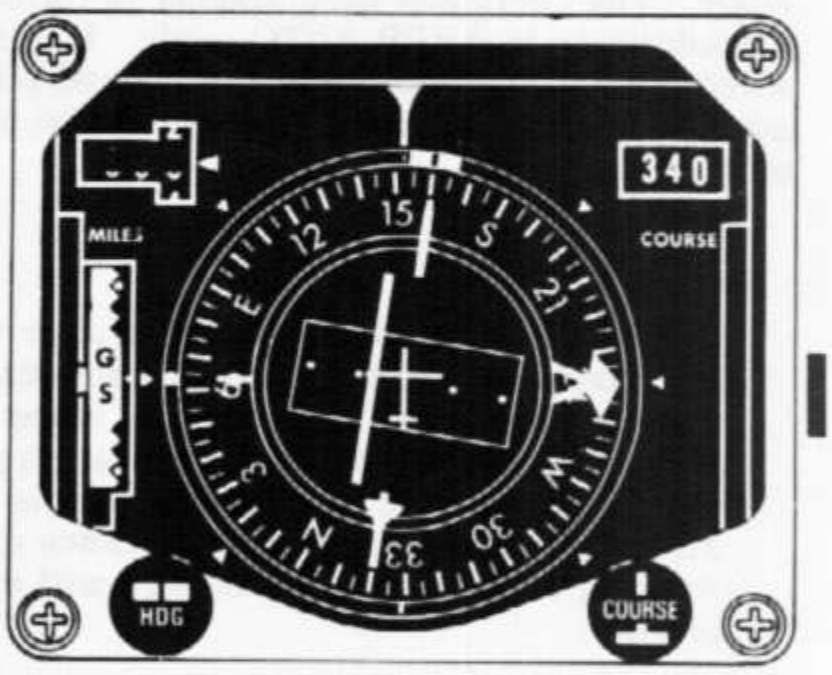












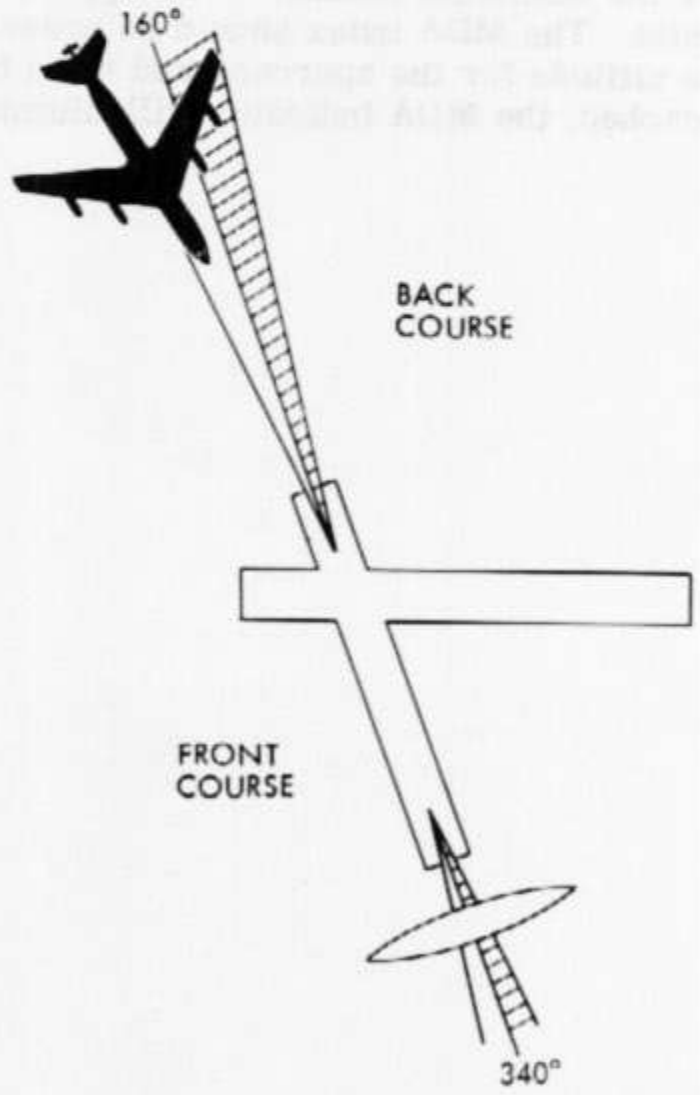


Figure 4-30W

Go-Around (Figure 4-30X)

The command bars will display go-around commands when the RGA pushbutton switch is activated during the approach. The FD mode selector moves to RGA position and the GO AROUND annunciator and ADI GA indicator will illuminate to indicate go-around mode has been selected.

NOTE

A malfunction indication will be generated on the respective ADI when airborne and the RGA mode is manually selected before actuating the RGA switch. The ADI CMPTR flag will appear and the command bars will drive from view. In this condition, if the RGA pushbutton switch is actuated, the command bars will reappear and a valid go-around command will be displayed provided the RGA mode was manually selected while the airplane was in a constant speed condition.

The command bars display a 7 degree initial pitch up attitude when the RGA pushbutton switch is actuated for go-around. Computed commands are then displayed for the airplane climbout. After reaching the desired missed approach climb attitude, set the FD mode selector to desired mode; the preset heading and manual pitch commands will be displayed. A typical go-around is shown in the illustration. In addition to providing a go-around indication and command bar display, the approach speed deviation switch will revert to off when the RGA pushbutton switch is actuated.

Touch and Go Landing

Due to deceleration forces encountered on landing as the WOW switch closes, the RGA command bars "flare" commands on a subsequent takeoff (touch and go landing) may not be as accurate as when the RGA selection is made while maintaining a constant speed. For RGA training during touch and go landings, a more accurate RGA display may be obtained if the pilot not flying the airplane selects RGA mode prior to touchdown.

Figure 4-30X

AIR REFUELING FLOODLIGHT ILLUMINATION

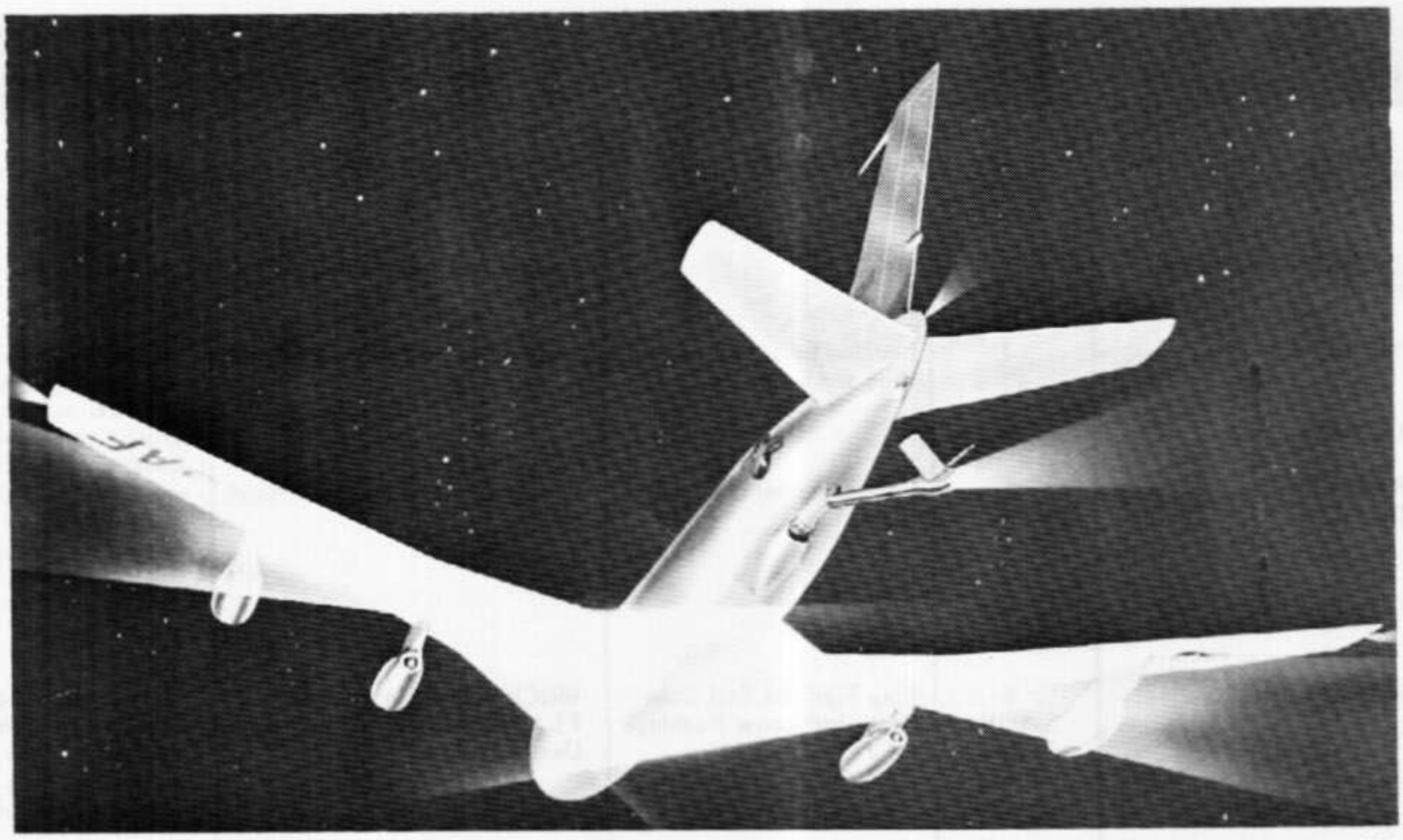


Figure 4-31

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LIGHTING EQUIPMENT

EXTERIOR LIGHTS

The exterior lights operate on both AC and DC power. Figure 4-32 shows light locations, switch locations and protective circuit breakers. Figure 1-36 shows the operating voltages. Special lighting equipment is provided for tanker underbody illumination and underwing illumination during night air refueling missions. Tanker floodlighting as seen from the receiver is shown in figure 4-31. The landing lights consist of a landing light in each wing leading edge and one light on the nose gear; these lights are operated by placing the LANDING, TAXI AND WING ILLUMINATION LIGHT SWITCH to the LANDING position. A retractable terrain light in the right wing is provided to aid in terrain lighting during night landings and takeoffs. A taxi light is installed on each wing leading edge. The nose landing light also operates as a taxi light. The taxi lights and nacelle illumination lights operate simultaneously and are controlled by placing the LANDING, TAXI AND WING ILLUMINATION LIGHT SWITCH to the TAXI & WING ILLUM position. The nacelle illumination lights may also be operated from the boom operator's panel. Rotating beacon lights on the fuselage are for anticollision and rendezvous purposes.

NOTE

- Refer to Section V for limitations on lights.
- The navigation lights and rotating beacon lights are wired so that when the beacon lights are on, the navigation body lights will be off.

INTERIOR LIGHTS

Interior lighting uses both AC and DC power. See figure 4-33 for light locations, switch location and protective circuit breakers. Figure 1-36 shows operating voltages for interior lighting groups. A light is installed over the crew entry chute to aid in night entry. Two switches are provided for the light, one on the aft wall of the crew entry chute and one on the forward end of the SBCBP. Additional lighting for night entry is provided by the alert lighting. The alert lighting consists of the overhead thunderstorm light in the control cabin and the dome light over the APU. Both are powered from the circuit breaker marked ENTRY DOOR LIGHT on the BATTERY CBP (figure 1-35, sheet 1) when airplane power is not available. When DC power is available to T-R No. 2 of the MCBP, the alert lights relay, powered from the circuit breaker marked ALERT LIGHTS, will switch the DC power for the alert lights from the battery to their normal power source. Switches for the alert lights are on the forward end of the SBCBP (figure 1-35, sheet 1).

CAUTION

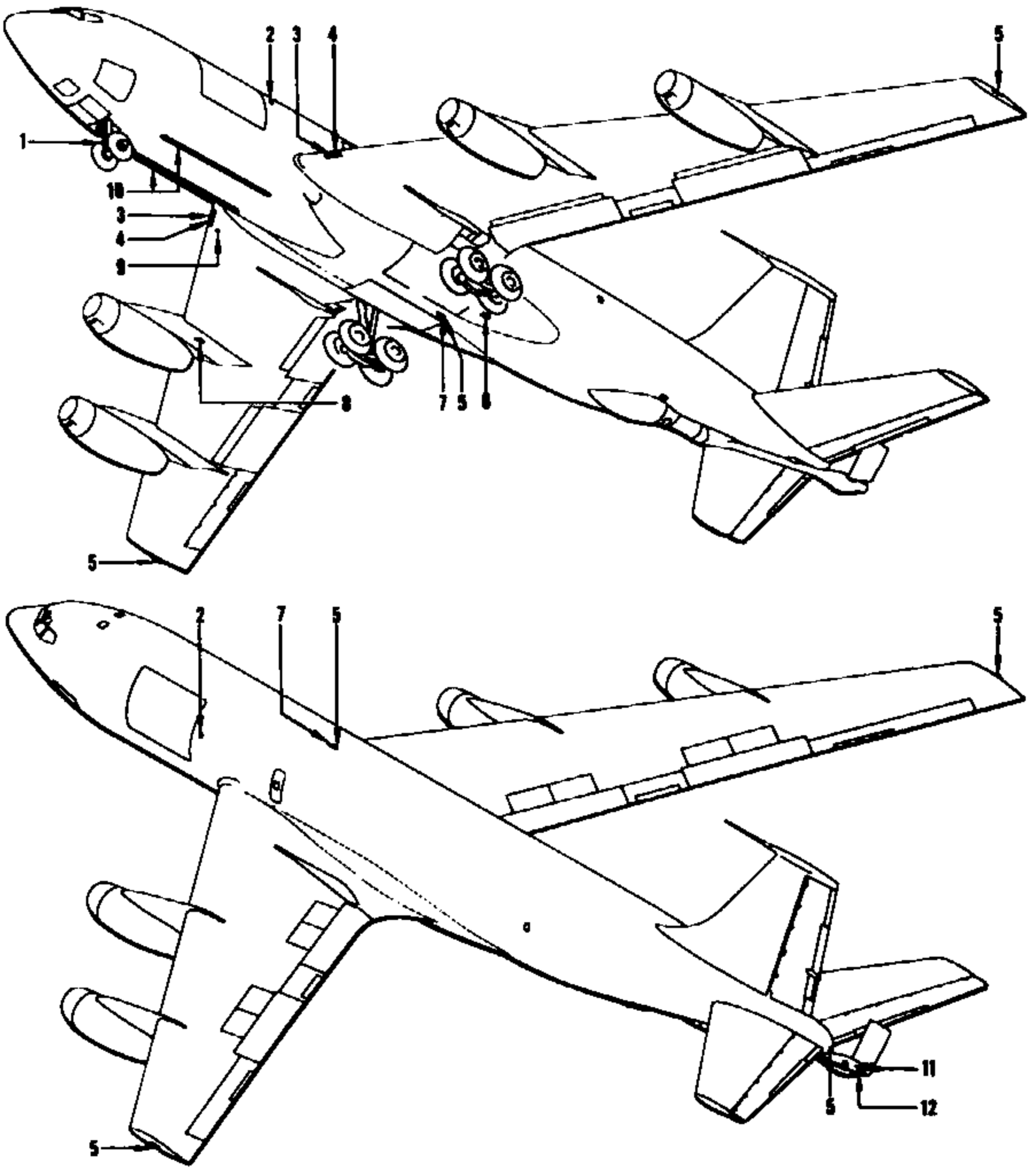
Turn the SIDE PANEL DIM control OFF prior to changing any light bulbs on the pilots' side panels when power is on the airplane.

EXTERIOR LIGHTING

LIGHTS	* QTY COLOR	LIGHT LOCATION	SWITCH LOCATION	NO. OF CB'S LABEL & LOC
BOOM LIGHTING NOZZLE LIGHT	1 White	In Boom Nozzle Hood	Rheostat Switch on Boom Operator's Panel	(1) Boom, Noz Light on the BOCBP
FLUORESCENT MARKER LIGHT	2 Ultra Violet		Control and Start Switch on Boom Operator's Panel	(1) Boom Marker Lights on the BOCBP
LANDING LIGHTS	3 White	Leading Edge of Inboard Wing and Nose Gear	Pilot's Center Instrument Panel	(4) Landing Light Wing and Landing Light Nose and Taxi and Landing Light Control and Ret. Landing Light Control on the MCBP. On airplanes 376▶ (1) in lower nose compartment, (2) in R wing, (1) in L wing adjacent to light fixture
TAXI LIGHTS	2 White			
TERRAIN LIGHT (RETRACTABLE)	1 White	Under Leading Edge of Right Wing	Pilot's Center Instrument Panel	
NAVIGATION LIGHTS	8 White Red Green Yellow	Wing Tips and Tail Cone Upper and Lower Fuselage	BRIGHT--DIM Switch and FLASHING--STEADY Switch On Overhead Panel	(3) Navigator Light Flasher and Light, Navigation-Body and Navigation Wing and Tail on the MCBP
RECEIVER PILOT DIRECTOR LIGHTS	18 White Red Green	Lower Surface of Fuselage Forward of Leading Edge of Wing	Four Rheostat Switches on Boom Operator's Instrument Panel	(2) External Lights, Receiver Director on the BOCBP
ROTATING BEACON LIGHTS	8 Red Green White	Upper and Lower Surface of Fuselage at Trailing Edge of Wing	Overhead Panel	(2) Rendezvous, Lower and Upper on the MCBP
SIGNAL LAMP	1 White	Forward Emergency Equipment Panel	Switch on Signal Lamp	(1) Portable Signal on the MCBP
NACELLE ILLUMINATION	2 White	On Fuselage Above and Forward of the Leading Edge of Wing	Pilot's Center Instrument Panel and Boom Operator's Panel	(1) External Lights, NAC on the BOCBP
UNDER BODY ILLUMINATION	2 White	Inboard Side of Each Inboard Engine Strut	Rheostat Switch on Boom Operator's Instrument Panel	(1) Under Body Illum on the BOCBP
UNDER WING ILLUMINATION	2 White	Lower Wing to Body Fairing Aft of Each Wing	Rheostat Switch on Boom Operator's Panel	(1) Under Wing Illum on the BOCBP
WHEEL WELL LIGHTS	3 White	One in Each Wheel Well	Overhead Panel and Single Point Refueling Panel	(1) Wheel Well on the MCBP and (3) Single Point Refuel on the Battery Circuit Breaker Panel

* All color lights are white bulbs with color filters

Figure 4-32 (Sheet 1 of 2)



1 NOSE LANDING AND TAXI LIGHT
2 NACELLE ILLUMINATION LIGHT (TYPICAL) (2 PLACES)
3. TAXI LIGHT (2 PLACES)
4 LANDING LIGHT (FIXED) (2 PLACES)
5 NAVIGATION LIGHT (7 PLACES)
6 UNDERWING ILLUMINATION LIGHT (TYPICAL)
7 ROTATING BEACON LIGHTS (2 PLACES)
8 UNDERBODY ILLUMINATION LIGHT (TYPICAL)
9 TERRAIN LIGHT (RETRACTABLE)
10 RECEIVER PILOT DIRECTOR LIGHTS
11 BOOM MARKER LIGHTS (FLUORESCENT)
12 BOOM NOZZLE LIGHT

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Figure 4-32 (Sheet 2 of 2)

INTERIOR LIGHTING

LIGHTS	*QTY COLOR	LIGHT LOCATION	SWITCH LOCATION	NO. OF CB'S LABEL & LOC
PILOTS'				
PILOTS' FORWARD AND SIDE PANEL FLOOD LIGHTS	2 Red	Pilots' Instrument Panel Light and Glare Shield	Rheostat Switch on Pilot's Overhead Light Control Panel	(1) Flood, Pilot Panel on the MCBP
PILOTS' INSTRUMENT PANEL AND CONTROL CABIN THUNDERSTORM LIGHTS	2 White 1 White	Pilots' Instrument Panel Light and Glare Shield, Aft of Overhead Panel	Rheostat Switch on Pilot's Overhead Light Control Panel	(1) Thunderstorm On the MCBP
PILOT'S AND CREW INSTRUCTOR SPOT AND MAP READING LIGHTS	2 White or Red	Above and Left of Pilot Above and Left of Crew Instructor	Rheostat Switch on Spotlight Cover	(1) Pilot's Spotlight on the SBCBP
COPILOT'S SPOT AND MAP READING LIGHT	1 White or Red	Above and Right of Copilot	Rheostat Switch on Spotlight Cover	(1) Spotlights on the CIPP
PILOTS' CONTROL STAND FLOOD LIGHT	1 Red	Aft of Overhead Panel	Rheostat Switch on Pilot's Overhead Light Control Panel	(1) Flood, Control Stand on the MCBP
MAGNETIC COMPASS LIGHT	1 Red	Magnetic Compass, Top Center of Pilots' Instrument Panel	Rheostat Switch on Copilot's Overhead Light Control Panel	(1) Magnetic Compass Light on the SBCBP
TAKEOFF AND LANDING DATA CARD HOLDER WITH TCTO 864	2 White	Center of Pilots' Instrument Panel Light and Glare Shield	ON--OFF Switch on Data Card Holder. Magnetic Compass Rheostat Switch	(1) Magnetic Compass Light on SBCBP
PILOT'S FLIGHT INSTRUMENT PANEL LIGHTS	15 Red	Adjacent to Each Instrument	Rheostat Switch on Pilot's Overhead Light Control Panel	(1) Pilot Panel on the MCBP
PILOT'S SIDE PANEL LIGHTS	11 Red	Adjacent to Each Instrument	Rheostat Switch on Pilot's Side Panel	(1) Pilot Panel on the MCBP
COPILOT'S FLIGHT INSTRUMENT PANEL LIGHTS	22 Red	Adjacent to Each Instrument	Rheostat Switch on Copilot's Overhead Light Control Panel	(1) Panel Lights on the CIPP
COPILOT'S SIDE PANEL LIGHTS	21 Red	Adjacent to Each Instrument	Rheostat Switch on Copilot's Side Panel	(1) Panel Lights on the CIPP
PILOT'S FLIGHT DIRECTOR LIGHTS	21 Red	Interior of Each Instrument	Rheostat Switch on Pilot's Overhead Light Control Panel	(1) Pilot Panel on the MCBP
COPILOT'S FLIGHT DIRECTOR LIGHTS	21 Red	Interior of Each Instrument	Rheostat Switch on Copilot's Overhead Light Control Panel	(1) Panel Lights on the CIPP
CENTER INSTRUMENT (ENGINE) PANEL LIGHTS	33 Red	Adjacent to Each Instrument	Rheostat Switch on Pilot's Overhead Light Control Panel	(1) Fuel Panel on the MCBP
FUEL PANEL LIGHTS	28 Red	Adjacent to Each Instrument	Rheostat Switch on Copilot's Overhead Light Control Panel	(1) Fuel Panel on the MCBP
PILOTS' OVERHEAD PANEL LIGHTS	81 Red	Adjacent to Each Instrument	Rheostat Switch on Copilot's Overhead Light Control Panel	(1) Overhead Panel on the MCBP

* All color lights are white bulbs with color filters

Figure 4-33 (Sheet 1 of 3)

LIGHTS	*QTY COLOR	LIGHT LOCATION	SWITCH LOCATION	NO. OF CB'S LABEL & LOC
PILOT'S OVERHEAD PANEL FLOOD LIGHT	1 Red	On Floor Between Pilots' Seats	Rheostat Switch on Copilot's Overhead Light Control Panel	(1) Overhead Instrument Panel Flood on the MCBP
NAVIGATOR				
NAVIGATOR'S WORK AND SPOT LIGHT	1 White or Red	Right Side of Navigator's Table	Rheostat Switch on Spot Light Cover	(1) Spot Lights on the CIPP
NAVIGATION INSTRUMENT FLOOD LIGHTS	1 White or 2 Red	Navigator's Instrument Panel	RED--WHITE switch and Rheostat Switch on Navigator's Instrument Panel	(1) Flood Navigator Instruments on the MCBP
NAVIGATION TABLE FLOOD LIGHTS	4 White or 4 Red	Navigator's Instrument Panel	RED---WHITE Switch and Rheostat Switch on Navigator's Instrument Panel	(1) Flood, Navigator Table on the MCBP
SEXTANT LIGHT	1 Red	Sextant	This Light is Illuminated When Sextant is Connected	(1) Sextant on the MCBP
NAVIGATOR'S INSTRUMENT PANEL LIGHTS	83 Red	Adjacent to Each Instrument	Rheostat Switch on Navigator's Instrument Panel	(1) Navigator Instrument and Panel on the MCBP
CONTROL CABIN MISCELLANEOUS				
CABIN DOME LIGHT	1 White or Red	On Control Cabin Ceiling Between Navigator and Auxiliary Crew Station	RED---WHITE Switch and Rheostat Switch on Navigator's Instrument Panel	(1) Dome, Cabin on the MCBP
BOOM OPERATOR'S PANEL LIGHTS	7 Red	Adjacent to Instruments	Rheostat Switch on Navigator's Instrument Panel	(1) Navigator Instrument and Panel on the MCBP
CREW INSTRUCTOR'S PANEL LIGHTS	9 Red	Adjacent to Instruments	Rheostat Switch on Navigator's Instrument Panel	(1) Navigator Instrument and Panel on the MCBP
ELECTRICAL EQUIPMENT SPOT LIGHT	1 White or Red	Side of Equipment Rack	Rheostat Switch on Spot Light Cover	(1) Spot Lights on the CIPP
ELECTRONIC RACK LIGHTS (Forward and Aft)	2 White	Forward and Aft End of Electronic Rack	Forward End of Electronic Rack	(1) Dome, Cabin on the MCBP
ENTRY DOOR LIGHT	1 White	Above Crew Entry Chute	Forward End of Switched Bus Circuit Breaker Panel and Aft Wall of Crew Entry Chute	(1) Entry Light on the Battery Circuit Breaker Panel

* All color lights are white bulbs with color filters

Figure 4-33 (Sheet 2 of 3)

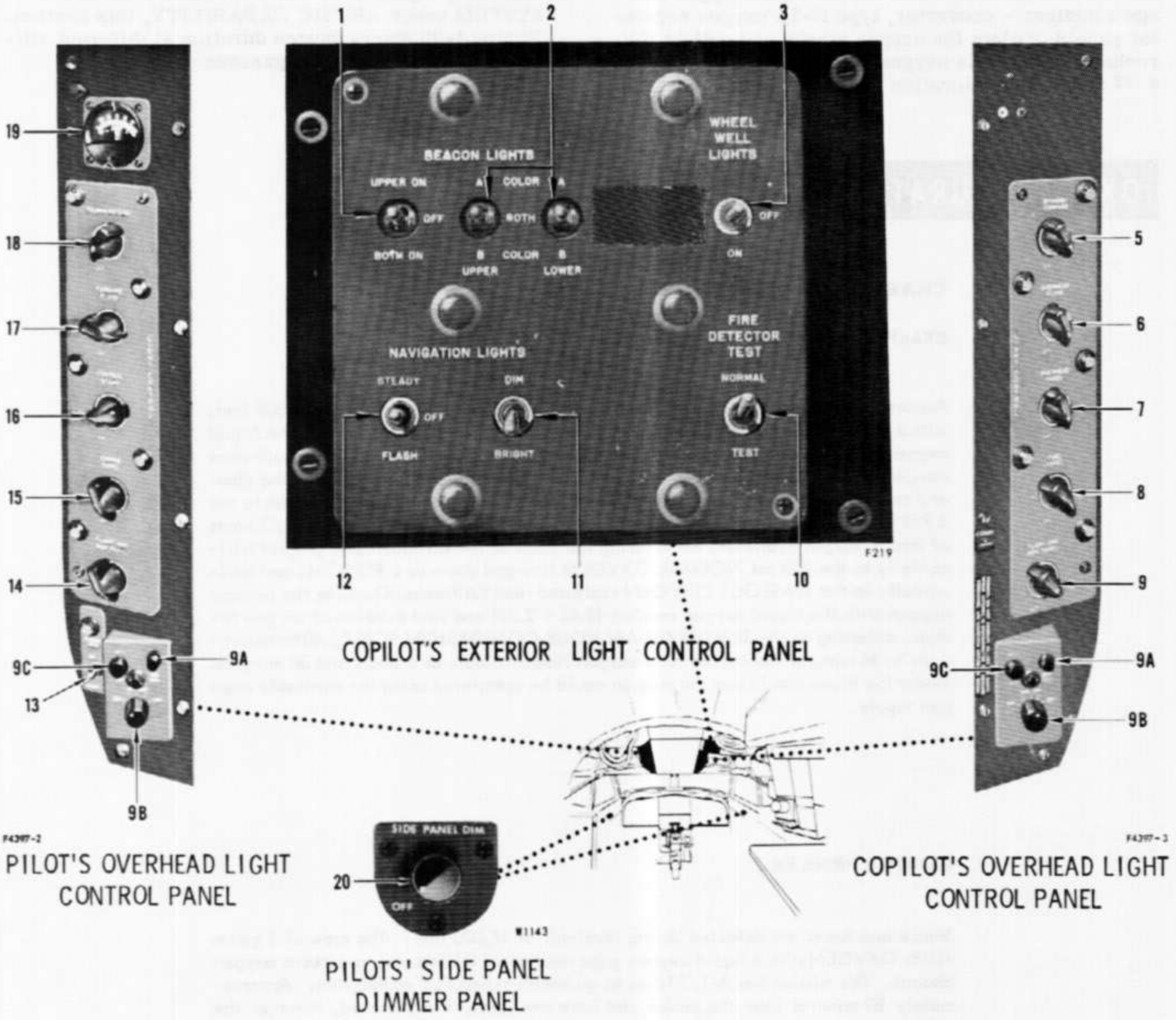
INTERIOR LIGHTING (CONT)

LIGHTS	*QTY COLOR	LIGHT LOCATION	SWITCH LOCATION	NO. OF CB'S LABEL & LOC
COMPARTMENT LIGHTS				
LAVATORY DOME LIGHT	1 White or Red	Toilet Compartment Ceiling	RED--OFF--WHITE Switch On interior Lavatory wall next to the door	(1) Dome, Cabin on the MCBP
LOWER NOSE COMPARTMENT LIGHT	1 White	On the Ceiling of the Lower Nose Compartment	Adjacent to the Light	(1) Dome, Lower Compartment on the MCBP
LOWER NOSE COMPARTMENT FORWARD LIGHT	1 White	On the Ceiling of the Lower Nose Compartment	Adjacent to the Light	(1) Dome, Lower Compartment on the MCBP
CARGO DOME LIGHTS	10 White	Five on Each Side of Cargo Dompartment	On Cargo Compartment Forward Bulkhead and on 186▶ Adjacent to Boom Operator's Window	(2) Dome, Cargo on the MCBP
CARGO DOOR ENTRY LIGHTS TCTO 951	2 White	On Cargo Door	ON--OFF Switch on Cargo Compt A/C Control Panel	(1) CARGO DOOR Lts on MCBP
BOOM COMPARTMENT HATCH LIGHTS 1▶202	2 Red	Overhead of Each Floor Hatch	Will Remain on When Aircraft Electrical System is Operating	(1) Panel & Compt Lights on the BOCBP
TAIL COMPARTMENT DOME LIGHT	1 White	On Ceiling Aft of Aft Pressure Bulkhead	Aft Pressure Bulkhead	(1) Panel & Compt Lights on the BOCBP
BOOM OPERATOR				
BOOM COMPARTMENT DOME LIGHT	1 White or Red	Overhead of the Boom Operator	RED--WHITE Switch and Rheostat Switch on Boom Operator's Panel	(1) Panel & Comp Lights on the BOCBP
BOOM OPERATOR'S SPOT LIGHT	1 White or Red	Right Side of Boom Operator's Panel	Rheostat Switch on Spot Light Cover	(1) Spot & Press to Test Lights on the BOCBP
BOOM OPERATOR'S INSTRUMENT PANEL LIGHTS	62 Red	Adjacent to Each Instrument	Two Rheostat Switches on Boom Operator's Circuit Breaker Panel	(1) Panel & Compt Lights on the BOCBP
BOOM OPERATOR'S AND INSTRUCTOR'S OXYGEN PANEL LIGHTS	2 White	Over Each Oxygen Panel	Boom Operator's Circuit Breaker Panel	(1) Panel & Compt Lights on the BOCBP

*All color lights are white bulbs with color filters

Figure 4-33 (Sheet 3 of 3)

PILOTS' LIGHTING CONTROL PANELS



1	RENDEZVOUS BEACON (ANTI-COLLISION) LIGHTS SWITCH	9C	FLIGHT DIRECTOR DIMMER CONTROL (2 PLACES)
2	BEACON LIGHTS COLOR SELECTOR SWITCH	10	FIRE DETECTOR TEST SWITCH
3	WHEEL WELL LIGHTS SWITCH	11	NAVIGATION LIGHTS BRIGHT-DIM SWITCH
4	(DELETED)	12	NAVIGATION LIGHTS FLASH-STEADY SWITCH
5	STANDBY COMPASS LIGHT CONTROL	13	WARNING LIGHTS BRIGHT-DIM SWITCH
6	OVERHEAD PANEL FLOODLIGHT CONTROL	14.	PILOT'S FLIGHT AND SIDE PANEL LIGHTS CONTROL
7	OVERHEAD PANEL LIGHTS CONTROL	15	ENGINE PANEL LIGHTS CONTROL
8	FUEL PANEL LIGHTS CONTROL	16	CONTROL STAND PANEL LIGHTS CONTROL
9	COPILOT'S FLIGHT AND SIDE PANEL LIGHTS RHEOSTAT	17	FORWARD FLOODLIGHTS CONTROL
9A	ANNUNCIATOR TEST SWITCH (2 PLACES)	18	THUNDERSTORM LIGHTS CONTROL
9B	ANNUNCIATOR DIMMER SWITCH (2 PLACES)	19	BATTERY CHARGING AMMETER
		20	SIDE PANEL DIMMER RHEOSTAT

Figure 4-34

OXYGEN SYSTEM

The airplane is equipped with a liquid oxygen system. The system consists of an 8 liter liquid oxygen storage container - converter, type D-2A oxygen regulator panels, outlets for oxygen masks and outlets for recharging portable oxygen bottles. Refer to figures 4-37 and 4-38 for location of oxygen equipment. A liquid oxygen filler valve provides a means of recharging the system on the ground. Six G-1 gaseous oxygen cylinders can be installed with the arctic capability equipment. See AUXILIARY OXYGEN SYSTEM under ARCTIC CAPABILITY, this Section. Figure 4-35 shows oxygen duration at different altitudes for both liquid and gaseous oxygen.

OXYGEN DURATION - HOURS

CHART EXAMPLE PROBLEMS

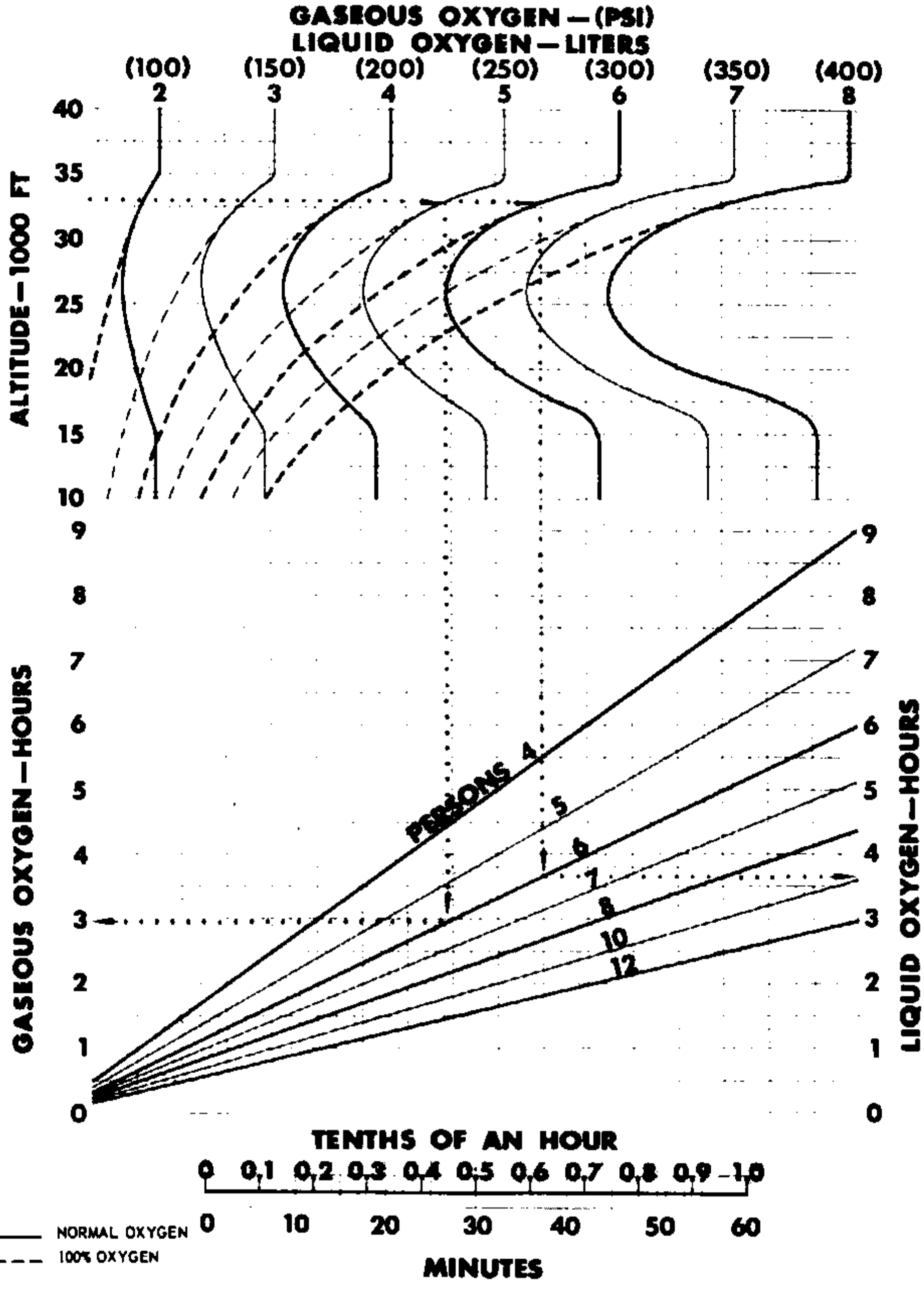
EXAMPLE PROBLEM 1

Assume cabin pressurization is lost during a mission being conducted at 33,000 feet, with 6 crewmen aboard. The mission has 6 hours to continue before descent; the liquid oxygen gage reads 6 liters and the gaseous oxygen gage reads 250 psi. Will sufficient oxygen be available to continue the mission? Enter the altitude scale of the chart and project horizontally to 6 liter NORMAL OXYGEN line, then project down to the 6 PERSONS line and horizontally to the LIQUID OXYGEN scale and read 3.65 hours of liquid oxygen available. Re-entering the chart at the altitude scale project horizontally to the 250 psi NORMAL OXYGEN line and down to 6 PERSONS and horizontally to the GASEOUS OXYGEN scale and read 2.95 hours. Combine the gaseous oxygen with the liquid oxygen reading (3.65 + 2.95) and find 6.60 hrs of oxygen remain. Referring to the TENTHS OF AN HOUR CONVERSION SCALE, .60 hours converts to 36 minutes making the total oxygen time available as 6 hours and 36 minutes. Under the given conditions the mission could be completed using the available oxygen supply.

EXAMPLE PROBLEM 2

Smoke and fumes are detected during level-off at 25,000 feet. The crew of 5 go on 100% OXYGEN with a liquid oxygen gage reading of 8 liters and no gaseous oxygen aboard. The mission has 5-1/2 hours to go before scheduled completion. Approximately 20 minutes later the smoke and fume emergency is eliminated, however the cabin must remain depressurized. Can mission be completed on the remaining 7-1/2 liters using the NORMAL setting? Enter chart at the altitude scale and project horizontally to 7-1/2 liters and down to 5 PERSONS and across to the LIQUID OXYGEN scale and read 4 hours and 40 minutes. With 5 hours and 10 minutes remaining in the mission, not enough oxygen remains to complete the mission at 25,000 feet; however, by increasing altitude to 32,000 or above or reducing altitude to 20,000 or below the mission could be completed with the remaining oxygen.

Figure 4-35 (Sheet 1 of 3)



LIQUID OXYGEN SYSTEM – 1 Type A-2 (8 liter) converter
GASEOUS OXYGEN SYSTEM – 6 G-1 Cylinders

1-221

Figure 4-35 (Sheet 2 of 3)

OXYGEN DURATION (Cont)

MA-1 PORTABLE OXYGEN SYSTEM

NOTE

A-6 cylinder with A-21 regulator. Normal breathing.

PRESSURIZED TO 300 PSI, UTILIZED DOWN TO 50 PSIG

ALTITUDE	SL to 30,000 FT	30,000 FT 40,000 FT	40,000 FT 42,000 FT	ABOVE 42,000 FT
Regulator Setting	NORMAL	30M	42M	EMERGENCY
Fire Fighters Mask	6 Min.	50 Sec.	35 Sec.	30 Sec*
PRESSURE DEMAND AIRCREW MASK	7 Min.	6 Min.	4 Min.	3 Min.

PRESSURIZED TO 400 PSI, UTILIZED DOWN TO 50 PSIG

ALTITUDE	SL to 30,000 FT	30,000 FT 40,000 FT	40,000 FT 42,000 FT	ABOVE 42,000 FT
Regulator Setting	NORMAL	30M	42M	EMERGENCY
Fire Fighters Mask	9 Min. 20 Sec.	1 Min. 10 Sec.	50 Sec.	45 Sec*
PRESSURE DEMAND AIRCREW MASK	10 Min. 20 Sec.	7 Min. 30 Sec.	5 Min. 45 Sec.	4 Min. 30 Sec.

* Mask cannot be fitted to stop all leakage. All other readings are with no mask leakage.

CAUTION

The oxygen pressure in the MA-1 portable oxygen bottle should not be permitted to drop below 50 psi.

Figure 4-35 (Sheet 3 of 3)

LIQUID OXYGEN FILLER VALVE



1 BUILD-UP AND VENT VALVE HANDLE
2 LIQUID OXYGEN FILLER VALVE
3 FILLER VALVE ACCESS DOOR

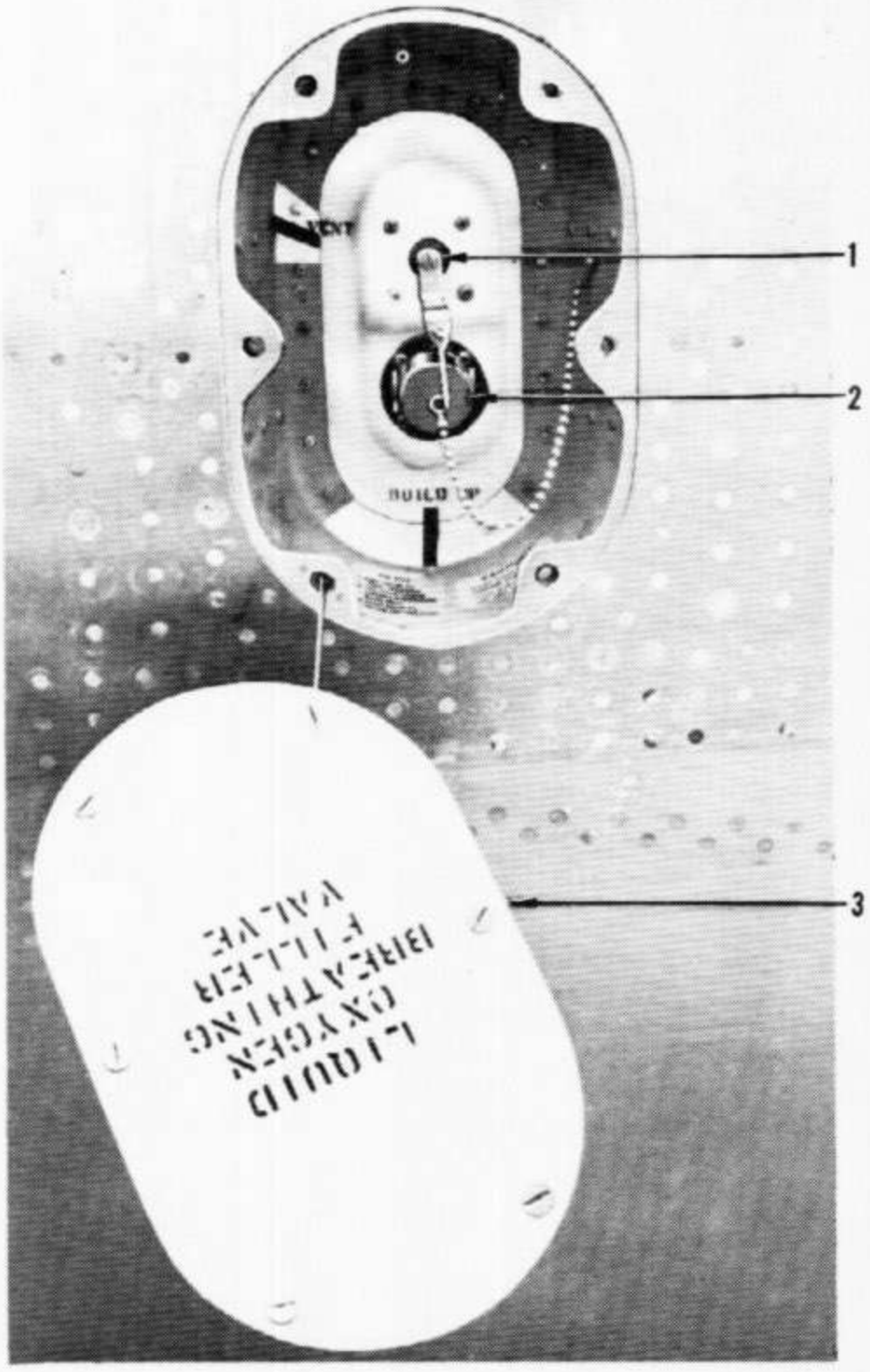


Figure 4-36

LIQUID OXYGEN FILLER VALVE AND BUILD-UP AND VENT VALVE

The liquid oxygen filler valve (2, figure 4-36 and 40, figure 1-65) and the build-up and vent valve (1, figure 4-36) are on the right side of the fuselage at the nose wheel well. These valves provide a means for ground servicing the liquid oxygen system. The build-up and vent valve should always be in the BUILD-UP position except when charging or purging the system. Charging the system is accomplished with the build-up and vent valve in the VENT position. Approximately 5 minutes with 20 psi filler cart pressure are required to fill the system. Liquid oxygen flowing out of the overboard vent indicates the system is filled. After charging the system, it should be allowed to stabilize for 30 minutes prior to flight; therefore, the system should not be topped off immediately prior to takeoff. This is to prevent misleadingly high pressure readings due to oxygen boil-off that occurs during system charging or anytime the build-up and vent valve is in the VENT position. This also allows sufficient time for the system to build up pressure.

CAUTION

Position build-up and vent valve slowly to prevent damaging the transducer.

OXYGEN SUPPLY SHUTOFF LEVER

An oxygen supply shutoff lever (8, figure 4-37) on the oxygen regulator panel has ON--OFF positions. When the lever is in the ON position, oxygen is supplied to the regulator. When the lever is in the OFF position, the oxygen supply to the regulator is shut off to prevent any flow of oxygen from the regulator when not in use.

WARNING

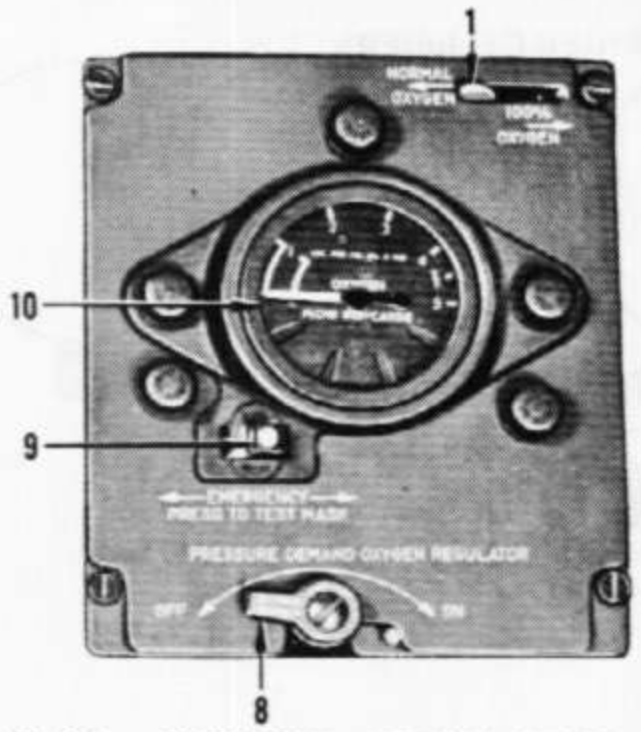
- If the oxygen supply lever is OFF and the diluter lever is in NORMAL, there is no restriction to breathing, but the crewmember will be breathing cabin air only and hypoxia may occur at cabin altitudes that require oxygen. With the supply lever OFF and the diluter lever 100%, neither cabin air nor oxygen will be available at the mask.

- Due to the automatic pressure breathing feature of the oxygen regulator, a continuous flow of oxygen at high cabin altitude (approximately 30,000 feet) will result if oxygen regulator is not being used and the oxygen supply lever is in the ON position. This condition will cause a rapid loss of oxygen.

REGULATOR DILUTER LEVER

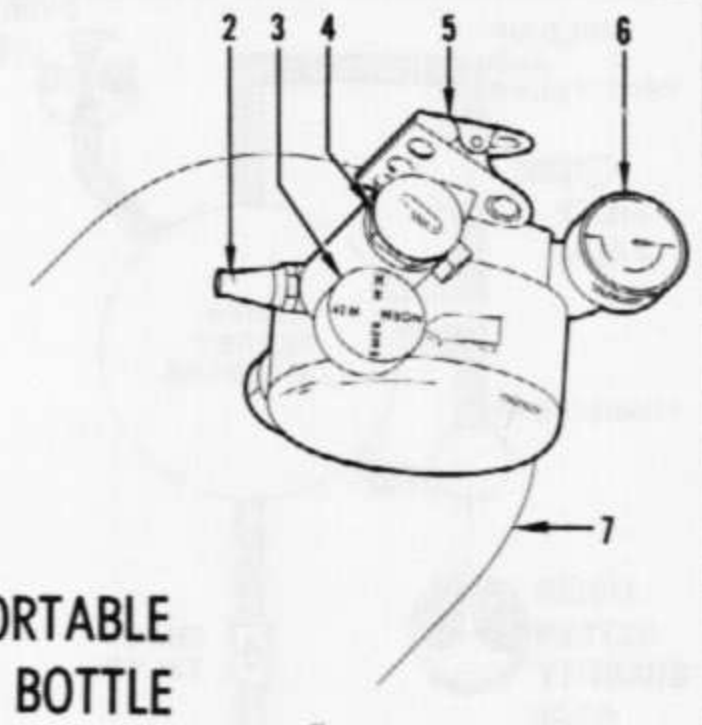
The regulator diluter lever (1, figure 4-37) on the oxygen regulator panel has NORMAL OXYGEN--100% OXYGEN positions. With the lever in the NORMAL

OXYGEN REGULATOR PANELS AND PORTABLE OXYGEN BOTTLES

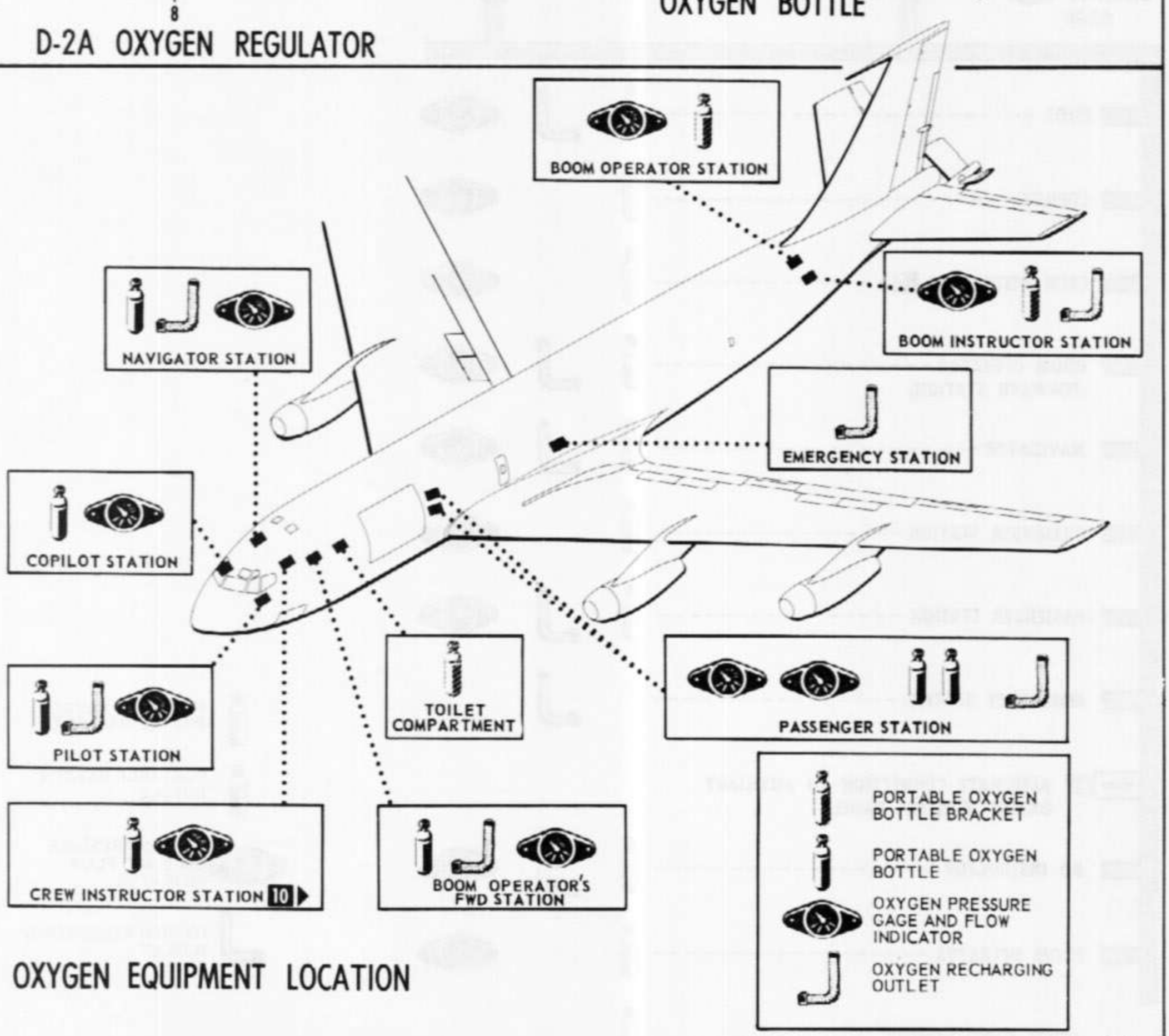


D-2A OXYGEN REGULATOR

1 REGULATOR DILUTER LEVER
2 OXYGEN BOTTLE FILLER PORT
3 ALTITUDE SELECTOR KNOB
4 OXYGEN MASK HOSE CONNECTION
5 CLIP
6 OXYGEN PRESSURE GAGE
7 A-6 OXYGEN BOTTLE
8 OXYGEN SUPPLY SHUTOFF LEVER
9 EMERGENCY OXYGEN TOGGLE LEVER
10 OXYGEN PRESSURE GAGE AND FLOW INDICATOR



MA-1 PORTABLE OXYGEN BOTTLE



OXYGEN EQUIPMENT LOCATION

F-223
F-224
F-225

Figure 4-37

OXYGEN SYSTEMS

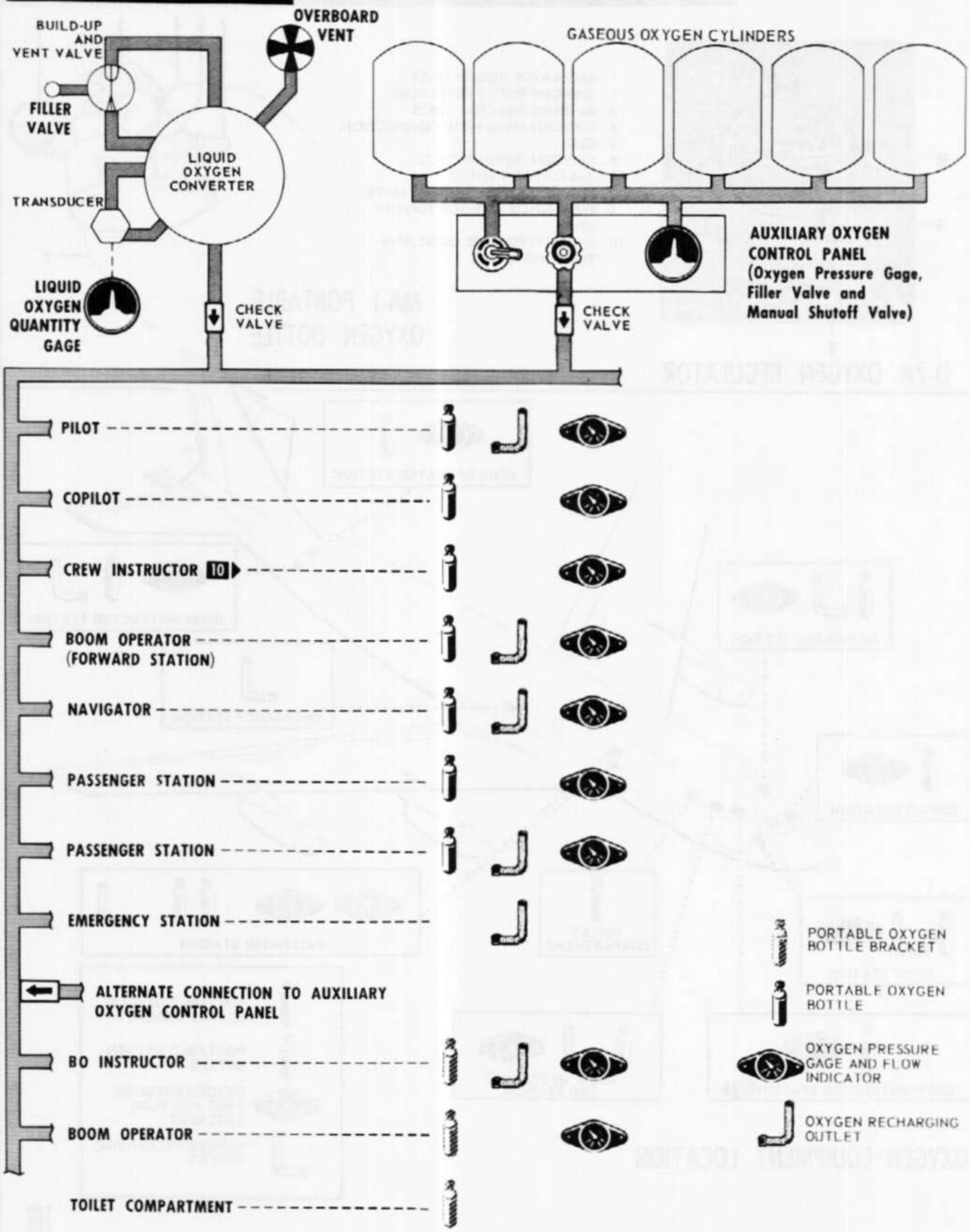


Figure 4-38

OXYGEN position the regulator automatically supplies the proper mixture of oxygen and air at all altitudes. Pure oxygen is supplied automatically above approximately 30,000 feet cabin altitude; however, at this altitude the lever should be placed in the 100% OXYGEN position as a safety precaution. With the lever in the 100% OXYGEN position, the air intake port is closed and pure oxygen is supplied on demand regardless of altitude.

EMERGENCY OXYGEN TOGGLE LEVER

An emergency oxygen toggle lever (9, figure 4-37) is on each oxygen regulator panel. Pushing the lever to either side locks the lever to give a continuous positive pressure to the crew member for emergency use. Pushing the emergency oxygen toggle lever straight into the panel will supply momentary positive oxygen pressure for checking the oxygen mask. Upon release of emergency toggle lever, operation will return to normal. The emergency oxygen toggle lever should remain in the center position at all times, unless an unscheduled pressure increase is required.

WARNING

When positive pressures are required, it is mandatory that the oxygen mask be well fitted to the face. Unless special precautions are taken to ensure no leakage, the continued use of positive pressure under these conditions will result in the rapid depletion of the oxygen supply. When liquid oxygen is used, this condition would result in rapid depletion and could also result in extremely cold oxygen flowing to the mask.

OXYGEN PRESSURE GAGE AND FLOW INDICATOR

An oxygen pressure gage and flow indicator (10, figure 4-37) is on each oxygen regulator panel. The gage is calibrated in psi. The flow indicator consists of four tear shaped windows, behind which is a disk having four white painted bars which appear and disappear with each breath to indicate that the crew member is getting a normal flow of oxygen.

LIQUID OXYGEN QUANTITY GAGE

An oxygen quantity gage (12, figure 1-14) is on the copilot's side panel. The gage is graduated from 0 to 8 liters in increments of 2 liters. Operating power for the circuit is 28 volt DC and circuit protection is through a circuit breaker marked OXYGEN QUANTITY on the T-R BUS NO. 2 section of the MCBP (figure 1-35, sheet 2).

PORTABLE OXYGEN BOTTLES

Portable oxygen bottles are provided at the pilots' and navigator's stations; the boom operator's forward station; and on airplanes 10▶, the crew instructor's station and the passenger stations. An extra bracket for holding a portable oxygen bottle is provided in the toilet compartment and at the boom operator's station.

The MA-1 portable oxygen bottle assembly consists of an A-6 low pressure oxygen cylinder, carrying harness, and an A-21 pressure demand regulator. The A-21 regulator consists of an oxygen pressure gage, altitude selector knob and may contain a clip to attach the portable oxygen bottle to the crew members flight clothing. The pressure gage (6, figure 4-37) is calibrated from 0 to 500 psi and is red lined at 450 psi. The altitude selector knob (3, figure 4-37) has NORM--30M--42M--EMER positions. Since the A-21 regulator does not incorporate a diluter mechanism, 100% oxygen is delivered on all positions. The NORM position is used on all cabin altitudes up to 30,000 feet and delivers oxygen only on demand. The 30M position is used from 30,000 feet to 40,000 feet cabin altitude. This position delivers oxygen under a slight positive pressure which is intended to combat mask leaks and possible altimeter lag. From 40,000 feet to 42,000 feet, the 42M position is used. This position delivers oxygen under the higher pressure required to sustain life at the altitudes. The EMER position further increases the pressure of the oxygen and should be used anytime the cabin altitude exceeds 42,000 feet. Duration of the oxygen supply is dependent upon altitude, activity, or oxygen quantity and should be computed using figure 4-35, sheet 3.

WARNING

- Oxygen duration is extremely limited for crewmembers using the firefighter's mask with the MA-1 portable oxygen system. (See figure 4-35.) The A-21 regulator must be set to the NORM position when used in conjunction with the firefighter's mask.

- Prior to servicing portable oxygen bottles, insure that oxygen bottle filler port and oxygen recharger outlet are free of oil or grease.

- A positive lock is not provided on the MA-1 portable oxygen bottle altitude selector knob. The knob can be unintentionally moved from the desired position, possibly causing a depletion of the oxygen supply.

QUICK-DONNING OXYGEN MASK (CREW SYSTEM)

Quick-donning oxygen masks attached to the oxygen regulators are authorized and provided at the pilot's and copilot's stations on some special purpose airplanes. The mask contains three adjustments for individual fits and can be donned with one hand in less than 2 seconds (figure 4-39A). On some airplanes, the masks are stowed in quick-release hanging suspension holders located just aft of the pilot/copilot's #5 windows and are always immediately available.

OXYGEN SYSTEM NORMAL OPERATION

Preflight

NOTE

The following procedure applies to each crewmember unless otherwise noted.

A. Oxygen Converter Quantity Gage - Check quantity (8 liters) (CP)

NOTE

It may not be possible to service the converter to the full 8 liter capacity due to temperature during servicing.

B. Oxygen Supply Lever - ON

Pressure gage should be approximately 300 psi.

C. Oxygen Mask - Don and connect

D. Regulator Diluter Lever - 100%

E. Emergency Oxygen Toggle Lever - Depress to test mask

Check for no flow around mask while holding breath. This indicates proper mask fit and serviceable hoses and connectors. Release oxygen emergency toggle lever.

F. Emergency Oxygen Toggle Lever - EMERGENCY

Breathe normally for a minimum of 3 cycles. The blinker should alternately show BLACK and WHITE. Hold breath - a white blinker indicates a leak.

G. Regulator Diluter Lever - NORMAL

Check for no flow around mask while holding breath. Blinker should remain BLACK and a WHITE blinker indicates a leak.

H. Emergency Oxygen Toggle Lever - Center

I. Oxygen Regulator Panel - OFF, 100% OXYGEN

Breathe pressure to zero. Ability to inhale once the pressure has dropped to zero indicates a faulty regulator.

J. Portable Oxygen Bottle - Checked

Insure that the portable oxygen bottle at crewmembers station is serviced and that altitude selector knob is set to the NORMAL position. Portable oxygen bottle may be checked any time prior to Interior Inspection crew report.

Oxygen Usage

The following procedure should be used when going on oxygen.

A. Oxygen Supply Shutoff Lever - ON

Check that oxygen pressure is approximately 300 psi.

B. Regulator Diluter Lever - As required

C. Oxygen Flow Indicator - Check frequently for normal operation

NOTE

Approximate oxygen duration can be determined from figure 4-35.

WARNING

When oxygen equipment is used, check to ensure that hose is connected, pressure is up, regulator settings as desired and flow indicator is operating. This is important as it is possible to breathe through the mask when the hose is disconnected or when diluter lever is on NORMAL OXYGEN and supply lever OFF.

OXYGEN SYSTEM EMERGENCY OPERATION

With symptoms of hypoxia or if smoke or fumes are present, immediately place the oxygen supply shutoff lever ON, and move the regulator diluter lever to 100% OXYGEN. Place the emergency oxygen toggle lever in the EMERGENCY position if required.

WARNING

- The type D-2A oxygen regulator is suitable for routine use up to 42,000 feet and for emergency use up to 50,000 feet. In case of loss of cabin pressurization during flights above 42,000 feet, descend to an altitude of 42,000 feet or below within 5 minutes.
- In case of failure of the oxygen system, switch immediately to the portable oxygen bottles. If failure is prolonged, descend to a safe altitude to operate without oxygen before the supply is depleted in the portable oxygen bottles.

NOTE

When the oxygen regulator diluter lever is placed in the 100% OXYGEN position or the emergency oxygen toggle lever in the EMERGENCY position, inform the pilot immediately as these actions will reduce the oxygen supply duration.

QUICK-DONNING OXYGEN MASK AND SMOKE GOGGLES

1 When ready to don the mask, take a firm grasp around the valve and hose assembly, with either the right or left hand. A sharp downward pull will release the mask from the quick-release hanger.

2



Hook the mask over the back of the head, as though it were a cap being placed in position. Pull forward on the mask, extending the sliders on each side to their maximum distance. Pull the mask down, over any goggles or glasses which may be worn, and bring into proper position over the nose and mouth.

3



The mask is now in proper position on the face and ready to use. Note that there is approximately 3/4 inch clearance between the harness and the ear.

NOTE

The smoke goggles are designed for use in conjunction with the quick-donning oxygen mask and are provided at the pilot's and copilot's stations. In donning, the goggle is placed on the face and the elastic strap brought backward over the head.

Figure 4-39A

AUTOPILOT SYSTEM

The airplane has a type MC-1 electronic autopilot system. The system consists of an autopilot control panel (figure 4-40) on the overhead panel, an autopilot flight controller (figure 4-41) on the control stand and gyros to control the system with servo motor and drive assemblies which connect the system to the control surfaces. During autopilot operation, by use of the autopilot turn knob and the autopilot pitch knob on the flight controller, the airplane can be made to climb, dive, and to make coordinated turns. Refer to figure 4-42 for autopilot operational tolerances. Azimuth reference for navigation is received from the N-1 compass system. Preset course selection is through the pilot's horizontal situation indicator (HSI). Signals from the TACAN or No. 1 VOR/ILS can command the autopilot to fly to or from any selected station. Glide slope signals through the glide slope receiver to the autopilot can bring the airplane down the glide slope. Altitude control maintains the airplane, upon engagement of the control, at a constant pressure altitude. The altitude control automatically disengages when the glide slope is engaged or when the constant Mach No. control is engaged. Constant Mach No. control maintains the Mach No. existing when the control was engaged. Automatic roll leveling is provided at any time of engagement; automatic trim is also provided. The autopilot is not intended to handle trim changes required as a result of lowering the landing gear or flaps or raising speed brakes. The rudder axis of the autopilot, when used independently, is an excellent yaw damper. Manual disengaging of the autopilot can be accomplished by a disengage button on the pilots' control wheels or by switches on the autopilot control panel. Operating power for the system is 115/200 volt AC through three circuit breakers marked AUTOPILOT on GENERATOR NO. 3 of the MCBP (figure 1-35, sheet 3). Control power is 28 volt DC from T-R BUS NO. 1 through a circuit breaker marked AUTOPILOT on the MCBP (figure 1-35, sheet 2).

NOTE

When the autopilot disengage button is pressed all switches on the autopilot control panel except the autopilot power switch will move to the OFF position and the servos will be disengaged. When the autopilot power switch is placed in the OFF position all the switches on the autopilot control panel will move to the OFF position and all servos will be disengaged.

AUTOPILOT POWER SWITCH

The autopilot power switch (6, figure 4-40) on the autopilot control panel has ON--OFF positions. The power switch must be in the ON position and the system allowed to warm up for three minutes before the autopilot can be engaged. The autopilot power switch should be ON except for emergencies or extended ground operation of other equipment. When the autopilot power switch is moved to the OFF position all power to the autopilot system will be discontinued and all servos will be disengaged.

ENGAGE SWITCHES

The engage switches (2, figure 4-40) on the autopilot control panel have ON--OFF positions. The switches are marked RUD., AIL. and ELEV. and when placed in the ON position they will engage the rudder, aileron and elevator servos to their respective flight control surfaces. The switches may be turned on simultaneously by pulling the engaging switch bar (1, figure 4-40) or may be turned on or off individually. The engaging switch bar is spring loaded to the OFF position of the engage switches.

NOTE

When the AIL. engage switch is engaged, the autopilot will automatically level the airplane.

CAUTION

To prevent unnecessary deterioration of the stabilizer trim system, use the autopilot controls to disengage the pitch axis of the autopilot prior to operation of the stabilizer trim switch during flight.

MACH NO. HOLD SWITCH

The Mach No. hold switch (5, figure 4-40) on the autopilot control panel has ON--OFF positions. When the switch is placed in the ON position the autopilot will act on the elevators and stabilizer to maintain the Mach No. that existed when the switch was activated. The Mach No. hold switch will automatically disengage when the altitude hold switch is placed in the ON position.

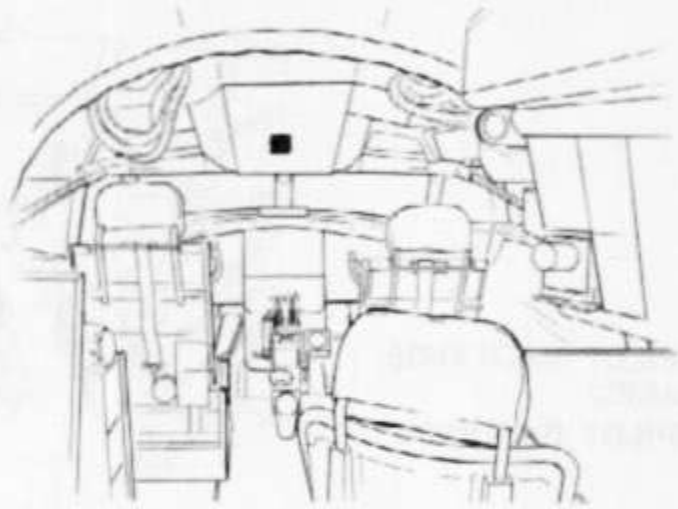
NOTE

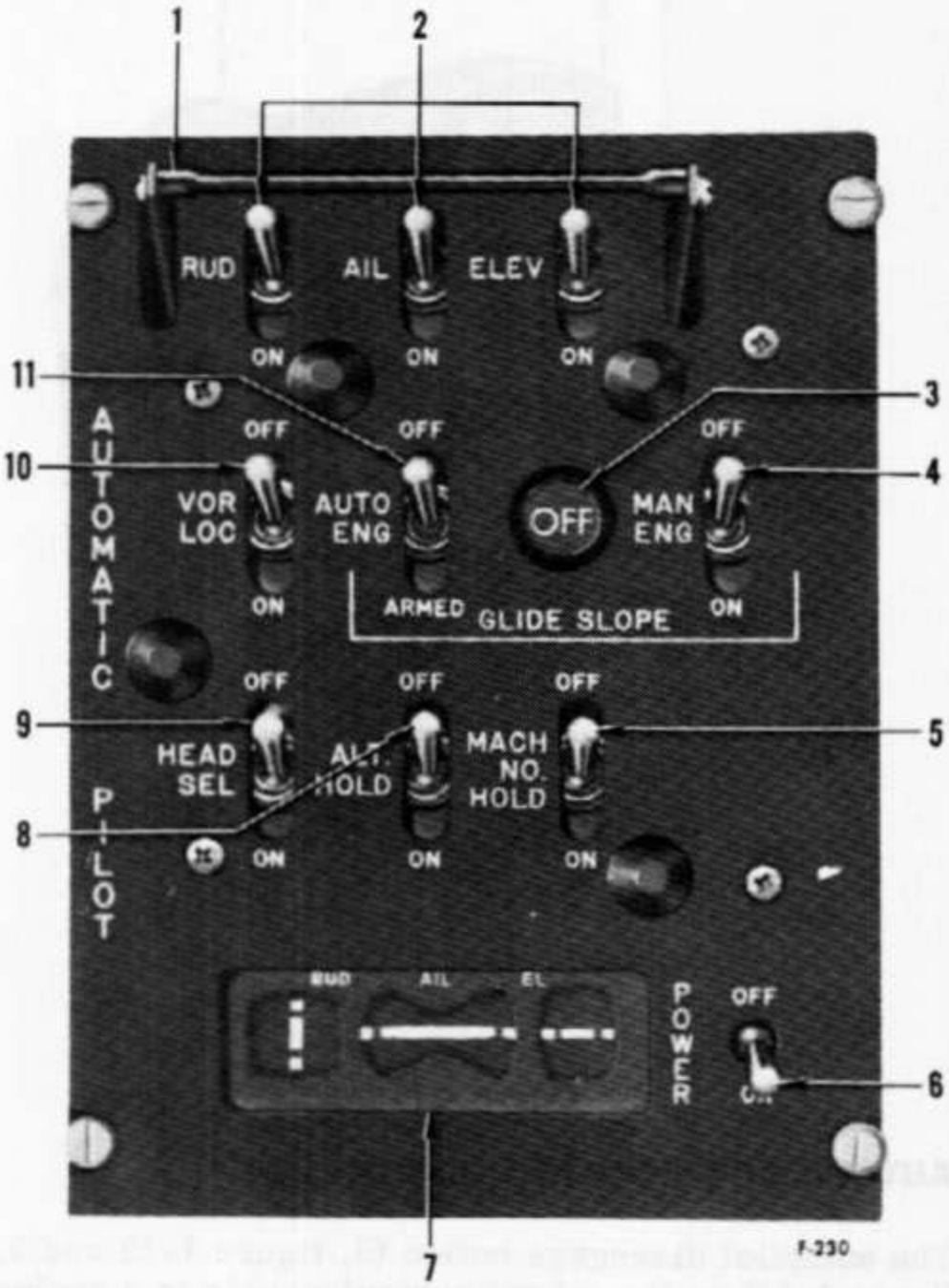
The Mach No. hold switch and the altitude hold switch are interlocked and when one switch is placed in the ON position, the other switch will automatically move to the OFF position.

ALTITUDE HOLD SWITCH

The altitude hold switch (8, figure 4-40) on the autopilot control panel has ON--OFF positions. The pressure altitude existing at the time of engagement will be held when the altitude hold switch is placed in the

AUTOPILOT CONTROL PANEL





1 ENGAGING SWITCH BAR
2 ENGAGE SWITCHES
3 GLIDE SLOPE MODE INDICATOR
4 GLIDE SLOPE MANUAL ENGAGE SWITCH
5 MACH NO. HOLD SWITCH
6 AUTOPILOT POWER SWITCH
7 TRIM METERS
8 ALTITUDE HOLD SWITCH
9 HEADING SELECT SWITCH
10 VOR-LOC ENGAGE SWITCH
11 GLIDE SLOPE AUTO ENGAGE SWITCH

Figure 4-40

ON position. The altitude hold switch will automatically be disengaged when the glide slope or Mach No. control is engaged.

HEADING SELECT SWITCH

The heading select switch (9, figure 4-40) on the autopilot control panel has ON--OFF positions. Any desired heading may be preset on the pilot's HSI. When the heading select switch is placed in the ON position, signals from the N-1 compass system through the HSI will actuate the autopilot to turn the airplane to the preset heading. A new heading can be selected when the heading select switch is in the ON position and the airplane will make a coordinated turn to the new heading. The heading select switch will automatically go to the OFF position when the VOR-LOC switch is moved to the ON position.

VOR-LOC ENGAGE SWITCH

The VOR-LOC engage switch (10, figure 4-40) on the autopilot control panel has ON--OFF positions. When the switch is ON, the autopilot automatically navigates along a selected course either to or from a ground station - providing the navigation radio is properly tuned (the airplane should be on or near the selected course before placing the switch ON) and the TACAN select switch must be in the correct position. The VOR-LOC engage switch also couples the localizer signal of an instrument landing system to the autopilot for ILS approaches. When making ILS approaches, the VOR/ILS receiver must be tuned to the ILS localizer frequency and, the TACAN select switch must be OFF (not illuminated).

NOTE

The inbound course of the ILS localizer must be set on the pilot's HSI to give the autopilot a directional reference during the approach.

GLIDE SLOPE AUTO ENGAGE SWITCH

The glide slope auto engage switch (11, figure 4-40) on the autopilot control panel has OFF-ARMED positions. Signals from the glide slope receiver (51V -4A) permit an approach using a standard glide slope signal. When the glide slope auto engage switch is placed in the ARMED position and before the airplane reaches the glide slope the glide slope mode indicator will go from the OFF tab to ARM. As the airplane reaches the glide slope inbound the glide slope mode indicator will go from ARM to ENG. The glide slope will then automatically be engaged and the autopilot will cause the airplane to follow the glide slope. When the glide slope is engaged the altitude hold switch will move to the OFF position.

GLIDE SLOPE MANUAL ENGAGE SWITCH

The glide slope manual engage switch (4, figure 4-40) on the autopilot control panel has ON--OFF positions and provides a means of manually engaging the autopilot to the glide slope. When the switch is placed in the ON position the airplane will take the most direct course to the glide slope and follow the glide slope. When the glide slope manual engage switch is in the ON position the glide slope mode indicator will show ENG.

NOTE

- It is recommended that the glide slope be manually engaged only when the glide slope indicator (GSI) on the pilot's HSI is approximately centered.
- The automatic and manual engagement of the glide slope is interlocked with the glide slope warning flag on the pilot's HSI. If the warning flag is visible, the glide slope cannot be engaged. If the warning flag appears with the glide slope engaged, disengagement will occur after 3 to 5 seconds and the engage switch used will return to the OFF position; the glide slope mode indicator will also show the OFF tab. When the glide slope warning flag disappears, the glide slope can be reengaged.

AUTOPILOT TURN KNOB

The autopilot turn knob (2, figure 4-41) on the autopilot flight controller has L--R turn positions and a detent position. Any degree of bank can be selected by the pilot, up to a maximum of approximately 40 degrees, by turning the autopilot turn knob in the desired direction.

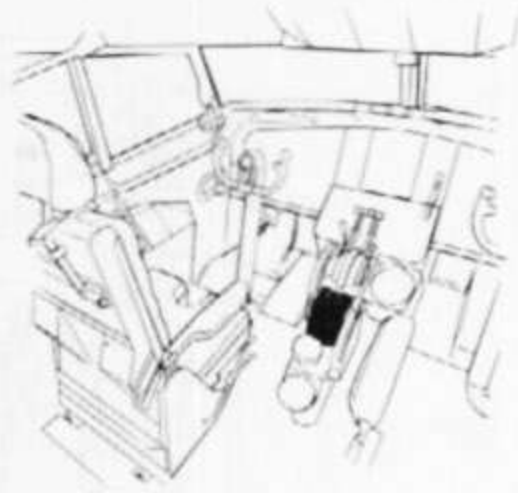
NOTE

If the autopilot turn knob is out of the detent position the AIL. and VOR-LOC engage switches and the heading select switch cannot be engaged. The VOR-LOC engage switch and the heading select switch will disengage when the autopilot turn knob is moved out of the detent.

AUTOPILOT PITCH KNOB

The autopilot pitch knob (1, figure 4-41) on the autopilot flight controller has UP--DN indicating arrows to indicate descent or climb. By rotating the autopilot pitch knob in the desired direction, the pilot may select up to 20 degrees of dive or climb. The autopilot may be engaged with the pitch knob in any position and the airplane will maintain the same pitch attitude that existed at the time of engagement.

AUTOPILOT FLIGHT CONTROLLER



1 AUTOPILOT PITCH KNOB (2 PLACES)
2 AUTOPILOT TURN KNOB



Figure 4-41

AUTOPILOT DISENGAGE BUTTON

The autopilot disengage button (9, figure 1-13 and 3, figure 1-14) on the pilots' control wheels is a spring loaded button. When depressed, this button will disengage the autopilot. When the autopilot disengage button is used all switches, except the autopilot power switch, on the autopilot control panel will move to the OFF position and must be manually moved to the ON position to reengage the autopilot. The RGA pushbutton switch function is combined with the autopilot disengage button. Regardless of the position of the RGA power switch, actuation of the RGA/AP pushbutton will result in the autopilot being disengaged (if engaged).

AUTOPILOT OPERATIONAL TOLERANCES

FUNCTION	CONDITION	CAPABILITY	ALLOWABLE TOLERANCE	REFERENCE INDICATOR
Pilot's Turn Knob	Heading Change	Maximum Bank Angle 40 Degrees	± 7 degrees bank	Attitude Director Indicator
Heading Select	Heading Change	Maximum Bank Angle 25 Degrees	± 2 degrees bank	Attitude Director Indicator
Omni Range VOR/TACAN*	Heading Change	Maximum Bank Angle 25 Degrees	± 2 degrees bank	Attitude Director Indicator
Localizer	Heading Change	Maximum Bank Angle 25 Degrees	+ 2 degrees bank	Attitude Director Indicator
Glide Slope	Heading Change	Maximum Bank Angle 10 Degrees	+ 1 degree bank	Attitude Director Indicator
Pilot's Pitch Control	Pitch Attitude Change	At least ± 15 degree Pitch Change	Not to exceed 50 ft per minute from established vertical velocity	Attitude Director and Vertical Velocity Indicators
Altitude Hold	Altitude Hold	Engaging Altitude	± 50 ft max from engaged altitude after stabilized	Altimeter
Mach No. Control	Mach Hold	Engage between Mach 0.5 and Mach 0.9	± .005 Mach max from engaged condition after stabilized	Mach Indicator

* In the "cone of confusion" over a station, clamping occurs which reduces the bank angle limit to 10 degrees until station passage is complete.

Figure 4-42

AUTOPILOT DISENGAGE LIGHT

The autopilot disengage light (23, figure 1-18) on the pilot's flight instrument panel is an amber light which may be checked with the ANN TEST switch. The light will be illuminated when the elevator servo is disengaged by actuation of the stabilizer trim control switch. The light will be extinguished when the elevator servo is reengaged or when the autopilot is disengaged.

TRIM METERS

The trim meters (7, figure 4-40) on the autopilot control panel consist of three meters marked RUD, AIL, EL, one for each axis of the airplane. Prior to engagement, the trim meters indicate the direction and magnitude of torque which will be delivered by the servos at the instant of engagement. When the autopilot is engaged the trim meters indicate to the pilot what the airplane trim condition will be, on disengagement of the autopilot.

GLIDE SLOPE MODE INDICATOR

The glide slope mode indicator (3, figure 4-40) on the autopilot control panel has OFF--ARM--ENG tabs that will appear in the window to indicate the condition of glide slope engagement. When the glide slope auto engage switch and glide slope manual engage switch are in the OFF position the glide slope mode indicator will show OFF. When the glide slope manual engage switch is in the OFF position and the glide slope auto engage switch is placed in the ARMED position before the airplane reaches the glide slope, the glide slope mode indicator will show ARM. If the glide slope mode indicator does not show ARM when the glide slope auto engage switch is placed in the ARMED position, the glide slope then must be manually engaged by the glide slope manual engage switch. When the glide slope auto engage switch is in the ARM position and the airplane reaches the glide slope, the glide slope mode indicator will show ENG. When the glide slope manual engage switch is placed in the ON position, the glide slope mode indicator will show ENG.

AUTOPILOT OPERATION

The autopilot has a three minute time delay that prevents engagement of the autopilot until the system has warmed up 3 minutes. The N-1 compass gyro has a 5 minute erection cycle; therefore, to prevent erratic signals from the N-1 compass to the autopilot, the autopilot should not be engaged until the N-1 compass system has warmed up at least 5 minutes.

Preflight

The autopilot power switch should be turned ON as soon as power is available; other autopilot switches cannot be engaged until the autopilot system is warmed up. After the autopilot has warmed up approximately three minutes the following checks should be performed.

A. Autopilot Turn Knob - Detent position

B. Engaging Switch Bar - Pull

C. Turn Knob - Rotate to left, then right

Control wheel should follow

D. Pitch Knob - Rotate nose-up, then nose-down

Control column should follow

E. Pilot's Disengage Button - Depress

Autopilot should disengage

F. Engaging Switch Bar - Pull

G. Pilot's or Copilot's Stabilizer Trim Control Switch - Actuate in either direction

Autopilot pitch axis should disengage

H. Engaging Switch Bar - Pull

J. Copilot's Disengage Button - Depress

K. Flight Controls - Check freedom of movement

This assures all autopilot servo clutches are disengaged.

CAUTION

Leave autopilot power switch ON if takeoff is planned. If the gyros are not running during taxi and takeoff, they could be damaged.

Flight

The autopilot may be used inflight as covered in NORMAL OPERATING PROCEDURES. Prior to engaging any axis of the autopilot, the following checks should be made:

A. Autopilot Turn Knob - Detent

B. Trim Meters - Check

Check to insure that individual trim indicators are gently oscillating equidistance back and forth from center and are not fully deflected in one constant direction.

WARNING

Engaging the autopilot when trim meter indicators are fully deflected in one constant direction from center, in any axis, will result in unscheduled control surface movements sufficient to cause unusual airplane attitude.

After a safe altitude is reached:

C. RUD, ELEV and AIL Engage Switches - ON

These switches may be turned ON separately, or they may be turned ON together by pulling the engaging switch bar. Proper operation of the autopilot rudder axis requires that there shall be no rudder input during engagement. To retrim the rudder, disengage the autopilot rudder axis,

accomplish rudder trim and re-engage autopilot rudder axis.

WARNING

- Pilots shall be prepared to immediately disengage the autopilot should any unscheduled control movement be evident. An autopilot lateral malfunction can result in bank angles of 55 degrees within 5 seconds even though recovery is started approximately 3 seconds after the malfunction occurs. A pitch up malfunction could cause a stall within 3 seconds and is therefore considered the most serious autopilot malfunction.

- Loss of generator bus No. 3 deenergizes the autopilot but the autopilot control switches and the servo clutches remain engaged. This condition coupled with the simultaneous loss of the pilot's instruments makes it imperative to closely monitor autopilot operation. Depressing the autopilot disengage button disengages the servo clutches and moves the autopilot control switches to OFF.

CAUTION

When engaging the autopilot at altitudes below 2000 feet above terrain, monitor and engage each axis separately and follow through manually on the control wheel and rudder, as applicable.

NOTE

- Do not operate the speedbrakes for extended periods at setting of less than 40 degrees with the autopilot engaged in the aileron axis. During extended periods of speedbrake operation with speedbrake lever settings of 30 degrees or less, the autopilot may cause the airplane to develop lateral oscillation. Momentary operation of the speedbrake in any position is permissible.

- Prolonged manual overpower of the pitch axis should be avoided due to the opposing action of the automatic pitch trim system. If a pitch porpoising should result from some unusual autopilot operation, the pitch axis should be momentarily disengaged, the airplane retrimmed and then the pitch axis re-engaged.

- The rudder power switch may be turned OFF during cruise flight, with autopilot engaged, if directional hunting or yaw axis oscillations occur. Turn rudder power switch ON before descending to lower altitudes, or reducing airspeed below approximately 250 KIAS.

With the exception of the heading select mode, the autopilot may be used for all air refueling operations. The aileron axis may be used as it will help stabilize the airplane and make the air refueling operation easier. The heading select mode will not be used during refueling.

WARNING

Use caution when disengaging the autopilot during air refueling since abrupt attitude changes about all axes can occur. Refer to Section IV, T.O. 1-1C-1-3, TANKER PILOT TECHNIQUE, for autopilot operations during air refueling.

CAUTION

The pitch axis may be used during air refueling or when boom is lowered; however, prior to air refueling the autopilot stabilizer trim follow-up should be checked for proper operation. Autopilot operation will be monitored closely during the air refueling operation. At any indication of autopilot malfunction a BREAKAWAY shall be initiated immediately.

D. Autopilot Stabilizer Trim Follow-up - Check

(1). This step is to be accomplished prior to air refueling or any time it is suspected that the stabilizer trim system is not functioning normally. Check operation of the system as follows:

(a) With autopilot pitch axis engaged, manually move the control column to overpower the autopilot and obtain an out-of-trim condition.

(b) As autopilot trim attempts to relieve pitch axis servo torque, check that the manual trim wheel rotates opposite to the direction of control column pressure. Release control column pressure gradually and note action of autopilot return to the original pitch mode.

(c) When trim wheel stops, observe the autopilot elevator trim meter to insure that elevator axis of the autopilot is not holding a sustained pitch torque.

(2). If autopilot trim action is not normal or is inoperative during checkout, see AUTOPILOT TRIM MALFUNCTIONS, Section III.

Turns and Banks

Rotate the autopilot turn knob until the desired bank angle is obtained. Banks to a maximum of approximately 40 degrees may be made with the autopilot.

Climbs and Dives

Rotate the autopilot pitch knob until the desired pitch attitude is obtained. Dives or climbs to a maximum of 20 degrees may be made with the autopilot.

NOTE

The autopilot pitch knob remains active when longitudinal path control functions (altitude, Mach No. and glide slope) are engaged. Use of the pitch knob should be avoided while these hold functions are engaged since, in general, such action will result in deviations from the controlled path.

Autopilot and N-1 Compass Relationship

The N-1 compass, operating either as a magnetic-slaved compass or as a directional gyro, supplies heading reference data to the autopilot. By using the N-1 compass as a reference, the autopilot can maintain a given heading in three ways: (1) engaging the aileron axis (heading hold mode), (2) placing the HDG SEL switch ON, and (3) placing the VOR-LOC switch ON. When the aileron axis is engaged, the autopilot continues to fly on the heading that the airplane was flying at the time the aileron axis was engaged. In this mode of operation, turning the airplane with the turn knob temporarily disengages the autopilot from the N-1 compass and engages again on a new hold heading when the turn knob is centered. During the HDG SEL and VOR-LOC operation, the autopilot controls the airplane along the flight path selected on the pilot's HSI by comparing the actual heading (from N-1 compass) with the selected course. Since VOR/ILS and TACAN courses are magnetic, the N-1 compass must be operating in the magnetic mode during autopilot VOR/ILS or TACAN operations.

NOTE

When engaged on VOR-LOC or HDG SEL mode, rotation of the N-1 compass synchronizer knob causes the airplane to turn.

Autopilot Heading Selection

Preset heading selection is provided to aid in the navigation of the airplane. A new heading may be selected at any time on the pilot's course selector. When it is desired to turn to the new heading, as set on the course selector, move the heading select switch to the ON position. After the airplane has stabilized on the new heading, the heading select switch may be moved to the OFF position and a new heading selected on the HSI for a future heading change. A new heading may also be selected with the heading select switch ON and the airplane will make a turn to the new heading. This type of heading selection is especially useful when making small corrections in heading during GCA.

NOTE

- When a new course is selected with the heading select switch ON, the course set knob should be moved smoothly until maximum bank angle is reached (approximately 25 degrees) to prevent abrupt airplane movement.

- If a new heading is selected which is exactly 180 degrees from the airplane heading the autopilot will be slow in initiating the turn.

- The control wheel (and sometimes the airplane) will oscillate on occasion in the roll axis while heading select is engaged and the pilot switches from VOR to TACAN or conversely. This oscillation is at approximately 10 cps and completely damps in less than 1 second. The oscillation follows the movements of the pilot's HSI No. 2 needle. Loading effects of the synchro-receiver within the HSI, which positions the pilot's HSI No. 2 needle and the co-pilot's HSI No. 1 needle when VOR No. 1 is selected, affect heading select inputs to the autopilot.

Autopilot Operation on VOR or TACAN

With either a VOR or TACAN selected and the VOR-LOC mode engaged, the autopilot will fly the airplane to the selected course and follow the course over the station, then capture and follow an outbound course to the limit of VOR-TACAN reception. If a crosswind exists, the autopilot will automatically crab the airplane to maintain its position on the course. (See Autopilot Operation on ILS, this Section.)

To fly inbound or outbound on a selected course:

A. N-1 Compass - Magnetic slaved operation

B. VOR or TACAN - Select frequency of desired station

C. Pilot's TACAN Select Switch - VOR-ILS (OFF) or TACAN (ON) as required

D. Course Set Knob (on pilot's HSI) - Rotate to desired course

E. Autopilot Turn Knob - Rotate to fly airplane toward intercept of the selected course at any convenient angle and return knob to detent

F. VOR-LOC Switch - ON after CDI departs full scale position

NOTE

When a 50 to 60 degrees intercept angle to the selected course will effect beam capture prior to reaching station vicinity, VOR-LOC may be engaged before the CDI departs full scale position. At distances closer than 25 nautical miles from the station, course capture can be best effected manually.

The autopilot will now fly the airplane to and along the selected course automatically, establishing a crab angle in accordance with the existing wind. If inbound, as the airplane enters the area above the station where the course signal becomes erratic (cone of confusion) the clamping circuit will cause the airplane to maintain heading until the area is passed.

G. Changing Courses - A new course may be selected at any time. When flying an inbound course, disengage VOR-LOC, select the desired course on pilot's HSI, and return the VOR-LOC switch to the ON position. If flying over the station or tracking an outbound course, it is not necessary to disengage VOR-LOC.

H. Changing Stations - The VOR-LOC switch may be disengaged before changing VOR or TACAN stations; however, to avoid losing drift correction, it is recommended that the pilot merely select the new frequency and inbound course. When this is done, the system will clamp and the aircraft will turn to the inbound course with the proper drift correction (as if over the cone of confusion because of CDI movements). The airplane will remain on or very near the course without unusual maneuvering until the system unclamps.

Autopilot Operation on ILS

The autopilot can be used to make safe ILS approaches to ILS minimum by using a standard glide slope and localizer beam subject to the following restrictions:

A. When performing an automatic ILS approach, disengage the autopilot at an altitude not lower than the published ILS minimum because of the large control forces required to overcome the autopilot.

WARNING

Check the autopilot trim meters for any indication of a sustained servo torque on any of the axes. If such a torque is indicated, be prepared to immediately assume the force with manual flight controls.

The following steps should be used to make an ILS approach:

A. N-1 Compass - Magnetic Slaved Operation

B. VOR/ILS Receiver - Select frequency of desired station

C. Pilot's TACAN Select Switch - VOR-ILS (OFF)

D. Course Set Knob - Set inbound localizer course

E. Planning - Approach localizer with an initial intercept angle of 45 to 90 degrees with respect to localizer center line. Plan to intercept localizer center line 12 to 20 miles from the station.

F. VOR-LOC Engage Switch - ON after CDI departs the full scale position

G. Altitude Hold Switch - ON if constant altitude desired

The autopilot will now fly the airplane inbound on the ILS localizer beam. Before the glide slope is reached:

H. Glide Slope Auto Engage Switch - ARMED

The glide slope mode indicator will change from OFF to ARM

As the airplane reaches the glide slope, the glide slope mode indicator will change from ARM to ENG and the autopilot will engage the glide slope; the altitude hold switch will automatically move to the OFF position and the airplane will follow the glide slope. Should the autopilot fail to engage the glide slope automatically when the glide slope is reached, move the glide slope manual engage switch to ON.

NOTE

After engagement of glide slope, the airplane airspeed should be monitored and controlled through manual operation of the throttle.

When visual contact is established with the runway:

J. Autopilot Disengage Button - Depress

Make normal landing

NOTE

If the autopilot is disengaged using the RGA/AP switch and the RGA power switches are ON, the command bars will display go-around command. See GO-AROUND, figure 4-30X.

Disengaging the Autopilot

The autopilot may be completely disengaged by pressing the autopilot disengage button. The rudder, elevator, or aileron servos may be released one at a time by moving the proper engage switch to the OFF position.

NAVIGATION EQUIPMENT AND SYSTEMS

NAVIGATOR INSTRUMENTS

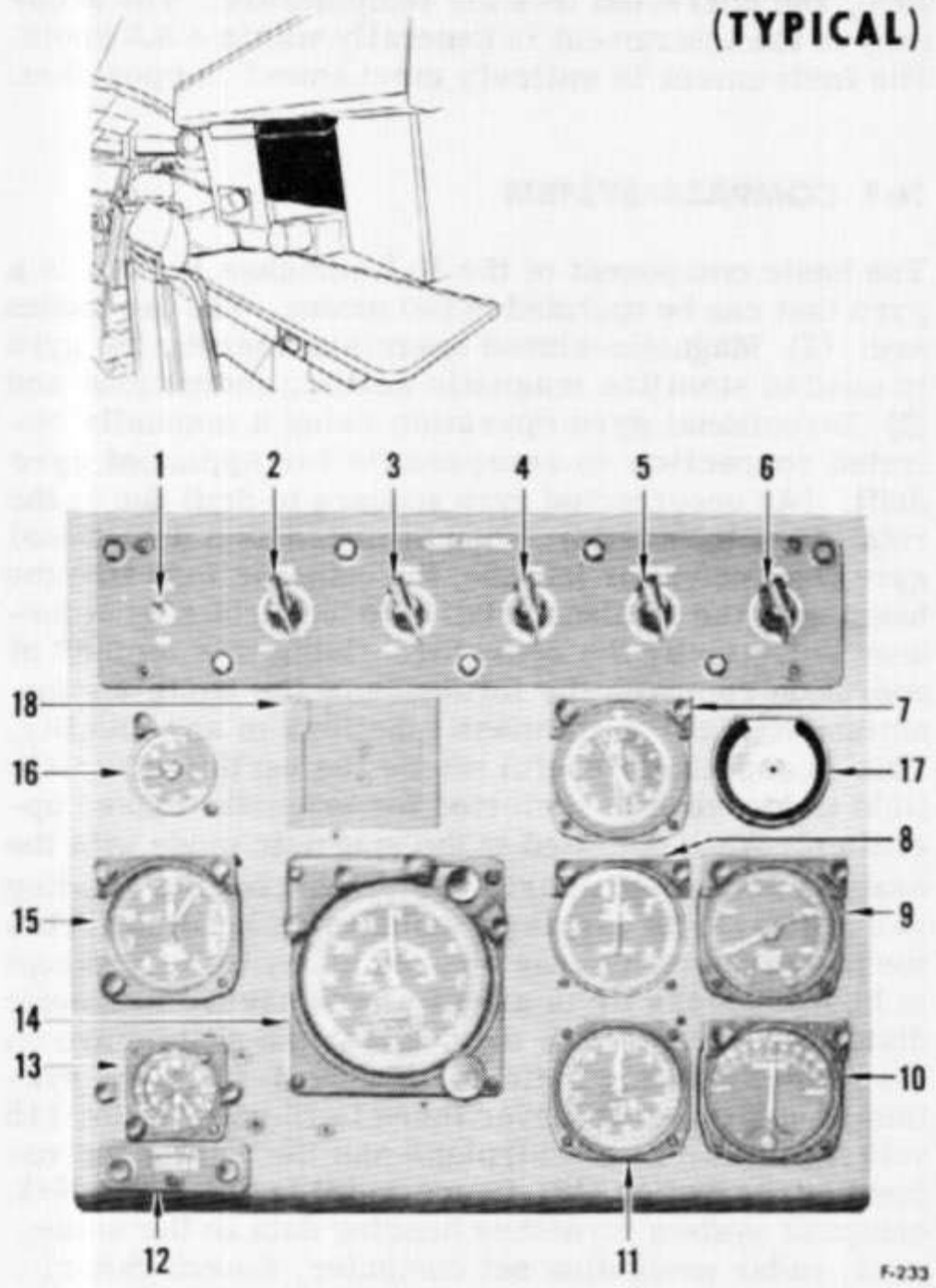
INDICATOR	INDICATOR DESCRIPTION LOCATION
Free Air Temperature Gage, Type G-10 (16, figure 4-43)	See FREE AIR TEMPERATURE GAGES, Section I.
Radio Magnetic Indicator (RMI), ID-250/ARN (7, figure 4-43)	See RADIO MAGNETIC INDICATOR (RMI), this Section.
Altimeter, Type AAU8/A or Type MA1 (15, figure 4-43)	See ALTIMETER, Section I.
Master Heading Indicator, N1 Master (14, figure 4-43)	See N-1 COMPASS SYSTEM, this Section.
Ground Speed Indicator, ID-341/APN-81 (9, figure 4-43)	See RADAR NAVIGATION SET (AN/APN-82) in this Section.
Clock, Type A-13A (13, figure 4-43)	See MISCELLANEOUS INSTRUMENTS, figure 1-54.
Ground Position Indicator, ID-389/ASN-6 1▶97 (11, figure 4-43)	See RADAR NAVIGATION SET (AN/APN-82) in this Section.
Destination Indicator, ID-390/ASN-7 98▶ (11, figure 4-43)	See DESTINATION INDICATOR in this Section.
Drift Angle Indicator, ID-342/APN-81 (10, figure 4-43)	See RADAR NAVIGATION SET (AN/APN-82) in this Section.
High Range Radio Altimeter I-152-E (18, figure 4-30)	See HIGH RANGE RADIO ALTIMETER (SCR-718 or AN/APN-133) in this Section.
True Airspeed Indicator, Type M-5 (8, figure 4-43)	See TRUE AIRSPEED INDICATOR in this Section

The navigator's instrument lights rheostat (5, figure 4-43) controls the intensity of instrument illumination.

TRUE AIRSPEED INDICATOR

The true airspeed indicator (8, figure 4-43) utilizes an aneroid, a differential pressure diaphragm, and a

NAVIGATOR'S INSTRUMENT PANEL (TYPICAL)



1 COLOR SELECTOR SWITCH
2 CABIN DOME LIGHT CONTROL
3 NAVIGATOR'S TABLE LIGHTS CONTROL
4 NAVIGATOR'S FLOODLIGHTS CONTROL
5 NAVIGATOR'S INSTRUMENT LIGHTS RHEOSTAT
6 NAVIGATOR'S PANEL LIGHTS CONTROL
7 RADIO MAGNETIC INDICATOR (RMI) (SEE FIGURE 4-18)
8 TRUE AIR SPEED INDICATOR
9 GROUND SPEED INDICATOR (SEE FIGURE 4-19)
10 DRIFT ANGLE INDICATOR (SEE FIGURE 4-19)
11 DESTINATION INDICATOR 98▶ (SEE FIGURE 4-19)
GROUND POSITION INDICATOR 1▶97
(SEE FIGURE 4-19)
12 RADIO CALL PLATE
13 CLOCK
14 MASTER HEADING INDICATOR (N-1 COMPASS SYSTEM)
(SEE FIGURE 4-44)
15 ALTIMETER
16 FREE AIR TEMPERATURE GAGE (OAT)
17 NAVIGATOR'S WATCH CLIP
18 ALTIMETER CORRECTION CARD HOLDER

Figure 4-43

bulb temperature diaphragm which respond respectively to changes in barometric pressure, impact pressure, and corrected free air temperature. The accuracy of the instrument is generally within ± 8.0 knots. The instrument is entirely mechanical in operation.

N-1 COMPASS SYSTEM

The basic component of the N-1 compass system is a gyro that can be operated in two modes. The two modes 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 in the magnetic mode with the heading pointer properly synchronized, the heading indication is the airplane's magnetic heading. This method of operation may be used in any locality except in high latitudes or in areas where severe magnetic distortion occurs. The controls for the system are on the master heading indicator (figure 4-44). The system is energized whenever there is 28 volt DC and 115 volt AC power on the airplane and the pilot's instrument gyros switch (17, figure 1-18) is ON. The N-1 compass system furnishes heading data to the autopilot; radar navigation set computer; search radar; navigator's master heading indicator (14, figure 4-43); pilot's flight director system, HSI and ADI (12 and 8, figure 1-18); and the radio magnetic indicators (RMI) at the copilot's and navigator's stations (figure 4-18). The 28 volt DC power is from T-R BUS NO. 2 on the MCBP (figure 1-35, sheet 2) through a circuit breaker marked N-1 COMPASS & PILOT ATTITUDE IND. The 115 volt AC power is obtained through three circuit breakers marked N-1 COMPASS. Two of the circuit breakers are on the 115V AC section and one circuit breaker on the GENERATOR NO. 3 section of the MCBP (figure 1-35, sheet 3).

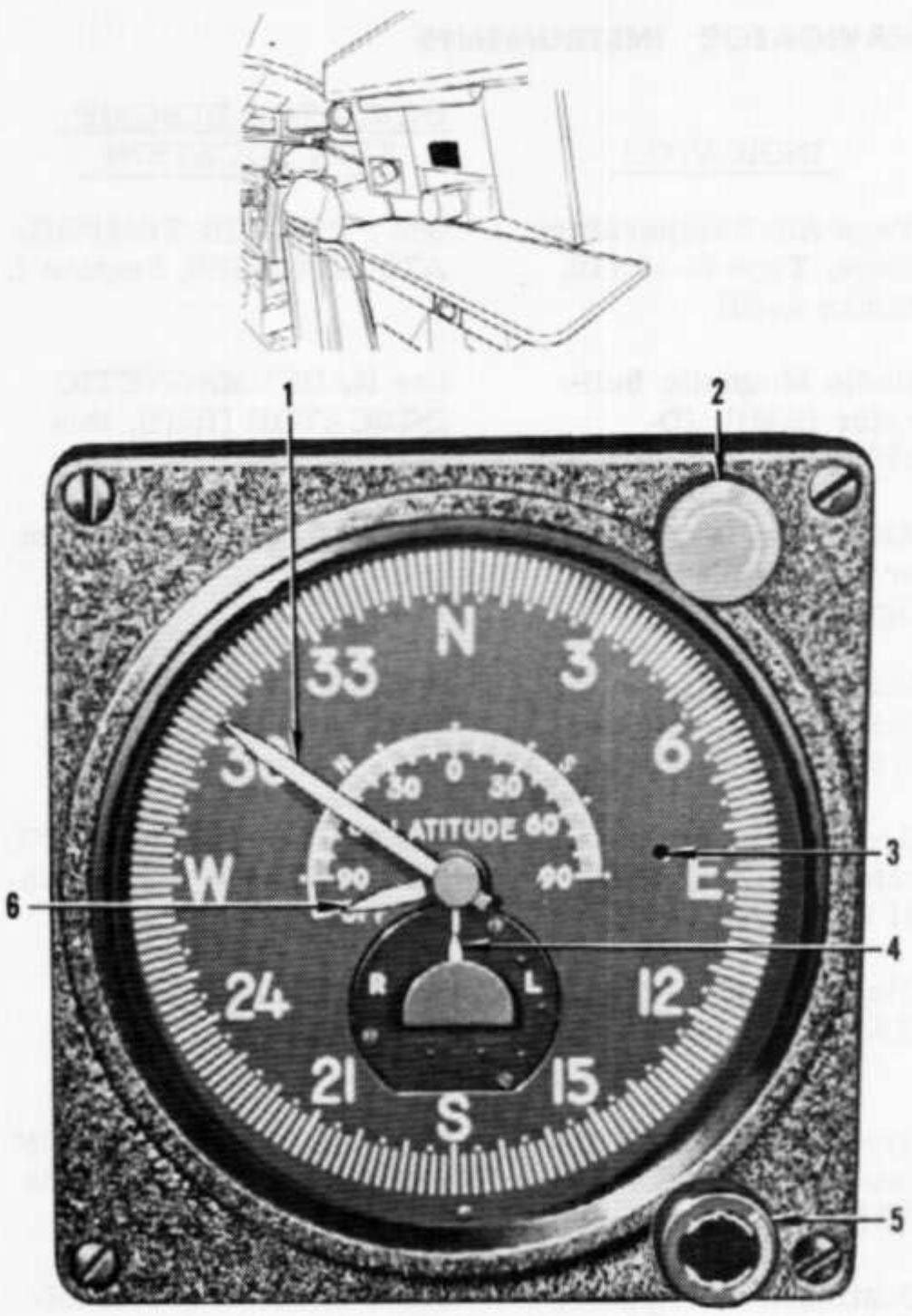
NOTE

The pilot's heading indicator displays the same heading as the master indicator within ± 2 degrees and the radio magnetic indicator headings are within 2-1/2 degrees of the master indicator.

Heading Indicator

The heading pointer (1, figure 4-44) indicates the correct magnetic heading while the compass is in magnetic mode (providing the pointer is properly synchronized),

N-1 COMPASS CONTROLS



MASTER HEADING INDICATOR

1 HEADING POINTER
2 LATITUDE CORRECTION CONTROL KNOB
3 CORRECTION INDICATOR PORT
4 ANNUNCIATOR POINTER
5 SYNCHRONIZER KNOB
6 LATITUDE CORRECTION POINTER

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Figure 4-44

or deviations from a preselected heading during directional gyro operation. Heading indications are accurate within ± 1/2 degree.

Latitude Correction Control Knob

The function of this knob (2, figure 4-44) is to switch from the magnetic mode to the directional-gyro mode or vice versa, and to adjust the latitude correction setting. Refer to LATITUDE CORRECTION POINTER.

Latitude Correction Pointer

The latitude correction control knob (2, figure 4-44) positions the latitude correction pointer (6, figure 4-44) 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 ± 4 degrees from the airplane position and should be changed to mid-latitude for each 8 degrees change in latitude, or computed false latitude.

Synchronizer Knob

During directional-gyro operation, the synchronizer knob (5, figure 4-44) is used to set the heading pointer to any desired position (usually repositioned for grid navigation reference). In the magnetic mode, 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 the N-1 compass heading information. It may cause the airplane to turn when the autopilot is engaged in the VOR-LOC or HDG SEL mode due to the change in heading reference to the autopilot and the pilot's course arrow. **The direction the airplane turns may not be in the direction of knob rotation, but will be a turn to the course set on the pilot's course arrow.**
- When the autopilot is engaged and the VOR-LOC and HDG SEL modes are not in use, the aircraft heading may be changed by turning the synchronizer knob if the N-1 compass is being operated in the magnetic-slaved mode. The aircraft will turn at a rate of 1 to 3 degrees per minute when using the synchronizer knob.

Annunciator (N-1 Compass)

The annunciator, operative only in the magnetic mode, consists of a dial and pointer (4, figure 4-44). The pointer indicates the direction in which to rotate the synchronizer knob to align the heading pointer with the earth's magnetic field. When the pointer is centered the compass is synchronized. A 30 degree deflection of the pointer from center indicates that the heading pointer has an error of approximately 3 to 5 degrees.

Correction Indicator Port

The intermittent appearance of the small white dot behind the correction indicator port (3, figure 4-44) indicates that the compass system is being corrected. In the directional gyro mode, 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 mode 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.

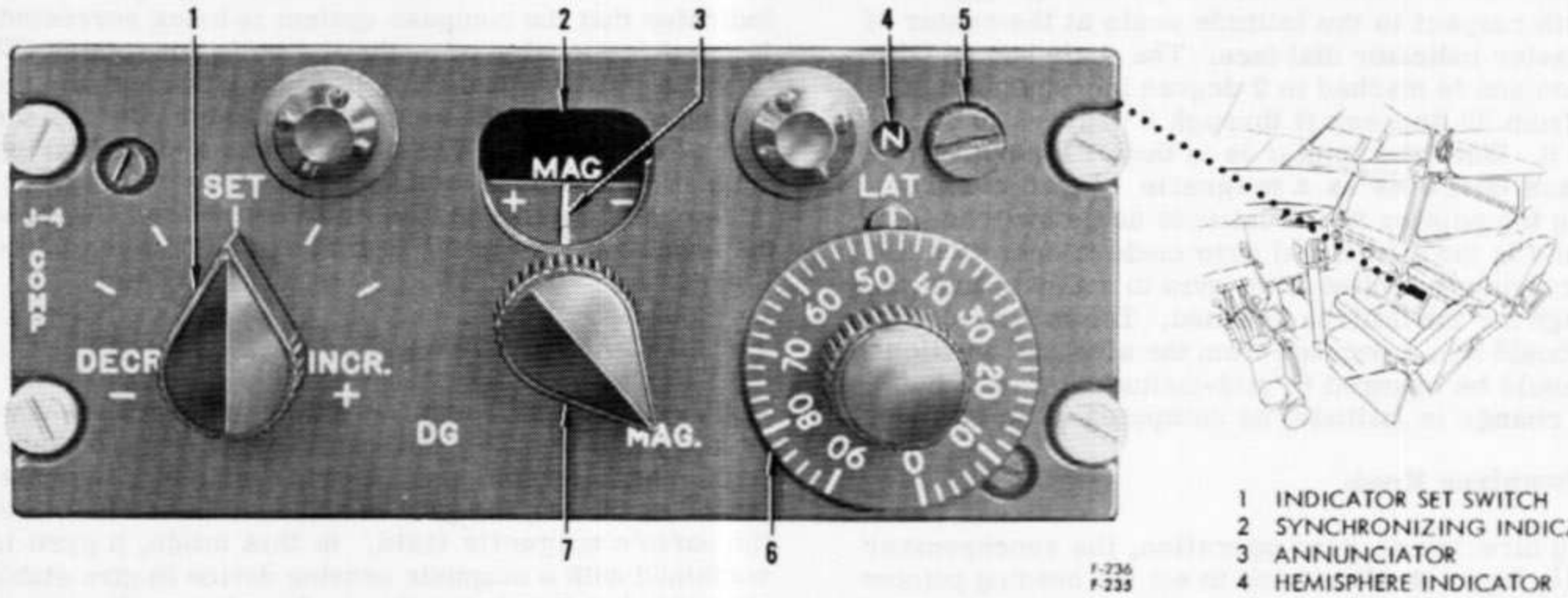
J-4 COMPASS SYSTEM

The J-4 compass operates either as a latitude corrected gyro heading indicator or as a gyro stabilized magnetic compass. During magnetic compass (MAG) operation, the gyro is slaved to (made to follow) the earth's magnetic field. In this mode, a gyro is combined with a magnetic sensing device to give stable magnetic heading indications. In polar regions or in areas having a weak or distorted magnetic field, the magnetic sensing device can be cutout of the system to give directional gyro (DG) operation. A gyro maintains a fixed position in space which is the reference for directional gyro heading indications. Since this reference is fixed in space, there is an apparent drift of the gyro due to the rotation of the earth. The magnitude of apparent drift varies from zero at the equator to a maximum at the North and South poles. Therefore, to maintain accurate heading indications during DG operation, it is necessary to manually insert latitude corrections periodically to compensate for the apparent drift. The accuracy of the heading indication is such that the error does not exceed two degrees. The J-4 compass system furnishes heading data to the copilot's flight director system, HSI and ADI (25 and 4, figure 1-19); and the pilot's RMI (21, figure 1-18). The system is turned on whenever power is supplied to the airplane and the copilot's instrument power gyros switch is positioned to ON. The system requires 28 volt DC and 115 volt AC power. Normal operating and control power for the system is from the copilot's instrument power system. See COPILOT'S INSTRUMENT POWER SYSTEM in Section I. In the event of failure of the copilot's instrument power system, the J-4 compass system can be switched to the main power systems for continued operation. See COPILOT'S INSTRUMENT POWER GENERATOR SWITCH in Section I. Circuit protection is through three fuses marked J-4 COMPASS INDICATOR on the CIPP (figure 1-35, sheet 8A).

NOTE

The J-4 compass system completes a synchronization cycle within 15 seconds after the compass has been placed in MAG operation. This synchronizatien removes any error that exists between the airplane magnetic heading and the indicator heading.

J-4 COMPASS CONTROLS



J-4 COMPASS CONTROL PANEL

1 INDICATOR SET SWITCH
2 SYNCHRONIZING INDICATOR
3 ANNUNCIATOR
4 HEMISPHERE INDICATOR
5 HEMISPHERE SELECTOR SWITCH
6 LATITUDE CORRECTION DIAL
7 MODE SELECTOR SWITCH

Figure 4-45

Mode Selector Switch

The mode selector switch (7, figure 4-45) on the J-4 compass control panel has two positions: MAG and DG. When the switch is on MAG, the system operates as a gyro-stabilized magnetic compass (slaved gyro). Placing the switch in DG raises a cover over the annunciator and unslaves the gyro so that the system operates as a directional gyro.

Annunciator (J-4 Compass)

The annunciator (3, figure 4-45) is operative when the mode selector switch is in the MAG position. The position of the pointer indicates the magnitude and direction of azimuth correction required to bring the compass into synchronization with the earth's magnetic field. The compass will synchronize itself automatically; however, an out of synchronization condition can be corrected more rapidly by using the indicator set switch. See INDICATOR SET SWITCH in this Section.

Indicator Set Switch

The indicator set switch (1, figure 4-45) on the J-4 compass control panel, marked DECR(-)--SET--INCR(+), is used to slew the copilot's HSI azimuth card (3, figure 4-30D) and pilot's RMI compass card (16, figure 4-18). The switch is used primarily for selecting a desired heading during DG operation. The azimuth card turns CW when the switch is held in INCR and CCW when held in DECR. During MAG operation, the switch is used in conjunction with the annunciator to manually synchronize the heading pointer with the compass (or to test the annunciator). The switch is spring loaded to the SET position and is turned towards (+) or (-), as indicated by the annunciator, to synchronize the compass. Turning the switch to the first (slow slew) or second (fast slew) position controls the rate at which the azimuth card rotates.

CAUTION

Do not use the set switch for the slew operation excessively or continuously for longer than 30 seconds. Excessive or continuous use may cause overheating of the slew motor.

NOTE

During MAG operation, the azimuth card can be synchronized either manually or automatically. The indicator set switch is used for manual synchronization. Placing the mode selector switch momentarily to DG and returning it to MAG initiates an automatic synchronization cycle.

Hemisphere Selector Switch

The hemisphere selector switch (5, figure 4-45) is used to position either N or S in the hemisphere indicator window. Apparent drift of a gyro is CW in the Northern hemisphere and CCW in the Southern hemisphere; therefore, the direction in which drift correction is applied to the gyro during DG operation depends upon the switch position.

Latitude Correction Dial

The rate of precession (drift) of a gyro is in direct proportion to the latitude. During DG operation, it is necessary to position the latitude correction dial (6, figure 4-45) to the local latitude to compensate for the drift. The indicated latitude should be ± 4 degrees from the airplane position and should be changed to mid-latitude for each 4 degree change in latitude, or computed false latitude.

PERISCOPIC SEXTANT AND MOUNT

The sextant (figure 4-47) consists of a sealed periscopic tube, sextant body, a bubble unit, light rheostat, eyepiece assembly, and an averager assembly. When not being used, the sextant is stowed in a stowage case (9, figure 1-3) near the navigator's table. The sextant is mounted in a special mount on the ceiling in the control cabin. The sextant mount (figure 4-47), consists of shutter and receptacle assemblies.

Illumination Switch

An ON--OFF switch (19, figure 4-47) on the mount, controls illumination of both the sextant and the mount, a short connecting cable transmits the power between the mount and the sextant. Illumination of the bubble and azimuth scale of the mount is adjustable by rheostat (7, figure 4-47). No adjustment is provided to control the illumination of the mount azimuth altitude counter, halftime dial and averager indices, or the watch clip. Power for illumination is 28 volt AC through a circuit breaker marked SEXTANT on the MCBP (figure 1-35).

Altitude and Averager Controls

The averager automatically plots variations in altitude reading of the celestial body being observed during the time of observation thus cancelling out minor airplane movement. Resetting the averager indicators (3, figure 4-47) after an observation, automatically sets the average or mean altitude on the sextant counter (4, figure 4-47) from which it may be read directly. The averager winding lever (12, figure 4-47) and the actuating lever (11, figure 4-47) control averager operation. An optical shutter operated by the averager closes and terminates the observation. The averager should be in the run down position when the sextant is stowed. A correlation between relative bearing and altitude angle is shown on figure 4-46 as an aid to navigation planning.

Bubble Control

The bubble unit reflects the bubble image to provide an artificial horizon image. Size of the bubble is regulated by the bubble control knob (22, figure 4-47) The bubble control knob should be in full increase position when stowing the sextant.

SEXTANT VISION OBSTRUCTION BY AIRPLANE

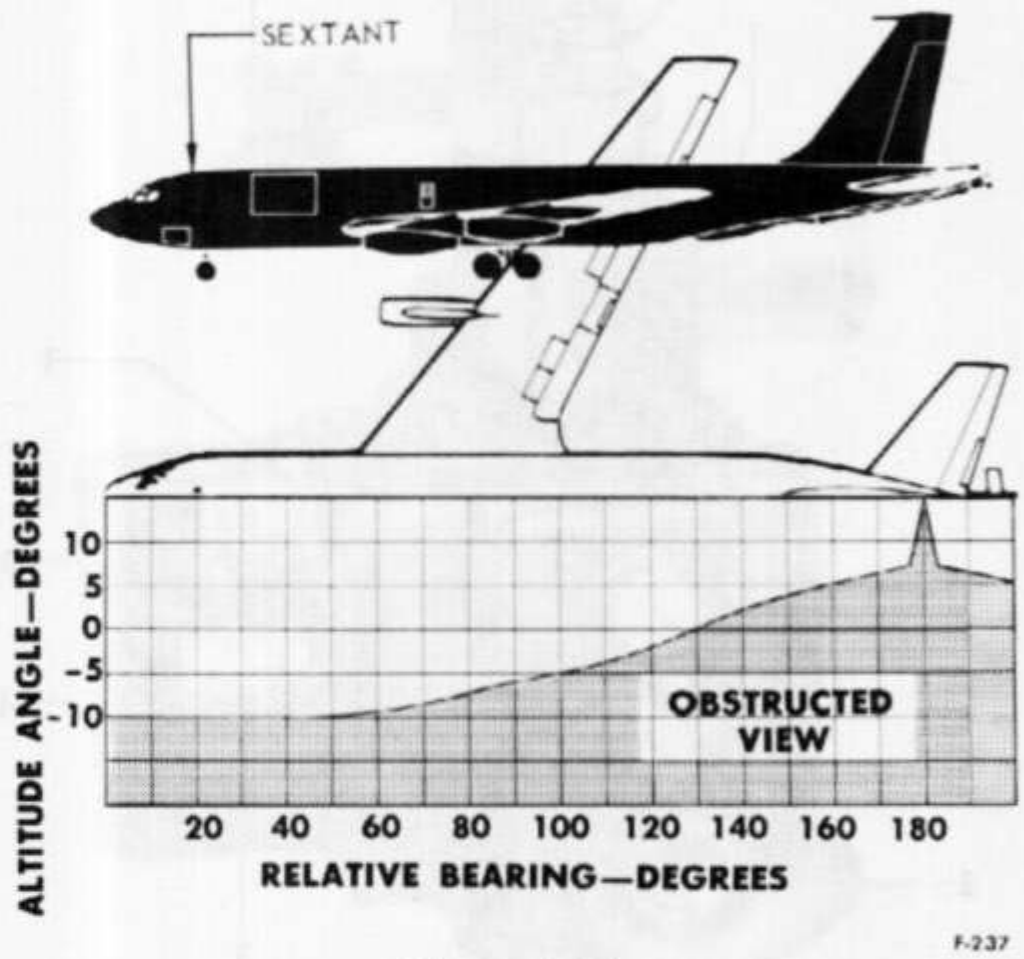


Figure 4-46

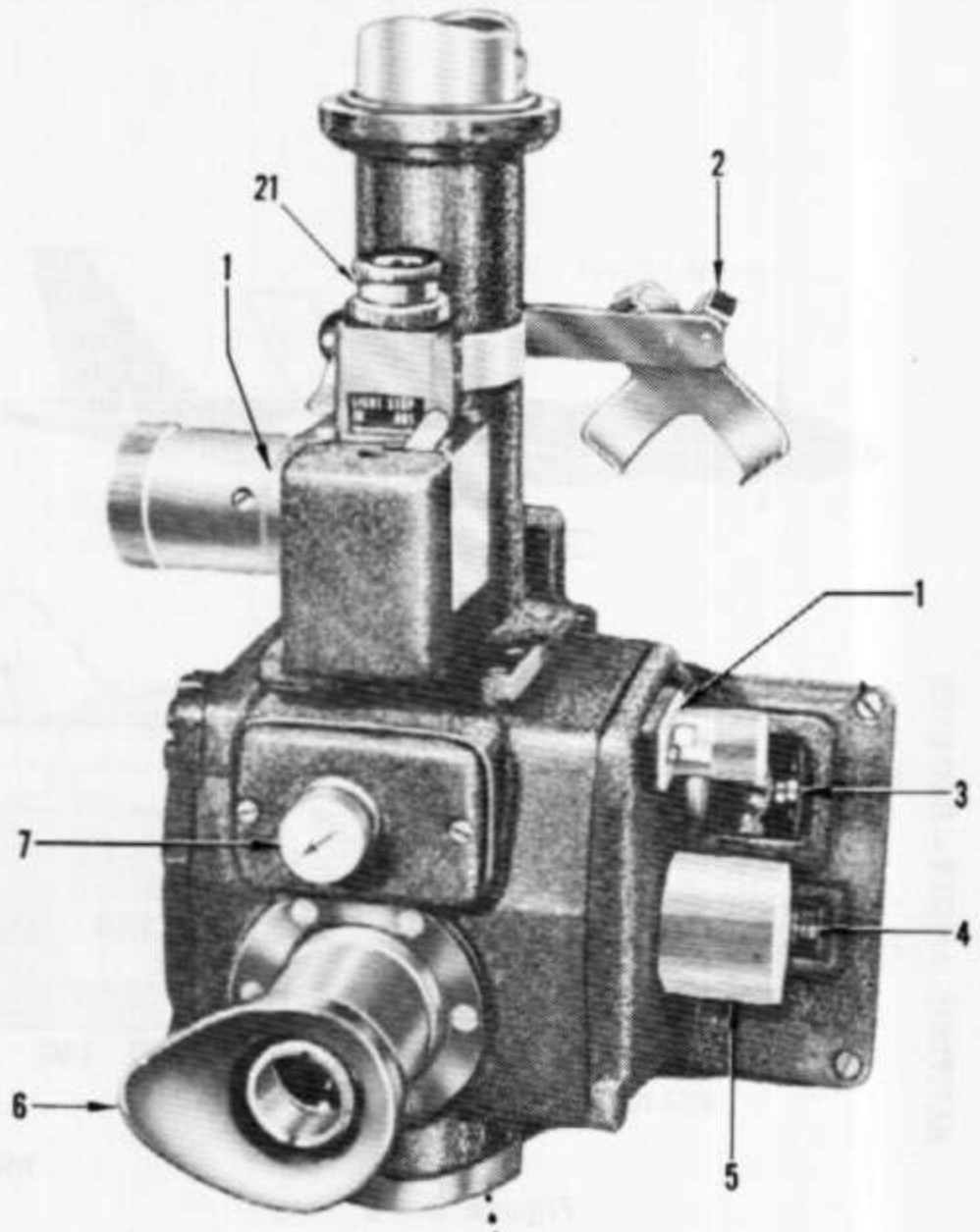
Projection Lens and Diffuser

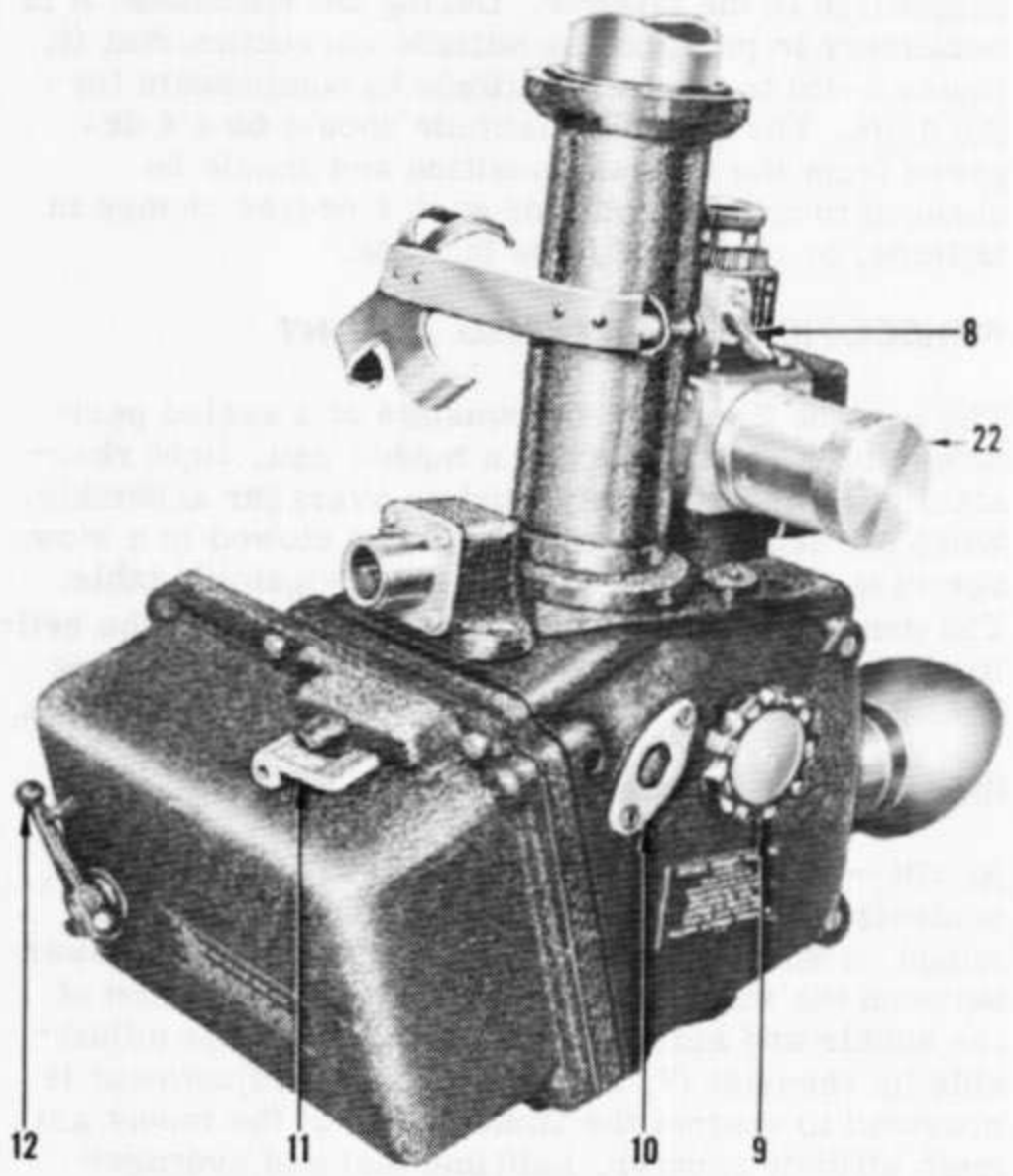
A true heading projection lens (21, figure 4-47) and diffuser lever (8, figure 4-47) are mounted on the top of the bubble unit to regulate the amount of natural light entering the bubble dome. Minor sextant alignment errors can be corrected by adjustment of the projection lens.

Azimuth Crank and Shutter

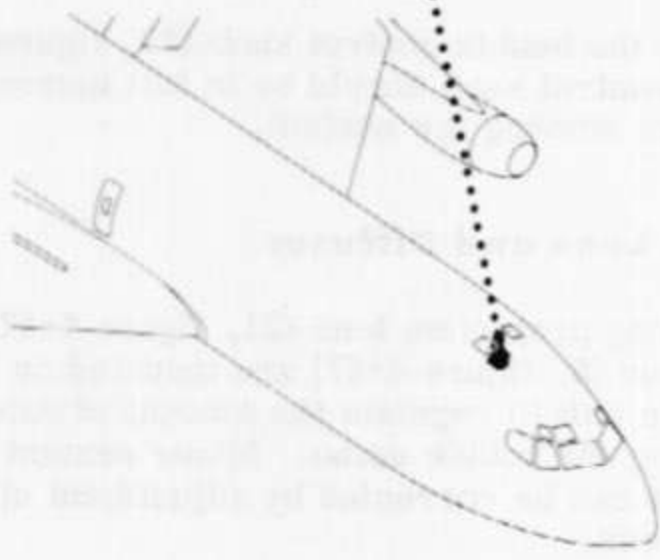
The azimuth crank (13, figure 4-47) operates the dial counter assembly which allows 360 degrees of azimuth rotation. The shutter lever (17, figure 4-47) controls the opening and closing of the sextant tube opening by means of a mechanical linkage to the shutter.

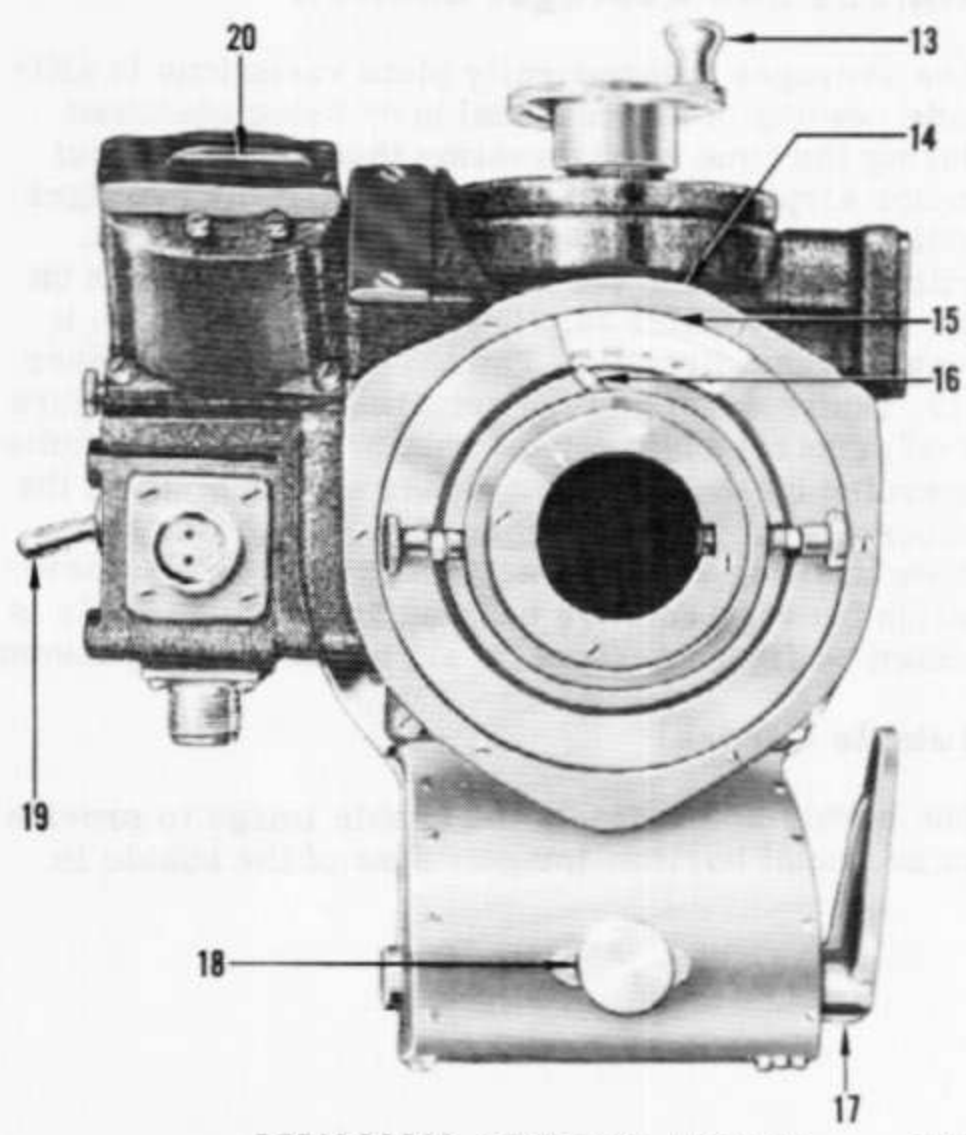
PERISCOPIC SEXTANT AND MOUNT CONTROLS





PERISCOPIC SEXTANT





PERISCOPIC SEXTANT MOUNT

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F-239
F-240

1	LAMP (2 PLACES)	12	AVERAGER WINDING LEVER
2	WATCH CLIP	13	AZIMUTH CRANK
3	HALFTIME DIAL AND AVERAGER INDICATOR	14	LUBBER LINE RING
4	ALTITUDE COUNTER	15	AZIMUTH SCALE
5	ALTITUDE KNOB	16	LOCKING LEVER
6	EYEPIECE	17	SHUTTER LEVER
7	RHEOSTAT	18	DRAIN PLUG
8	DIFFUSER LEVER	19	ILLUMINATION SWITCH
9	FILTER ADJUSTMENT SELECTOR	20	AZIMUTH COUNTER
10	DESICCANT	21	PROJECTION LENS
11	ACTUATING LEVER	22	BUBBLE KNOB

Figure 4-47

CARGO LOADING AND STOWAGE EQUIPMENT

The airplane is well adapted for carrying cargo and troops with the refueling equipment installed. Cargo may be loaded on the upper deck of the fuselage between a station aft of the toilet compartment extending to the aft pressure bulkhead. See figure 4-51. On airplanes with an arctic kit installed, cargo may be loaded on the upper deck of the fuselage between a station aft of the overwing hatches extending to the aft pressure bulkhead. In addition limited cargo may be carried forward of the overwing hatches on arctic equipped airplanes provided the floor has been properly shored and an adequate number of tie-down fittings have been made available by removing the screws and plastic washer above each fitting. No cargo can be loaded in the lower part of the fuselage. The main cargo floor is made of plywood supported by metal beams. A large area of this plywood floor covering may be readily removed from the airplane when it is used as a tanker. The removal of flooring reduces the empty weight of the airplane, thus allowing a greater payload of fuel to be carried. The cargo floor beams are fitted with a variety of cargo tie-down fittings which range in capacity from 1250 to 10,000 pounds. No cargo securing devices are installed overhead or on the sidewalls of the fuselage. Due to the vast amount of space and large number of tie-down fittings, larger types of equipment such as jet or reciprocating engines may be carried. The cargo should always be secured with the proper tie-down rings provided, thus preventing shifting. For more detailed information concerning cargo loading and tie-down, refer to the Handbook of Cargo Loading Instructions, T.O. 1C-135(K)A-9. Other information applicable to cargo loading can be found in the Handbook of Weight and Balance Data, T.O. 1-1B-40. This handbook is located in the airplane "G" file. Also, see Section V of this manual for weight and cg limitations.

NOTE

When loading cargo, personnel should ascertain that the following areas are kept clear of cargo:

a. **Area near the emergency flap drive shaft door.**
b. **Area near the emergency landing gear extension door.**
c. **Area near the landing gear lock inspection door.**
d. **On airplanes 406 ▶, the area near the emergency wheel well door release access.**
e. **Escape routes and exit areas.**

The floor around areas a, b and c is clearly marked.

CARGO DOOR CONTROLS

The cargo door (39, figure 1-3) is on the left side of the fuselage forward of the wing. This door can only be operated from inside the airplane. See figure 4-51 for cargo door hydraulic controls. A cargo door safety barrier, in the form of web straps 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. The door is locked closed by slotted cams operated by four latch handles. Two pressure plates lock the cams in an over center position and prevent opening the door when the airplane is pressurized. A toe pedal on each of these plates is depressed and held down to release this lock when there is no pressure differential. Serrations on the end of the spring loaded grip of the locking handles mate with serrated plates to further secure the handles in the locked position. The door is operated by an independent hydraulic system. A cargo door selector valve handle (1, figure 4-49) has OPEN--NEUTRAL--CLOSE positions. In the OPEN and NEUTRAL positions the door is held in any given position by blocked hydraulic fluid; in the CLOSE position the door is allowed to fall slowly to a near closed position. A hand pump (5, figure 4-49) supplies hydraulic pressure to the door actuators. On airplanes with ▶ 1610 944 ◀, an electrically driven hydraulic pump is installed for opening and closing the cargo door. An ON--OFF switch, located on the bulkhead above the hydraulic pump, controls operation of the motor. Operating and control power is from the main airplane battery through a circuit breaker marked CARGO DOOR on the battery circuit breaker panel. The hand pump is operative and may be used as a backup for the electric motor driven hydraulic pump. Pressure relief valves prevent overpressurization of the system, even though the pump is operated when the door is fully open or closed. The cargo door on airplanes ▶ 316 ◀ have seal strips around the edges to reduce heat losses and noise. The seal strips are hook and pile tapes that are joined together by running a hand around the edge of the insulating blanket after the door is closed.

CARGO DOOR OPERATION

Opening the Door

A. Seal Strip (bottom of door) - Roll up and fasten ▶ 376 ◀

B. Aft Toe Pedal - Depressed (unlocks latch handles)

C. Aft Latch Handles - Released and rotated inboard and down

D. Forward Toe Pedal - Depressed (unlocks latch handles)

E. Forward Latch Handles - Released and rotated inboard and down

F. Selector Valve Handle - OPEN

G. Electric Motor Control Switch (With ▶ 1610 944 ◀) or Handle - Operate until door is in desired position

H. Door Hold - Selector valve OPEN or NEUTRAL

WARNING

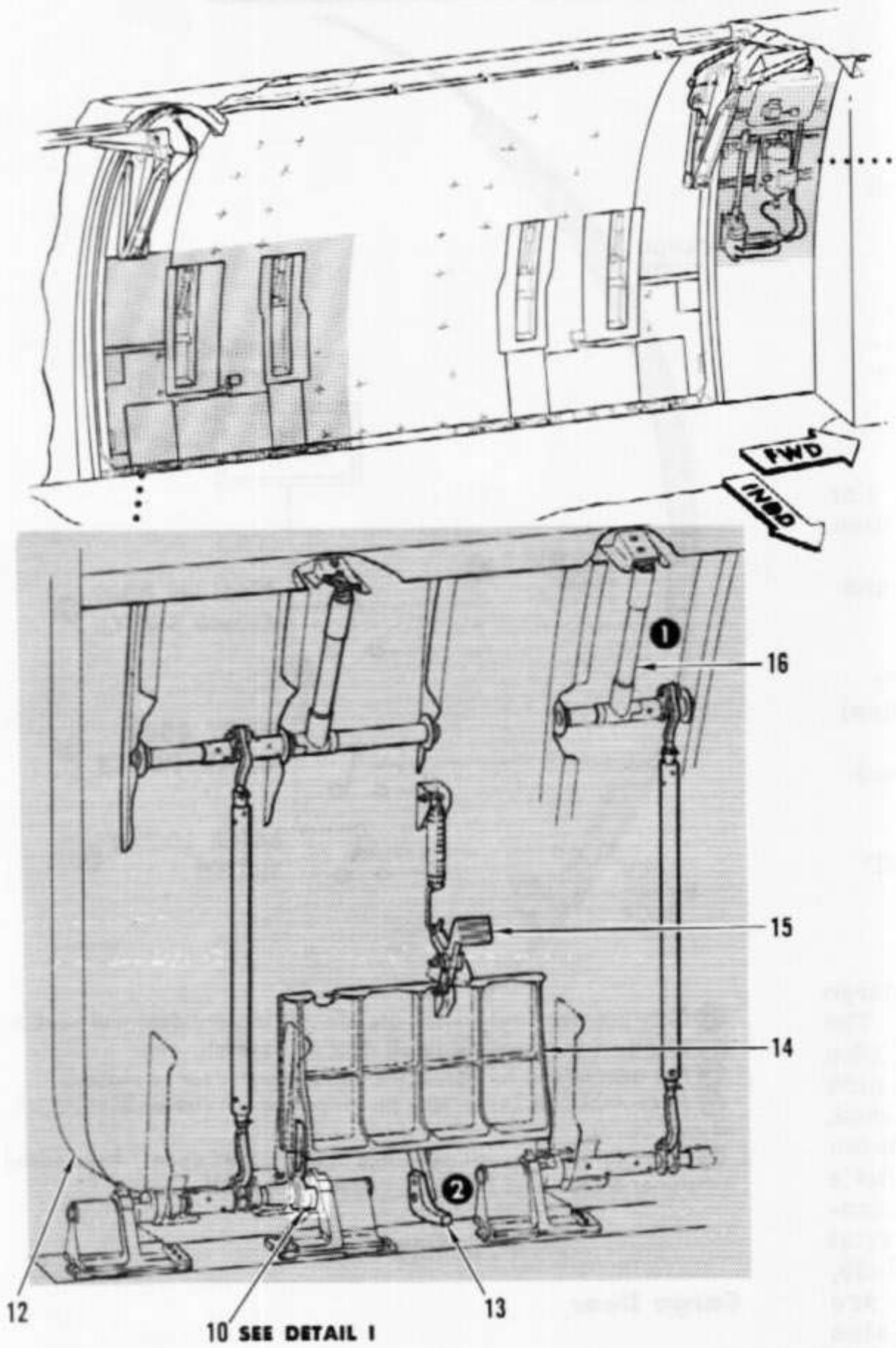
The cargo door safety barrier will be installed any time the cargo door is open. It will not be removed except when it actually interferes with loading or unloading operations. Use extreme caution when barrier is removed.

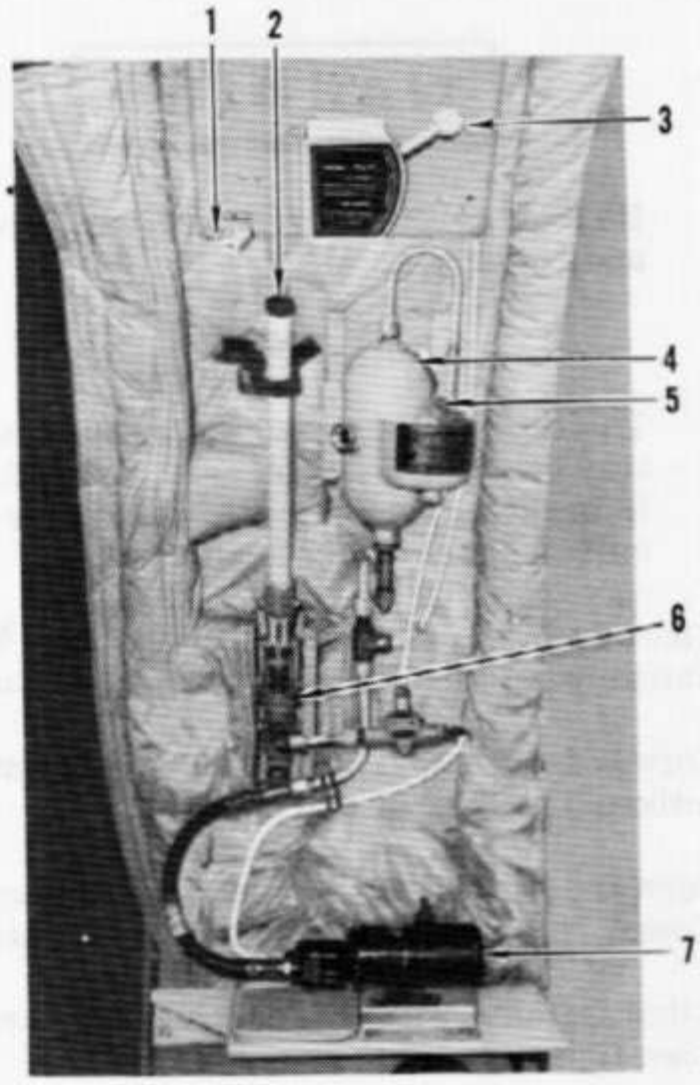
CAUTION

Do not open the cargo door or leave cargo door open if ground winds exceed 65 knots (75 mph).

Figure 4-48 (Deleted)

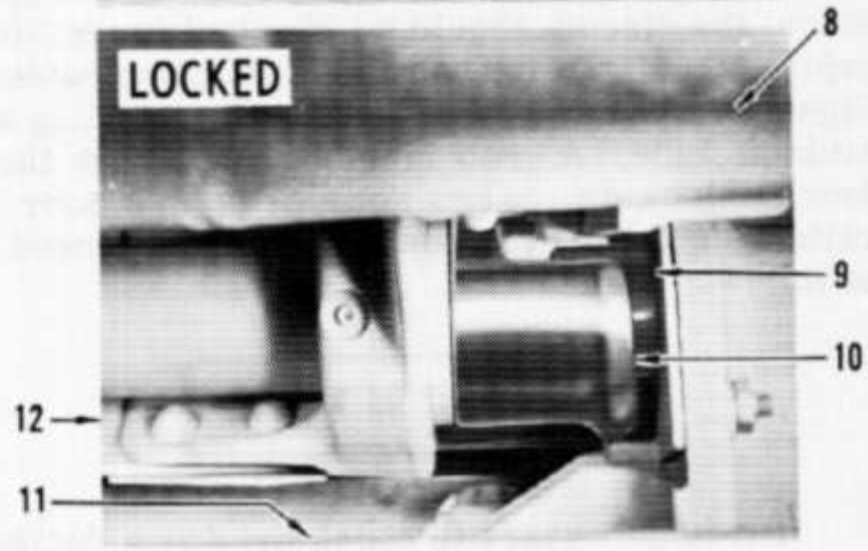
CARGO DOOR CONTROLS





DETAIL I





LATCH CAM

F-247
F-248
F-249
F-246

1 CARGO DOOR ELECTRIC MOTOR CONTROL SWITCH TCTO 944
2 HAND PUMP HANDLE
3 SELECTOR VALVE HANDLE
4 HYDRAULIC RESERVOIR
5 HYDRAULIC RESERVOIR FILLER PORT
6 HYDRAULIC HAND PUMP
7 ELECTRIC MOTOR DRIVEN HYDRAULIC PUMP TCTO 944
8 BOTTOM SEAL STRIP (2 PLACES) 376
9 LATCH PIN (2 PLACES)
10 LATCH CAM (3 PLACES)
11 CARGO FLOOR (2 PLACES)
12 CARGO DOOR (3 PLACES)
13 PRESSURE DOOR ARM
14 PRESSURE DOOR (TYPICAL)
15 TOE PEDAL (TYPICAL)
16 LATCH HANDLE (TYPICAL)

NOTE

❶ Each latch handle operates two latch cams. The cargo door has a total of eight latch cams.

❷ The pressure door arms actuate the door warning switches when the latches are locked and the pressure doors are closed. See figure 4-50.

Figure 4-49

Closing the Door

A. Selector Valve Handle - CLOSE

WARNING

Be sure cargo doorway is clear of personnel and equipment.

NOTE

The door will descend to a near closed position by gravity. Lowering from full open is braked by a hydraulic restrictor and requires approximately 20 seconds.

B. Electric Motor Control Switch (With TCTO 944) or Handle - Operate until door is in locking position

C. Forward and Aft Latch Handles - Rotated up and outboard to lock latch cams.

D. Forward and Aft Toe Pedals - Pressure doors closed, toe pedals released (locks latch handles)

E. Latch Cams - Visually check latch cams locked (See figure 4-49).

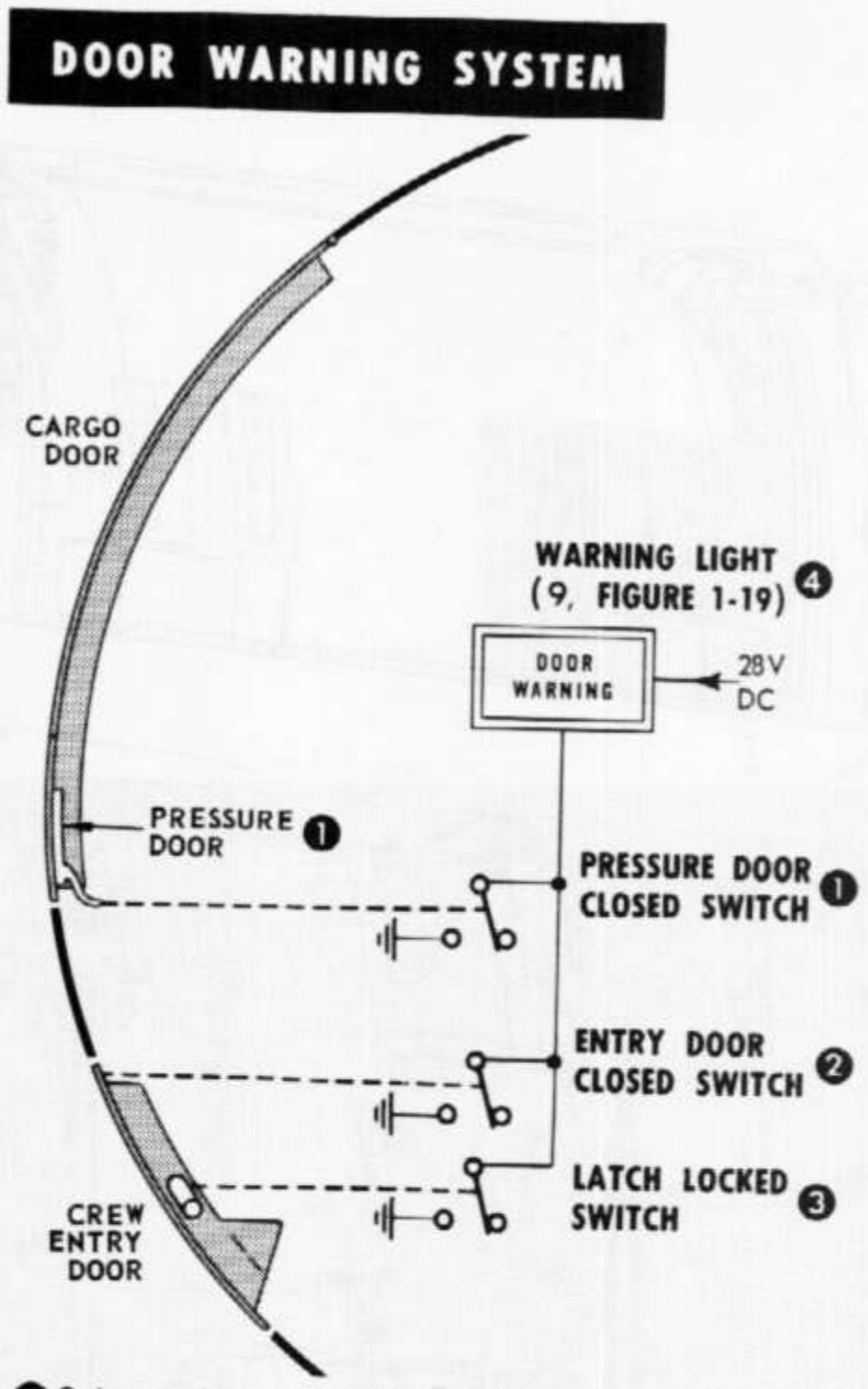
F. Selector Valve Handle - NEUTRAL or CLOSED

DOOR WARNING SYSTEM

A door warning system indicates when either the cargo door or crew entry door is not closed and locked. The doors incorporate door locked warning switches. (See figure 4-50.) These are push button switches which break the circuit when the doors are closed and latched. If any switch is left closed, the cargo door or hatch unlocked warning light (9, figure 1-19) on the copilot's flight instrument panel will illuminate. The door warning circuit is protected by the DOOR WARNING circuit breaker on T-R BUS NO. 2 of the MCBP (figure 1-35, sheet 2). Prior to takeoff, check that all doors are closed and locked. If the warning light illuminates before takeoff, the doors should be unlocked, opened, closed and locked. If the warning light remains on and all warning switches are found to be in the open position, the circuit should be checked for malfunction before takeoff. If the warning light illuminates during flight, decrease the cabin pressure by selecting a higher cabin altitude. A crew member may check the cargo door latch cams, cargo door pressure door closed switches and the crew entry door latch closed switch as follows:

WARNING

If it is necessary to check the doors during flight, the crewmember that checks the doors must ensure that his helmet is on and his parachute is properly adjusted prior to making the check.



1 Only one door and switch are shown, forward door and switch are identical in operation to aft door and switch.
2 Not accessible for inspection when entry door is closed.
3 Accessible for inspection by loosening insulation blanket aft of exit chute.
4 Light is off when all switches are actuated open. Any closed switch or a grounded lead will cause light to illuminate.

Figure 4-50

Cargo Door

All eight latch cams and both pressure door closed switches are accessible for inspection inflight.

A. Parachute and Helmet - On and adjusted

B. Selector Valve Handle - CLOSED

C. Hydraulic Hand Pump - Actuate to insure positive closing pressure

D. Forward and Aft Latch Handles - Checked Up

E. Forward and Aft Toe Pedals - Checked released, pressure doors closed

F. Latch Cams - Visually check latch cams (See figure 4-49.)

G. Pressure Door Closed Switches - Check pressure door arms in positive contact with switches (See figure 4-49.)

CARGO COMPARTMENT DIMENSIONS

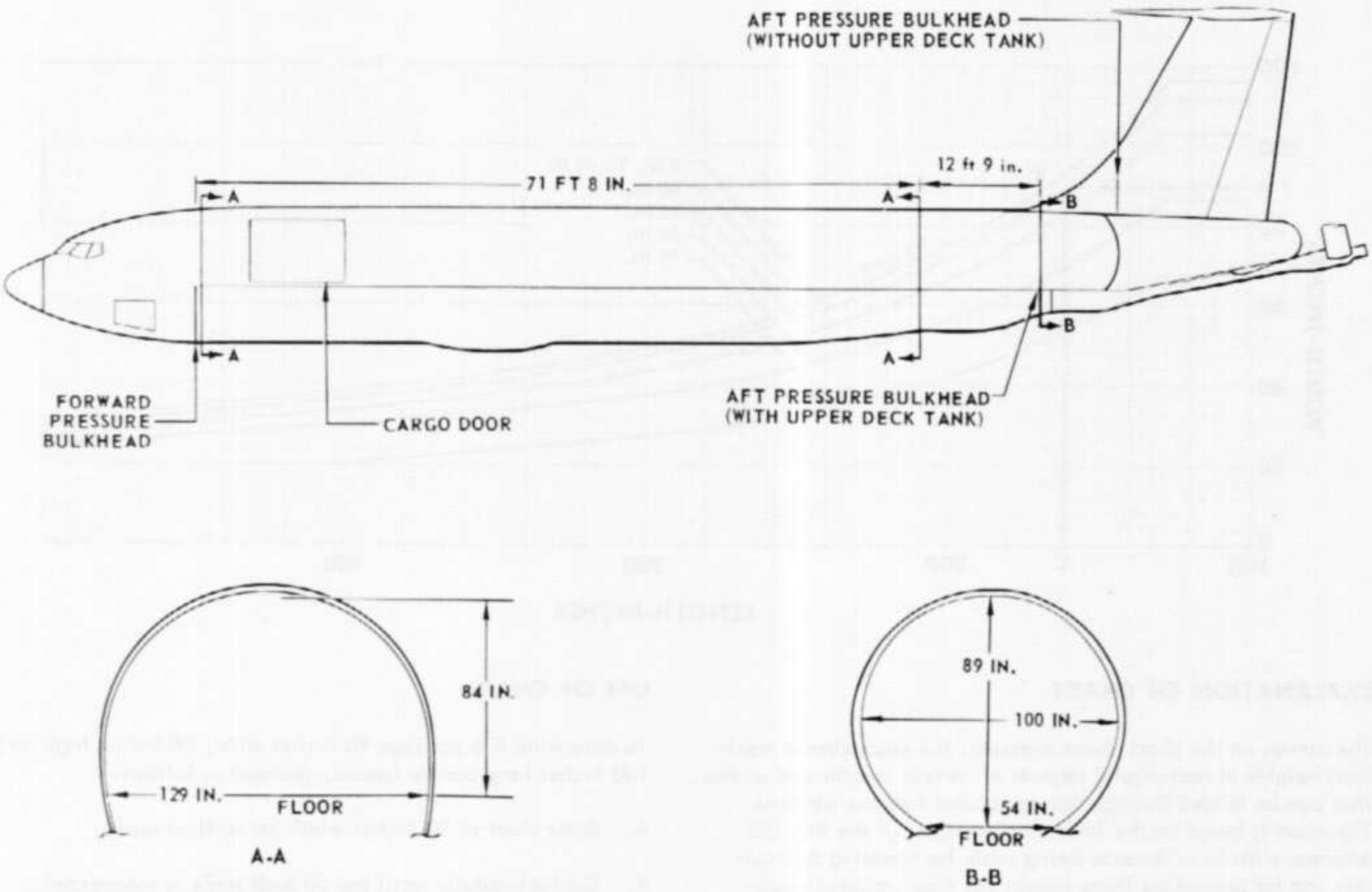


Figure 4-51

Cre Entry Door

The door closed switch and the latching mechanism are not accessible for inspection when the door is closed; however, the latch closed switch is accessible for inspection when the door is closed.

A. Parachute and Helmet - On and adjusted

B. Winch and Interior Latch Handle - Apply closing force to winch and check latch handle in locked position

C. Latch Locked Switch - Descend to lower nose compartment, lift insulation blanket aft of door frame, check that arm on external latch handle shaft is in positive contact with the latch closed switch (See figure 4-50.)

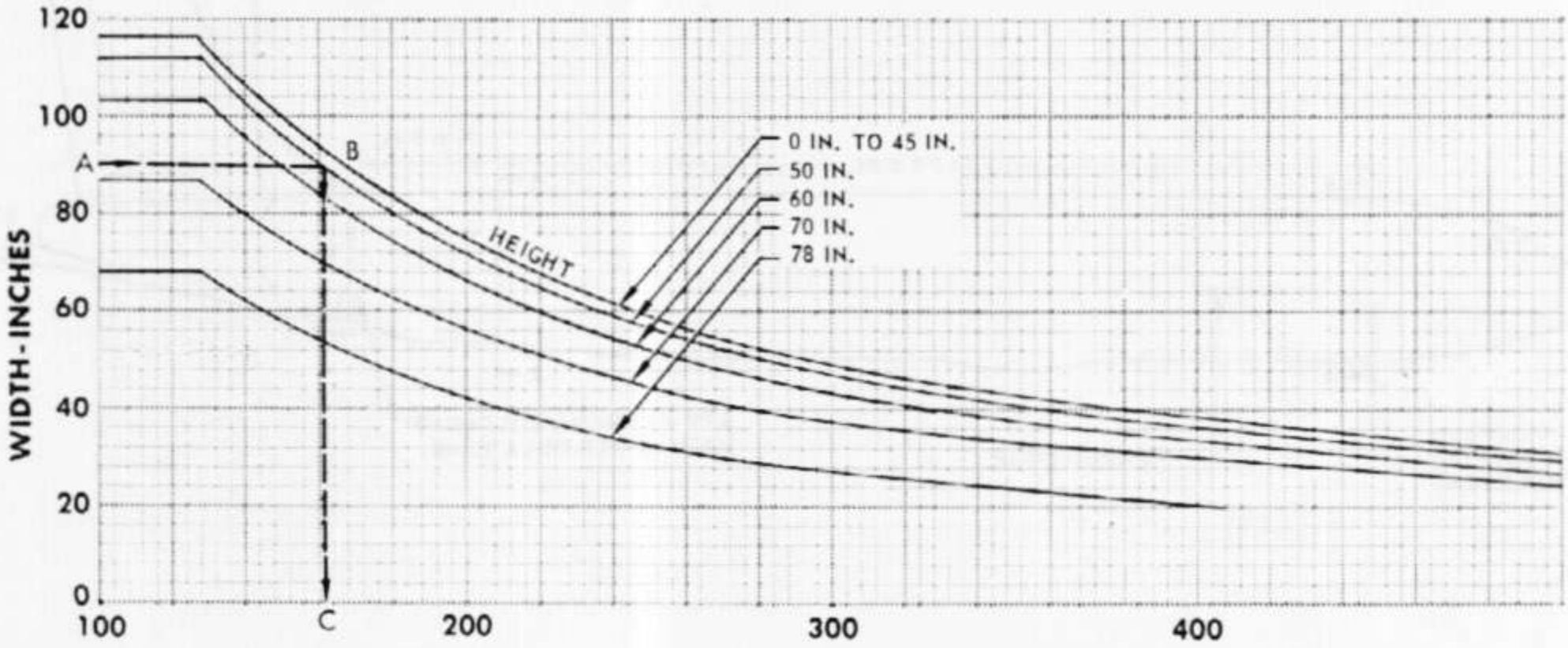
If it can be determined that a warning switch malfunction is the cause of the warning light illumination, it is safe to continue mission at normal cabin pressure.

CARGO FLOOR

The floor in the cargo compartment consists of plywood panels laid over structural floor beams. These beams run longitudinally except in the areas over the main wheel wells where they run transversely. Most of the plywood floor covering can be removed to decrease empty weight when the airplane is used as a tanker. However, enough of the plywood panels are retained to form a catwalk to the emergency exits, emergency station, boom operator's station and scanning stations. Both the plywood and the floor beams have load limits which should not be exceeded. Certain types of cargo such as dollies with small wheels or heavy items with legs could dent or gouge the plywood panels if not handled properly. Heavy concentrated loads, if placed between floor beams, could break the plywood panels. The floor being plywood is relatively

PACKAGE DIMENSIONS

AIRPLANES WITHOUT



EXPLANATION OF CHART

The curves on the chart above represent the approximate maximum heights of rectangular objects of various lengths and widths that can be loaded through the cargo door into the airplane. The chart is based on the internal dimensions of the KC-135 airplane with no allowance being made for handling difficulties and for protruding items except the door actuator equipment. Other protruding items such as first aid kits and fire extinguishers may be removed if necessary. Due to the varying methods of loading, the dimensions are not the absolute maximum.

USE OF CHART

To determine if a package 90 inches wide, 50 inches high and 140 inches long can be looded, proceed as follows:

A. Enter chart at 90 inches width on vertical scale.

B. Go horizontally until the 50 inch scale is intersected.

C. Follow vertical line downward to lower scale and read 160 inches on horizontal length scale.

CONCLUSION: Any package 90 inches wide, 50 inches high and 160 inches or less in length may be loaded.

Figure 4-52

inexpensive and easily replaced as compared to a metal floor; however, it should not be subjected to unnecessary hard use.

CAUTION

If any indication of damage is visible on the upper surface of the plywood floor panels, the panels will be removed and inspected to insure that splinters or fragments on the lower side will not jam or interfere with any cables.

NOTE

If additional shoring is required when loading heavy cargo, the shoring must be either located or modified to allow free and proper movement of the main gear and flap emergency crank.

It is possible to distort the floor beams if heavy concentrated loads are placed over a single beam. The floor beam capacities vary depending on where the load is applied to the beam, the number of beams used and their location in the fuselage. It is important, therefore, when loading heavy cargo to use adequate shoring to protect the plywood floor and also properly distribute the weight over the floor beams. When shoring, the direction of the floor beams as mentioned previously must be kept in mind. Station letters are stenciled on the lining in the cargo compartment to identify cargo compartment limits and centroids. The letters range from C through S on airplanes without upper deck tank, and C through R on airplanes with upper deck tank.

CARGO TIEDOWN DEVICES AND FLOOR FITTINGS

Cargo is secured with tiedown devices to fittings fixed to the floor of the cargo compartment. The following is a list of equipment used for securing cargo:

Item	Load Capacity - lbs	Quantity
Floor fitting	5,000	229
Floor fitting	10,000	16
Floor fitting (some airplanes)	1,250	6
Ring and stud shackle	5,000	90
Ring and stud shackle	10,000	16
Chain and fastener	10,000	16
Nylon web strap	5,000	80
Nylon web cargo net	10,000	2
Chains	10,000	12

The chains are used with the nylon web straps to secure the cargo net.

TAIL SUPPORT STRUT

The tail support strut (figure 4-53) is provided for support of the fuselage at the jacking fitting near the tail of the airplane. The strut should always be installed except when the airplane is moving, engines are operating, the airplane is on alert status or when directed otherwise. The support strut consists of an adjustable outer tube with an adjusting screw (8, figure 4-53) and base (10, figure 4-53). Handles (6, figure 4-53) on the outer tube are provided for turning the tube for extension or retraction. Painted markings on the spring loaded extension tube are to be lined with the top of the outer tube to show cargo loading and unloading settings. The white mark (5, figure 4-53) indicates the cargo loading setting and the red mark (3, figure 4-53) the cargo unloading setting. After loading or unloading is accomplished while on a cargo carrying mission, the strut may be secured to tiedown fittings on the cargo deck. See figure 4-53.

Installation of the tail support strut is as follows:

CAUTION

To prevent damage to the ball socket of the strut swivel base, do not drop the support strut. Avoid the application of excessive side loads to the swivel base.

A. Support Strut - Adjust to desired length

B. Jack Pad Adapter - Insert

Insert this adapter fitting (1, figure 4-53) in jacking fitting located at the aft end of the airplane.

C. Support Strut - Adjust to vertical position

D. Turning Arm - Hold with foot

This arm (9, figure 4-53) is held firmly with foot to prevent adjusting screw (8, figure 4-53) from turning while handle is being turned.

E. Handle - Grasp and rotate

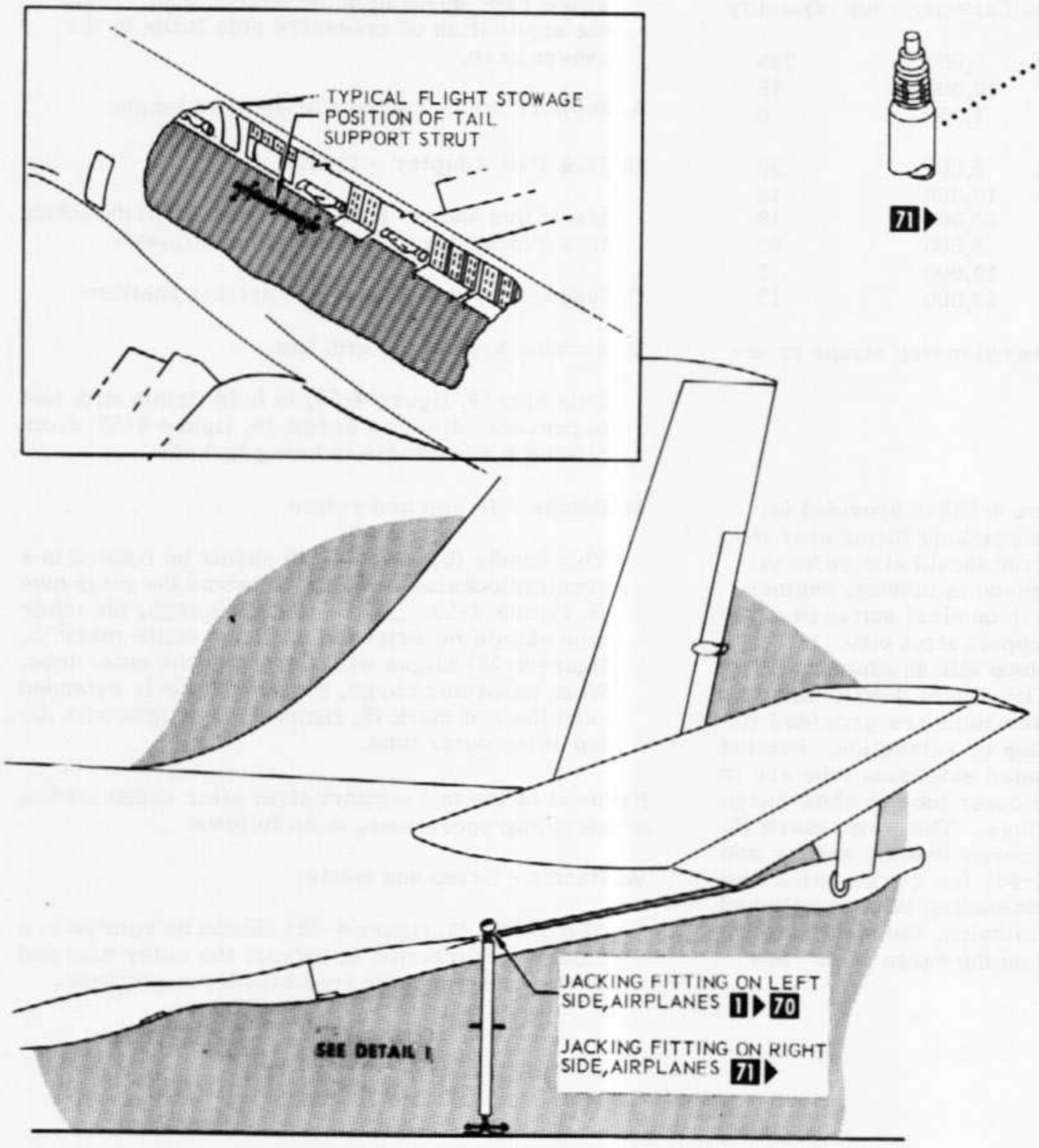
This handle (6, figure 4-53) should be rotated in a counterclockwise direction to extend the outer tube (7, figure 4-53. When loading cargo, the outer tube should be extended until the white mark (5, figure 4-53) aligns with the top of the outer tube. When unloading cargo, the outer tube is extended until the red mark (3, figure 4-53) aligns with the top of the outer tube.

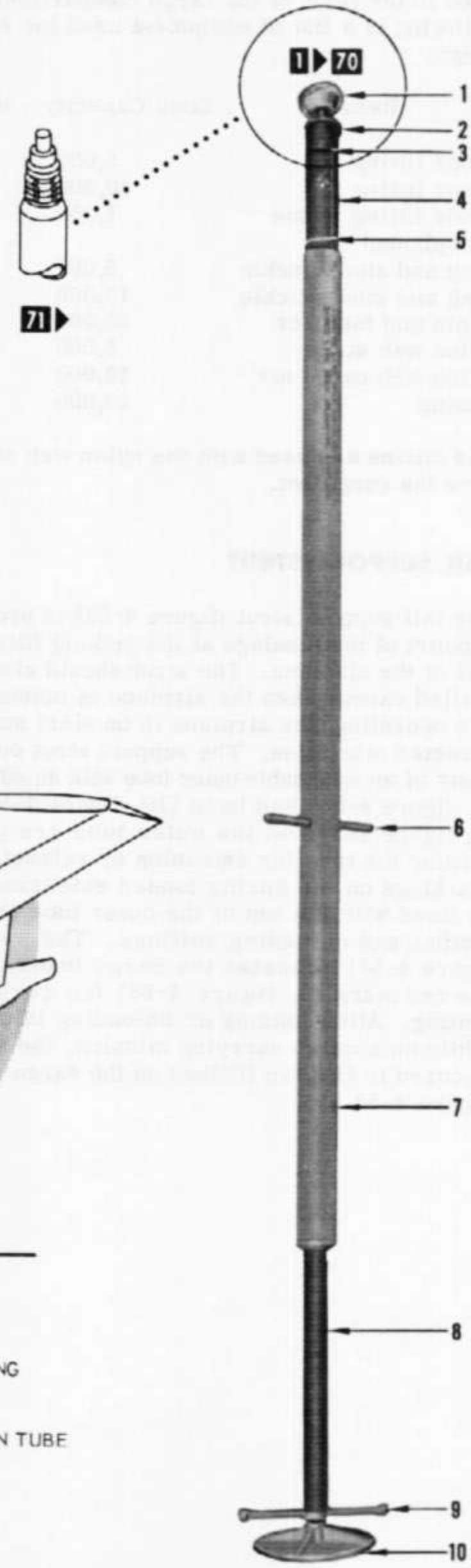
Removal of the tail support strut after cargo loading or unloading operations, is as follows:

A. Handle - Grasp and rotate

The handle (6, figure 4-53) should be rotated in a clockwise direction to retract the outer tube and allow the strut to be freed from the airplane.

TAIL SUPPORT STRUT





DETAIL I

CAUTION

TO PREVENT DAMAGE TO THE AIRPLANE STRUCTURE, USE THE LOADING METHODS IN THE HANDBOOK OF CARGO LOADING INSTRUCTIONS, T.O. 1C-135(K)A-9. DO NOT ALLOW COLLAR (2) TO BOTTOM ON OUTER TUBE (7).

1 JACK PAD ADAPTER FITTING
2 COLLAR
3 RED MARK
4 SPRING-LOADED EXTENSION TUBE
5 WHITE MARK
6 HANDLE
7 OUTER TUBE
8 ADJUSTING SCREW
9 TURNING ARM
10 BASE

F-112
F-259
F-258

Figure 4-53

TROOP CARRYING EQUIPMENT

TROOP SEATS

Collapsible seats of nylon fabric, supported by metal tubing, are stowed on each side of the fuselage in the cargo compartment. The seats are readily erected by folding down. They provide seating capacity for 80 persons. See figure 4-56. Each seat is fitted with a safety belt and shoulder harness. To use the harness, arrange the entire harness in front of the seat back webbing. Place the straps over the shoulders insuring that the strap fastened at the right side of seat is over the left shoulder, and the strap fastened at the left side of seat is over the right shoulder. Be sure straps are not twisted.

WARNING

When using the shoulder harness, the straps must not be routed over the upper support tube, behind or through the seat back webbing. Boom operator, or designated troop commander, must insure that passengers wear the shoulder harness properly to avoid injury.

Fasten and adjust seat belt and shoulder harness as shown in figure 4-55.

AIRLINE TYPE SEAT

The airplane can be converted to a personnel airlift configuration by the installation of 30 aft-facing two-man airline type seats. See figure 4-54. Each seat is secured to cargo tiedown fittings on the floor and cannot be adjusted horizontally or vertically. The separate seat backs on each seat can be reclined independently to any of three positions up to 24 degrees. Seat belts, but not shoulder harnesses are provided. Spacing between seats in each group of seats is 40 inches, with seat groups beginning at fuselage station numbers indicated (figure 4-56). If a mixed cargo and personnel load are to be airlifted using the airline type seats, the configuration can be varied according to the load plan.

ARCTIC CAPABILITY

The airplane has provisions for the installation of an arctic kit to increase the self sufficiency of the airplane when it is used at remote bases in arctic areas. The kits are removable and may be stored at the home base, may be flown installed in the airplane, or may be flown as cargo to a remote base for installation on arrival. The kit consists of an auxiliary power unit which includes air conditioning equipment and a generator to produce electrical power for the airplane, a supplementary gaseous oxygen supply, galley, living quarters equipment, a portable air compressor, portable heater, portable light (2 portable lights on airplanes 250 ▶), and airplane maintenance equipment. The kit, including food, water, flooring and tie-downs, adds approximately 4500 pounds to the airplane and reduces the troop carrying capacity to 41 men. The weight of the arctic kit components must be considered when computing the airplane center of gravity. Use the weight data outlined in the Basic Weight Checklist and Loading Data Handbook, T.O. 1C-135(K)A-5, or T.O. 1-1B-40.

AIRLINE TYPE SEATS



Figure 4-54

OPERATION OF SAFETY BELTS AND SHOULDER HARNESSES

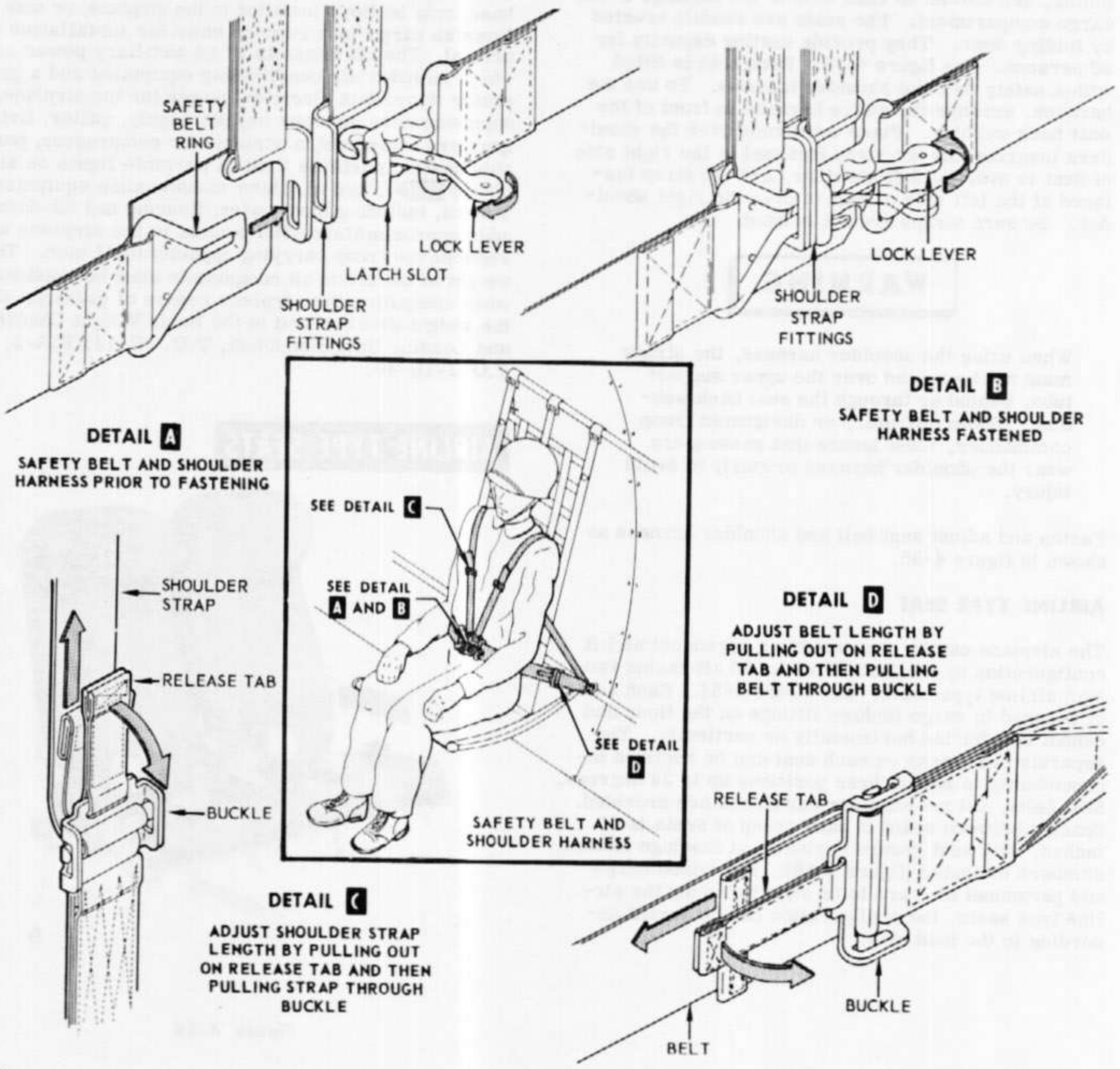
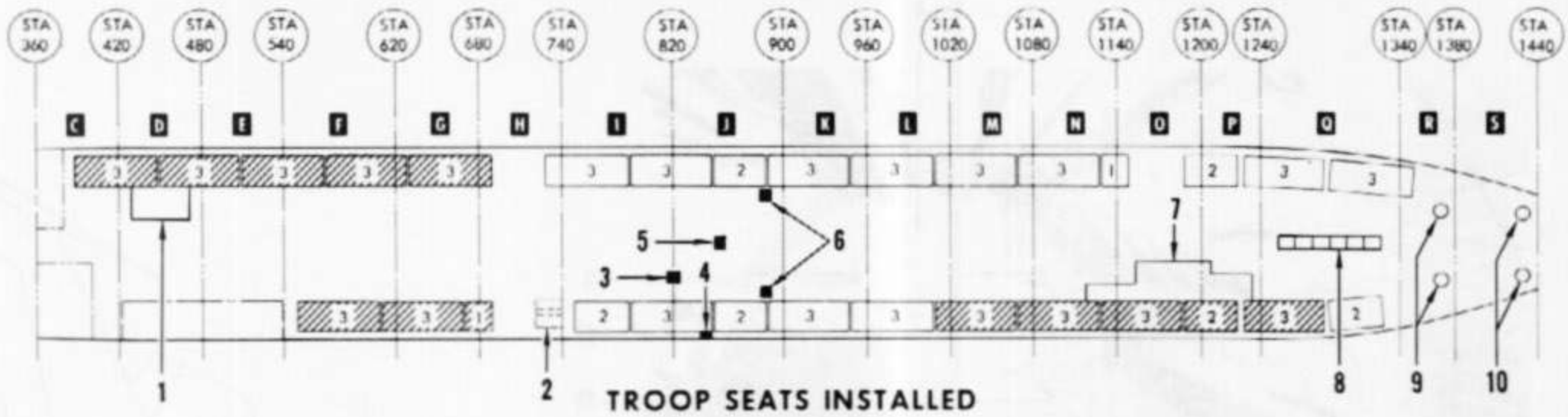


Figure 4-55

CARGO COMPARTMENTS AND TROOP SEATING ARRANGEMENT

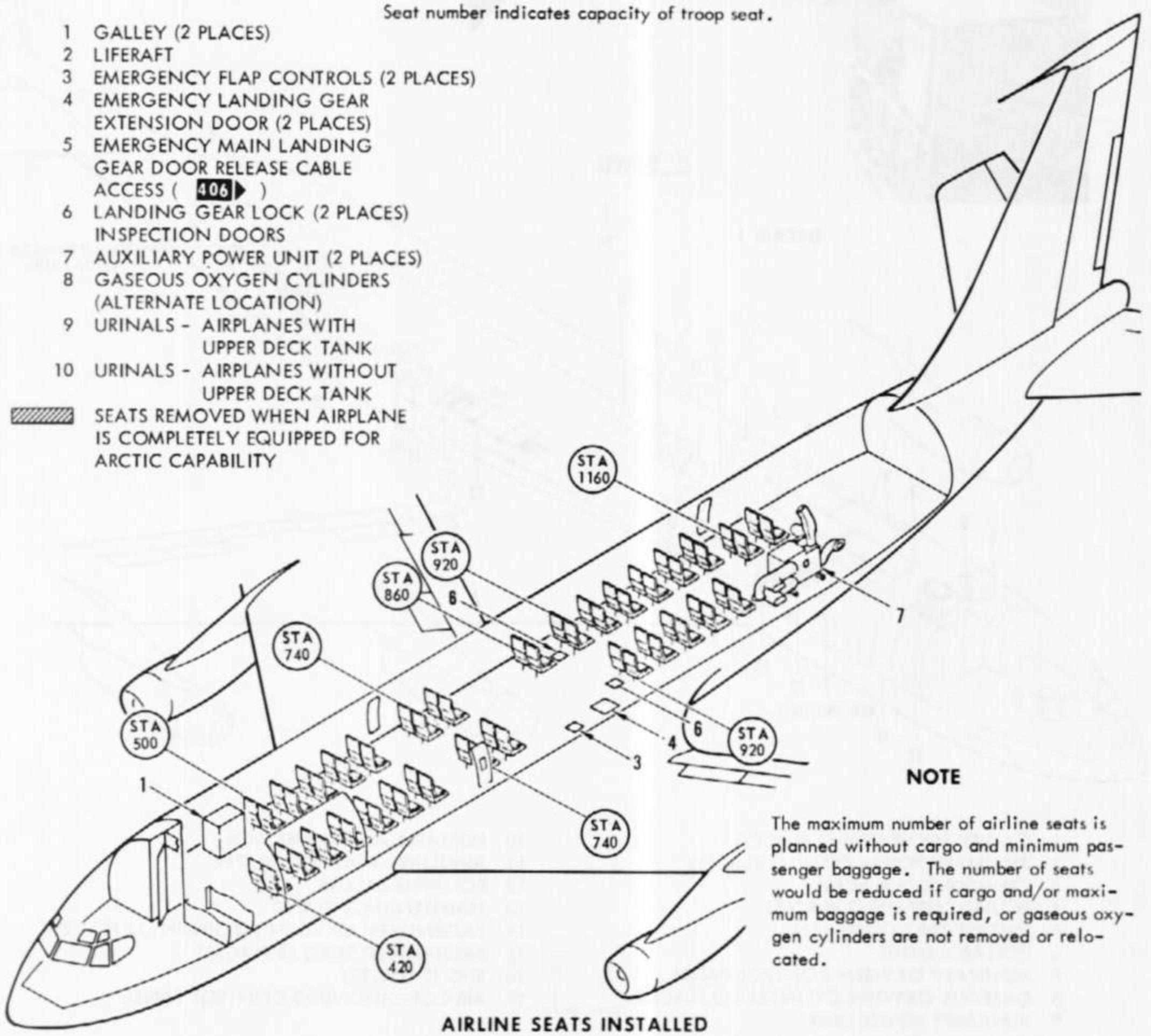


TROOP SEATS INSTALLED

NOTE

Seat number indicates capacity of troop seat.

1 GALLEY (2 PLACES)
2 LIFERAFT
3 EMERGENCY FLAP CONTROLS (2 PLACES)
4 EMERGENCY LANDING GEAR EXTENSION DOOR (2 PLACES)
5 EMERGENCY MAIN LANDING GEAR DOOR RELEASE CABLE ACCESS (406 ▶)
6 LANDING GEAR LOCK (2 PLACES) INSPECTION DOORS
7 AUXILIARY POWER UNIT (2 PLACES)
8 GASEOUS OXYGEN CYLINDERS (ALTERNATE LOCATION)
9 URINALS - AIRPLANES WITH UPPER DECK TANK
10 URINALS - AIRPLANES WITHOUT UPPER DECK TANK
▨ SEATS REMOVED WHEN AIRPLANE IS COMPLETELY EQUIPPED FOR ARCTIC CAPABILITY



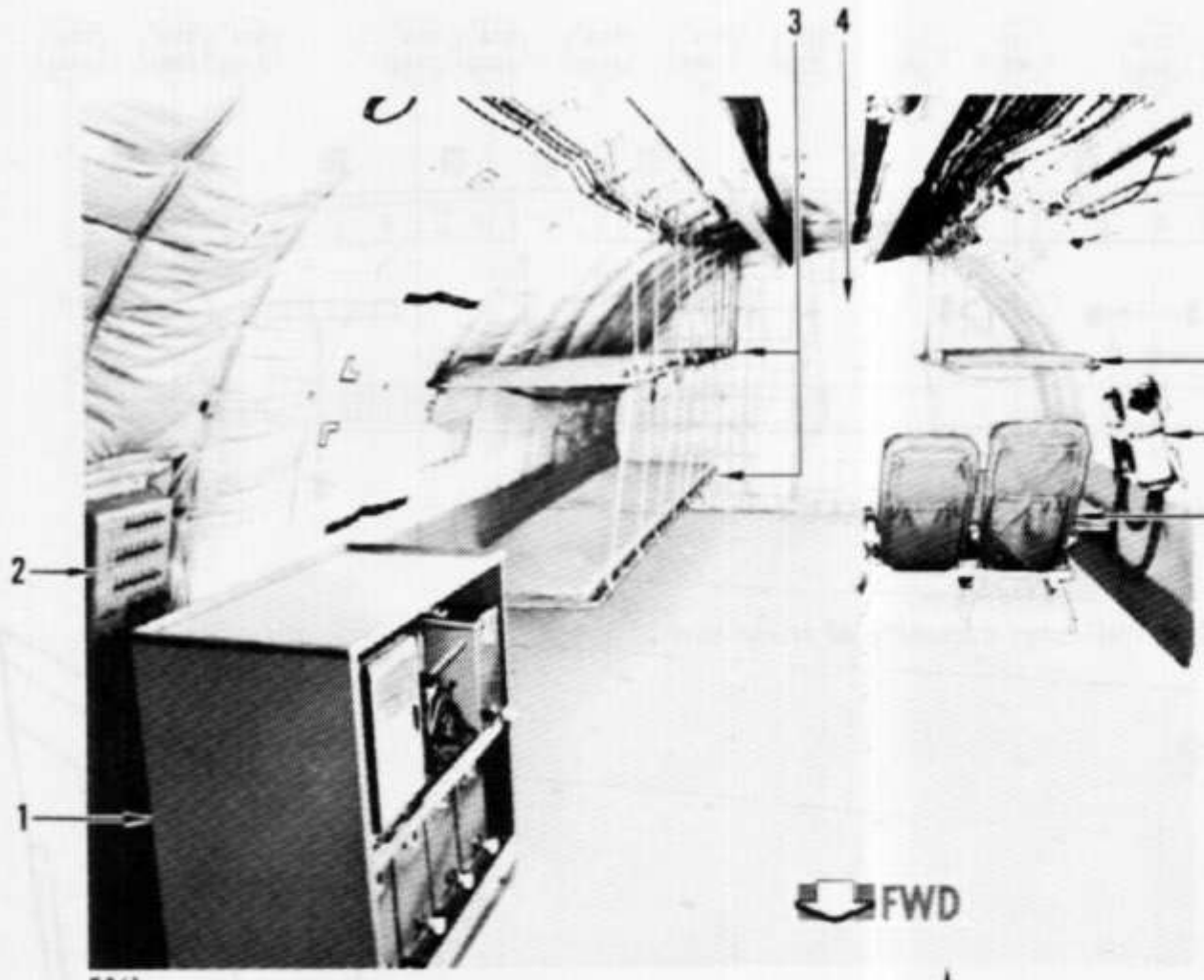
AIRLINE SEATS INSTALLED

NOTE

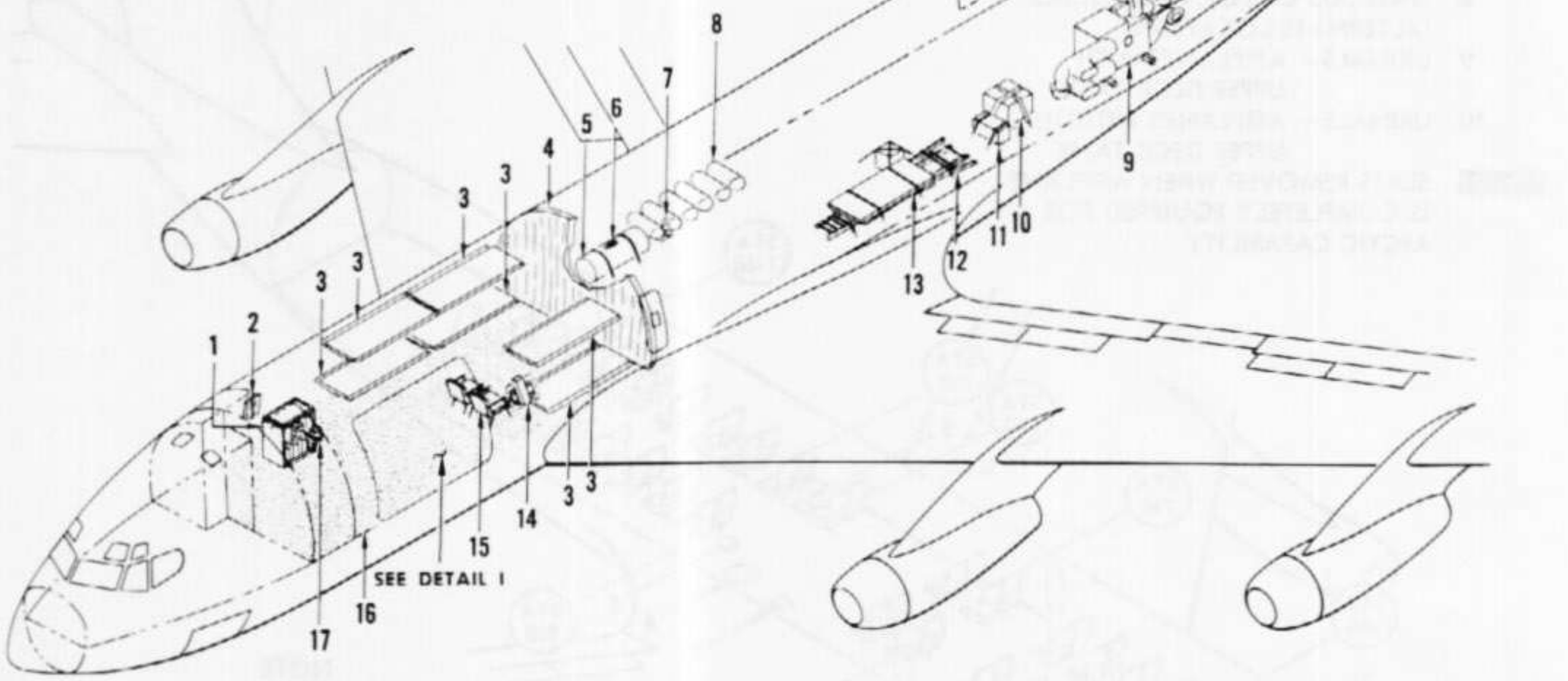
The maximum number of airline seats is planned without cargo and minimum passenger baggage. The number of seats would be reduced if cargo and/or maximum baggage is required, or gaseous oxygen cylinders are not removed or relocated.

Figure 4-56

ARCTIC CAPABILITY ARRANGEMENT



DETAIL I



1 GALLEY EQUIPMENT (2 PLACES)
2 AUXILIARY POWER PANEL (2 PLACES)
3 CREW BUNK (8 PLACES)
4 SOUND CURTAIN (2 PLACES)
5 ENGINE ENCLOSURE TENT
6 PORTABLE LIGHT
7 AUXILIARY OXYGEN CONTROL PANEL
8 GASEOUS OXYGEN CYLINDERS (2 PLACES)
9 AUXILIARY POWER UNIT
10 PORTABLE AIR COMPRESSOR
11 AUXILIARY PORTABLE HEATER
12 FOLDING LADDER
13 MAINTENANCE STAND
14 PASSENGERS' OXYGEN EQUIPMENT (2 PLACES)
15 PASSENGERS' SEATS (2 PLACES)
16 RUG (2 PLACES)
17 AIR CONDITIONING CONTROL PANEL

Figure 4-57

AUXILIARY POWER UNIT

The arctic kit will have either an AiResearch or Solar APU. Although these units are interchangeable, they are not identical. The following paragraphs describe the controls and operating procedure for each unit. Each unit is powered by a gas turbine engine using JP-4 fuel from the airplane aft body tank. A 30 KVA generator turned by this engine, produces 115/200 volt 400 cycle AC power which is distributed through the airplane electrical system as well as supplying electrical power for the control and operation of the unit itself and to charge the APU battery. The APU battery is automatically charged by the airplane electrical system when the airplane electrical system is energized and the APU is installed. Four plug connections (15, figures 4-58 and 4-60) connect the APU with the airplane electrical system and the arctic capability units and services. A forced air heating and ventilating component is also an integral part of the APU. An electrically powered blower draws in outside air which is routed through a control valve, heated as required by the turbine exhaust and distributed through the airplane overhead distribution duct. Cabin air is exhausted by allowing a metered amount of flow into the turbine air intake through the cabin air outlet. A check valve in this duct prevents fumes or odors from entering the cabin. Air intake and exhaust is through ports in the side of the fuselage. Three manually operated valves open and close these ports. All port valves must be closed during flight or the airplane cannot be pressurized. Three valve actuated switches, wired in series, close when the ports are open and permit starting and operation of the APU. When the ports are closed the switches are open, the fuel supply valve is closed and ignition is off, thus preventing operation of the unit. The fire extinguisher cannot be actuated manually but discharges automatically when there is an overheat condition within the unit. However, there are fire access doors for inserting a hand fire extinguisher into the turbine section.

AIRESEARCH APU

Master Switch (AiResearch APU)

This switch (11, figure 4-59) on the turbine controls section of the APU control panel has ON and OFF positions. In the ON position and with the intake and exhaust ducts open, electrical power is supplied to operate the fuel valve and to all other components either from the battery, transformer rectifier, or the generator, permitting starting of the unit. When the switch is placed to OFF, electrical power is cut to the air conditioning and turbine units and the fuel valve is closed, stopping all operations within the APU. Circuit protection is provided by the CONTROL circuit breaker on the APU circuit breaker panel (figure 4-59).

Start-Stop Switch (AiResearch APU)

This is a momentary switch (9, figure 4-59) with START--NEUTRAL--STOP positions. It is spring loaded from the START and STOP positions to the NEUTRAL position. When momentarily placed in the START position, relays are activated to carry out the starting operation. Momentarily depressing this switch to STOP closes the fuel valve to stop the turbine and trips the generator from the electrical system. Circuit protection is provided by the CONTROL circuit breaker on the APU circuit breaker panel (figure 4-59).

Primer Switch (AiResearch APU)

This switch (10, figure 4-59) with ON--OFF positions, controls the fuel boost pump. It is placed in the ON position to deliver priming fuel for starting the engine. Normally this switch is returned to OFF after the start is accomplished. Under high ambient temperatures or heavy load conditions, turbine rpm may fade to or below the 95% minimum. Under this condition, the primer switch should be placed to ON and the boost pump used to augment the fuel pump. Circuit protection is provided by the CONTROL circuit breaker on the APU circuit breaker panel (figure 4-59).

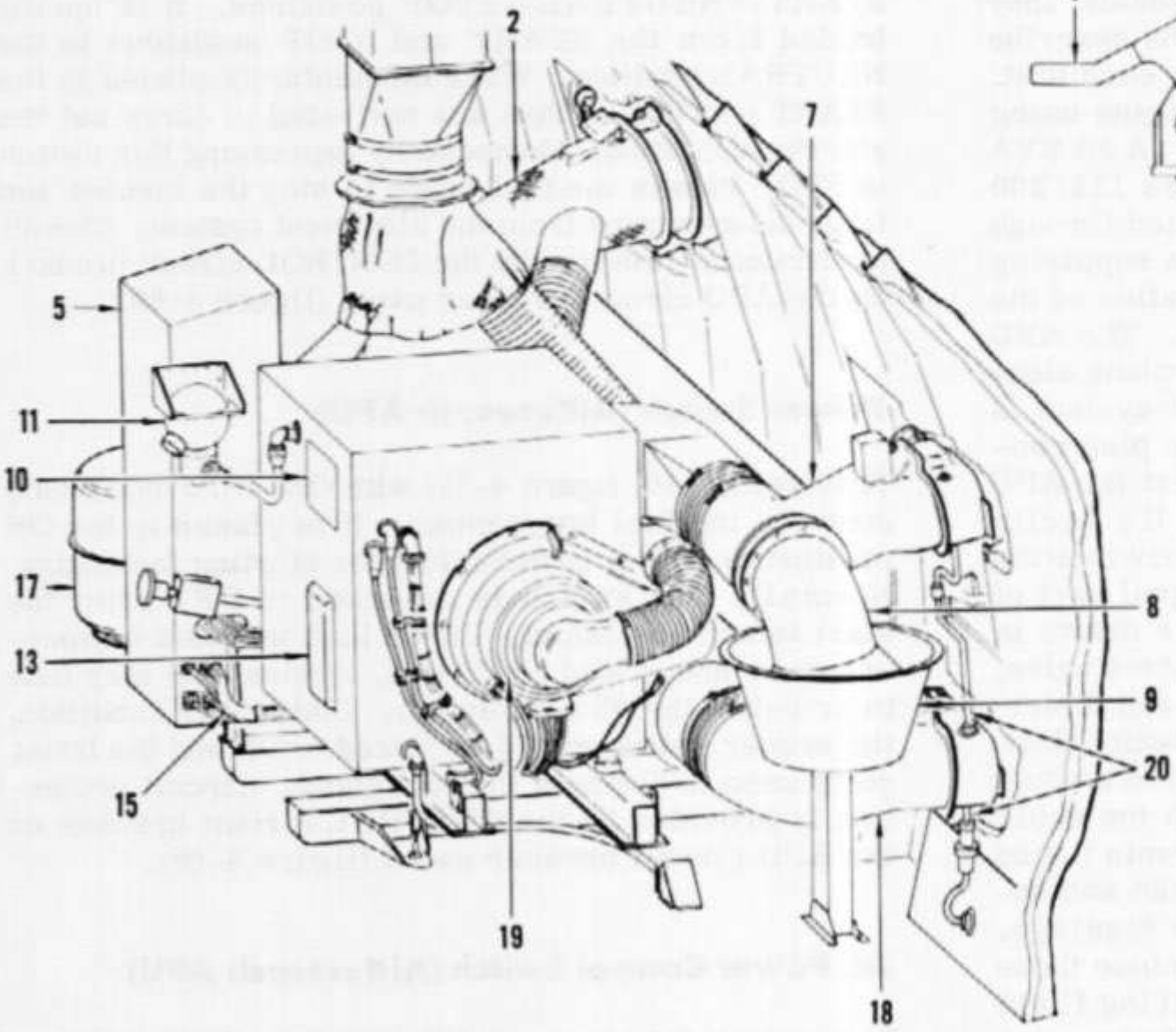
AC Power Control Switch (AiResearch APU)

This switch (13, figure 4-59) with ON--OFF--RESET positions controls the AC output of the APU generator. The switch is spring loaded from RESET to OFF. Momentarily holding the switch in the RESET position closes the circuit to excite the generator field. Placing this switch to ON connects the generator to the electrical distribution system. Placing the switch to OFF trips the APU generator breaker and removes power from the electrical system. Circuit protection is provided by the CONTROL circuit breaker on the APU circuit breaker panel (figure 4-59).

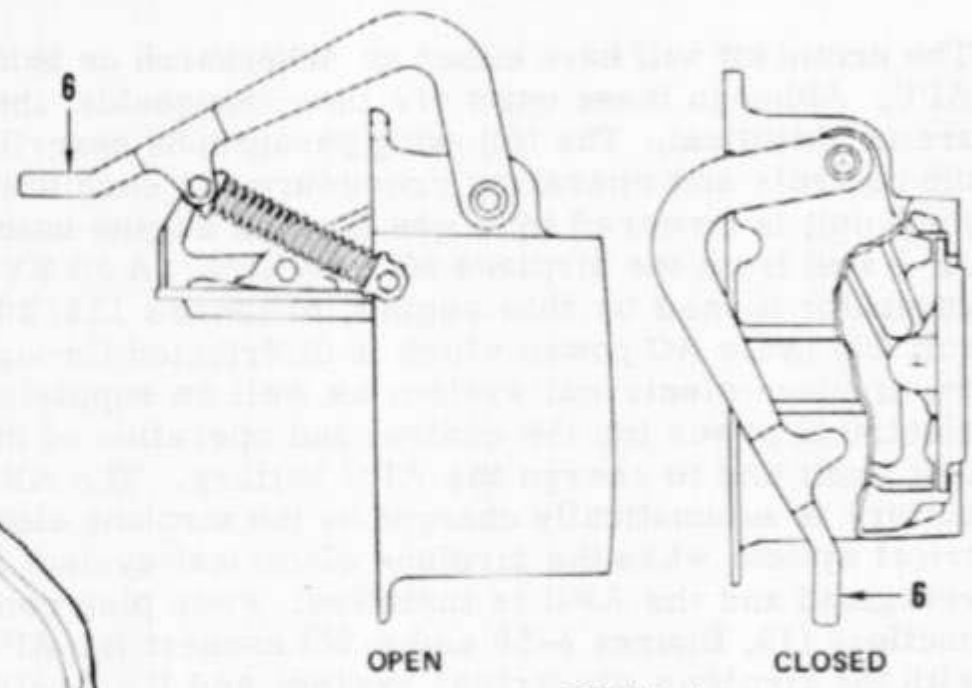
Cabin Air Temperature Gage (AiResearch APU)

This gage (1, figure 4-59) calibrated in degrees Centigrade is on the APU control panel. The temperature indicated on this gage is that of the air as it enters the overhead distribution duct. Temperatures up to 121°C are permissible. Higher temperatures may damage the airplane air conditioning ducting system. A temperature sensing switch will shut off the blower if the cabin air exceeds 156°C.

AIRESEARCH AUXILIARY POWER UNIT



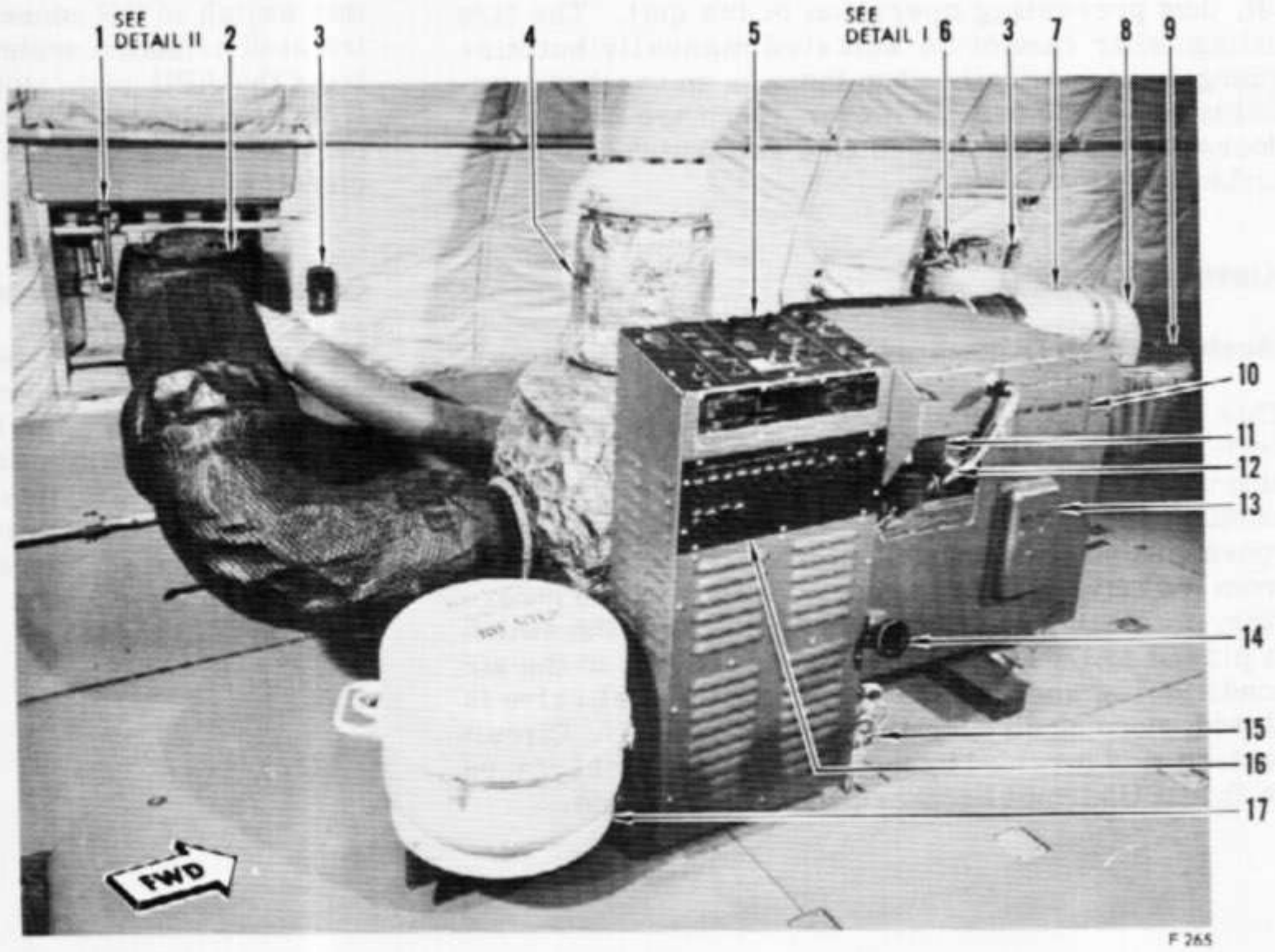
1 TURBINE EXHAUST VALVE HANDLE (2 PLACES)
2 TURBINE EXHAUST DUCT (2 PLACES)
3 VALVE SWITCH (2 PLACES)
4 TO OVERHEAD DISTRIBUTION DUCT
5 APU CONTROL PANEL (2 PLACES) (SEE FIGURE 4-59)



DETAIL I

6 COMPRESSOR INLET VALVE HANDLE (3 PLACES)
7 COMPRESSOR INLET DUCT (2 PLACES)
8 CABIN AIR OUTLET DUCT (2 PLACES)
9 HIGH FREQUENCY NOISE SUPPRESSOR (2 PLACES)
10 FIRE ACCESS DOOR (2 PLACES)
11 FIRE EXTINGUISHER (2 PLACES)
12 FIRE EXTINGUISHER PRESSURE GAGE
13 OIL TANK FILLER ACCESS (2 PLACES)
14 TEMPERATURE CONTROL MANUAL OVERRIDE
15 ELECTRICAL CONNECTIONS (2 PLACES)
16 APU CIRCUIT BREAKER PANEL (SEE FIGURE 4-59)
17 BATTERY (2 PLACES)
18 CABIN AIR INLET DUCT
19 GENERATOR
20 DRAIN LINE (280)

DETAIL II



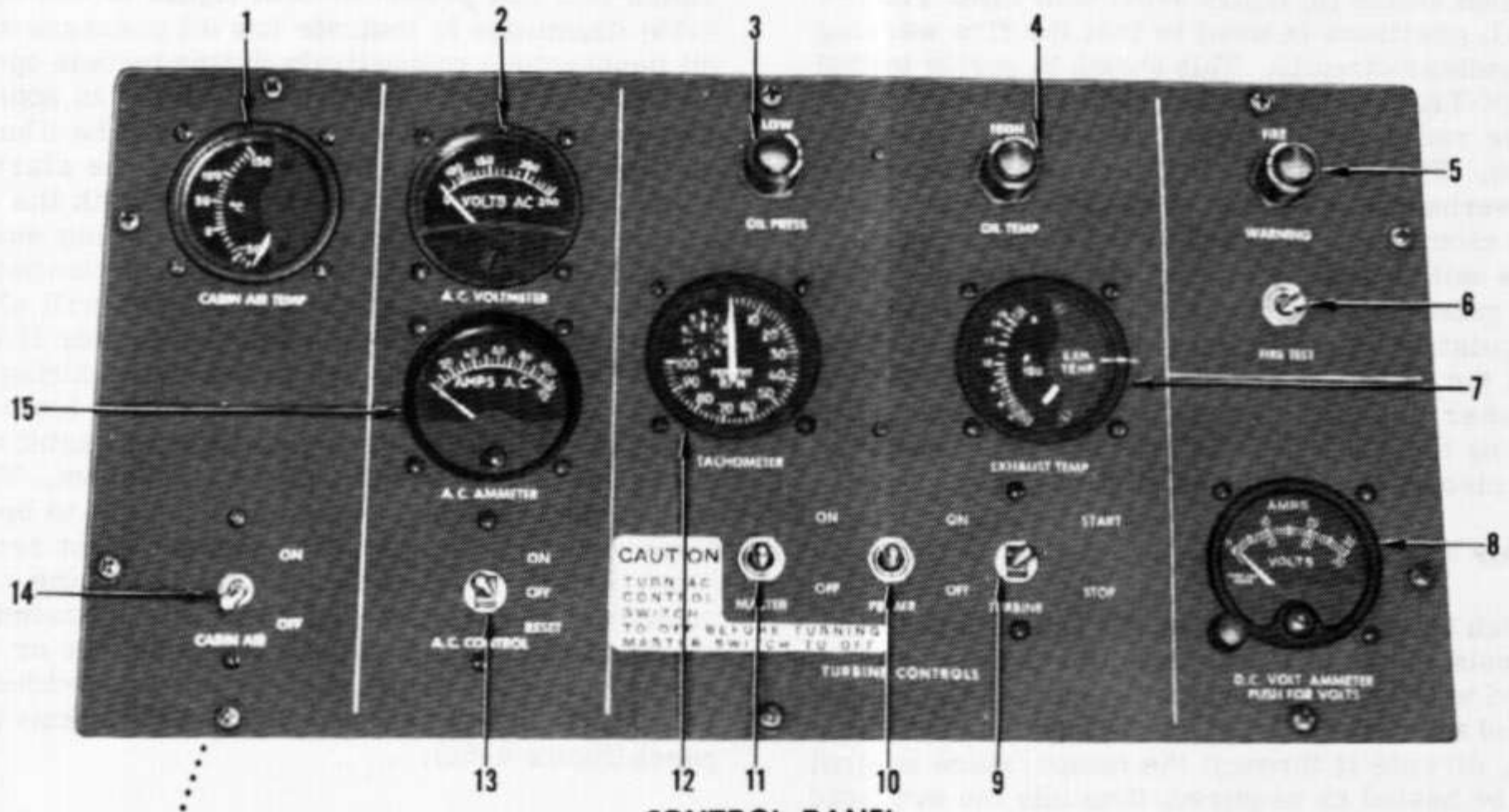
F 265

NOTE: The cabin air inlet valve handle (same as DETAIL I) is directly below the compressor inlet valve handle (6).

Figure 4-58

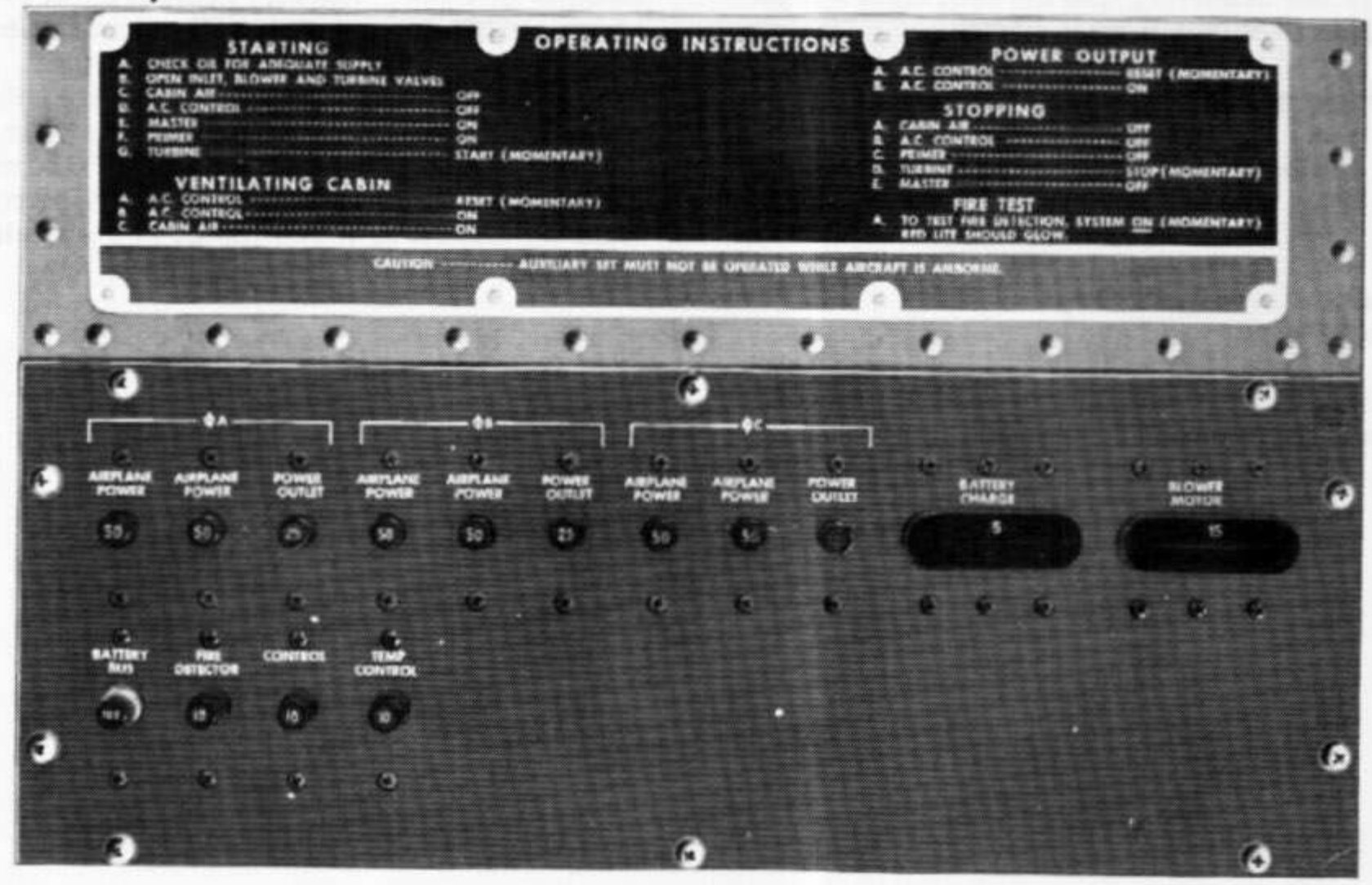
All data on pages 4-110A thru 4-110D (Deleted)

AIRESEARCH APU CONTROL AND CIRCUIT BREAKER PANELS



CONTROL PANEL

1 CABIN AIR TEMPERATURE GAGE
2 AC VOLTMETER
3 LOW OIL PRESSURE WARNING LIGHT
4 HIGH OIL TEMPERATURE WARNING LIGHT
5 FIRE WARNING LIGHT
6 FIRE TEST SWITCH
7 EXHAUST TEMPERATURE GAGE
8 DC VOLT-AMMETER
9 START-STOP SWITCH
10 PRIMER SWITCH
11 MASTER SWITCH
12 TACHOMETER
13 AC POWER CONTROL SWITCH
14 CABIN AIR SWITCH
15 AC AMMETER



CIRCUIT BREAKER PANEL

F-266
F-267

Figure 4-59

Fire Test Switch and Warning Light (AiResearch APU)

The fire test switch (6, figure 4-59) with FIRE TEST--NEUTRAL positions is used to test the fire warning and extinguisher circuits. This switch is spring loaded from FIRE TEST to NEUTRAL. When placed to FIRE TEST, the red press-to-test fire warning light will illuminate. The light will also illuminate whenever a fire or overheat condition occurs within the APU and the same circuit also discharges the fire extinguisher within the unit as well as closing the fuel supply valve, trips the generator, and stops the unit. The light will be extinguished when the fire detector cools. Discharge of the extinguisher will be indicated by the fire extinguisher pressure gage. Circuit protection is provided by the FIRE DETECTOR circuit breaker on the APU circuit breaker panel (figure 4-59).

Cabin Air Switch (AiResearch APU)

This switch (14, figure 4-59) has ON and OFF positions and controls power to the blower. When the switch is positioned to ON and the turbine is running, the blower is powered and draws outside air through the ventilating air inlet, directs it through the temperature control valve to be heated as required, then into the overhead distribution duct. In the OFF position, power is removed from the blower. Circuit protection is provided by the TEMP. CONTROL circuit breaker on the APU circuit breaker panel (figure 4-59).

Tachometer (AiResearch APU)

This instrument (12, figure 4-59) is calibrated in % of turbine rated rpm. A turbine driven generator supplies power to the indicator. During operation a reading of 100% plus or minus 0.5% is normal.

Exhaust Temperature Gage (AiResearch APU)

Exhaust gas temperature is registered on this gage (7, figure 4-59).

Fire Extinguisher Pressure Gage (AiResearch APU)

This gage (12, figure 4-58) indicates the pressure within the fire extinguisher.

Oil Pressure and Oil Temperature Warning Lights (AiResearch APU)

These two red press-to-test lights (3 and 4, figure 4-59) illuminate to indicate low oil pressure and high oil temperature respectively during turbine operation. The low pressure light will illuminate as soon as the master switch is placed to ON and will be illuminated until oil pressure builds up during the start cycle. It will also illuminate on shutdown with the drop in oil pressure in all cases except during automatic shutdown caused by fire or high oil temperature. Circuitry controlling these two lights will also shut down the turbine and trip the generator if high oil temperature or low oil pressure occurs during operation of the unit. An illuminated high oil temperature light immediately following emergency shutdown indicates that this is the reason for the shutdown. The light will be extinguished when the oil cools to operating temperature. The low oil pressure light remaining illuminated could indicate this being the cause of shutdown; however, it will remain illuminated during all shutdowns except those caused by fire or high oil temperature. Circuit protection is provided by the CONTROL circuit breaker on the APU circuit breaker panel (figure 4-59).

SOLAR APU

Power Switch (Solar APU)

The function of the power switch (13, figure 4-61) is similar to an automobile ignition switch. Placing the switch ON connects battery power (from APU battery) to the generator control, turbine control, and heat exchanger circuits. The fuel pressure, oil pressure, and generator off warning lights illuminate when the switch is placed ON prior to starting the unit. Moving the switch to OFF removes DC power from the APU and, if the unit is operating, trips the generator and causes the APU to stop. The ENGINE CONTROL and HEATER CONTROL circuit breakers on the APU control panel must be closed to make the power switch operative.

Start Switch (Solar APU)

The two position start switch (12, figure 4-61) is spring-loaded to the neutral position. The engine is started by momentarily holding the switch in the START position. This energizes the starter and fuel pump, which builds up fuel pressure in the fuel system. At the proper pressure, the fuel pressure switch turns the low pressure light off, automatically supplies ignition, and opens the main fuel valve. During the starting cycle, the fuel bypass valve is open only as long as the START switch is held in START.

Fire Detector Test Switch and Warning Light (Solar APU)

The fire detector test switch (11, figure 4-61) is spring loaded to the OFF position. Holding the switch in the ON position tests the fire warning light circuit. Illumination of the fire warning light (9, figure 4-61) indicates that the circuit is operative. The warning light is the press-to-test type and is the only light that can be tested with the power switch off. The FIRE CONTROL circuit breaker on the APU control panel must be closed for the fire detector switch and warning light to be operative.

Generator Switch (Solar APU)

The generator switch (17, figure 4-61) marked ON, OFF, and RESET, connects or disconnects power from the APU generator to the APU and the airplane electrical distribution system. One of the preparatory steps in turning on the generator is to hold the switch in RESET until the AC generator voltmeter indicates approximately 200 volts. Placing the switch in RESET prepares the generator and generator control circuits for generating power. This generator cannot be paralleled with any other generator, and each of the following conditions must be satisfied before the APU will supply any electrical power: (1) the door on the external power receptacle (39, figure 1-65) must be closed, (2) the turbine is operating at normal rpm, (3) the field trip switch (15, figure 4-61) is OFF, and (4) the generator switch is ON. The APU control panel, auxiliary power panel and outlets (figure 4-64), and water heater power panel receive electrical power from the APU when the generator switch is ON.

When the generator switch is OFF, electrical power from the APU generator is removed from the airplane electrical system and the APU control circuits. This is indicated by illumination of the generator off warning light. When the generator is off and there is no power on the airplane electrical system, the engine will continue to operate with the electrical controls receiving power from the APU battery. The generator has several protective devices that automatically remove the load when there are faults in the electrical system or when the engine is stopped either manually or automatically. The circuit breakers, marked AIRPLANE POWER SYSTEM A.C. and EXTERNAL POWER A.C., also protect the generator.

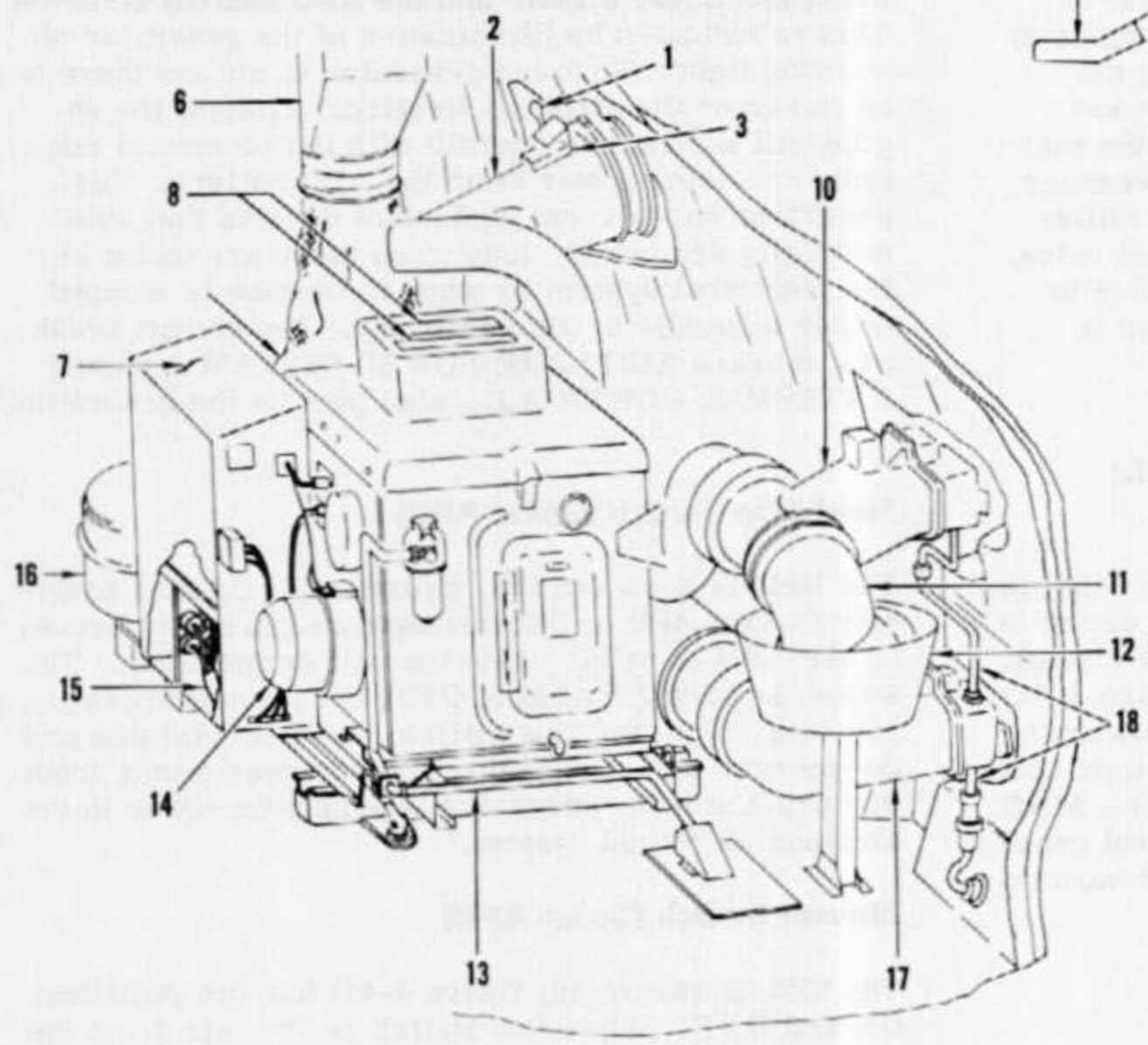
Field Trip Switch (Solar APU)

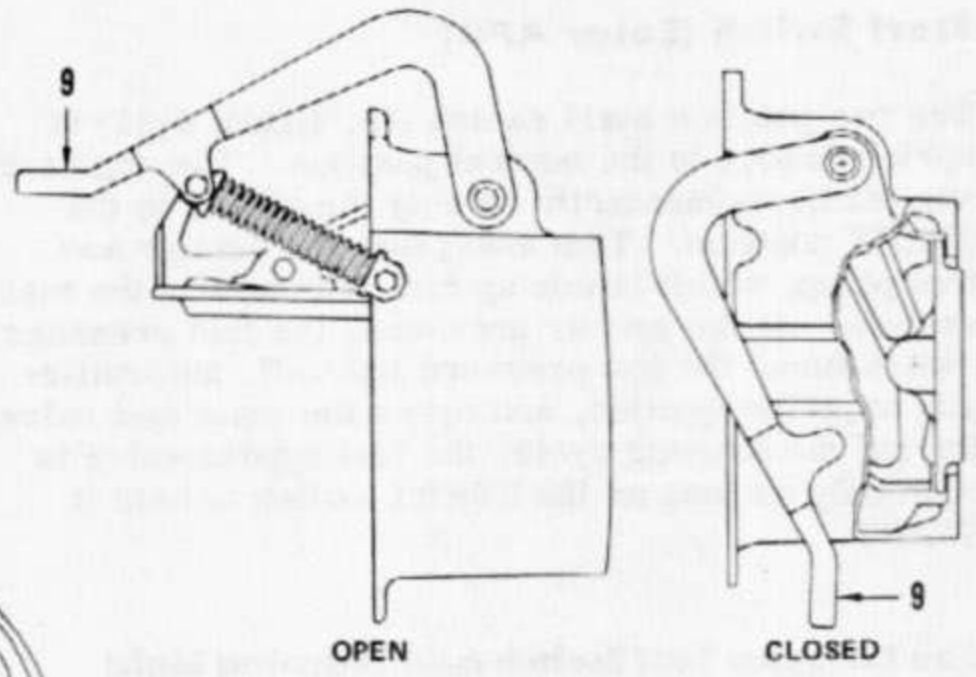
The field trip switch (15, figure 4-61) is used to de-energize the APU so that maintenance can be performed on the APU in safety while the unit is operating. The switch is spring loaded to OFF, the normal operating position. Placing the switch on TRIP isolates and de-energizes the generator and removes power from the airplane if the generator is supplying power to the airplane electrical system.

Blower Switch (Solar APU)

The blower switch (18, figure 4-61) has two positions: ON and OFF. When the switch is ON, air from the APU heat exchanger is blown into the overhead distribution duct. The temperature of the air is controlled by the APU temperature control (1, figure 4-7) or the mixing valve manual control (5, figure 4-60). The blower operates on three phase power from the APU generator; therefore, the turbine must be operating and the generator supplying power before the blower switch is effective. A thermostatic switch will shut off the blower if the temperature in the overhead distribution ducts reaches 150°C (the red line on the cabin heat temperature gage). After the blower has been shut off by the thermostatic switch, the blower switch has to be placed OFF and then ON to re-start the blower after the unit cools. In the OFF position, electrical power is removed from the blower. Four circuit breakers, marked D.C. CONTROL, BLOWER A, B, and C, on the APU control panel must be closed for the blower to operate.

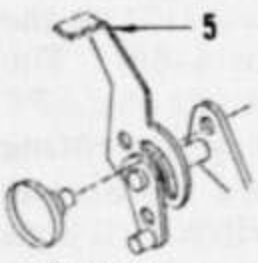
SOLAR AUXILIARY POWER UNIT



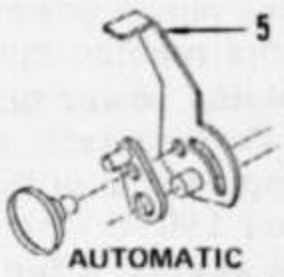


DETAIL III

1 TURBINE EXHAUST VALVE HANDLE (3 PLACES)
2 TURBINE EXHAUST DUCT (2 PLACES)
3 VALVE SWITCH (3 PLACES)
4 TEMPERATURE CONTROL ELECTRICAL CONNECTOR
5 MIXING VALVE MANUAL CONTROL (3 PLACES)
6 TO OVERHEAD DISTRIBUTION DUCT (2 PLACES)
7 APU CONTROL PANEL (2 PLACES) (SEE FIGURE 4-61)
8 FIRE ACCESS DOORS (2 PLACES)
9 COMPRESSOR INLET VALVE HANDLE (3 PLACES)
10 COMPRESSOR INLET DUCT (2 PLACES)
11 CABIN AIR OUTLET DUCT (2 PLACES)
12 HIGH FREQUENCY NOISE SUPPRESSOR (2 PLACES)
13 FUEL LINE (2 PLACES)
14 GENERATOR (2 PLACES)
15 ELECTRICAL CONNECTIONS AND ACCESS (2 PLACES)
16 BATTERY (2 PLACES)
17 CABIN AIR INLET DUCT
18 DRAIN LINE (280)

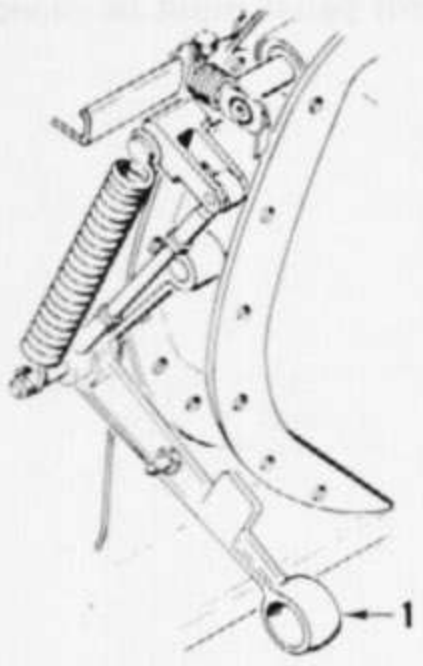


MANUAL TEMPERATURE CONTROL

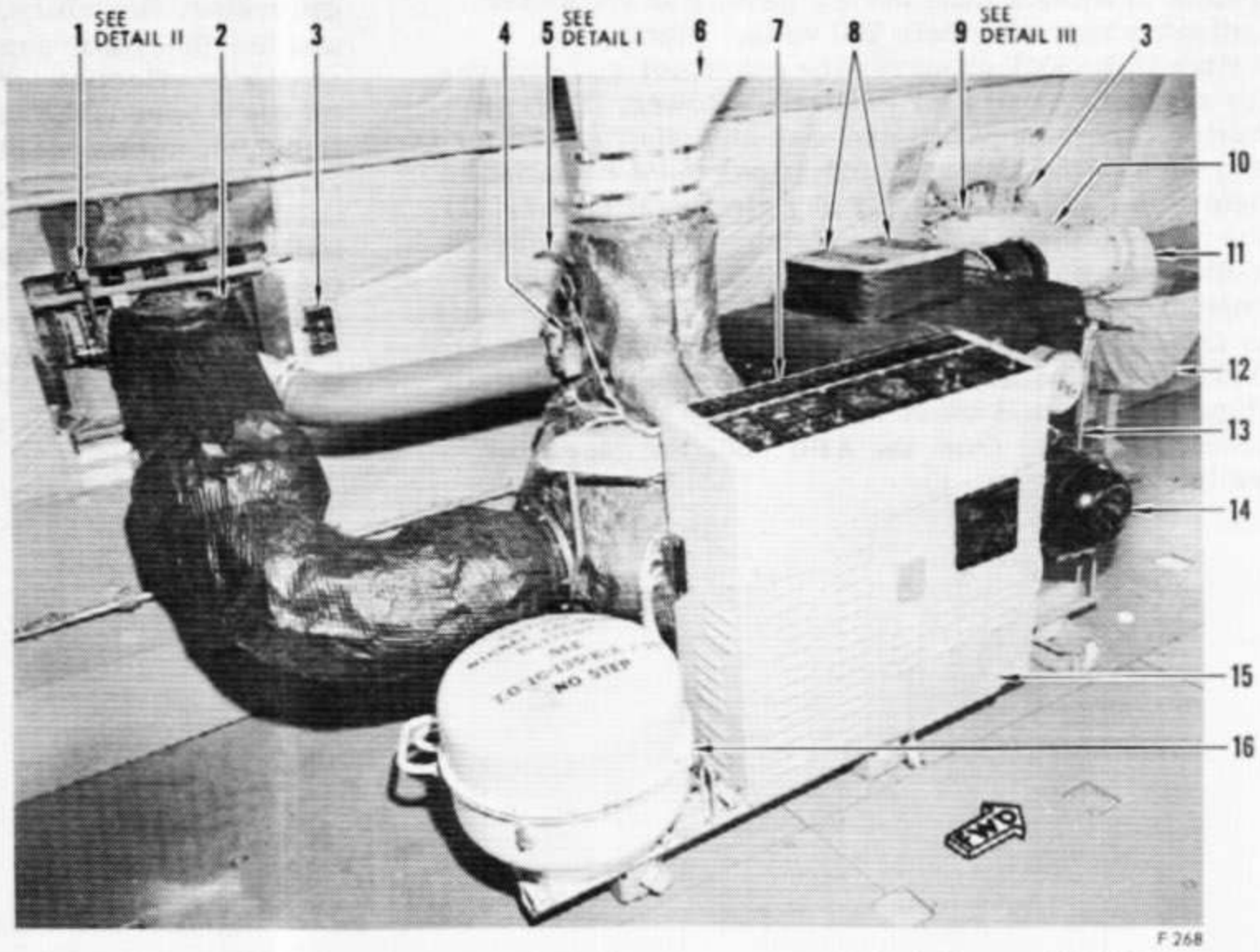


AUTOMATIC TEMPERATURE CONTROL

DETAIL I



DETAIL II

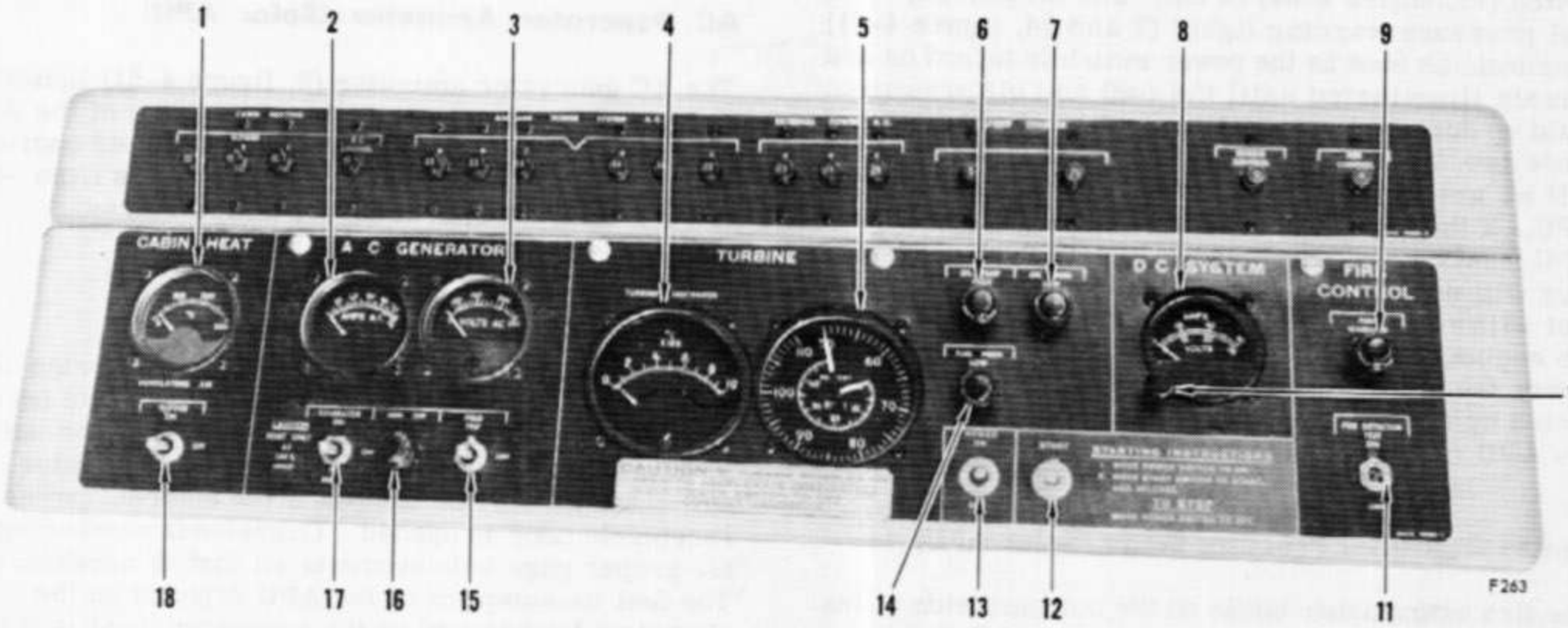


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NOTE: The cabin air inlet valve handle (same as DETAIL III) is directly below the compressor inlet valve handle (9).

Figure 4-60

SOLAR APU CONTROL AND CIRCUIT BREAKER PANELS



1 CABIN HEAT TEMPERATURE GAGE
2 AC GENERATOR AMMETER
3 AC GENERATOR VOLTMETER
4 TURBINE DISCHARGE TEMPERATURE GAGE
5 TACHOMETER
6 OIL TEMPERATURE HIGH WARNING LIGHT
7 OIL PRESSURE LOW WARNING LIGHT
8 DC VOLT-AMMETER
9 FIRE WARNING LIGHT
10 PUSH-FOR-VOLTS BUTTON
11 FIRE DETECTOR TEST SWITCH
12 START SWITCH
13 POWER SWITCH
14 FUEL PRESSURE LOW WARNING LIGHT
15 FIELD TRIP SWITCH
16 GENERATOR OFF WARNING LIGHT
17 GENERATOR SWITCH
18 BLOWER SWITCH

Figure 4-61

Tachometer (Solar APU)

The tachometer (5, figure 4-61) indicates the speed of turbine rotation in percent of rated rpm. A separate generator, driven by the turbine, supplies the power to operate the tachometer. The speed of rotation varies slightly depending upon the load carried by the generator and is the speed necessary for the APU generator to produce 400 ± 4 cycles. At full load the speed is approximately 100% and at no load the speed is approximately 102%.

Turbine Discharge Temperature Gage (Solar APU)

The temperature of the exhaust gases discharged from the APU is indicated in degrees C on the turbine discharge temperature gage (4, figure 4-61). The APU is automatically shut down when the exhaust gas temperature reaches 610° C (the red line on the instrument). The indicating portion of the instrument is operated by a thermocouple and requires no electrical power. However, the switch within the gage that shuts down the APU at the high temperature limit receives 28 volts DC from APU electrical system through the ENGINE CONTROL circuit breaker.

Oil Pressure, Oil Temperature, and Fuel Pressure Warning Lights (Solar APU)

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 power switch (13, figure 4-61) is ON. The oil pressure and fuel pressure warning lights (7 and 14, figure 4-61) illuminate as soon as the power switch is turned on and remain illuminated until the 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 high oil temperature light comes on, the APU must be shut down manually. (High oil temperature will usually be caused by an engine malfunction that will eventually result in automatic shut down of the engine.) Each of the lights operate on 28 volt DC power from the APU electrical system and are protected by the ENGINE CONTROL circuit breaker on the APU control panel.

Fire Extinguisher Pressure Gage (Solar APU)

The fire extinguisher bottle on the outboard side of the APU has a gage to indicate the pressure of the nitrogen charge that expels the extinguishing agent.

DC Volt-Ammeter (Solar APU)

The voltage or current in the APU DC system is indicated on the DC volt-ammeter (8, figure 4-61). The meter, calibrated for both volts and amperes, gives a continuous indication of amperage. The meter indicates voltage when the push-for-volts button (10, figure 4-61) is depressed. When the APU is operating, the meter indications show the DC output or DC load on the APU generator. When the APU is not operating, the battery is recharged from the airplane electrical system and the volt-ammeter indicates the battery charging voltage and current. On airplanes 372▶, the ammeter portion of the instrument has a green arc to show the normal charging rate (indicating that battery is over 50% charged). See figure 7-10 and BATTERY CHARGE LEVEL in Section VII.

Cabin Heat Temperature Gage (Solar APU)

The cabin heat temperature gage (1, figure 4-61) on the APU control panel is calibrated in degrees C. The temperature indicated on the gage is the temperature of the air flowing from the APU into the overhead distribution duct. The temperature of the air is controlled by the APU temperature control (1, figure 4-7) or the mixing valve manual control (5, figure 4-60). The blower is automatically shut down if the temperature of the air for cabin heat reaches 150° C (the red line on the gage). The gage is operated by a temperature sensing bulb that requires 28 volt DC power from the APU electrical system. This circuit is protected by the HEATER CONTROL circuit breaker.

AC Generator Voltmeter (Solar APU)

The generated voltage of the APU generator is indicated continuously on the voltmeter (3, figure 4-61). The normal operating range is 200 ± 5 volts.

AC Generator Ammeter (Solar APU)

The AC generator ammeter (2, figure 4-61) indicates the amperage (load) carried by one phase of the APU generator. The indication should not exceed approximately 87 amps with ambient temperatures from -65° to 85° F (slightly less at higher temperatures).

OPERATION OF APU

The APU can be operated for an extended period of time, with little or no monitoring. Automatic features will trip the generator and shut down the unit in case of an abnormal condition. The generator will automatically be tripped if the external power receptacle door is opened. Occasional monitoring for proper gage indications is all that is necessary. The fuel consumption of the APU depends on the electrical load placed on the generator (heat is taken from the exhaust gases and does not require burning additional fuel). Normal fuel usage will be approximately 55 pounds per hour with a maximum consumption of 100 to 117 pounds per hour for high electrical loads.

NOTE

When the APU is to be used for "live aboard" operations:

(1) It may be necessary to keep one engine operating (preferably No. 1 engine) until the APU is supplying heat and power.

(2) The aft body tank should have a minimum quantity of 2500 pounds.

(3) Before shutting down the engines, it may be necessary to transfer fuel to the aft body tank to have fuel for the APU. See FUEL TRANSFER FOR APU OPERATION, Section VII. If fuel transfer is necessary, do not allow the center of gravity to shift too far aft. See figure 5-5.

WARNING

To prevent the possibility of igniting fuel vapors, do not operate the APU during fueling operations.

Starting APU

NOTE

The APU can be started only with power from the APU battery. It is not possible to start the APU from the airplane electrical system or an external power source; however, the APU battery can be charged from the airplane electrical system.

A. Inlet and Exhaust Valves (3) - OPEN

B. All Circuit Breakers - Closed (pushed in)

C. Master/Power Switch - ON

D. AiResearch Primer Switch - ON

E. Start/Stop Switch - Momentarily ON

CAUTION

AiResearch APU

- The duty cycle of the starter motor is one minute of continuous cranking. After a one minute duty cycle allow the starter motor to cool for four minutes before repeating the duty cycle. When starting the engine at extremely low temperatures, the engine may shut down automatically due to the cold lubricating oil. Several starts may be necessary before the unit will operate continuously.

- If a false or hung start occurs, check turbine drain valve for proper fuel drainage. If no fuel is visible or draining, do not attempt to restart the APU until the drain valve has been removed and checked for proper operation.

Solar APU

- Failure to release the start-stop switch immediately when the fuel pressure low warning light goes off can cause excessive fuel to flow to the burner. The excessive fuel can cause an overheat condition which will automatically stop the APU and possible damage the unit.

- In the event of a false start, allow at least three minutes for residual fuel to drain from the turbine scroll before attempting another start. Check that scroll drain is not obstructed and drains freely. After two successive false starts, determine cause of difficulty before repeating start attempt.

F. Oil Pressure - Warning light extinguished.

AiResearch APU: The light should go out when the rpm is between 20% and 40%

Solar APU: The light should go out within ten seconds after the start switch has been placed in START.

G. Tachometer - Check

AiResearch APU: Should indicate 100 ± 0.5%

Solar APU: Should indicate 102 ± 0.5%

H. AiResearch APU Primer Switch - OFF

I. AC Power Control/Generator Switch - RESET then ON

AiResearch APU: Check that voltage is between 192 and 207 volts.

Solar APU: When the turbine speed reaches 102 ± 0.5% load can be applied to the generator. Hold the switch in RESET until the AC generator voltmeter indicates approximately 200 volts and then place switch ON.

J. Cabin Air/Blower Switch - As desired

K. All Instruments - Check for proper reading

Cabin air temperature - 121° C maximum
DC Volt-ammeter - 25 to 28 volts

AiResearch APU:

AC voltmeter - 192 to 207 volts
AC ammeter - 107 amps maximum
Tachometer - 100 ± 0.5%
Exhaust temperature - within the marked range

Solar APU:

AC generator ammeter - 87 amps maximum continuous
AC generator voltmeter - 195 to 205 volts
Turbine discharge temperature - between marked limits

L. Solar APU Fuel and Oil Drains - No leakage

Check the drain lines of the Solar APU from the outside of the airplane for evidence of any continued leakage.

M. Battery Charge Circuit Breakers - Pull when battery is charged

AiResearch APU: Pull the BATTERY CHARGE circuit breakers on the APU panel and the 3 circuit breakers marked STA 1180 POWER OUTLET on the GENERATOR No. 2 section of the MCBP.

Solar APU: Pull the 2 BATTERY CHARGER circuit breakers on the APU panel.

Pull the circuit breakers when the ammeter reading drops to 4 amps. If the DC volt-ammeter indicates more than 28.5 volts, the ammeter reading may not drop to 4 amps and the circuit breakers should be pulled when the ammeter reading stabilizes at a slightly higher value.

CAUTION

The battery may be damaged if charging current is applied to the battery after it becomes fully charged.

After the battery charge circuit breakers have been pulled for flight, it will not be necessary to reset the circuit breakers for the remainder of the flight. For live aboard concept, periodically close the circuit breakers long enough for the battery to charge.

(See BATTERY CHARGE LEVEL, Section VII.)

CAUTION

- Airplane should not be left unattended while APU is operating.
- Do not dry clothing or other materials on or near the APU exhaust or heat ducts. There is sufficient heat produced in these areas to ignite such materials and cause a fire.

HEATING THE LIVING QUARTERS

A. Cargo Compartment A/C Master Switch - OFF

B. Air Conditioning Master Switch (Control Cabin - OFF

C. Flow Divider Valve - APU

This valve is forward of the sound curtain in the overhead distribution duct.

D. Boom Operator's Compartment Air Outlet Doors - Close

Close the emergency defrost slide prior to closing the outlet door.

E. All Diffusers Aft of Sound Curtain - As desired

F. Cabin Air/Blower Switch - ON

G. APU Temperature Control - As desired

The APU temperature control is on the cargo compartment A/C control panel (near the cargo door). See CABIN AIR CONDITIONING, PRESSURIZATION, AND VENTILATING SYSTEM, this section.

NOTE

If the APU temperature control does not effectively regulate the cabin temperature after a normal stabilization period, the temperature can be adjusted manually.

AiResearch APU: Adjust with the temperature control manual override (14, figure 4-58)

Solar APU: Adjust with the mixing valve manual control. To make the manual control operative, disconnect the electrical connector (4, figure 4-60) and unscrew the locking knob from the lever. Screw the knob into the threaded hole (through the slot) behind the lever and tighten knob to hold lever in the desired position. See Detail 1 of figure 4-60.

Stopping APU

A. Cabin Air/Blower Switch - OFF

B. AC Power Control/Generator Switch - OFF

C. AiResearch Start-Stop Switch - Momentarily to STOP

D. Master/Power Switch - OFF

CAUTION

Stopping the APU prior to tripping the generator from the electrical system may cause unnecessary wear or damage to electrical components.

E. Inlet and Exhaust Valves - Close

Close the inlet and exhaust valves immediately when securing the APU during an alert; however, if time permits, wait until the turbine stops before closing the valves. Close prior to flight to insure cabin pressurization or on the ground as protection from birds and blowing sand or snow. Check for positive closing spring action.

WARNING

Failure to completely close the cabin air inlet valve before takeoff, can result in reverse rotation, overspeed and subsequent disintegration of the APU cabin air fan, endangering personnel in the area of the APU.

F. Battery Charge Circuit Breakers - OPEN

G. Boom Operators Compartment Air Outlet Doors - Open

APU Fire

WARNING

Automatic stopping of the APU may indicate a fire or an overheat condition within the unit.

The APU fire extinguisher discharges automatically when an overheat condition exists within the unit.

A. Fire - Combat (as required)

If the APU fire extinguisher fails or additional fire extinguishing agent is required, insert hand fire extinguisher into the turbine section through fire access doors (10, figure 4-58) (8, figure 4-60).

WARNING

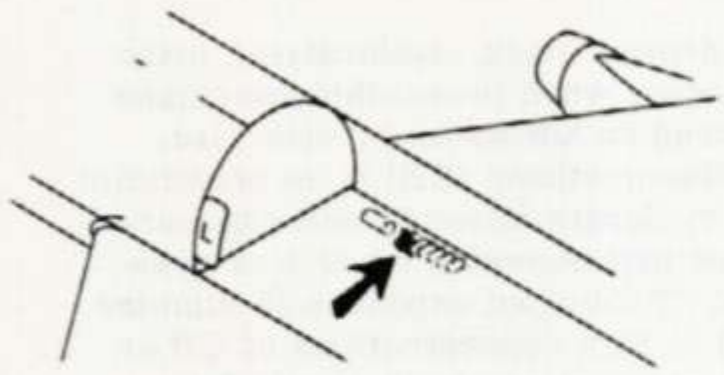
- Heavy, dense, black, suffocative, toxic smoke occurs when bromochloromethane (CB) is used on hot metal or open fire. Bromochloromethane (CB) is an anesthetic agent of moderate intensity and exposure may cause pronounced irritation of eyes and nose. Prolonged exposure (5 minutes or more) to high concentrations of CB or its decomposition products should be avoided. Adequate respiratory and eye protection from excessive exposure should be sought as soon as the primary fire emergency will permit. The use of 100% oxygen will provide respiratory protection.

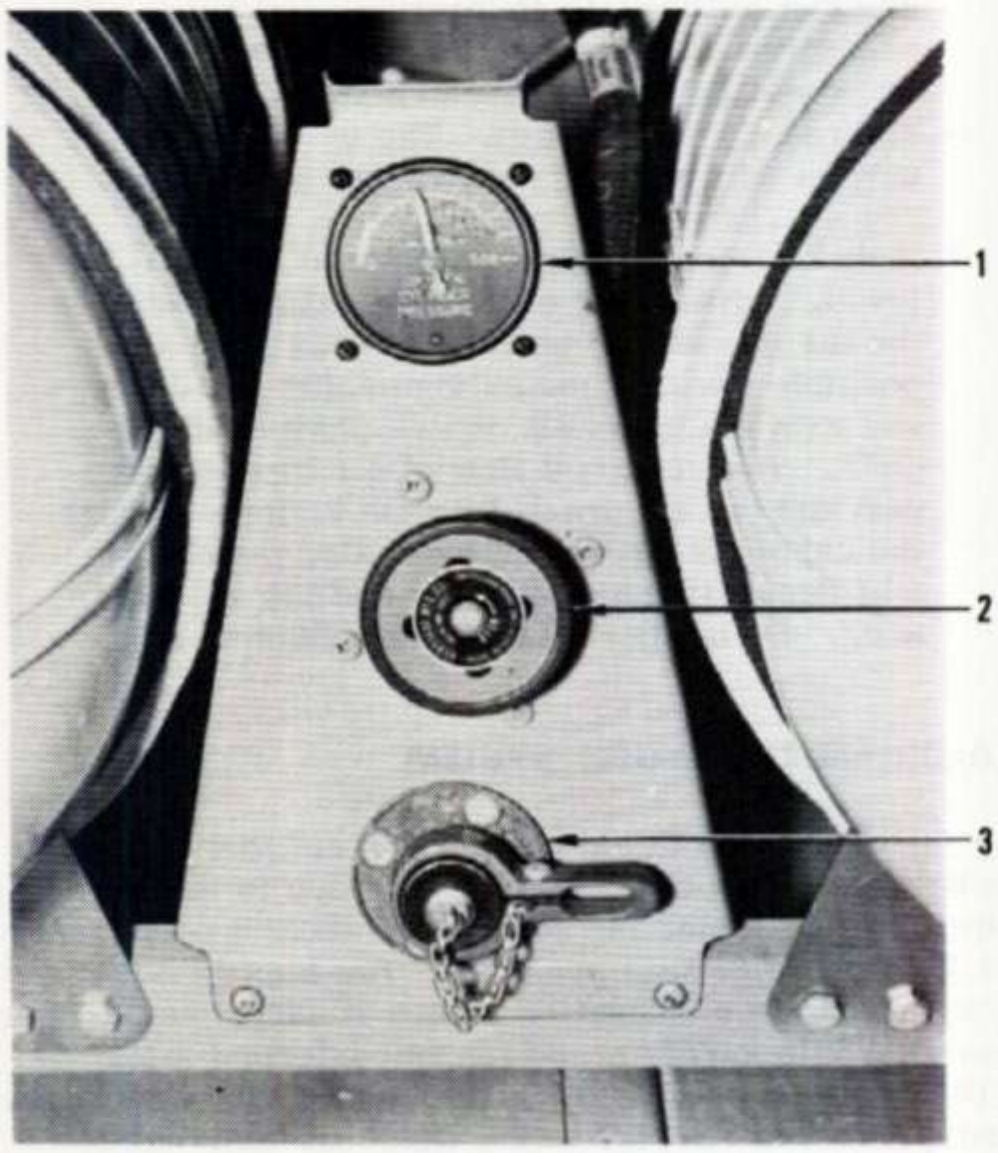
- If there is no apparent damage to the APU following a discharge of the fire extinguisher, the turbine should be restarted as soon as possible having hand extinguishers available, and with the cabin air switch positioned to OFF. The resultant flow of air through the unit and the air drawn into the turbine through the cabin air outlet and exhausted overboard will decontaminate the APU and the adjacent, area. Do not use water as a cleansing agent.

AUXILIARY OXYGEN SYSTEM

A fully serviced liquid oxygen system will deplete itself within approximately 6 days due to the normal evaporation inside the converter (about 3 pounds or 1.2 liters evaporate per day). The loss of liquid oxygen due to evaporation makes it necessary to have an alternate supply of oxygen for extended missions. The arctic capability kit includes an auxiliary oxygen supply that is carried in the cargo compartment. The auxiliary system has 6 G-1 tanks (8, figure 4-57) that are filled with gaseous oxygen. The tanks are connected to the airplane oxygen distribution system by a valve on the auxiliary oxygen control panel (figure 4-62). The control panel also has a pressure gage and filler valve for servicing the tanks. The

AUXILIARY OXYGEN CONTROL PANEL





1 GASEOUS OXYGEN PRESSURE GAGE
2 OXYGEN SHUTOFF VALVE
3 OXYGEN FILLER VALVE

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Figure 4-62

auxiliary oxygen system has a pressure between 400 to 425 psi when fully serviced (the liquid system pressure is automatically maintained at 300 psi). If the liquid and gaseous systems are used simultaneously, oxygen will be supplied by the gaseous system until the pressure drops to 300 psi.

During the period when liquid oxygen is not being used, some oxygen will be lost due to evaporation. Therefore, to reduce waste, the auxiliary oxygen supply should not be used until the liquid supply is nearly depleted. (The gaseous oxygen can be stored indefinitely.) Check valves in the oxygen distribution system prevent crossflow of oxygen between the liquid oxygen converter and the gaseous oxygen storage containers. See figure 4-38. Oxygen duration is shown in figure 4-35.

NOTE

Use the auxiliary oxygen supply whenever the liquid oxygen system is empty or inoperative. When using the auxiliary supply, insure that oxygen duration requirements do not exceed the hours listed in the oxygen duration chart (figure 4-35).

Oxygen Shutoff Valve

This manually-operated valve (2, figure 4-62) on the auxiliary oxygen control panel controls the flow of oxygen from the auxiliary oxygen system. When the valve is closed (rotated full clockwise), the oxygen is confined in the cylinders. Opening the valve (rotate counterclockwise) connects the 6 gaseous oxygen tanks to the airplane oxygen distribution system.

CAUTION

The liquid oxygen system is considered depleted when the liquid oxygen quantity gage indicates zero. (There is only one quantity gage and it is on the copilot's side panel.) Pressure in the liquid system will be within the normal operating range (approximately 300 psi) until the liquid oxygen is nearly depleted. When the system pressure begins to drop, use the auxiliary oxygen supply. (System pressure is indicated by the gage (10, figure 4-37) on each oxygen regulator.)

Gaseous Oxygen Pressure Gage

This gage (1, figure 4-62) on the auxiliary oxygen control panel indicates the pressure in the gaseous oxygen storage cylinders. An indication of 400 to 425 psi indicates that the cylinders are fully charged.

All data on pages 4-121 thru 4-128 (Deleted)

Oxygen Filler Valve

The storage tanks for the auxiliary oxygen system are serviced by connecting the filler hose from an oxygen cart to the filler valve (3, figure 4-62). The cylinders are connected so that they are filled simultaneously. A check valve in the outlet from the tanks prevents recharging the tanks from the airplane liquid oxygen system.

ARCTIC KIT MISCELLANEOUS EQUIPMENT

Additional equipment in the arctic kit includes a galley, living compartment furnishings, and maintenance items.

Crew Living Compartment

Equipment is included in the arctic kit to set up living quarters for the crew in the forward area of the cargo compartment. A sound curtain (4, figure 4-57) is placed across the compartment at the overwing emergency exit hatch. This curtain is split to allow passage. Six bunks, two passenger seats, and a rug (3, 15, and 16, figure 4-57) can be installed. The arctic kit also adds the following equipment to the toilet compartment: an adjustable mirror, paper towel dispenser, waste paper receptacle, lavatory with hand pump and soap dispenser, two four-gallon containers (one for wash water and one for waste water), a utility hook, and a doorway curtain. See figure 4-83 for location of this additional equipment in the toilet compartment.

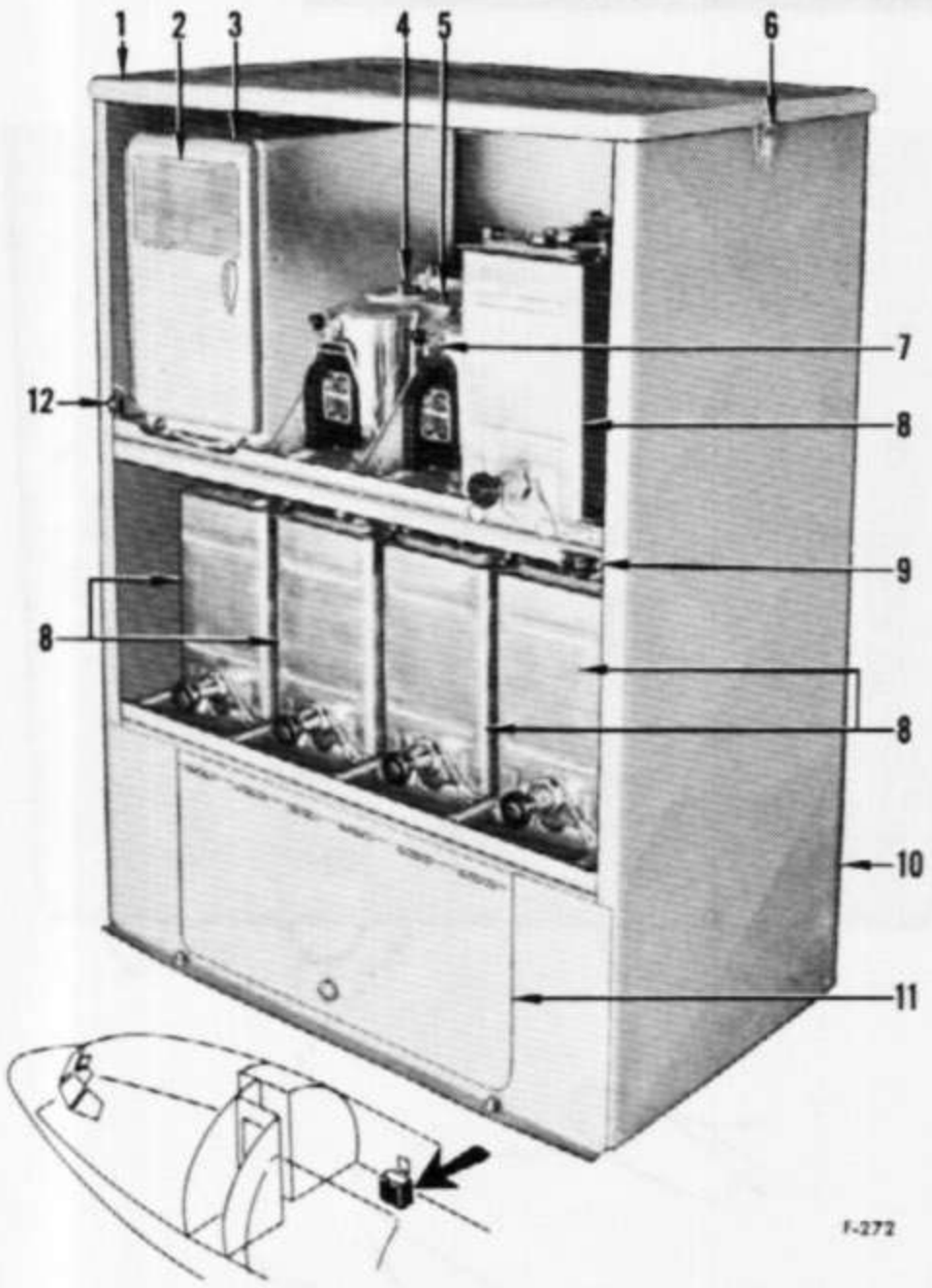
WARNING

The six bunks installed as part of the arctic capability kit are not stressed for side loads, therefore the bunks should not be occupied during takeoff, landing, or other procedures where side loads on the bunks may be encountered.

Galley Equipment

There are two galley equipment configurations. Both units are identical except for the stowage cabinet (11, figure 4-63). See figure 4-57. The galley equipment includes a stand wired to supply electrical power for the oven (3, figure 4-63), two hot cups (7, figure 4-63) and one two gallon beverage container (8, figure 4-63). Storage for the four additional two gallon beverage containers (8, figure 4-63) is provided on a lower shelf. The oven is for heating pre-cooked frozen meals, foil pack meals, and individual food packets. The galley equipment can be operated in flight. Power to the galley equipment is 115/200 volt AC with circuit protection on the MCBP. The circuit breaker is marked RECP NO. 3 on the auxiliary power panel and AUX PWR PANEL on the MCBP.

GALLEY EQUIPMENT



1	DETACHABLE GALLEY TOP	8	BEVERAGE CONTAINER (3 PLACES)
2	OPERATING INSTRUCTIONS	9	BEVERAGE CONTAINER SWITCH
3	GALLEY OVEN	10	GALLEY STAND
4	TIMER SWITCH	11	STOWAGE CABINET
5	INDICATOR LIGHTS	12	GALLEY OVEN SWITCH
6	GALLEY TOP FASTENER		
7	HOT CUPS		

Figure 4-63

Oven Controls

The oven has six removable shelves each of which has an attached heating element that plugs into the rear wall of the oven. These elements are turned on for cooking by depressing the reset buttons on the top-front of the oven (inside the door). Illumination of the pilot light on the bottom-front of the oven indicates that the heaters are energized. When the temperature in the oven reaches 212° F, a thermostat automatically de-energizes the shelf heaters, trips the reset buttons, and extinguishes the pilot light. The buttons cannot be reset if the temperature in the oven is above 160° F. In addition to the heating elements on the shelves, there is another heating element in the oven that maintains a temperature between 150° and 160° F whenever there is power to the galley stand. In the event of malfunction of a heating

AUXILIARY POWER PANEL OUTLETS

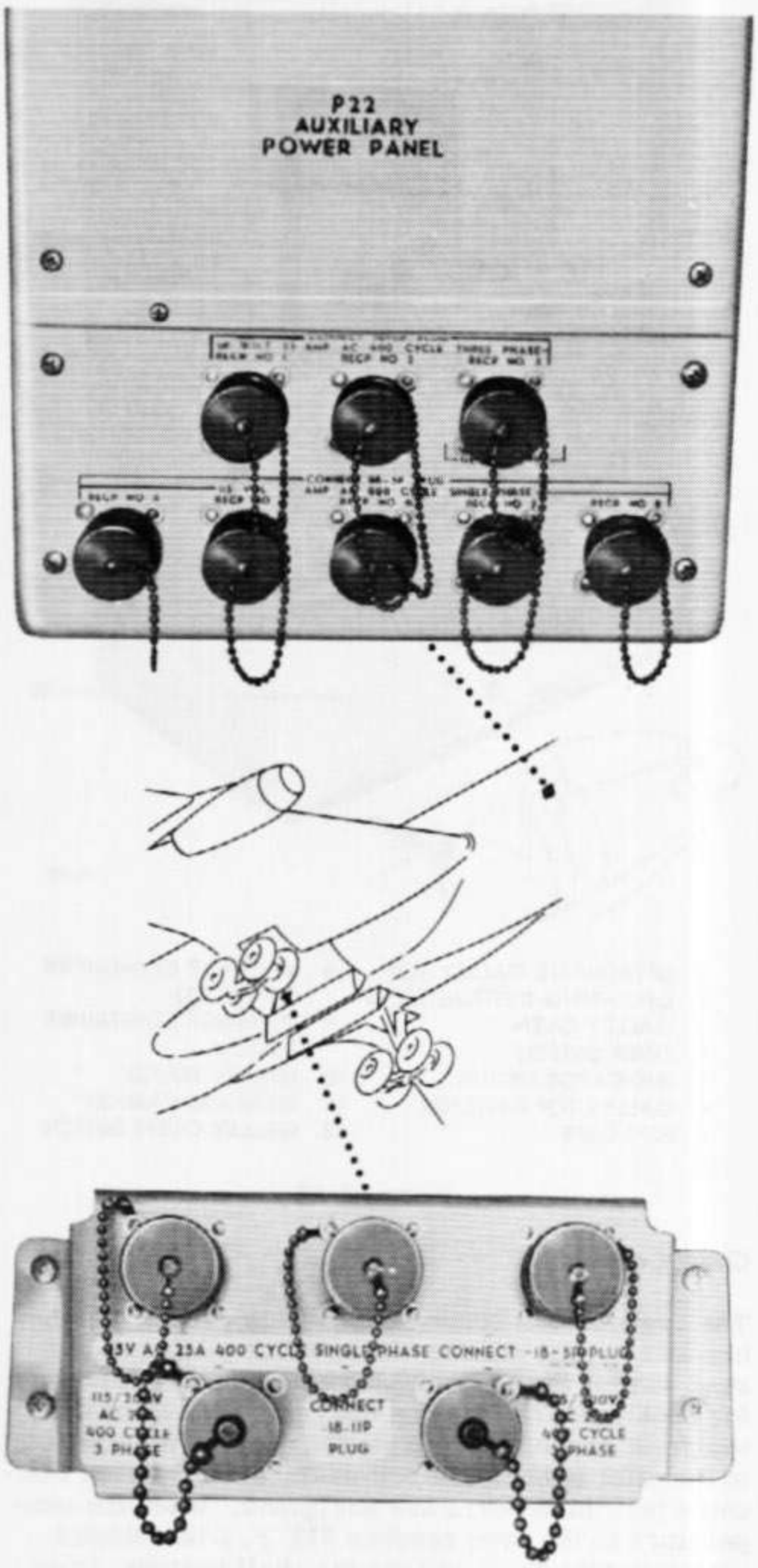


Figure 4-64

element or elements, a "high limit" thermostat de-energizes the oven when the temperature reaches 320° F.

Galley Oven Switch

Most airplanes have an oven switch (12, figure 4-63) with ON-OFF positions installed on the left of the upper galley shelf. The switch provides a means of controlling the power supply to the oven. With the switch in the OFF position, no power is supplied to the oven; with the switch in the ON position, power is supplied from the auxiliary power panel to the oven. Galleys not equipped with the oven switch have no control of power supply to the oven since power is supplied to the oven whenever power is on the galley stand.

Hot Cups Control

Two hot cups (7, figure 4-63), each with a capacity of 37 ounces, are stowed plugged into electrical receptacles in the center of the upper galley shelf. Each receptacle has an indicator light (5, figure 4-63) and a timer switch (4, figure 4-63) that is calibrated from 0 to 30 minutes. When the timer is rotated clockwise from the 0 position, power is connected to the cups and the indicator light will illuminate. When the timer returns to 0, power is automatically turned off and the indicator light will go off. Manual rotation of the timer knob to 0 will also remove power.

Beverage Container Switch

The beverage container (8, figure 4-63) on the right of the upper galley shelf has a power connection for heating its contents. A switch (9, figure 4-63) has ON-OFF positions. When the switch is OFF no power reaches the container. With this switch ON, power flows through a thermostatically controlled unit that will heat the contents to, and maintain, 180° F.

Maintenance Equipment

Field maintenance equipment to aid in servicing the airplane under arctic conditions is included.

Engine Enclosure Tent

This tent, made of flame resistant material, is large enough to enclose an engine and cowling. It is supported by the cowling at the top but weights, such as tool boxes or other available items, must be used to hold the bottom. Some tents use a tent pole (18, figure 4-57) to hold the front of the tent off the engine.

Maintenance Stand

This collapsible stand (13, figure 4-57), when erected, is two feet wide, six feet long and three and one-half feet high.

Folding Ladder

This two-piece ladder (12, figure 4-57) may be used as a self supporting "A" ladder to reach under wing access points or upper engine areas, or the two parts may be connected to form an extension ladder to reach the stabilizer or the top of the wing.

Electrical Outlets

Additional external and internal outlets for electrical power are part of the arctic equipment. These outlets are primarily powered by the APU, but may receive external power through the airplane system. The external outlets are in the lower aft inboard corner of the right wheel well (figure 4-64) and consists of five receptacles; two are three phase 115/200 volt 400 cycle AC and three are 115 volt AC. Circuit protection is on the APU circuit breaker panel (figures 4-59 and 4-61). The internal outlets are on the auxiliary power panel (figure 4-64) and consist of eight receptacles; three are three phase 115/200 volt 400 cycle AC and five are 115 volt 400 cycle AC. Circuit protection for each of the internal outlets is on the auxiliary power panel (figure 1-35, sheet 7) on airplanes 1▶249 . On airplanes 250▶ , receptacle No. 3 is protected separately by three circuit breakers marked AUX PWR PANEL on the GENERATOR NO. 3 of the MCBP (figure 1-35, sheet 3).

Portable Electric Heater

This heating unit has an ON--OFF switch, a blower and an eighty foot detachable power cable. This unit draws 7.5 KW and will supply sufficient heat to warm the engine enclosure tent under mild conditions, but must be directed on specific areas for warming during extreme cold conditions. This unit uses 115/200 volt AC and may be plugged in either at the outlet on the auxiliary power panel (2, figure 4-57), or the outlet in the right wheel well (figure 4-64).

Portable Air Compressor

A portable electrically powered compressor will supply moisture free air for servicing the airplane. This assembly has three gages, an ON--OFF control switch, a pressure regulator, a timer which logs the operating time and an eighty foot power cable. Power is 3 phase 115/200 volt AC. The unit may be plugged into the receptacles in the right wheel well or those at the auxiliary power panel.

Pressure Regulator

This device may be set at any desired pressure from 50 to 3000 psi to inflate tires or pressurize accumulators, struts etc. When the pressure in the unit reaches the pressure indicated on the regulator, electrical power is automatically removed from the compressor.

Pressure Gages

Three pressure gages are installed on the compressor. The first upstream of a back pressure valve indicates the output of the compressor and should read approximately 3000 pounds when the compressor is in operation. The two gages downstream of the regulator are for reading pressures in the unit being pressurized. The low pressure gage is calibrated in 20 psi increments for readings from 0 to 500 psi and is accurate to + 10 psi; the high pressure gage is calibrated in 100 psi increments for readings to 3200 psi and accurate to ± 50 psi.

AIR REFUELING SYSTEM

This airplane is equipped to transfer fuel in flight to receiver airplanes by means of the flying boom air refueling system. Fuel is carried in two fuselage tanks and an upper deck tank on airplanes so equipped, (figure 4-73) which can be supplemented with fuel from the airplane fuel system. See figure 1-24. All of the airplane fuel system fuel can be transferred by gravity into the body tanks, except amounts indicated in figure 7-6. There is no provision for transferring fuel from the body tanks to the wing tanks in flight. Body tank fuel, however, can be fed to the engines. See BODY TANKS TO ENGINES in Section VII. There are two hydraulically driven fuel pumps in each body tank. The four pumps are designed to transfer fuel to a receiver airplane at a minimum flow rate of 5850 pm with all receiver tanks open. The regulated nozzle pressure varies between 45-50 psi, depending on boom length, elevation, and fuel flow rate. The fuel flows from the pumps through check valves directly into the A/R manifold, the A/R line valve, through the A/R pressure regulator, fuel flow transmitter, and out the boom. The boom when not in contact with a receiver airplane, can be extended or retracted hydraulically by the boom operator. Hoisting of the boom in flight from any lower angle can be accomplished hydraulically. Lowering of the boom from stowed to trail should be accomplished with the boom hoist lever in the LOWER position. Movement of the boom when in a lowered position is controlled by the boom operator by actuating a control stick which is linked to the ruddevator control valve. The ruddevators are hydraulically actuated and the boom can be flown into the stowed position. The air refueling electrical system operates on power from the 28 volt DC system. The receiver pilot director light power is 32 volt AC. Hydraulic pressure is used to operate the boom operator's sighting door, hoist motor, tension motor, A/R fuel bypass valve, ruddevators and the fuel dump actuator. The refueling hydraulic system receives its power from the airplane hydraulic system. See HYDRAULIC SYSTEM Section I and figure 1-37. The forward air refueling pumps in the body tanks are

BOOM HYDRAULIC SYSTEM

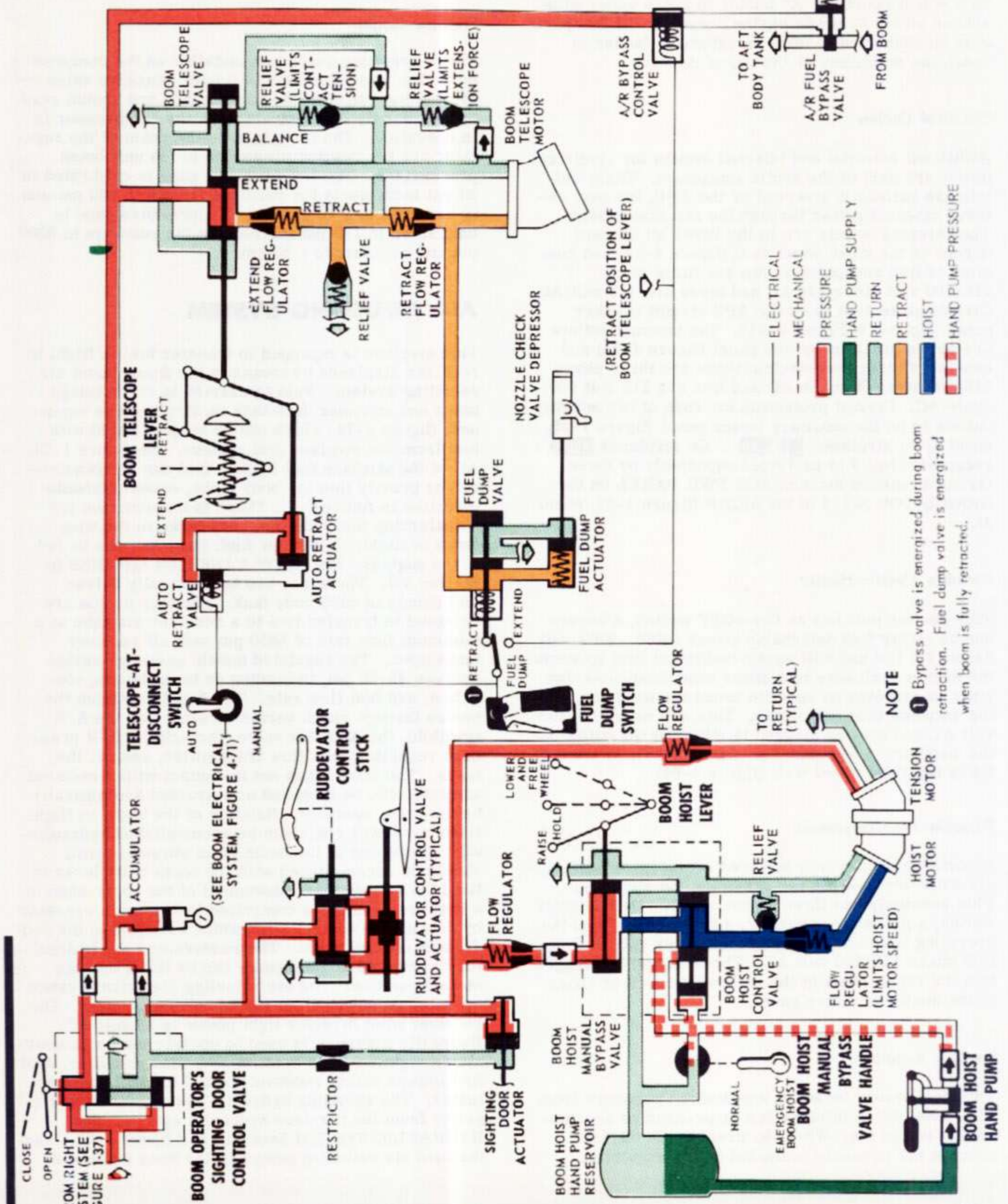


Figure 4-65

driven by the left hydraulic system only and the aft pumps by the right hydraulic system only. The air refueling pumps are not affected by the crossover valve, but the boom hydraulic system can be operated from either system through use of the crossover valve. The right system normally pressurizes the boom hydraulic system.

BOOM HYDRAULIC SYSTEM

The boom hydraulic system (figure 4-65) is pressurized by the main hydraulic system. Description and operation of the main hydraulic system is as described in HYDRAULIC SYSTEM Section I. The pilot has primary control of the main hydraulic system and the boom operator has sole control over the sighting door, ruddevator actuation, boom hoist, boom telescoping, and such automatic functions as are brought about by the A/R signal system. A boom hoist hand pump using fluid from a 1.5 quart reservoir serves as an auxiliary source of boom hoist pressure for either ground maintenance or in case of main system hydraulic malfunction while in flight. The boom operator's sighting door lever must be in the OPEN position in order to supply pressure to the powered ruddevators, and the hoist and tension motors. The primary means of stowing the boom is by flying the boom into the stowage chock. The hoist motor is also capable of bringing the boom up to the latched position from any lower elevation angle in case there is a malfunction in the ruddevator control system. This should be accomplished below an airspeed of 300 KIAS below 30,500 feet, and Mach 0.80 at 30,500 feet and above, to overcome any resistance from the ruddevators. An accumulator, preloaded to 1500 psi, is in the system near the boom operator's sighting window. A pressure gage is on the air side of the accumulator. This gage has a red radial indicating the low limit of normal hydraulic pressure and another red radial indicating maximum allowable pressure. A green arc on the gage, indicates normal operating range of the system. 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 automatically controlled by a flow limiter in the hoist motor pressure line. 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. The bypass control valve switch will energize the bypass control valve open whenever the boom telescope lever is moved to RETRACT, provided the fuel dump relay has not been energized, boom electrical power is on and the boom is extended. Actuating the disconnect switch on airplanes 8▶ and the fuel dump switch on all airplanes will energize the bypass control valve open provided the boom is not in the retracted position. The A/R bypass valve opens to permit excess fuel trapped in the boom to be returned to the aft body tank during boom retraction. A check valve in the return line from the boom system prevents loss of right system hydraulic fluid in event of damage to any portion of the boom hydraulic system except boom hoist.

Boom Operator's Sighting Door Lever

The boom operator's sighting door lever (6, figure 4-66) above the boom operator's sighting window is used to open or close the boom operator's sighting door hydraulically. The lever housing has OPEN--CLOSE positions. When the lever is moved to the OPEN position, hydraulic pressure is directed to the hoist and tension motors, powered ruddevators and the sighting door actuator. When the lever is moved to the CLOSE position, the sighting door is closed and hydraulic pressure to the hoist and tension motors and powered ruddevators is shut off. Hydraulic pressure to all other functions of the boom hydraulic system is maintained when the lever is in either the OPEN or CLOSE position.

CAUTION

- If the hoist cable is broken the boom should be flown into the latched position before closing the sighting door. The whipping action of the broken cable will cause damage to the tension motor housing. Refer to BOOM HOIST CABLE BROKEN, Section III.

- Do not attempt to fly the A/R boom with the sighting door closed. Closing the sighting door will shut off hydraulic pressure to the tension motor, and the resulting slack may cause kinks in the cable with subsequent breakage.

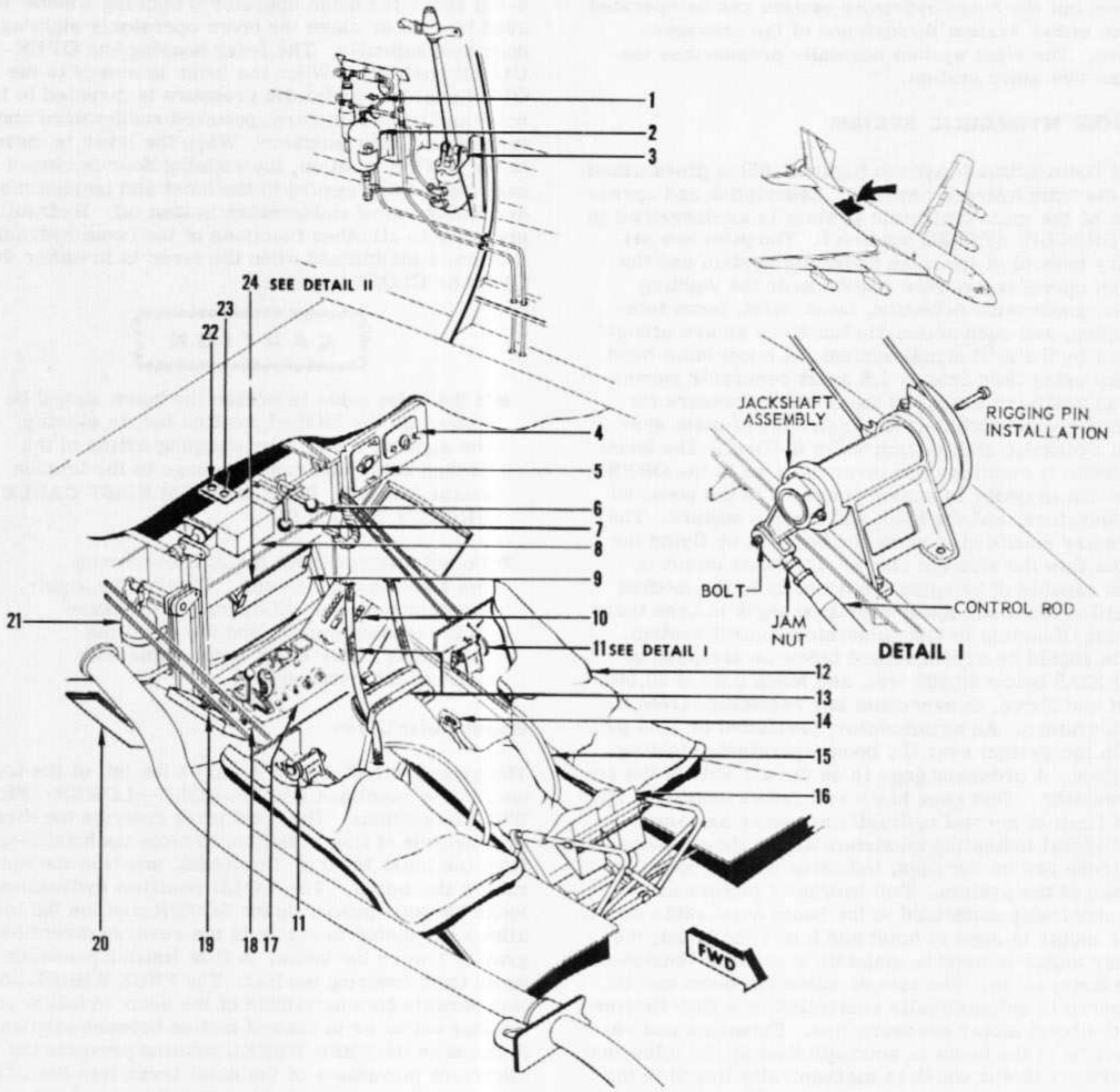
Boom Hoist Lever

The hoist lever (3, figure 4-68) on the left of the boom operator's panel has RAISE--HOLD--LOWER--FREE WHEEL 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 RAISE position the motor raises the boom. The HOLD position hydraulically locks the hoist motor. In the LOWER position the lever allows the motor to rotate in the reverse direction as gravity lowers the boom. A flow limiter prevents the boom from lowering too fast. The FREE WHEEL position permits free movement of the boom to follow ruddevator action or in contact motion between airplanes. A detent in the FREE WHEEL position prevents the inadvertent movement of the hoist lever into the HOLD position. A cutout has been provided in the panel cover at the RAISE position to provide for hoisting of the boom without the boom operator holding the hoist lever in the RAISE position. This will permit the boom operator to make an emergency exit from the boom pod while the boom is being hoisted with the hoist lever in the raise detent. It will also permit the boom operator and crew to expedite a bailout without the delay of stowing the boom.

NOTE

A flow regulator installed in the pressure line to the hoist control valve reduces the hoist rate such that raising the boom from 30 degrees of down elevation, without ruddevator assistance could take as long as 3 minutes.

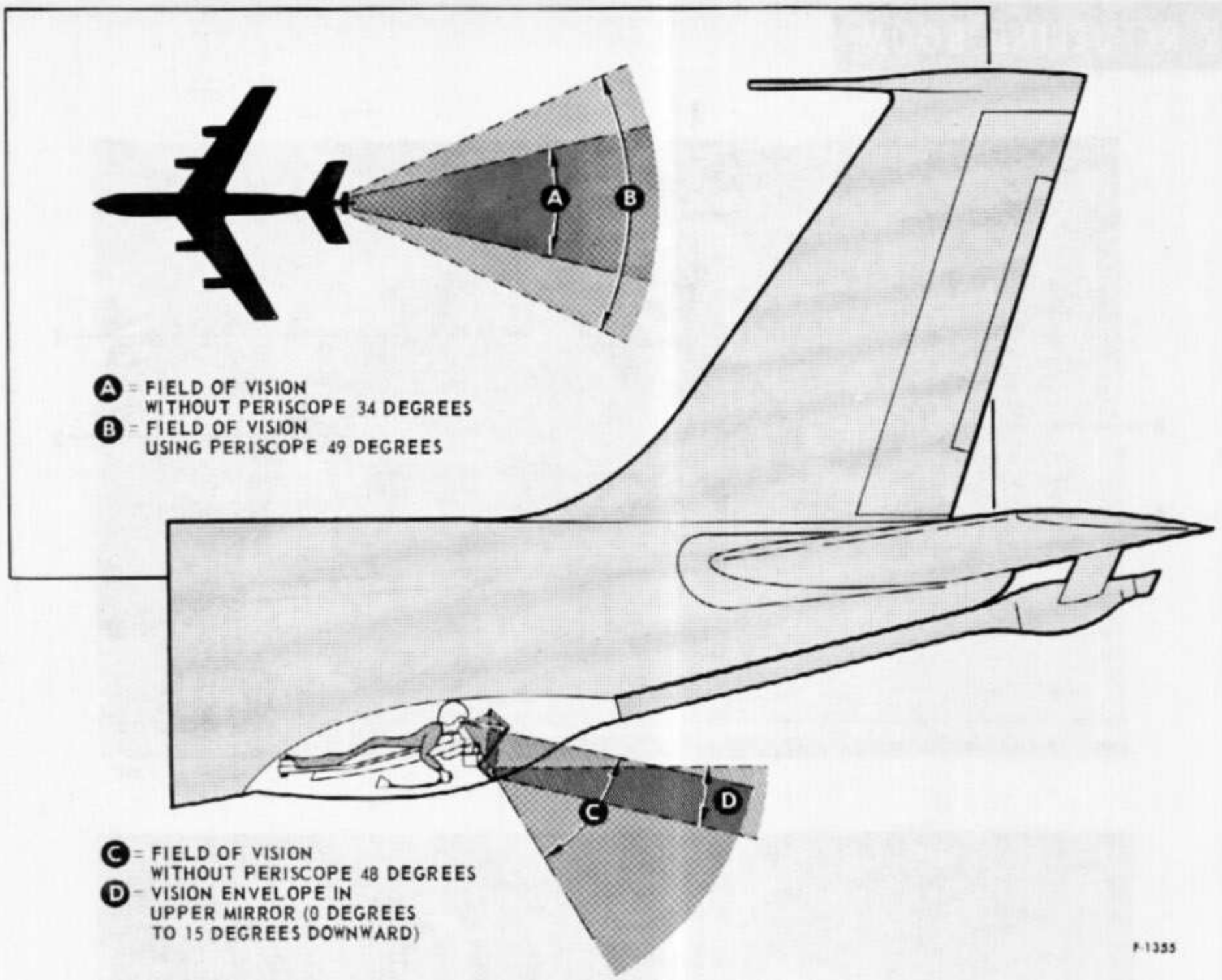
BOOM OPERATOR'S COMPARTMENT



1 BOOM HOIST MANUAL BYPASS SHUTOFF VALVE
2 BOOM HOIST HAND PUMP RESERVOIR
3 BOOM HOIST HAND PUMP
4 INSTRUCTOR'S INTERPHONE CONTROL PANEL
5 INSTRUCTOR'S OXYGEN REGULATOR PANEL
6 SIGHTING DOOR LEVER
7 BOOM LATCHING LEVER
8 SIGNAL AMPLIFIER
9 SIGHTING WINDOW
10 CIRCUIT BREAKER PANEL
11 RUDDEVATOR CONTROL JACK SHAFT (2 PLACES)
12 INSTRUCTOR'S PALLET
13 SAFETY HARNESS (SEE FIGURE 4-81)
14 RUDDEVATOR CONTROL STICK
15 PALLET
16 FOOT REST
17 INSTRUMENT PANEL
18 SWITCH PANEL
19 OXYGEN REGULATOR AND INTERPHONE CONTROL PANEL
20 SIDE WINDOW
21 PORTABLE OXYGEN BOTTLE STOWAGE
22 COMPARTMENT LIGHT
23 ALARM BELL
24 PERISCOPE

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F-276

Figure 4-66 (Sheet 1 of 2)



DETAIL II

Figure 4-66 (Sheet 2 of 2)

Boom Telescope Lever

The telescoping lever (4, figure 4-68) at the left of the boom operator's panel has RETRACT--NEUTRAL--EXTEND positions. 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 further into the EXTEND position the rate of extension of the boom is increased, reaching a maximum extension rate at full EXTEND. This action is the same for the RETRACT function of the lever. Whenever the telescope lever is moved into the RETRACT position, manually or automatically, the A/R bypass control valve is energized open, provided the fuel dump relay has not been energized, boom electrical power is on and the boom is extended.

CAUTION

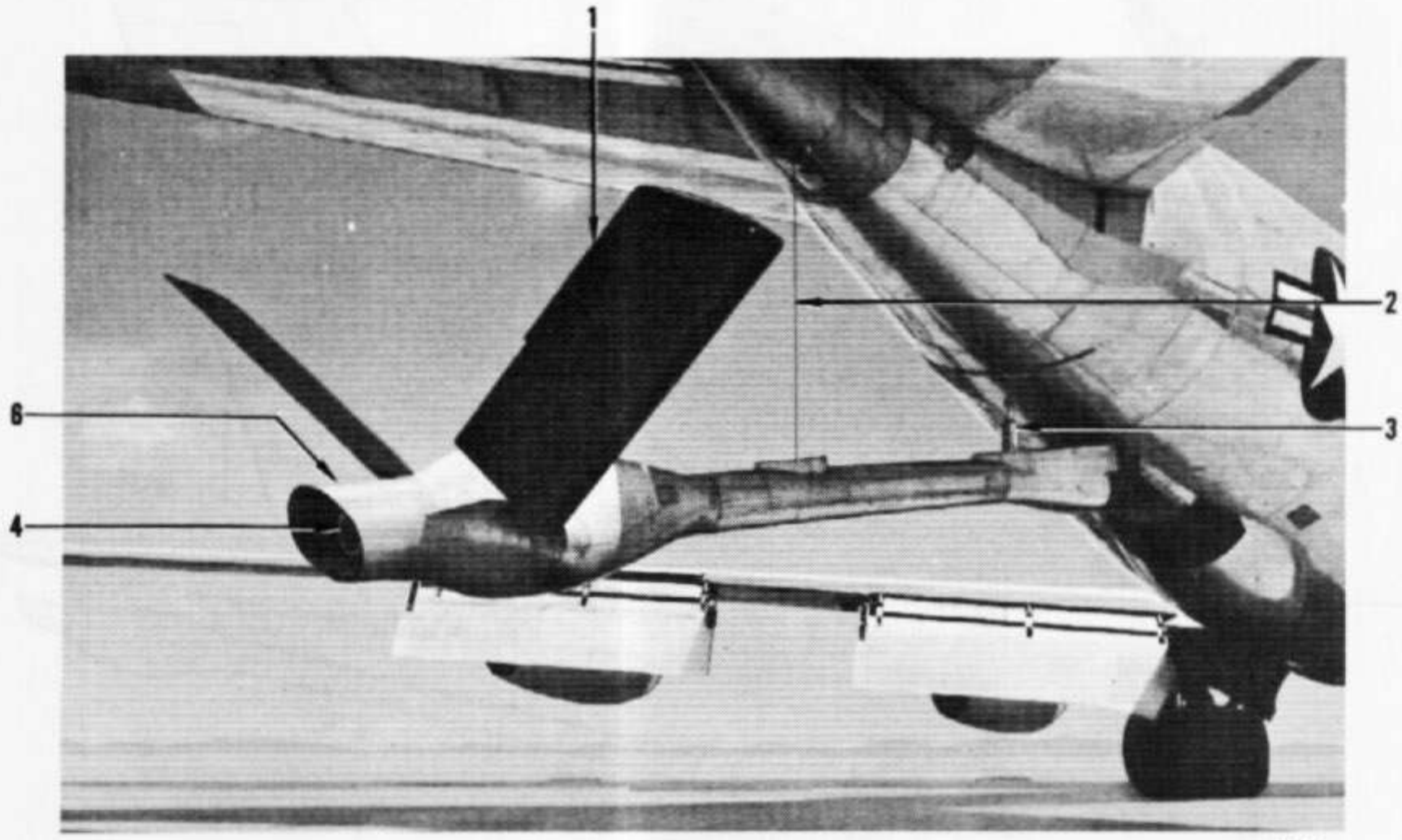
Do not retract boom without DC electrical power and the A/R master switch ON. This is necessary to prevent exceeding boom fuel pressure limitations.

Opening the bypass valve permits fuel trapped in the boom to be returned to the aft body tank. In the NEUTRAL position, the boom is free to follow the relative displacements between the tanker and receiver airplanes in contact made. In this condition flow regulators and relief valves in the telescoping control lines allow the boom to extend and retract according to the relative displacements of the two airplanes. An auto retract valve (figure 4-65), electrically actuated, provides for automatic retraction of the boom during fuel dump or disconnect conditions, when the telescope-at-disconnect switch is in AUTO. See description of this under SIGNAL SYSTEM this Section. See figure 4-72.

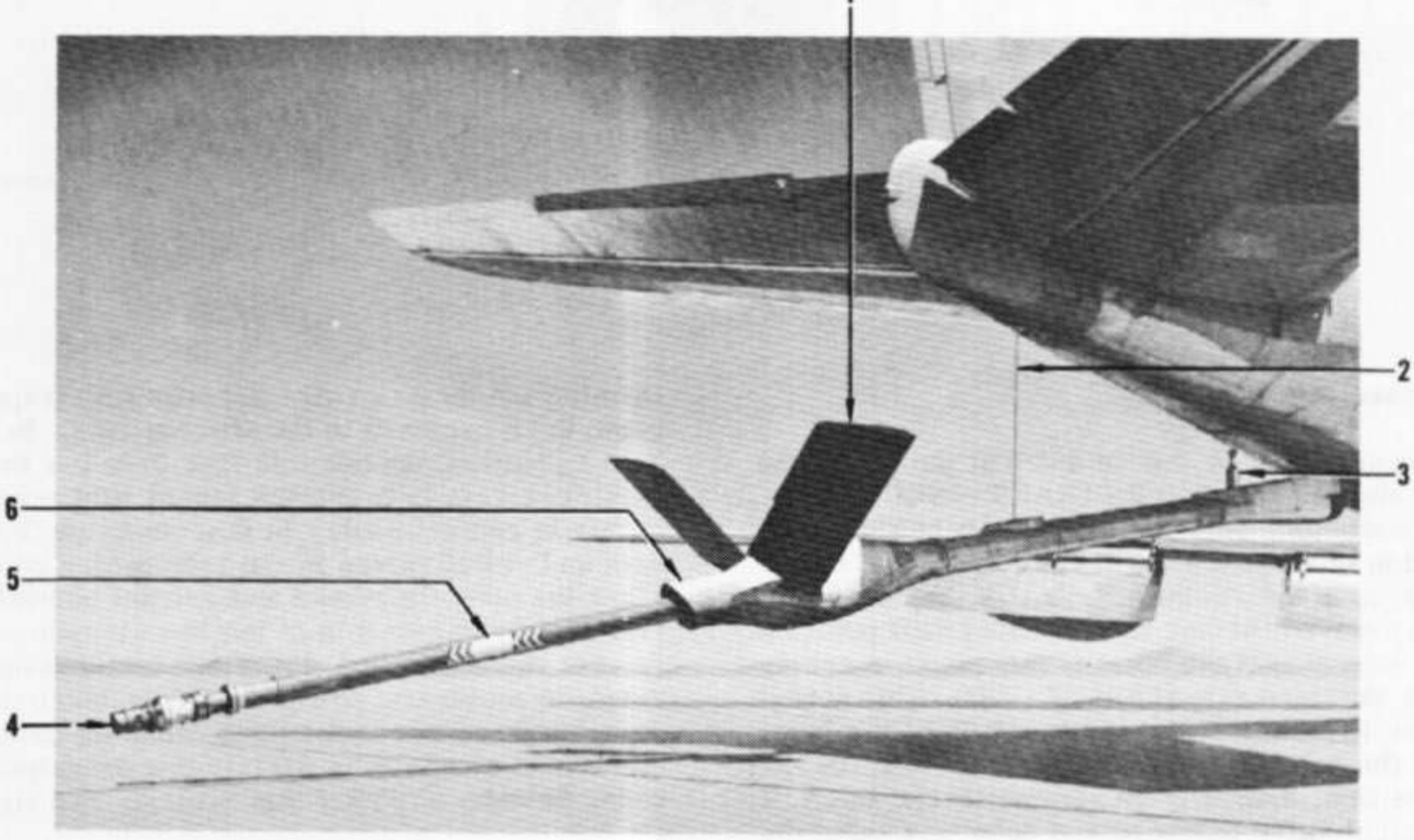
Boom Hoist Manual By-Pass Shutoff Valve

The boom hoist manual bypass shutoff valve (1, figure 4-66) with NORMAL--EMERGENCY BOOM HOIST positions is used to open or close the bypass line between the emergency hoist pressure and emergency return. With the bypass valve in the NORMAL position the bypass line is open thus inactivating the hand pump. With the bypass valve in the EMERGENCY BOOM

AIR REFUELING BOOM



F 3116

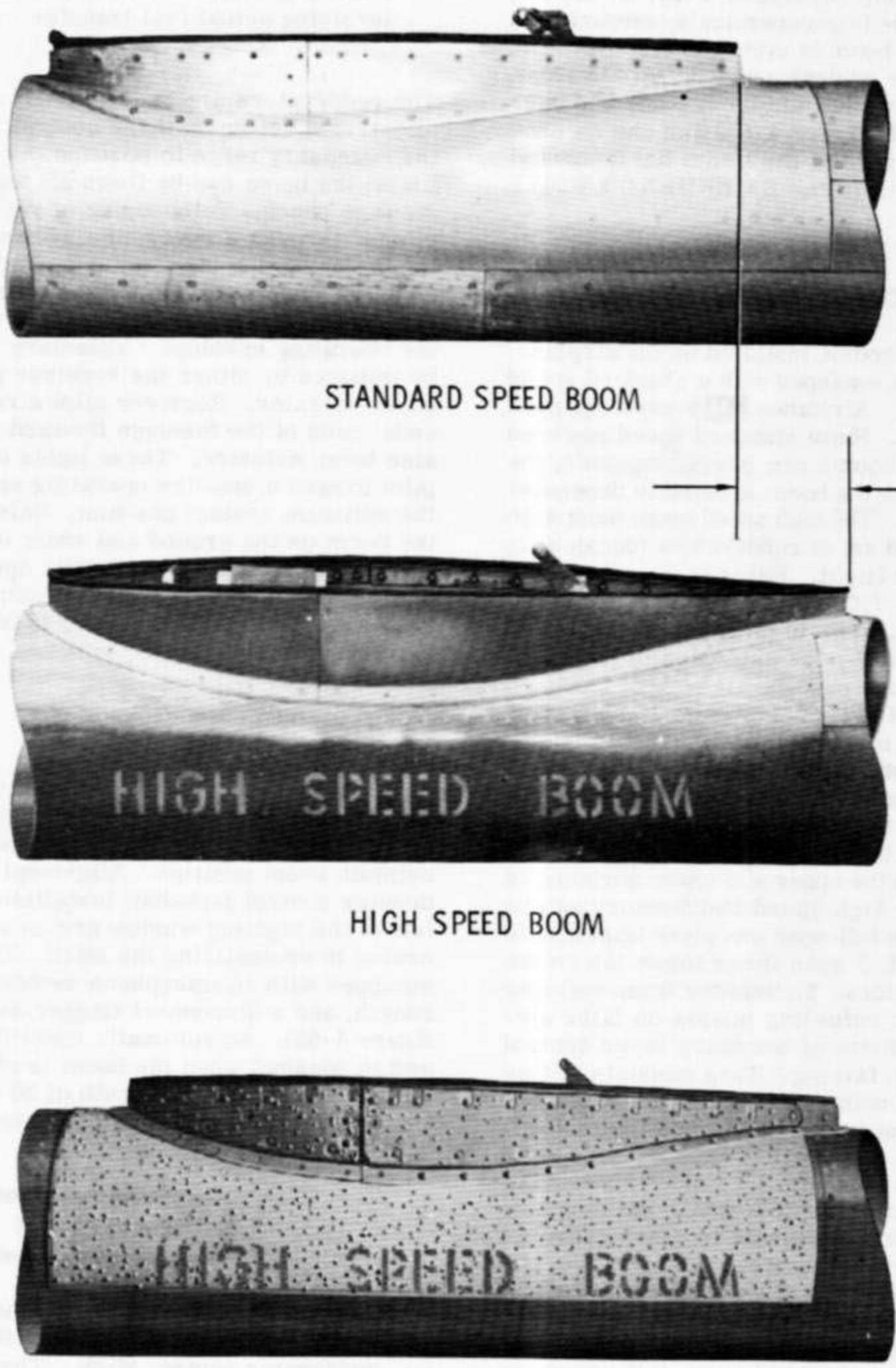


F 3115

1 RUDDEVATOR (2 PLACES)
2 BOOM HOIST CABLE (2 PLACES)
3 STOWAGE SHOCK ABSORBER (2 PLACES)
4 BOOM NOZZLE (2 PLACES)
5 BOOM MARKINGS
6 ICE SHIELD (2 PLACES)

Figure 4-67 (Sheet 1 of 2)

BOOM IDENTIFICATION



STANDARD SPEED BOOM

HIGH SPEED BOOM

HIGH SPEED BOOM WITH BOUNDARY LAYER CONTROL

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F-279

Figure 4-67 (Sheet 2 of 2)

HOIST position the line is closed and the hand pump can be activated regardless of the position of the boom hoist lever. The valve should be returned to the NORMAL position at completion of emergency hoist to prevent locking the hoist motor.

Boom Hoist Hand Pump

A boom hoist hand pump (3, figure 4-66) on the left side of the cabin near the boom operator's compartment can be used to hoist the boom in event of main hydraulic system pressure failure or during ground maintenance. The pump utilizes hydraulic fluid from a one and one-half quart reservoir (2, figure 4-66) and can be used to hoist the boom, provided the boom hoist manual bypass shutoff valve is in the EMERGENCY HOIST position.

AIR REFUELING BOOM

There are two types of booms installed on the airplane. Airplanes 1 ▶ 345 were equipped with a standard speed boom during production. Airplanes 346 ▶ were equipped with a high speed boom. Since standard speed powered booms and high speed booms are interchangeable, the airplane speed limit with the boom lowered is dependent upon the boom installed. The high speed boom must also be fitted with a matched set of ruddevators (decaled) to qualify for high speed flight. Refer to Section V and Part 7 of the Appendix, T.O. 1C-135(K)A-1-1, for boom placard speed limits. The high speed boom, if not stenciled, is recognized by the extension of the boom latch fairing trailing edge past the aft edge of the fixed fairing. (See figure 4-67.) The boom latch fairing on the high speed boom is approximately 5 inches longer than the fairing on the standard speed boom. High speed booms should be marked with the words "HIGH SPEED BOOM" on each side of the boom latch fairing. The high speed ruddevators can be identified by the decal "HIGH SPEED BOOM" on both the upper and lower surfaces of the ruddevators. The high speed ruddevators can be further identified by the full-span one piece trim tab, in comparison with the 1/2 span three piece tab on the standard speed ruddevators. To improve boom stability at high airspeeds, air refueling booms on later airplanes incorporate a form of boundary layer control around the boom latch fairing. This consists of thin secondary skins coated with coarse aluminum oxide grit which is applied in a random pattern. See figure 4-67.

The air refueling boom consists of 2 concentric tubular sections which will extend from a minimum length of approximately 28 feet to a maximum length of approximately 47 feet. Before mechanical interference, the boom has a total of 30 degrees of azimuth each way and an elevation of plus 12.5 degrees and minus 50 degrees. To permit movement in azimuth and elevation a yoke and trunnion attachment is used to attach the boom to the underside of the fuselage near the tail. A flexible coupling connects the high capacity fuel system with the boom. The inner telescoping tube of the boom is fitted with two surge boots in tandem, to protect the A/R system components from fuel pressure surge at disconnect. The boots are between the inner structural tube and the outer fuel tube. The outer fuel tube is perforated to give the fuel surges access to the boots. These boots are to be inflated with dry air to 50 plus 5 minus 2 psi.

NOTE

Both surge boots are to be inflated for any flight involving actual fuel transfer.

The ruddevators are hydraulically actuated and the slipstream acting on these control surfaces provides the necessary force to position the boom while in flight; the boom can be flown all the way into the stowage chock. Telescoping of the boom is accomplished through a reversible hydraulic motor. During the normal contact made condition the boom actuates limit switches which automatically initiate disconnect when the boom reaches the boundary of the operating envelope. Voluntary disconnects may be initiated by either the receiver pilot or the boom operator. Receiver pilot director lights on the under side of the fuselage forward of the wing are also boom actuated. These lights direct the receiver pilot toward a smaller operating envelope known as the optimum contact position. Raising and lowering the boom on the ground and while in flight can be accomplished with a hydraulically operated hoist. A hydraulic cable tension motor maintains tension on the hoist cable while the boom is being controlled aerodynamically.

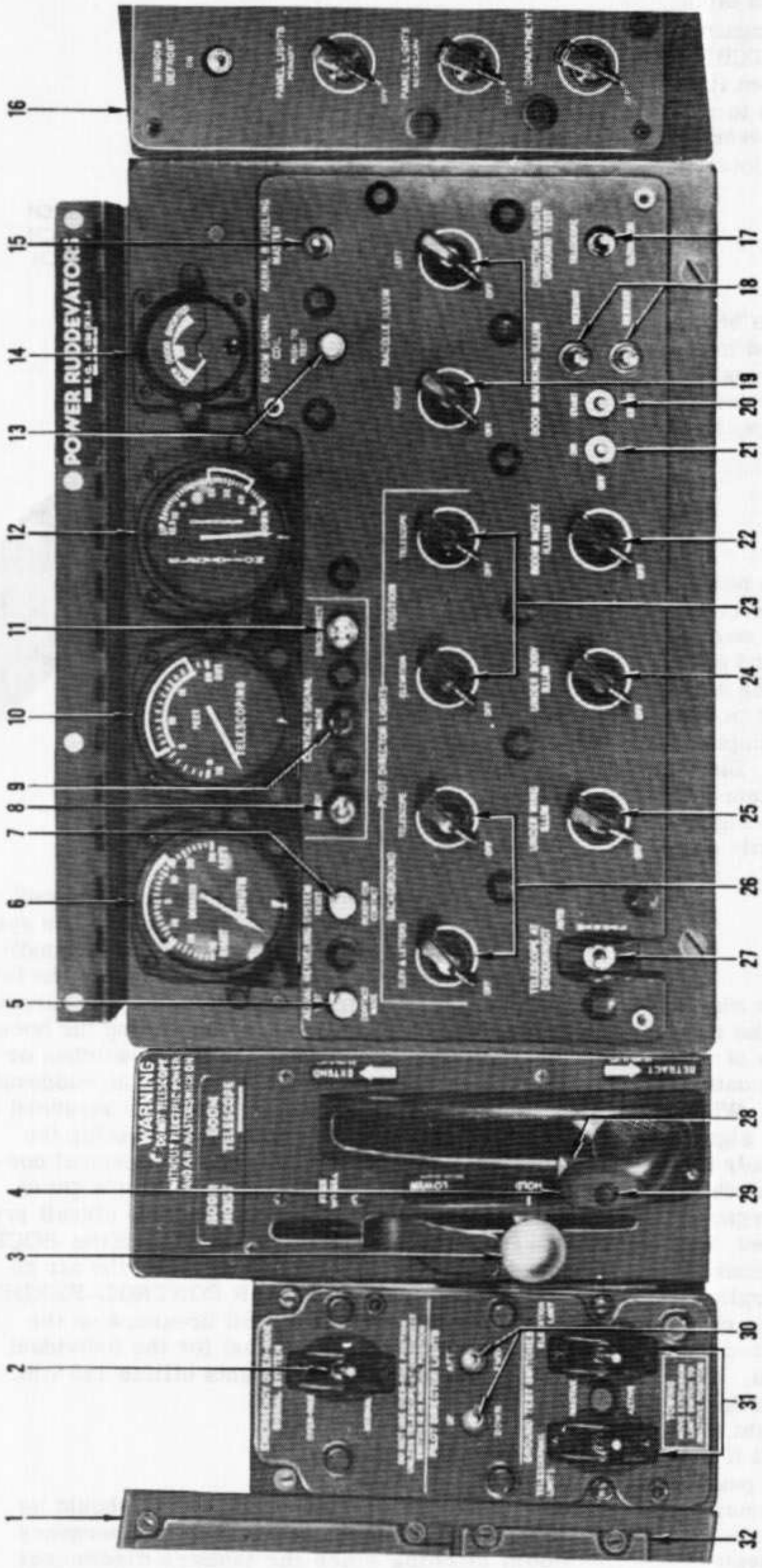
Ruddevator Control Stick

In flight, the ruddevator control stick (figure 4-69) located to the right and slightly below the boom operator, provides aerodynamic control of elevation and azimuth boom position. Alignment marks on the ruddevator control jackshaft installation to the right and left of the sighting window are an aid to the boom operator in neutralizing the stick. The control stick is equipped with an interphone switch, a microphone switch, and a disconnect trigger switch (1, 2, and 3, figure 4-69). An automatic control lock is provided and is engaged when the boom is stowed. The boom envelope has a total azimuth of 30 degrees, an elevation of 20 degrees, and an extension of 12 feet.

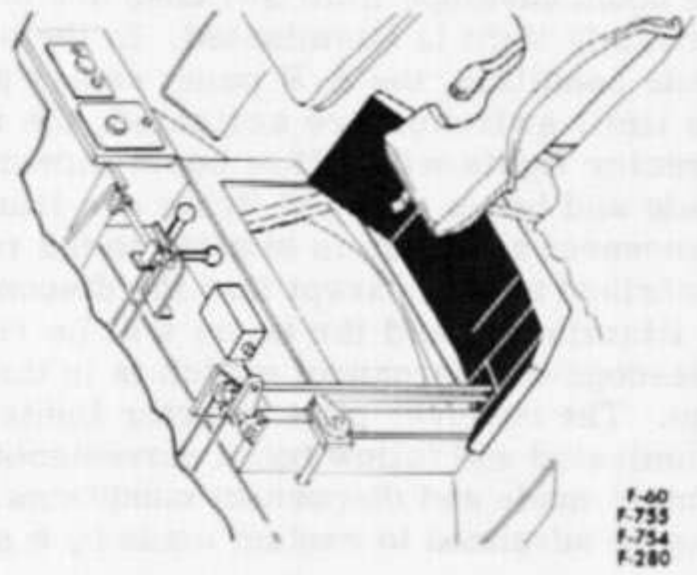
CAUTION

Operate the boom controls smoothly. Avoid rapid or abrupt movement of the boom with the ruddevator control stick. The rated strength of the hoist cable is 7,000 pounds minimum; however, it is possible to develop loads in excess of 13,000 pounds on the hoist cable with a maximum down ruddevator deflection. This excessive load can result in hoist cable failure.

BOOM OPERATOR'S PANEL



1 OXYGEN REGULATOR PANEL (REF)
2 EMERGENCY OVERRIDE SWITCH
3 BOOM HOIST LEVER
4 BOOM TELESCOPE LEVER
5 SIGNAL AMPLIFIER TEST SWITCH
6 BOOM AZIMUTH INDICATOR
7 A/R SYSTEM RESET SWITCH
8 READY CONTACT SIGNAL LIGHT
9 MADE CONTACT SIGNAL LIGHT
10 BOOM TELESCOPING INDICATOR
11 DISCONNECT CONTACT SIGNAL LIGHT
12 BOOM ELEVATION INDICATOR
13 BOOM SIGNAL COIL TEST SWITCH
14 BOOM SIGNAL COIL TEST VOLTMETER
15 A/R MASTER SWITCH
16 BOOM OPERATOR'S CIRCUIT BREAKER PANEL (REF)
17 RECEIVER PILOT DIRECTOR LIGHT GROUND TEST SWITCH
18 RESTART INDICATOR LIGHTS
19 NACELLE ILLUMINATION CONTROLS
20 BOOM MARKER LIGHT START SWITCH
21 BOOM MARKER LIGHT CONTROL SWITCH
22 BOOM NOZZLE ILLUMINATION RHEOSTAT
23 RECEIVER PILOT DIRECTOR POSITION LIGHT CONTROLS
24 UNDERBODY ILLUMINATION RHEOSTAT
25 UNDERWING ILLUMINATION RHEOSTAT
26 RECEIVER PILOT DIRECTOR BACKGROUND LIGHT CONTROLS
27 TELESCOPE-AT-DISCONNECT SWITCH
28 EMERGENCY CONTACT MADE SWITCH
29 EMERGENCY BREAKAWAY SIGNAL SWITCH
30 RECEIVER PILOT DIRECTOR LIGHT SWITCHES
31 LIMIT CUTOUT SWITCHES
32 INTERPHONE PANEL (REF)



F-60
F-755
F-754
F-280

Figure 4-68

Boom Latching Lever

The latching lever (7, figure 4-66) with LATCHED--UNLATCHED positions controls a cable actuated latch which secures the boom. With the boom hoisted against the stowage support, placing the lever in the 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 UNLATCHED position. The latching lever is located above the boom operator's sighting window.

Boom Position Indicators

Three indicators (6, 10, 12, figure 4-68) on the boom operator's panel indicate azimuth, elevation and telescoping positions of the boom. A circuit breaker marked POS IND on the BOCBP protects the electrical circuit connecting the indicators and their respective transmitters. See figure 4-70.

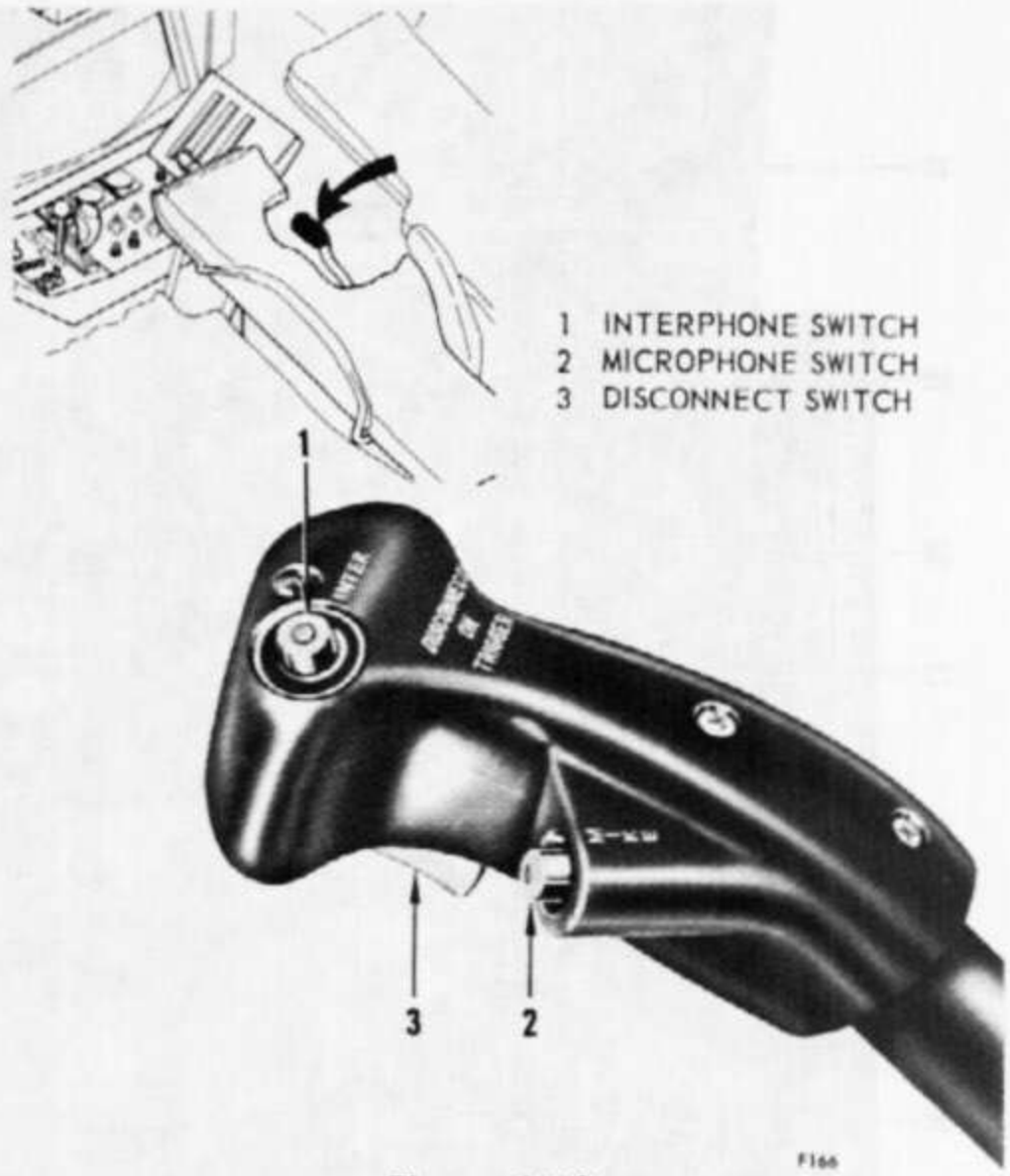
AIR REFUELING ELECTRICAL SYSTEM

The air refueling electrical system operates on power received from the tanker 28 volt DC system. See figure 4-71. On airplanes 1▶139 the A/R master switch controls the power flow to the signal amplifier and A/R control circuits only. On airplanes 140▶ the A/R master switch controls all electrical equipment in the boom operator's compartment, except fuel dumping, the alarm bell and communications equipment. Electrically powered units in the air refueling system include the A/R line valve, hydraulic valves, and a signal amplifier. Due to increased life expectancy, only one signal amplifier is supplied.

Signal System (Amplifier Control)

The tanker signal system 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 the ready, contact made, and disconnect conditions; see figure 4-71. When the A/R master switch is first turned ON the signal system will be in the ready condition. In the ready for contact condition, with the emergency override switch in the NORMAL position, the A/R pumps are de-energized, the boom envelope limit switches are deactivated, and the ready light is illuminated. In the normal contact made condition, the A/R pump relays are energized, the limit switches are activated, the receiver pilot director lights will follow boom movements, and the made and boom engaged lights are illuminated. The disconnect condition is similar to the ready condition described above, except that the disconnect light will be illuminated and the boom will be retracted if the telescope-at-disconnect switch is in the AUTO position. The receiver pilot director lights will remain illuminated and follow boom movements in both the contact made and disconnect conditions. The system may be advanced to contact made by a signal from

RUDDEVATOR CONTROL STICK



1 INTERPHONE SWITCH
2 MICROPHONE SWITCH
3 DISCONNECT SWITCH

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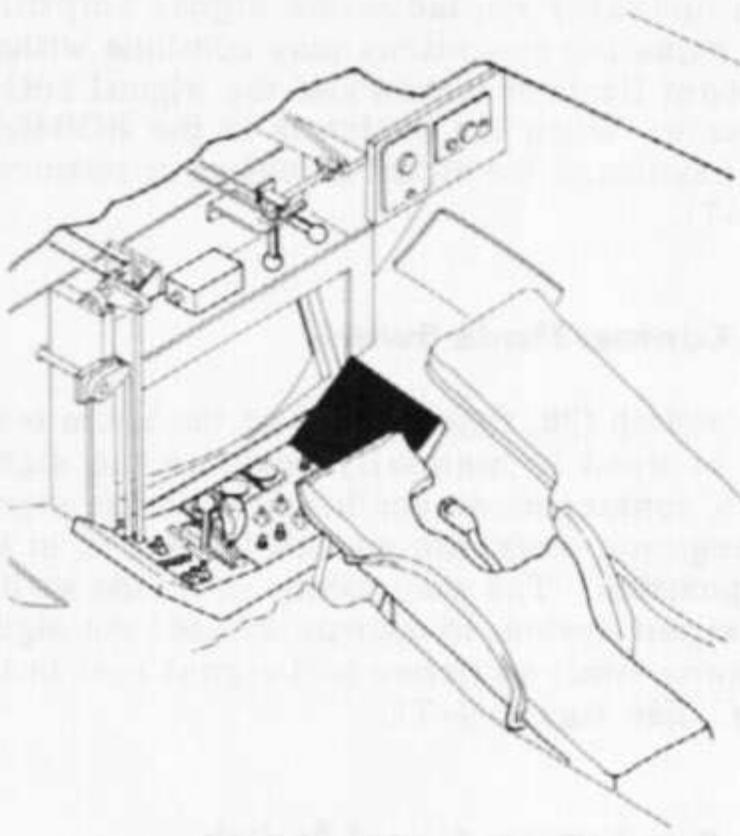
Figure 4-69

the receiver airplane through the boom signal coil or by depressing the A/R system test switch. The system may be advanced from the contact made condition to the disconnect condition by any one of the following inputs: by a signal from the receiver airplane through the boom signal coil, by exceeding the boom envelope limits and actuating the limit switches or by depressing the disconnect switch on the ruddevator control stick. The signal system may be returned to the ready condition at any time by depressing the A/R system reset switch. All boom electrical controls and indicators on the boom operator's panel operate on 28 volt DC power and receive circuit protection from the SBCBP (figure 1-35) and the BOCBP (figure 4-70). The SBCBP breakers for the air refueling system are marked A/R CONTROL-FEEDERS. Markings for the various circuit breakers on the BOCBP are described in the text for the individual circuits. The boom marker lights utilize 115 volt AC.

NOTE

The telescope-at-disconnect switch should be in MANUAL when the receiver is in emergency boom latching since the tankers disconnect signal will not release the toggles.

BOOM OPERATOR'S CIRCUIT BREAKER PANEL



1 WINDOW HEAT SWITCH
2 PRIMARY PANEL LIGHTS RHEOSTAT
3 SECONDARY PANEL LIGHTS CONTROL
4 COMPARTMENT LIGHTS COLOR SELECTOR SWITCH
5 COMPARTMENT LIGHTS CONTROL

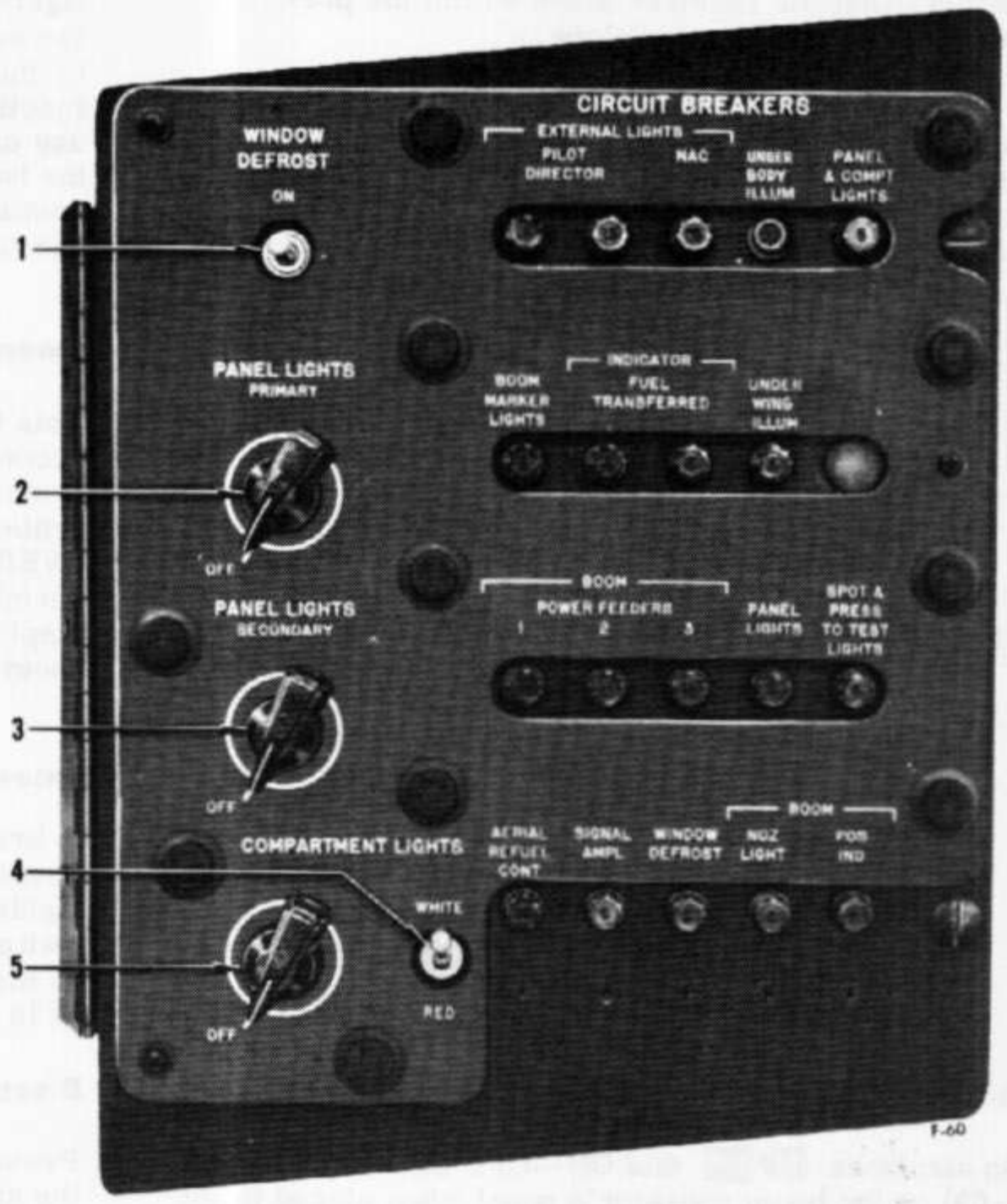


Figure 4-70

Solenoid Valves

There are three automatically controlled solenoid valves in the boom control system, and one solenoid for each air refueling pump. The three boom control solenoid valves are the A/R bypass control valve, the auto retract valve, and the fuel dump valve. The A/R bypass valve and the auto retract valve receive power through both the A/R master switch and the fuel dump switch. The fuel dump valve receives power only through the fuel dump switch. The A/R bypass valve is energized open by placing the boom telescope lever in the RETRACT position, provided the boom is extended. The A/R bypass valve may also be energized open by an auto retract signal or by actuating the fuel dump switch to FUEL DUMP, provided the boom is extended. Actuation of the auto retract valve is accomplished during disconnect provided the telescope-at-disconnect switch is in the AUTO position. Actuation of the auto retract valve is also accomplished during the fuel dump condition. See figures 4-65 and 4-71. The auto retract valve is energized and de-energized in the same manner in override as it is in normal. provided automatic telescope-at-disconnect is selected. In manual telescope-at-disconnect the auto retract valve cannot be energized by either a normal or override disconnect. Actuation of the fuel dump switch will always energize the auto retract valve. For a description of the air refueling pump solenoids, see AIR REFUELING FUEL SYSTEM and figure 4-74 this Section. The fuel dump valve is energized when the fuel dump switch is placed in FUEL DUMP position and the boom is fully retracted. See figure 4-71.

Signal Amplifier Override

A signal system override serves as a secondary system in the event of failure of the normal system. An emergency override switch (2, figure 4-68) on the boom operators panel, when in OVERRIDE, will allow manual control of the refueling operation by the boom operator, thus replacing the amplifier function.

Contact configuration is established in the tanker system by pressing the signal system emergency contact made switch (28, figure 4-68) on the telescoping lever as soon as the nozzle is properly seated in the receiver receptacle.

With the tanker signal system in OVERRIDE, the boom envelope limit switches are out of the circuit. During contact the boom operator must constantly observe that the receiver stays within the prescribed air refueling envelope.

Disconnect is initiated by the disconnect switch (3, figure 4-69) on the ruddevator control stick dependent on the following conditions:

a. On airplanes 8▶ either the tanker or the receiver can initiate a disconnect provided the receiver signal system is in normal, the boom signal coil checks GOOD, and all other components applicable to the manual system are functioning properly. If the telescope at disconnect switch is in AUTO hold the disconnect switch depressed until the boom fully retracts, the system will return to READY when the disconnect switch is released.

b. On airplanes 8▶ only the tanker system will advance to DISCONNECT if the signal coil circuit checks OPEN or SHORTED, or the receiver system is in MANUAL. This also applies to airplanes 1▶7 as placing the tanker system in OVERRIDE removes the signal coil circuit from the system. Release of the nozzle from the receiver receptacle can only be accomplished by a DISCONNECT initiated in the receiver. The telescope switch must be in MANUAL to prevent boom retraction against the receiver toggles.

Air Refueling Master Switch

On airplanes 1▶139 this ON--OFF switch (15, figure 4-68) on the boom operator's panel when placed in the ON position supplies power to the signal system and boom control circuits. On airplanes 140▶ the A/R master switch controls all electrical equipment in the boom operator's compartment except fuel dumping, the alarm bell, and communications equipment. Circuit protection is provided by the A/R CONTROL FEEDERS circuit breakers on the SBCBP and the POWER FEEDERS circuit breakers on the BOCBP. See figures 1-35 and 4-70.

Emergency Override Switch

This switch with NORMAL--OVERRIDE positions (2, figure 4-68) 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 function 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. See figure 4-71.

Emergency Contact Made Switch

This trigger switch (28, figure 4-68) on the boom telescope lever is used to manually advance the signal system into a contact made condition when the signal system emergency override switch is placed in the OVERRIDE position. The emergency override switch permits the signal system to operate without the signal amplifier, boom limit switches and signal coil in the boom nozzle. See figure 4-71.

Emergency Breakaway Signal Switch

A breakaway signal switch (29, figure 4-68) when depressed, will extinguish the receiver pilot director lights (except telescope background lights). The switch may be used to flash the lights ON and OFF to signal a breakaway to the receiver, if the system is in contact made or disconnect configuration.

Disconnect Switch

Pressing this trigger type switch (3, figure 4-69) on the hand grip of the ruddevator control stick initiates a disconnect in the signal system whether in ready for contact or contact made. This switch is operative in both NORMAL and OVERRIDE conditions. See figure 4-72.

Signal Amplifier Test Switch

A push-to-test button (5, figure 4-68 on the boom operator's panel, when pressed, advances the signal amplifier to a contact made condition for an operational check of the signal system.

A/R System Reset Switch

A push-to-reset button (7, figure 4-68) on the boom operator's panel, when pressed, will return the signal system to the ready condition from either the made or disconnect condition.

BOOM ELECTRICAL SYSTEM

AIRPLANES 1 ▶ 7

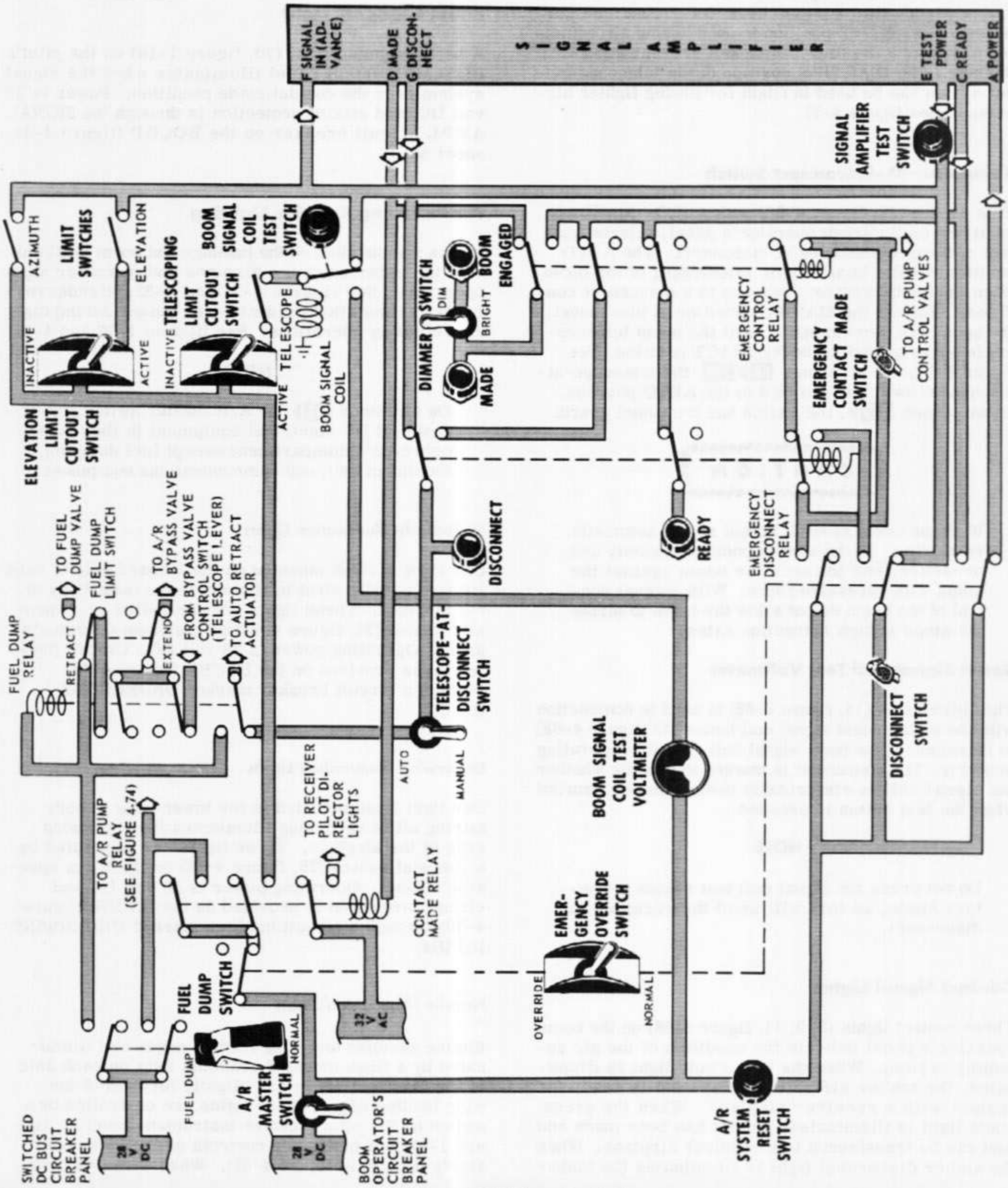


Figure 4-71 (Sheet 1 of 2)

F-284

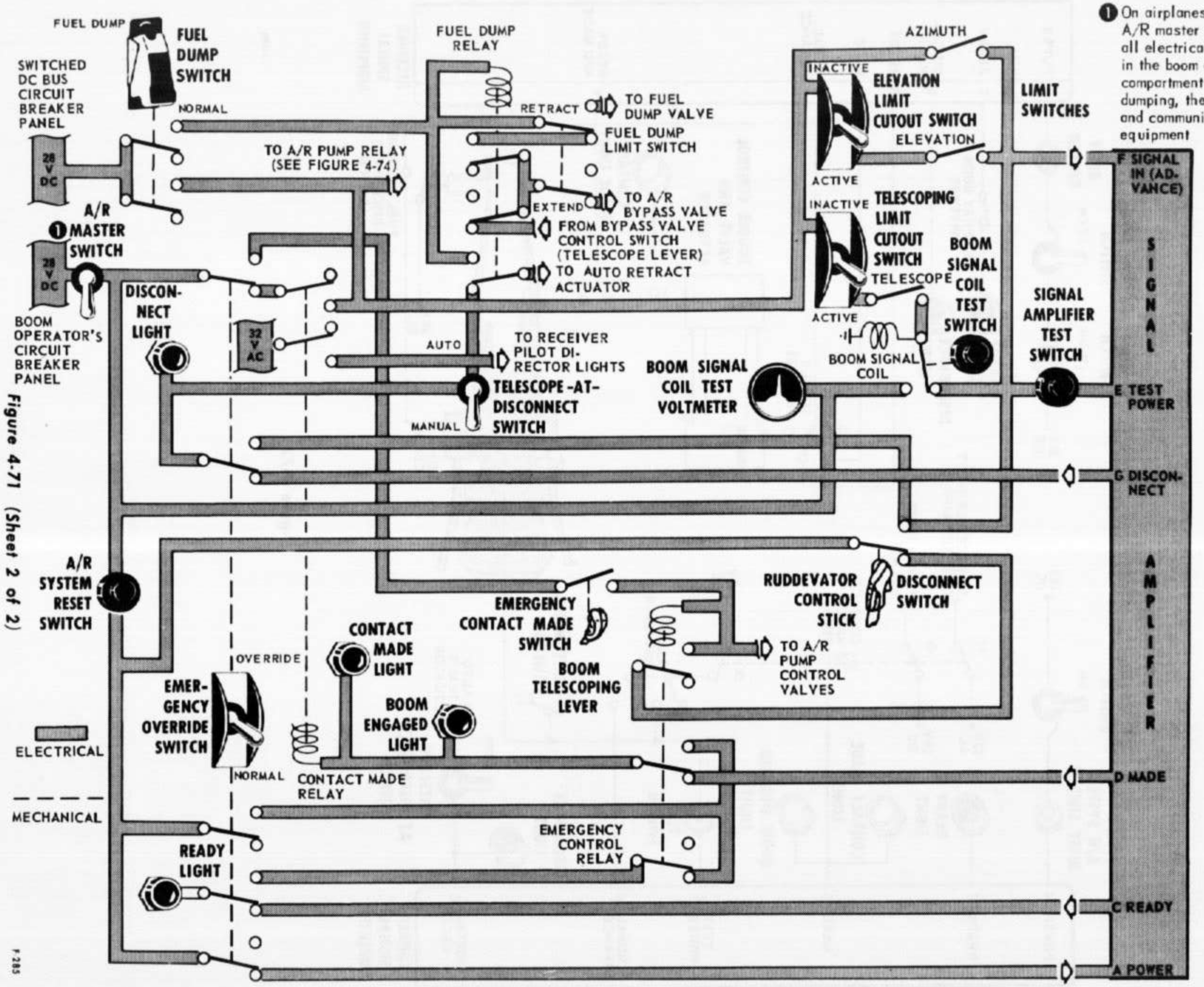


Figure 4-71 (Sheet 2 of 2)

❶ On airplanes 140 ▶ the A/R master switch controls all electrical equipment in the boom operator's compartment except fuel dumping, the alarm bell and communications equipment

TANKER-RECEIVER ELECTRICAL MARRIAGE
(TYPICAL)

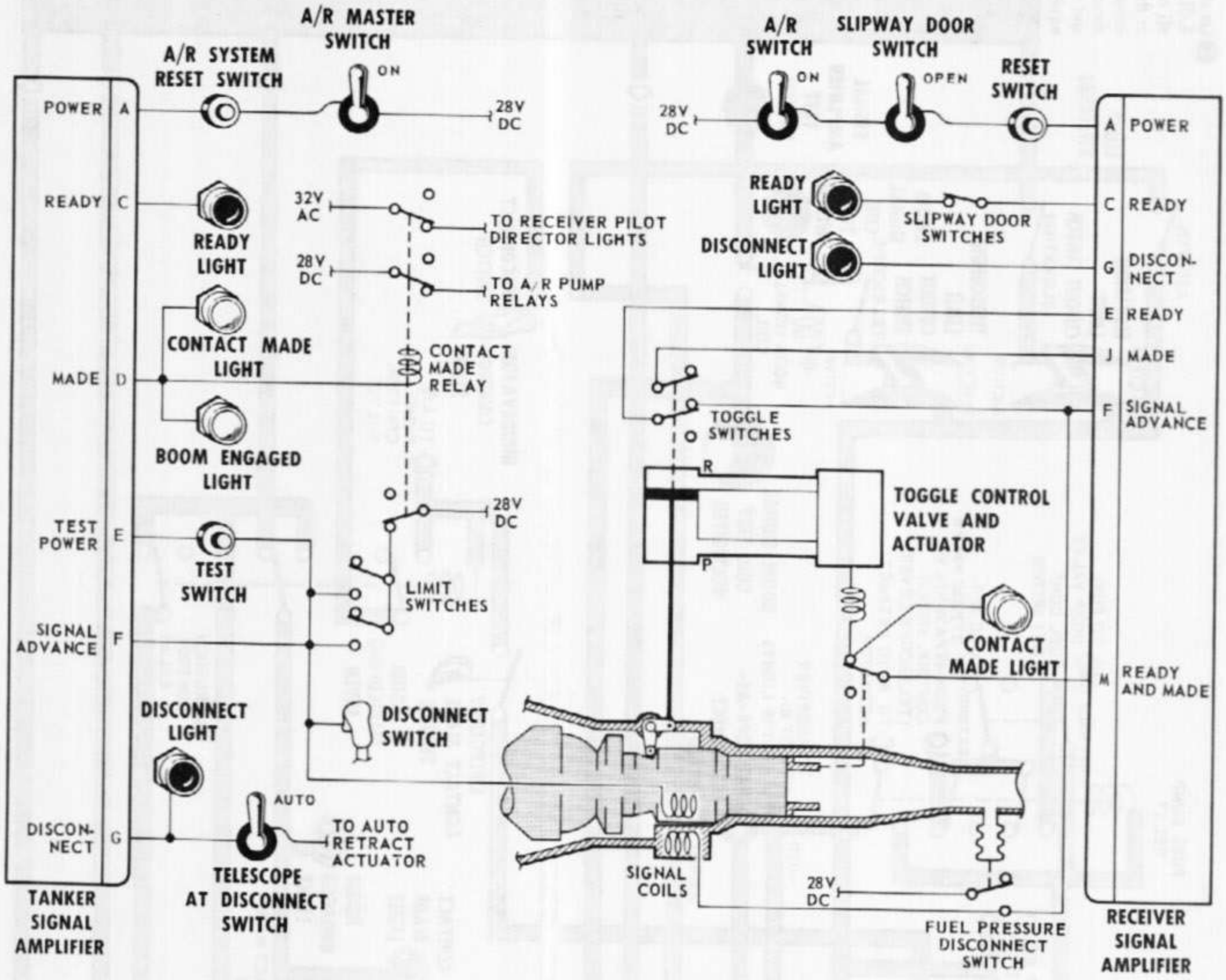


Figure 4-72

1-286

the boom operator's position, operating and control power is 28 volt AC from the BOCBP. When operated from the taxi and wing illumination light switch, operating power is 28 volt AC from the BOCBP and control power is 28 volt DC from the MCBP. Circuit protection is provided through the 28 volt TRANSFORMER circuit breaker on the MCBP and the NAC circuit breaker on the BOCBP (figures 1-35, sheet 5 and 4-70).

CAUTION

Limit nacelle illumination lights ground operation to 15 minutes to prevent distortion of pressure windows covering the lights.

Boom Marker and Nozzle Lights

The boom nozzle fairing contains two fluorescent lights and one white light. The two fluorescent lights are located in the upper portion of the boom nozzle fairing. These two lights emit a near ultraviolet light which excites the luminous boom markings making them glow during night air refueling operations. These two lights are controlled by an ON-OFF switch (21, figure 4-68) and a spring loaded, three position START switch (20, figure 4-68) on the boom operator's panel. Each light must be started individually. To start the fluorescent lights the boom marker light control switch must be moved to ON. This will illuminate the neon indicator lights (18, figure 4-68). Then the boom marker light start switch for either light should be moved to START and held there momentarily. The respective neon indicator light for that light will be extinguished when the start switch is actuated, and will stay extinguished when the start switch is released if the respective fluorescent light is illuminated. The fluorescent lights require 115 volt AC power and circuit protection is provided by the BOOM MARKER LIGHTS circuit breaker on the boom operator's circuit breaker panel (figure 4-70) and the A/R CONTROL PANEL circuit breaker on phase B of GENERATOR NO. 3 on the MCBP. The white light in the bottom of the nozzle fairing is used in illuminating the boom nozzle for the boom operator during night air refueling operation. It is controlled by a rheostat switch (22, figure 4-68) on the boom operator's panel. Operating power is 28 volt DC and circuit protection is provided by the NOZ light circuit breaker on the BOCBP (figure 4-70).

Rotating Beacon Lights

Rotating beacon lights are mounted on the top and bottom of the fuselage, opposite the wing trailing edge. Whenever flight conditions require use of anticollision lights both beacon light colors will be used. The 4 lamps in each assembly rotate horizontally at a speed of 45 + 3 rpm. The rendezvous beacon lights switch (1, figure 4-34) on the overhead panel has UPPER ON--OFF--BOTH ON positions. The rendezvous beacon lights color selector switches (2, figure 4-34) provide a means for individual or multiple color selection. Red and green colors with ground changing provisions only are provided with two filters each. The two color selector switches are decalled UPPER and LOWER, and each switch is three position, COLOR A--BOTH--COLOR B. Normally, color A selects the red filter and color B selects white. On airplanes 3▶, when the rendezvous beacon lights switch is in any position but OFF, the white upper body and lower body lights cannot be illuminated. Operating power is 28 volt AC through circuit breakers marked RENDEZVOUS UPPER and LOWER on the MCBP (figure 1-35, sheet 3).

NOTE

The rotating beacon lights should be turned OFF during flight through conditions of reduced visibility where the pilot could experience spatial disorientation as a result of the rotating reflections of lights against the clouds. In addition, these lights would be ineffective as rendezvous lights or anticollision lights during these conditions since they could not be observed by pilots of other airplanes.

Receiver Pilot Director Lights

Receiver pilot director lights are on the bottom of the fuselage between the nose gear and the main gear. They consist of two rows of lights; the left row for elevation and the right row for telescoping. The elevation lights consist of five colored panels with strip green, green and red colors and two illuminated letters, D and U, for down and up respectively. Background lights are located behind the panels. The colored panels are illuminated by lights that are controlled by boom elevation during the contact made condition. The lights will remain illuminated and follow boom movements in both the contact made and disconnect conditions. On the telescoping side, the colored panels are not illuminated by background lights. There is an illuminated white panel between

each panel to serve as a reference. The letters A for aft and F for forward augment the colored panels on the telescope side. There are no lights for azimuth position. On airplanes 1▶2 , the receiver pilot director light buttons (30, figure 4-68) actuate the red panels adjacent to the letters so that the boom operator may direct the receiver into the contact position. On airplanes 3▶, the two three-position toggle switches control the red lights. In the contact made condition, all of these switches are deactivated and the panels will automatically reflect the correction the receiver pilot should make to attain the optimum contact position. The lights will remain illuminated and follow boom movements in both the contact made and disconnect conditions. There is a breakaway signal switch button on the top of the telescope lever. This switch will turn off and on the receiver pilot director lights (except the background lights) to signal an emergency breakaway if the system is in contact made or disconnect configuration. There is also a three-position ground test switch (17, figure 4-68) on the boom operator's panel, to test elevation and telescope lights independently. The intensity controls for the receiver pilot director lights (23, 26, figure 4-68) are also on the boom operator's panel. Power is 32 volt AC and circuit protection is provided by the PILOT DIRECTOR circuit breaker on the BOCBP (figure 4-70) and the 28 volt TRANSFORMER circuit breaker on phase B of GENERATOR NO. 3 on the MCBP (figure 1-35, sheet 3).

NOTE

As a further visual aid to the receiver pilot in maintaining longitudinal alignment behind the tanker, an 8 inch by 65 foot fluorescent red stripe is on the bottom of the fuselage between the receiver-pilot director lights and the boom pod.

Air Refueling Interior Lighting

Boom Compartment Lights

The compartment lights consist of a dome light and spotlight. The dome light consists of two lights (red and white), selected by a color selector switch (4, figure 4-70). The intensity and illumination is controlled by a brilliance control (5, figure 4-70). Power is 28 volt AC and circuit protection is provided by the PANEL and COMPT LIGHTS circuit breaker on the BOCBP (figure 4-70). The spotlight has a rheostat on the light, requires 28 volt DC and has circuit protection on the BOCBP (figure 4-70) through the SPOT and PRESS-TO-TEST LIGHTS circuit breaker.

Boom Operator's Cargo Compartment Dome Light Switch

186▶

A cargo compartment dome light switch is on the right side of the boom operator's window frame. This switch is wired to permit control of the cargo compartment dome lights from either the forward end of the cargo compartment or the boom operator's station. Operating power is 28 volt AC and control power is 28 volt DC. Circuit protection is provided on the MCBP (figure 1-35). The 28 volt DC circuit breaker is marked CARGO LIGHTS CONTROL and the two 28 volt AC circuit breakers are marked CARGO.

Panel Lights

The boom operator's primary and secondary panel lights are each controlled by rheostat switches (2 and 3, figure 4-70) on the boom operator's circuit breaker panel. Each circuit gives coverage to each lighted unit on the panel, so that in the event of failure of one, the other will light all units. The primary lights utilize 28 volt DC and the secondary lights utilize 28 volt AC. Circuit protection is provided on the BOCBP (figure 4-70) by the PANEL LIGHTS circuit breaker.

Boom Operator's Heated Window

See WINDOW ANTI-ICING SYSTEM in this Section.

AIR REFUELING FUEL SYSTEM

Air refueling fuel is carried in 2 lower fuselage tanks and an upper deck tank (figure 4-73). Additional fuel may be transferred into the air refueling fuel system from the main, reserve, and center wing tanks. Each of the two fuselage tanks has two fuel pumps located in the lower part of the tanks into which fuel is gravity fed. The normal flow of air refueling fuel is from the pumps through check valves, a line valve, a pressure regulator, a flow measuring transmitter, and out through a self sealing poppet valve in the boom nozzle. The regulated nozzle pressure varies between 45-50 psi depending on boom length, elevation, and fuel flow rate. An automatic bypass valve protects the air refueling fuel system at disconnect by allowing the fuel to flow back to the aft fuselage tank as soon as a disconnect is initiated. The bypass valve is open while the boom is being retracted and remains closed when the boom is fully retracted. See figure 4-73. The fuel dump switch on the fuel control panel receives 28 volt DC power through the FUEL DUMP circuit breaker on the SBCBP. If a power failure occurs in the normal source of power, battery power can be supplied by positioning the battery power switch to EMERGENCY. See FUEL DUMPING, Section III.

AIR REFUELING FUEL SYSTEM

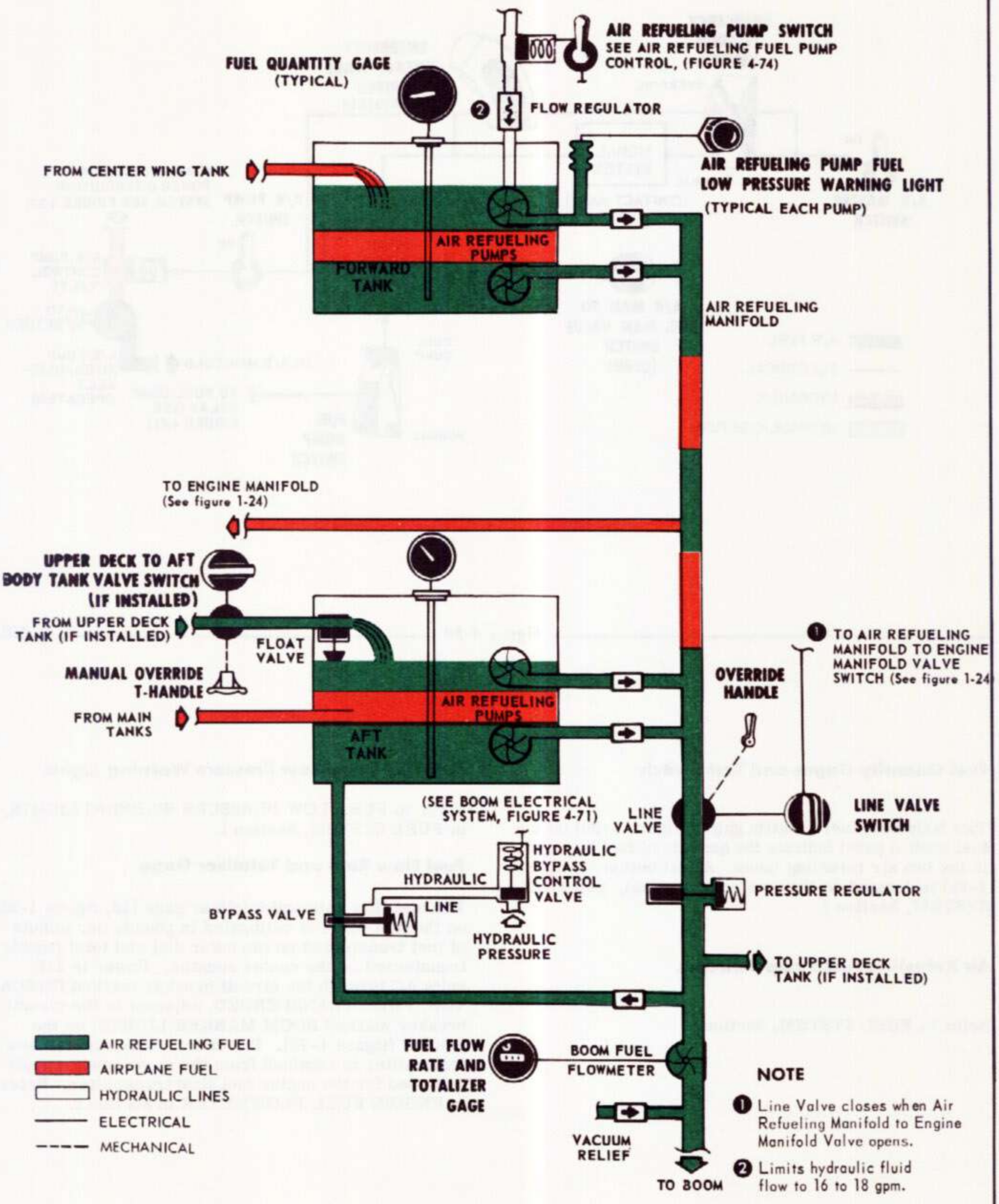


Figure 4-73

AIR REFUELING FUEL PUMP CONTROL

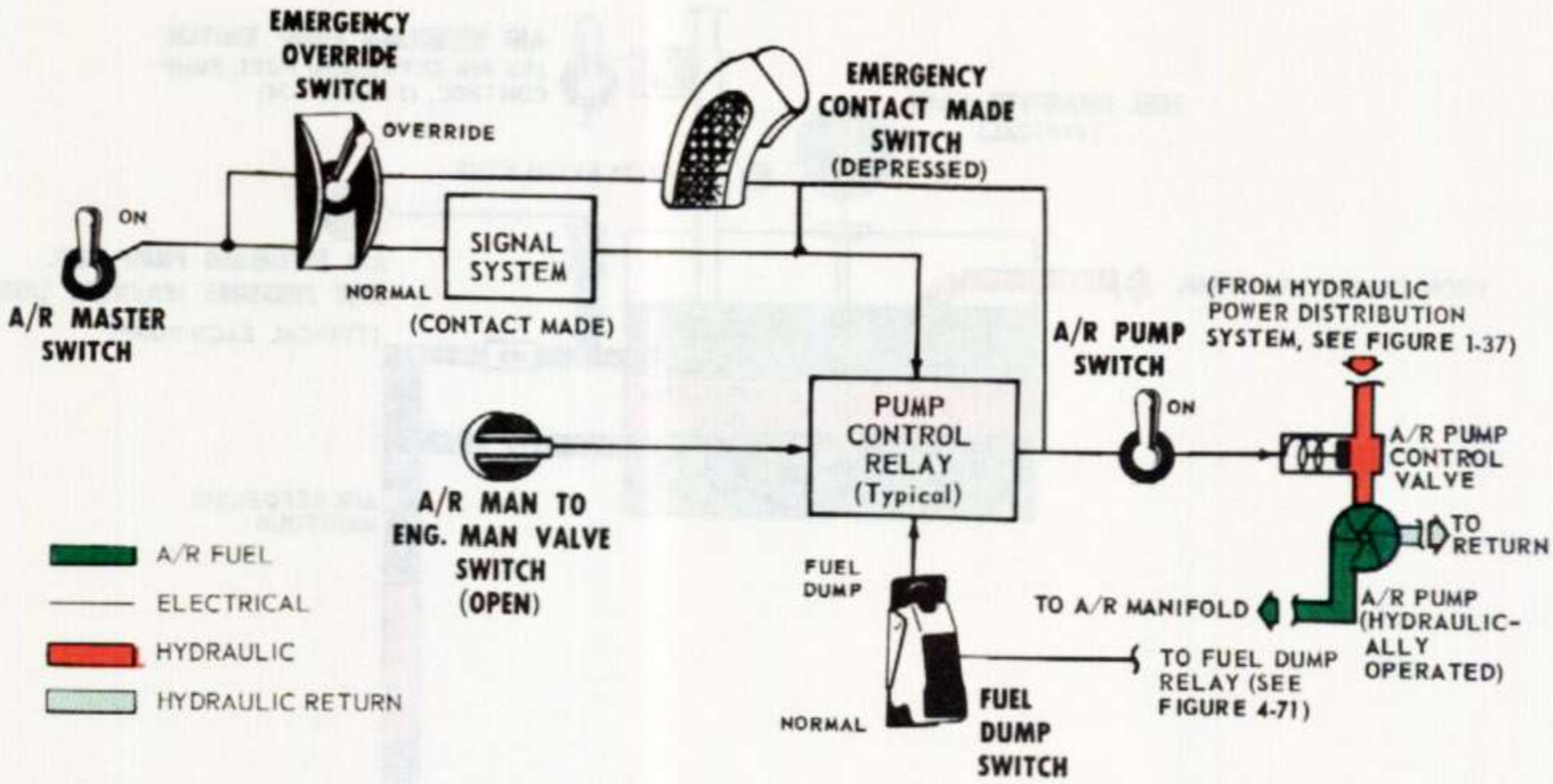


Figure 4-74

F 291

Fuel Quantity Gages and Test Switch

Two body tank fuel quantity gages (figure 1-25) on the fuel control panel indicate the quantity of fuel in pounds in the two air refueling tanks. A test button (1, figure 1-25) is located on the fuel control panel. See FUEL SYSTEM, Section I.

Air Refueling Fuel Pump Switches

Refer to FUEL SYSTEM, Section I.

A/R Fuel Pump Low Pressure Warning Lights

Refer to FUEL LOW PRESSURE WARNING LIGHTS, in FUEL SYSTEM, Section I.

Fuel Flow Rate and Totalizer Gage

The fuel flow rate and totalizer gage (13, figure 1-25) on the fuel panel is calibrated in pounds per minute of fuel transferred on the outer dial and total pounds transferred on the center counter. Power is 115 volts AC through the circuit breaker marked INDICATOR, FUEL TRANSFERRED, adjacent to the circuit breaker marked BOOM MARKER LIGHTS, on the BOCBP (figure 4-70). Power for the boom fuel flow transmitter is obtained from the same power supply unit used for the engine fuel flow transmitter. Refer to ENGINE FUEL FLOWMETER in Section I.

AIR REFUELING OPERATION

NOTE

All air refueling operations, amplified and abbreviated checklists, are contained in T.O. 1-1C-1 and its appendices.

Air Refueling Fuel System Failure

In the event of a fuel leak within the airplane, a disconnect shall 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, the receiver pilot will be notified and a disconnect initiated if required.

Hydraulic Pressure System Failure

The boom hydraulic system is normally pressurized by the right hydraulic system, but the boom hydraulic system may be pressurized by the left hydraulic system, through use of the crossover valve. If the left hydraulic system fails, the left auxiliary pump will not operate the forward air refueling pumps. If the right hydraulic system fails, the right auxiliary pump will not operate the aft air refueling pumps. Since each engine driven hydraulic pump output is 22.5 gpm, and the air refueling pumps each utilize 16-18, gpm, the failure of one engine driven hydraulic pump should be noticeable in A/R pump output. Refer to BOOM HOIST HAND PUMP, Section IV. See also HYDRAULIC SYSTEM EMERGENCY OPERATION, Section III.

Fuel Fumes Ventilation Procedure

See SMOKE AND FUME ELIMINATION, Section III.

Effect of Engine Failure

An engine failure on the tanker is more serious than on the receiver. 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.

Boom Retraction Mechanism Failure

If the boom retraction mechanism malfunctions, necessitating a landing with a partially or fully extended boom, the landing should be made with extreme caution and the following steps should be taken:

A. 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.

B. Boom should be stowed.

C. Land with as little fuel in boom as possible.

D. Close line valve.

E. Make as smooth a landing as possible to prevent any excessive whipping action on the boom. After any landing with boom extended, have the boom, stowing mechanism, and chock attachments to the fuselage carefully checked for structural damage.

CAUTION

To prevent further damage to the boom in case of retraction mechanism failure, the receiver pilot will not under any circumstances try to push the boom in.

Boom Uncontrollability

Minor damage or maladjustment of some part of the A/R system could result in boom uncontrollability. If boom uncontrollability is encountered, consideration should be given to slowing the airplane or changing the boom elevation. If possible the boom should be stowed as cautiously and as soon as possible.

Probe and Drogue Air Refueling

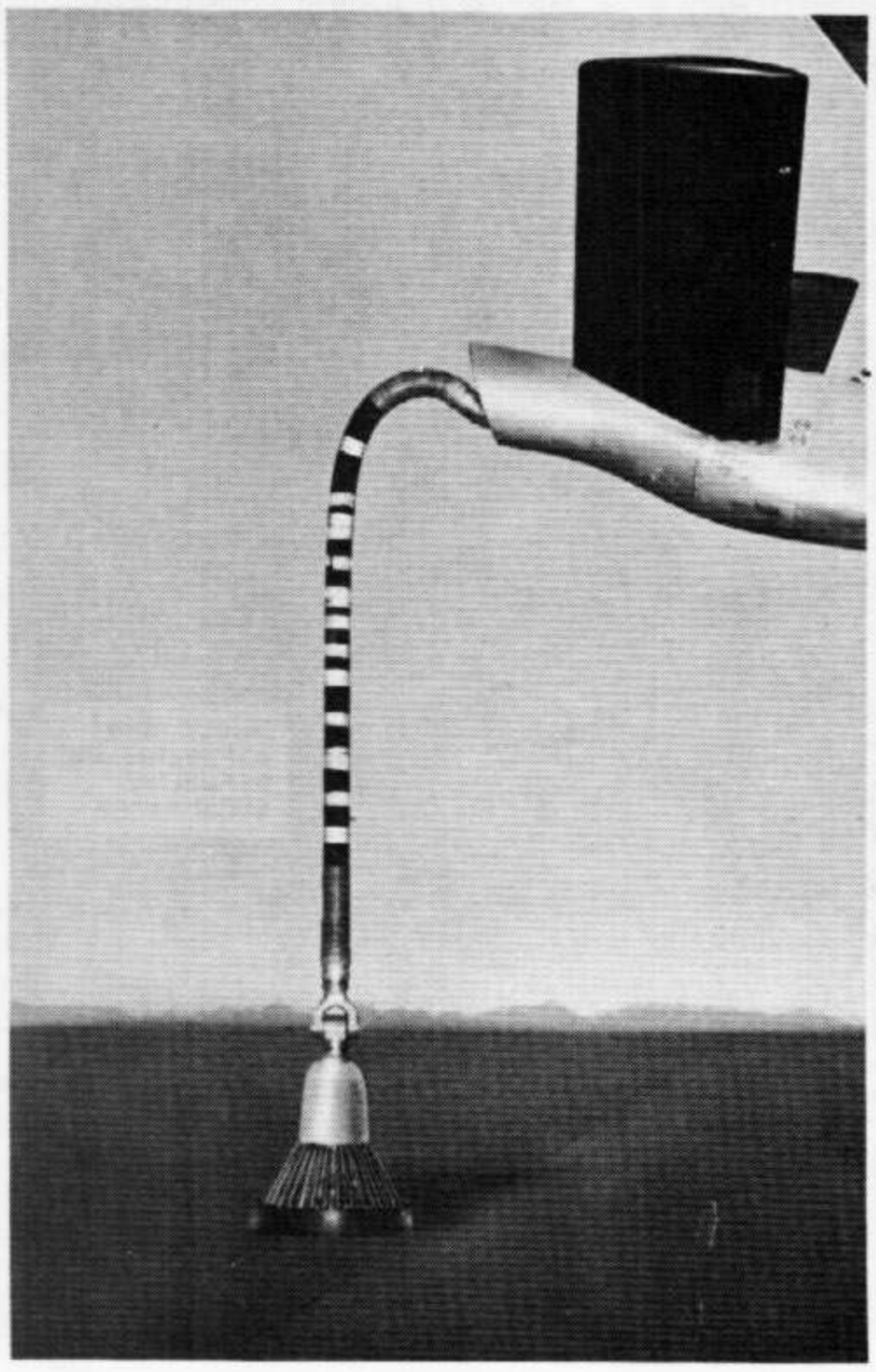
Description

The boom to drogue adapter aerial refueling kit is used for field installation of a drogue adapter. The weight increase due to drogue adapter kit installation is approximately 120 pounds plus the weight of the additional trapped fuel. The adapter kit incorporates a fuel dump fitting (poppet valve spring loaded to approximately 5 pounds), an internally stiffened hose, a trunnion, and a conical rubber drogue. Brute force separation of the probe and drogue is set at a maximum of 320 pounds.

General

The performance of the KC-135, as affected by the addition of the boom drogue on the end of the boom has only slight adverse effect on airplane performance. The drag effect will increase fuel consumption by about 3%. See Part 7 of T.O. 1C-135(K)A-1-1 for more specific fuel mileage at various airspeeds, altitudes and gross weights.

BOOM DROGUE ATTACHMENT



F-302

Figure 4-75

SINGLE POINT REFUELING AND DEFUELING

Fueling and defueling of all tanks may be accomplished by use of the single point refueling system. See figure 1-24, and figure 4-78. Individual filling of tanks may also be conducted through the external filler port for each tank. Fuel enters the airplane from the hydrant refueling station or fuel truck nozzle through the single point refueling and defueling receptacle in the right wheel well. From the receptacle, flow is directed to the A/R manifold and the single point refueling manifold which are interconnected for this operation. All the wing tanks are filled through the single point refueling manifold and both body tanks and the upper deck tank are filled by the A/R manifold. In order to fill the upper deck tank it is necessary to have the A/R line valve open. Through the interconnection of manifold lines, fuel flows to all tanks simultaneously and will continue to flow until all the tanks are filled or shut off manually. When a tank is filled, flow to the tank is automatically stopped by the closing of the fuel level control valve. Defueling of the airplane is accomplished by using the boost pumps for the wing tanks, the override pumps for the center wing tanks, and the air refueling pumps for body tanks. The reserve tanks drain by gravity into the outboard mains and the upper deck tank drains into the aft body tank for this operation. Fuel is directed from the pressurized engine manifold through the manual defueling valve, the single point refueling manifold, the A/R manifold and out the single point refueling and defueling receptacle. Pressurized fuel from the A/R pumps is taken directly from the A/R manifold out the single point refueling and defueling receptacle. See figure 4-78.

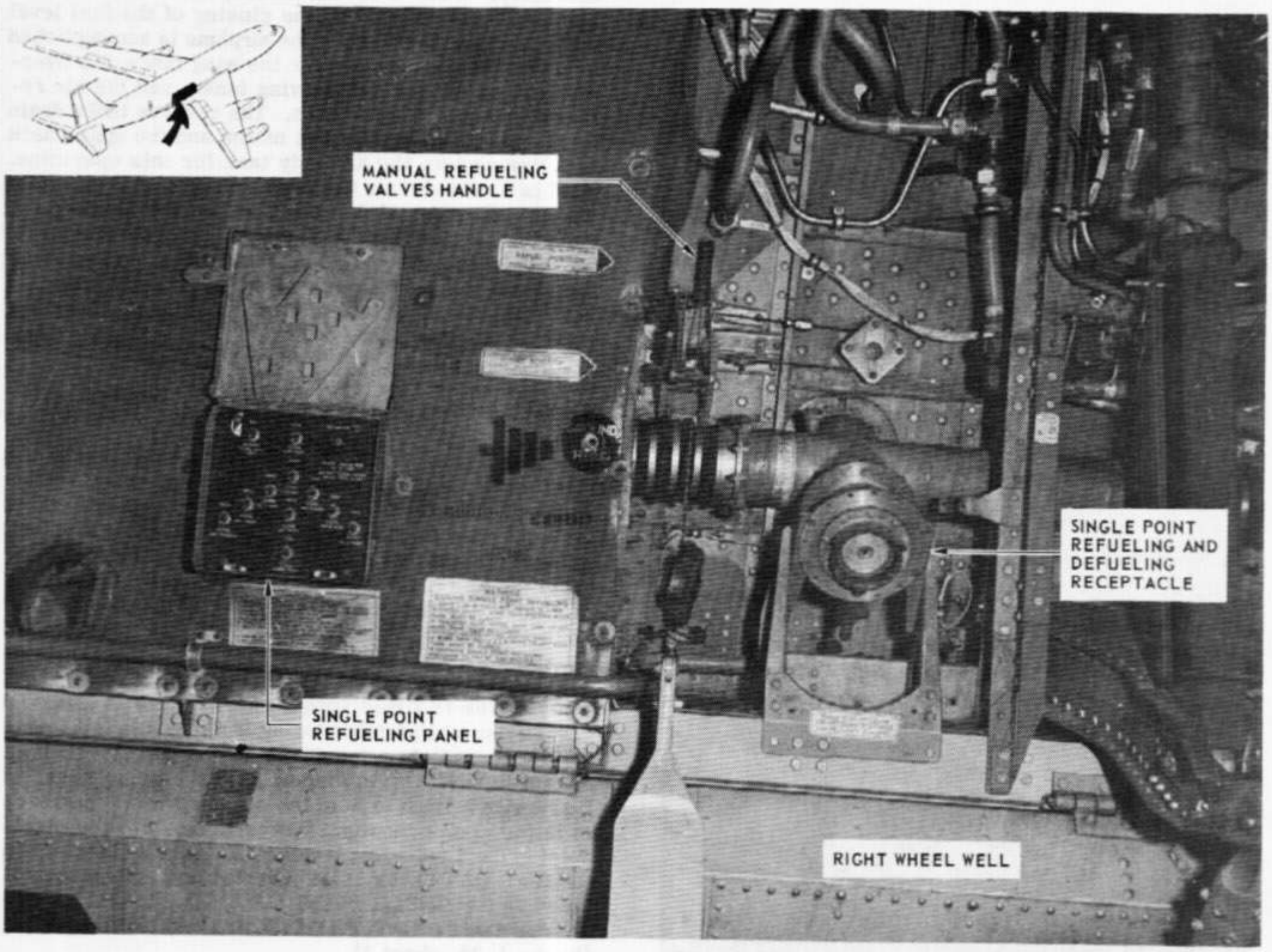
SINGLE POINT REFUELING PANEL

The single point refueling panel (figure 4-77) is in the right wheel well. On those airplanes not equipped with an upper deck tank there are nine level control valve switches used to open or close the level control valves at any point in the ground refueling operation. The panel cover (2, figure 4-77) is fitted with three bars (1, figure 4-77), to prevent closing of the panel cover when any switch has been left OPEN. On airplanes equipped with an upper deck tank there are ten level control valve switches. On these same airplanes the panel cover is fitted with a raised plate to keep the cover from completely closing if any of the level control valve switches are OPEN or the wheel well light switch is ON. On airplanes 30▶ the panel cover is fitted with a latch to hold the cover up when the cover is in the open position. Power to operate the single point ground refueling panel is 28 volt DC taken from the HOT BATTERY BUS. Circuit protection is provided by the SINGLE POINT GROUND REFUEL circuit breakers on the BATTERY CIRCUIT BREAKER PANEL, (figure 1-35, sheet 1).

LEVEL CONTROL VALVE SWITCHES

A fuel level control valve is installed in each tank. Valve opening is accomplished electrically, and valve closing is accomplished either electrically or mechanically. The level control valve switches (3, figure 4-77) on the single point refueling panel are used to control flow of fuel to the tanks. The level control valve switch has two positions, OPEN and CLOSE. When the switch is in the OPEN position, a solenoid is energized, releasing the float level control valve to the open position. In this condition the float is free to close the valve whenever the fuel level reaches the tank capacity. When the level control valve switch is placed in the CLOSE position, the solenoid is released causing the float valve to move to the closed position. The level control valves on the body tanks also act as emergency fuel bypass relief in case of A/R bypass valve malfunction.

SINGLE POINT REFUELING AND DEFUELING



F-308

Figure 4-76

POWER ON INDICATOR LIGHT

The power on indicator light (4, figure 4-77) will illuminate at any time the wheel well light switch (5, figure 4-77) or a level control valve switch has been actuated to ON or OPEN, respectively. The light is a press-to-test light.

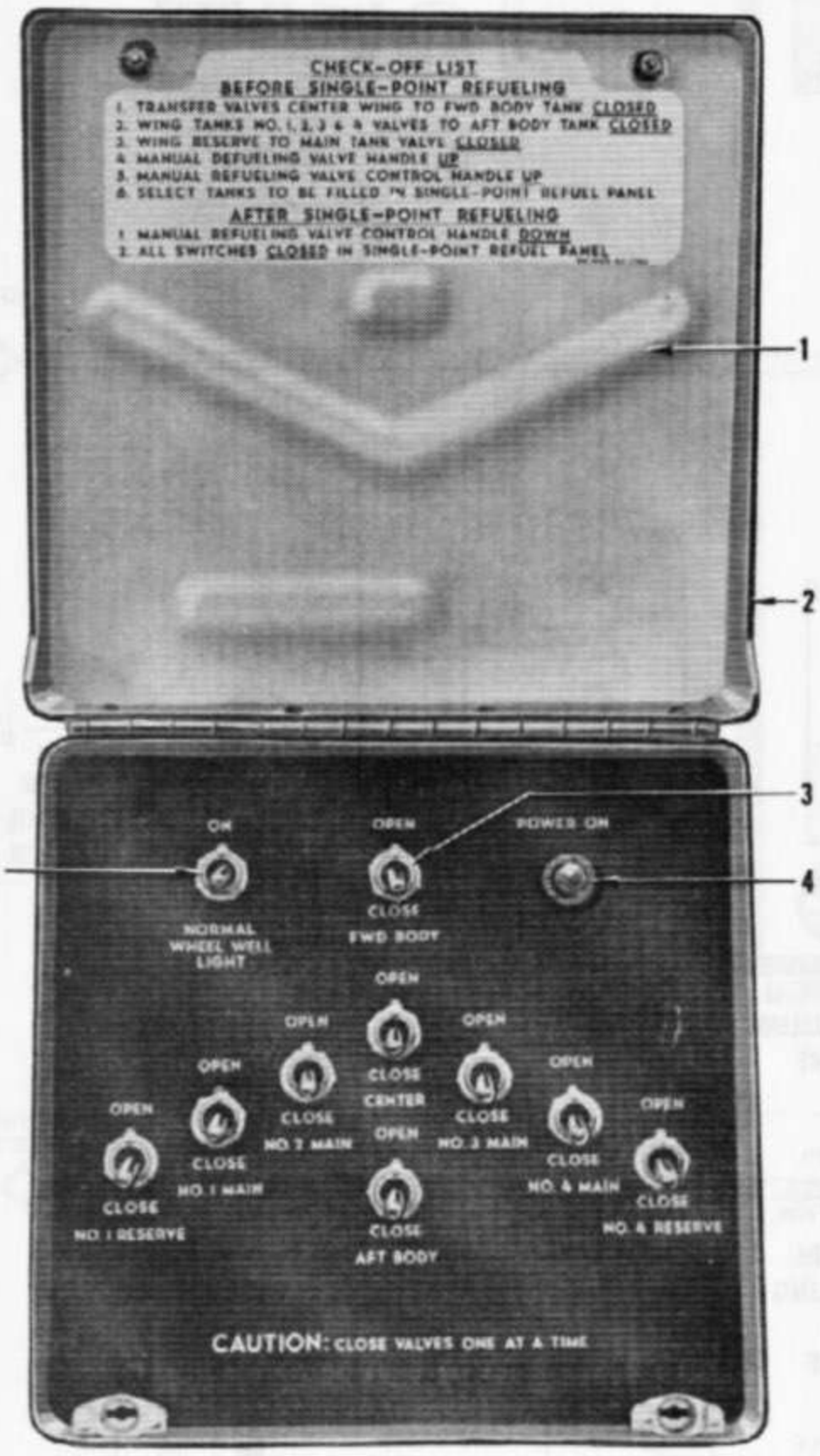
MANUAL REFUELING VALVES HANDLE

Two manual refueling valves are installed in the fuel system to facilitate control of the ground refueling operation. These valves are controlled by a single handle (figure 4-76) in the right wheel well. These valves are ground operated only. One valve is between the A/R manifold and line connecting the aft body tank with the single point refueling manifold, and the other valve is in the line connecting the aft body tank with the single point refueling manifold. See figure 4-78 and figure 1-24. When the manual refueling valves handle is placed in the REFUEL POSITION, the valve in the line between the A/R manifold and the single point refueling manifold is mechanically opened and the valve in the line to the aft body tank is mechanically closed. In this condition the entire fuel system is prepared to receive fuel through the single point refueling receptacle. When the manual refueling valves handle is placed to the FLIGHT POSITION it will be possible to gravity transfer fuel from the main tanks to the aft body tank, and the single point refueling manifold will be isolated from the air refueling manifold. There is a chain connection between the manual refueling valves handle and the dust cover for the single point refueling receptacle, such that the dust cover cannot be replaced unless the handle is in the FLIGHT POSITION.

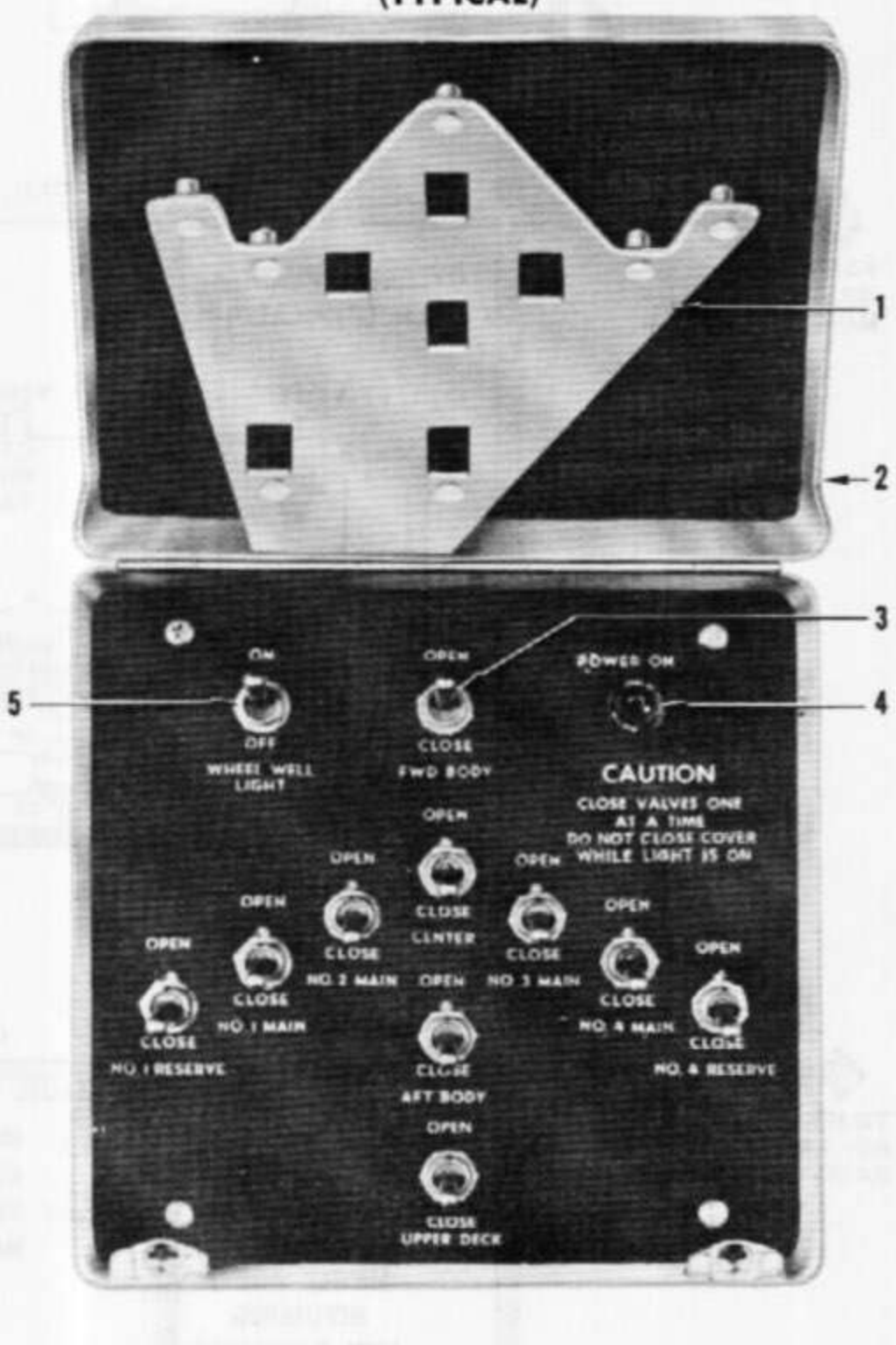
SINGLE POINT REFUELING PANEL



(AIRPLANES WITHOUT UPPER DECK TANK)



(AIRPLANES WITH UPPER DECK TANK)
(TYPICAL)



1 SWITCH OPEN INDICATOR BARS OR PLATE (2 PLACES)
2 PANEL COVER (2 PLACES)
3 LEVEL CONTROL VALVE SWITCHES (2 PLACES)
4 POWER ON INDICATOR LIGHT (2 PLACES)
5 WHEEL WELL LIGHT SWITCH (2 PLACES)

F-309
F-310

Figure 4-77

SINGLE POINT REFUELING AND DEFUELING SYSTEM

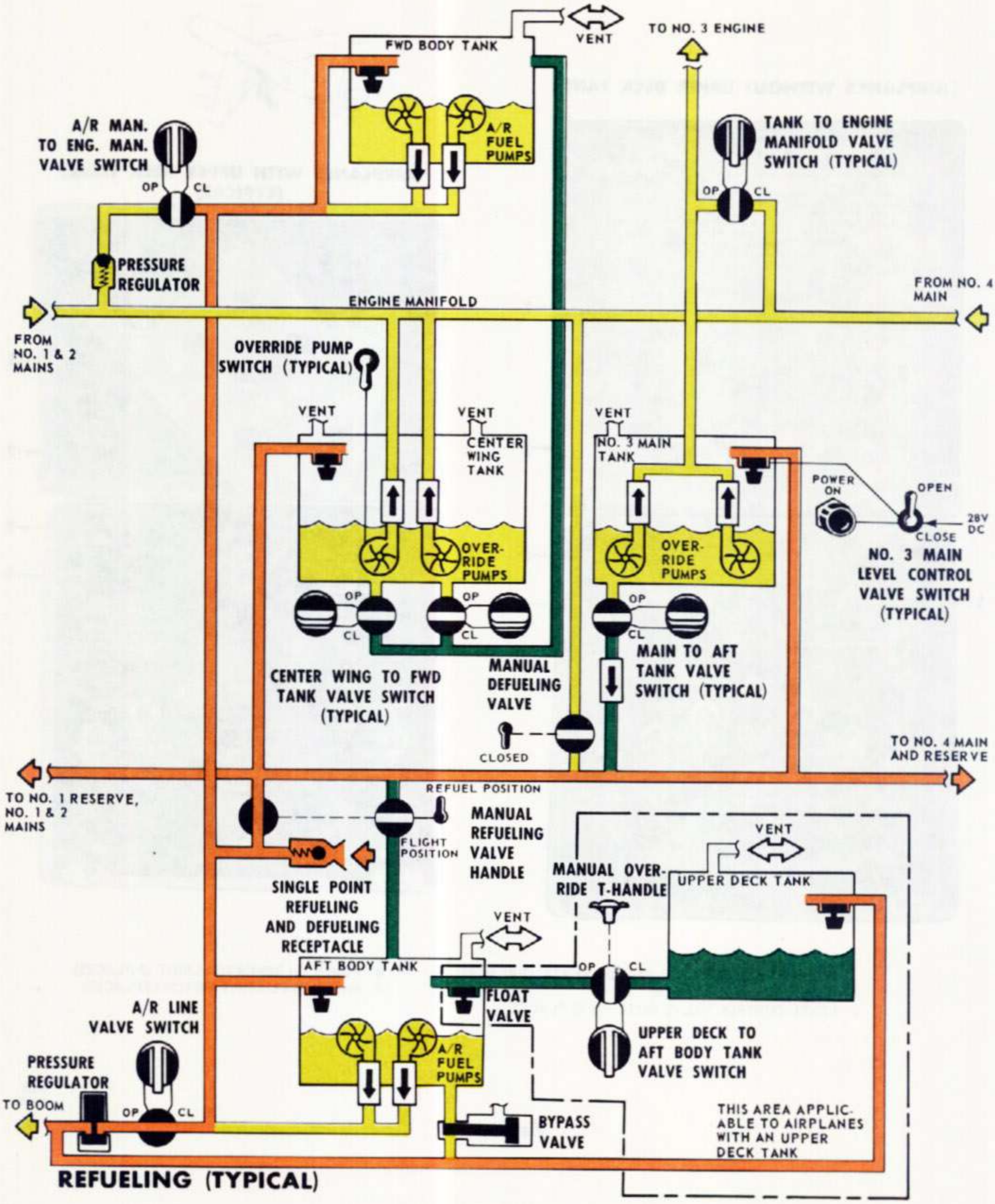
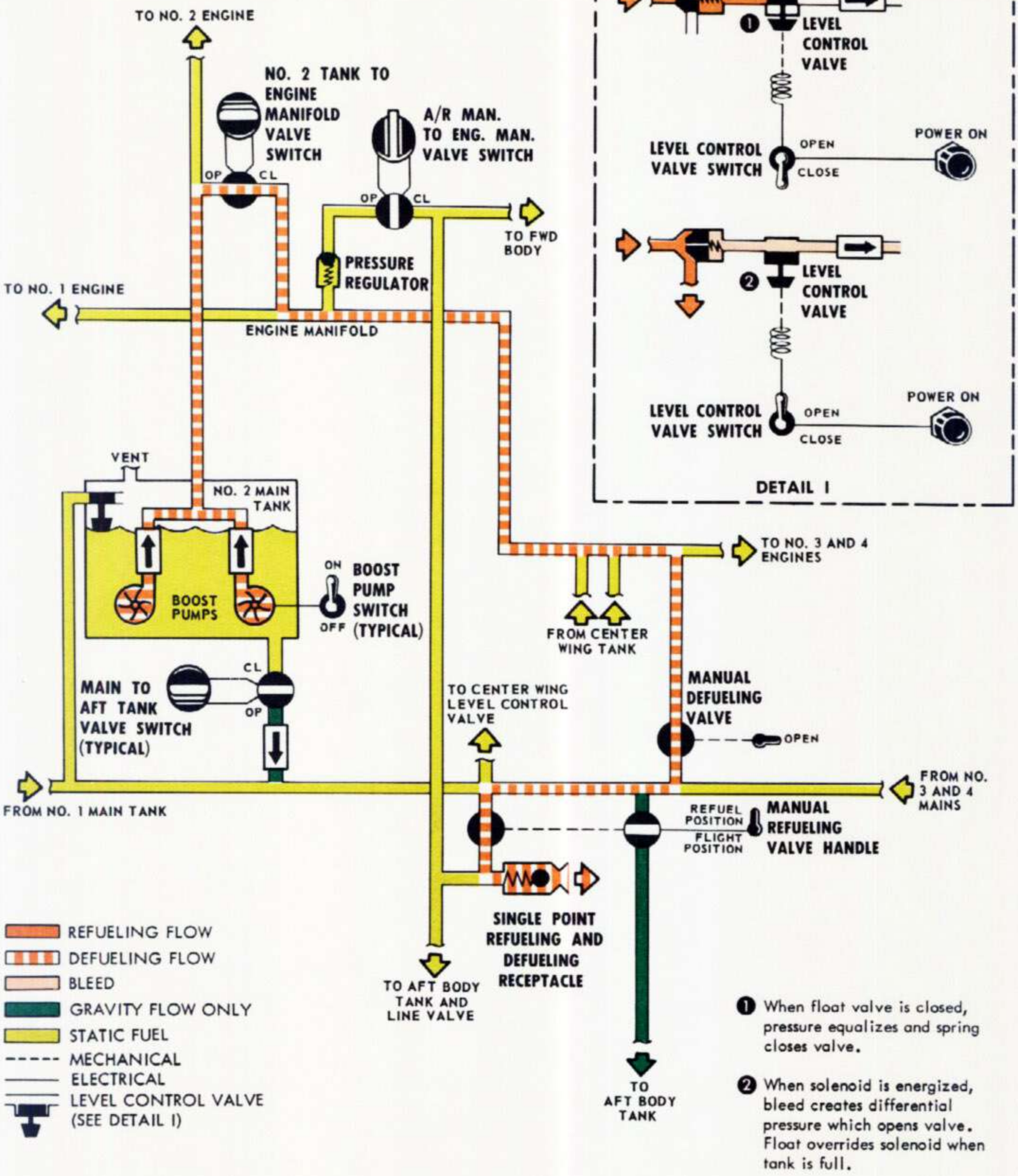


Figure 4-78 (Sheet 1 of 2)



DEFUELING NO. 2 MAIN TANK (TYPICAL)

Figure 4-78 (Sheet 2 of 2)

All data including figure 4-79 on page 4-158 (Deleted)

MANUAL DEFUELING VALVE HANDLE

A manual defueling valve (figure 1-24 and figure 4-78) is located just outboard of the forward edge of the right wheel well in the lower aft portion of the wing. Access to this valve is through an access door. This valve is in the line between the engine manifold and the single point refueling manifold, and is used to facilitate defueling the airplane through the single point refueling and defueling receptacle. This valve is mechanically opened when the handle is in the DOWN position, and mechanically closed when the handle is in the UP position. This valve is ground operated only and must always be closed when the airplane is being prepared for flight. When the valve is open, wing tank fuel from the engine manifold will be conducted to the single point refueling manifold and then to the single point refueling and defueling receptacle through the properly positioned manual refueling valves. Body tank fuel will flow directly from the air refueling manifold to the receptacle when those tanks are being defueled.

NOTE

For single point refueling procedures refer to T.O. 1C-135(K)A-2-2.

MISCELLANEOUS EQUIPMENT

NAVIGATOR'S STOWAGE CABINET

A navigator's stowage cabinet (1, figure 4-30) is directly above the navigator's table. This cabinet is used for stowing the airplane G file and other miscellaneous equipment. Spare fuses for the electrical system and electronic equipment and spare bulbs for the lights are on the aft wall of the cabinet.

NAVIGATOR'S SIGHTING STOOL

This stool (10, figure 1-3) is stowed between the navigator's table and the electronic cabinet. The top of the stool is a 24 inch circular platform on which the navigator stands to use the periscopic sextant. On airplanes 1▶ 27 the stool is raised and lowered by a telescoping column which is locked at the desired height by a spring loaded pin. Airplanes 28▶ have an improved stool with a ten inch screw column for height adjustment. A friction brake on the screw prevents the stool adjustment from creeping.

ASH TRAYS

Ash trays are conveniently located at each crew station with the exception of the boom operator's station.

MAP BIN

A map bin (12, figure 4-30) in the navigator's table provides for stowage of maps and charts.

HOT CUPS

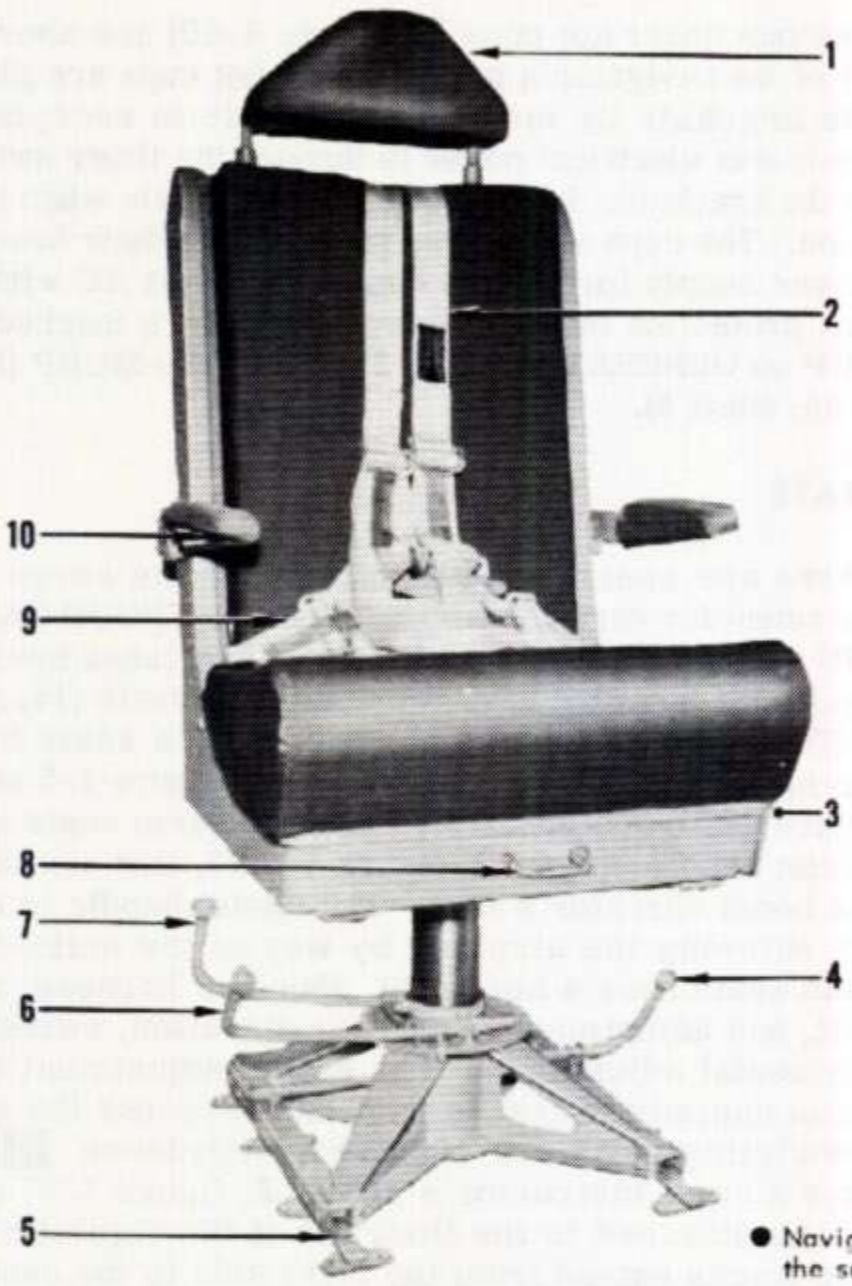
Two one quart hot cups (8, figure 4-30) are above and aft of the navigator's table. These hot cups are plugged into brackets by means of the built-in receptacles. Control of electrical power is through the timer switches on the brackets. Indicator lights illuminate when power is on. The cups are stowed plugged into their brackets. Power supply for the hot cups is 115 volt AC with circuit protection through 2 circuit breakers marked HOT CUP on GENERATOR NO's. 2 and 3 on the MCBP (figure 1-35, sheet 3).

SEATS

There are seats along both sides of the cargo compartment for carrying troops. Refer to TROOP CARRYING EQUIPMENT in this Section. Airplanes having an arctic kit installed have two additional seats (15, figure 4-57) in the cargo compartment. The seats for the navigator and the boom operator (13, figure 1-5 and 14, figure 1-26) are identical, except for arm rests and an assist handle (10 and 8, figure 4- 80), that are only on the boom operator's seat. The assist handle is an aid for entering the airplane by way of the entry chute. Both seats have a head rest, shoulder harness, safety belt, and adjustment levers for elevation, swivel, and horizontal adjustment. The swivel adjustment on the boom operator's seat is inoperative unless the swivel restricting bolts are removed. Airplanes 10▶ 215 have a crew instructor's seat (12, figure 1-5) on the tracks attached to the floor aft of the copilot's seat. The tracks extend from the right side to the center of the cabin. The seat can be moved along these tracks to a position behind and between the pilots for the use of a pilot instructor, rotated to face the navigator's table for a navigation instructor, or rotated to face aft for stowage under the navigator's table as shown in figure 1-5. The crew instructor's seat has two handles (11, figure 4- 80) linked together to allow control of seat swivel as well as horizontal movement along the track with either hand. An emergency release handle on the upper right corner of the back rest will free the seat to rotate and move along the tracks for quick stowage. The seat has a safety belt and shoulder harness, but does not have arm or head rests. Airplanes 216▶ have a light-weight crew instructor's seat that stows under the navigator's table. The hinged back of the seat operates the lock assembly (14, figure 4- 80). Raising

MISCELLANEOUS CREW SEATS

NAVIGATOR'S AND BOOM OPERATOR'S SEAT (USED ON LATER AIRPLANES)

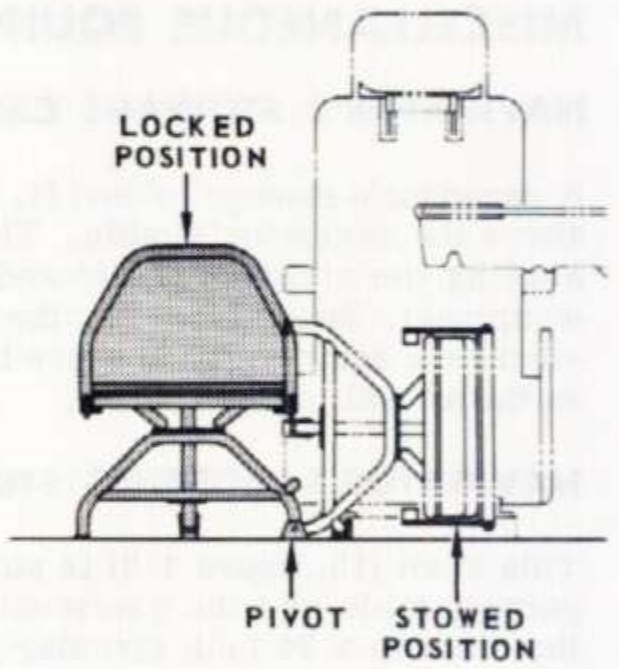


CREW INSTRUCTOR'S SEAT 10 ▶ 215



CREW INSTRUCTOR'S SEAT 216 ▶





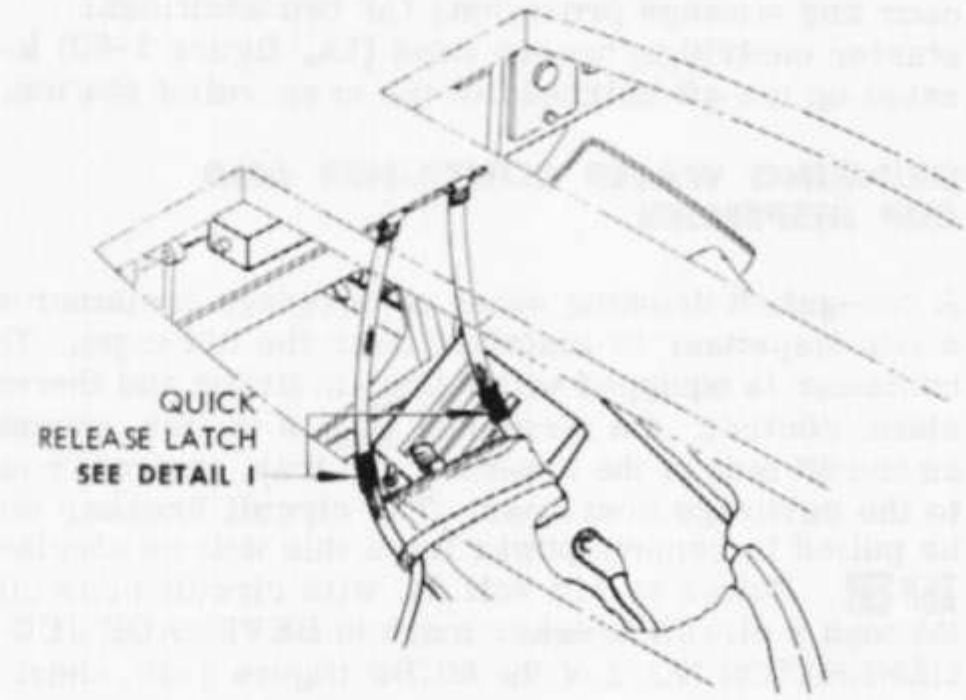
NOTE

- Navigator's and boom operator's seats are the same, except for items 8 and 10
- See figure 1-66 for the pilot's and copilot's seats.

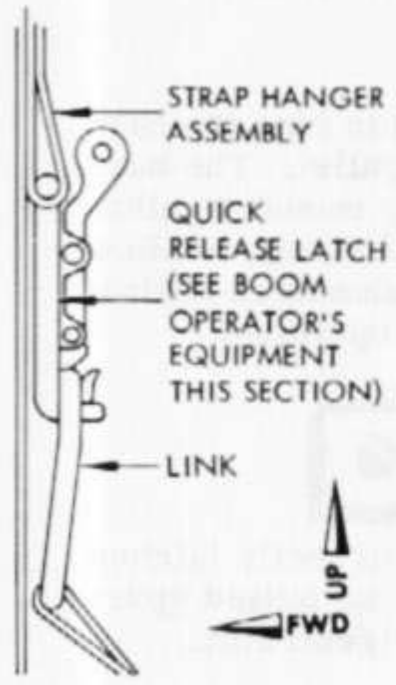
1 HEAD REST
2 SHOULDER HARNESS (2 PLACES)
3 SHOULDER HARNESS INERTIA REEL LOCK HANDLE (2 PLACES)
4 HORIZONTAL ADJUSTMENT LEVER (BOTH SIDES ON NAVIGATOR'S SEAT)
5 SEAT TRACKS
6 SWIVEL ADJUSTMENT LEVER (2 PLACES)
7 ELEVATION ADJUSTMENT LEVER
8 ASSIST HANDLE (BOOM OPERATOR'S SEAT ONLY) (SOME AIRPLANES)
9 SAFETY BELT (3 PLACES)
10 ARM REST (BOOM OPERATOR'S SEAT ONLY)
11 SWIVEL AND HORIZONTAL ADJUSTMENT LEVER (2 PLACES)
12 EMERGENCY RELEASE HANDLE
13 ADJUSTABLE FOOT
14 LOCK ASSEMBLY

Figure 4-80

BOOM OPERATORS' SAFETY HARNESSES



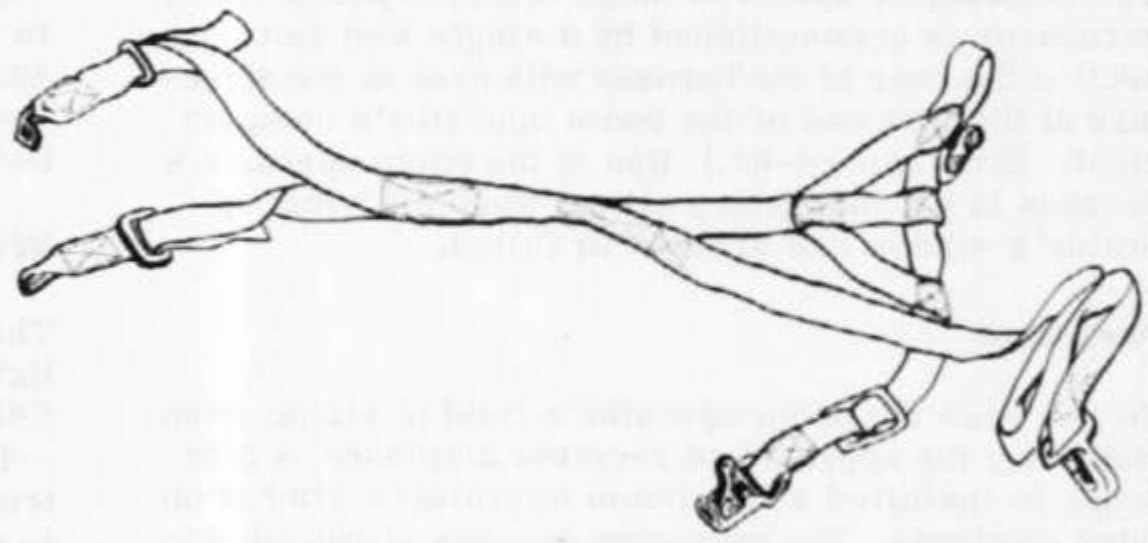
BOOM OPERATOR'S HARNESS



DETAIL I







INSTRUCTOR AND STUDENT
BOOM OPERATORS' HARNESS

F 317

Figure 4-81

the back of the seat locks the seat to a floor fitting and the lock releases when the back is folded forward. The seat can be rotated by actuating the swivel adjustment lever (6, figure 4- 80). The seats for the pilot and co-pilot are described in Section I.

WARNING

On airplanes 216▶, the crew instructor's seat is stressed only to withstand normal acceleration loads experienced during flight; therefore, this seat is not designed for use during takeoff and landing.

BOOM OPERATOR'S EQUIPMENT

The boom operator's station has positions for a boom operator, a boom operator instructor and a student boom operator. The compartment contains three pallets, with safety harness for each; necessary equipment and controls for operation of the A/R boom; communication equipment; oxygen equipment and an alarm bell. (See figure 4-66.) The boom operator's harness consists of two permanently fixed straps at the head end of the boom operator's pallet. A quick release latch in each shoulder strap facilitates emergency egress. The operator need only place his head between these two straps and he will be restrained from exiting through the boom operator's vision door opening in event of

window failure. Use of the boom operator's harness is not mandatory except when the boom operator's window has cracked or failed.

NOTE

The cross strap is to be used to bind the harness to the boom operator's pallet. The harness should be adjusted loosely enough to allow easy entry and egress, yet tight enough to allow the boom operator to push his shoulders against the straps during the refueling operation.

WARNING

If a quick release latch is incorrectly latched (upside down), the latch may be pulled apart and will not provide positive restraint.

The instructor and student boom operator harnesses are worn like a vest over the flight clothing and equipment. The shoulder harness meets at the lap belt latch and release mechanism is similar to the conventional shoulder harness installation on the airplane seats. The restraining action of these two side pallet safety harnesses is accomplished by a single web belt connecting the rear of the harness with eyes in the structure at the foot end of the boom operator's compartment. (See figure 4-81.) Use of the boom operator's harness is not mandatory except when the boom operator's window has cracked or failed.

Periscope

To increase the boom operator's field of vision when observing the approach of receiver airplanes, a periscope is installed at the boom operator's window on later airplanes. The periscope consists of two adjustable mirrors, one located slightly above the inside of the window and the other located below and outside the window. The upper mirror can be adjusted as required by the boom operator during flight.

ACCESSORY EQUIPMENT

The following equipment is provided in a kit with each airplane for servicing and ground use: shackle tiedown rings, engine plugs, air conditioning inlet and exhaust plugs, combustion starter exhaust plug, generator exhaust plugs, engine surge bleed plugs, engine air intake shields, miscellaneous locks and pins, rotating rendezvous lights, light filters, engine tailpipe shields, engine oil cooling inlet and exhaust plugs, pilots' window enclosure covers and the navigator's window cover. Separate kits for the main and nose landing gear down locks are stowed on the wall near the cargo door. Another kit for the pitot tube covers and boom nozzle cover is stowed on the wall below the other two kits. Plugs for the arctic capability kit are delivered installed in the airplane.

STARTER CARTRIDGE/BREECH CAPS

On airplanes without 1610 920, stowage provisions for two starter cartridges are on the airplane sidewall just forward of the cargo door. On airplanes with 1610 920, stowage provisions for two starter cartridges/breech caps (1A, figure 1-63) are located on the airplane sidewall, just forward of the cargo door and stowage provisions for two additional starter cartridge/breech caps (1A, figure 1-63) located on the aft bulkhead of the crew relief station.

DRINKING WATER CONTAINER AND CUP DISPENSER

A two-gallon drinking water or beverage container and a cup dispenser is installed near the hot cups. This container is equipped with a plug-in fitting and thermostatic control. On airplanes 46▶ a switch, mounted on the aft side of the lower hot cup tray, controls power to the beverage container. The circuit breaker must be pulled to remove power from this unit on airplanes 1▶45. Power is 115 volt AC with circuit protection through a circuit breaker marked BEVERAGE JUG on GENERATOR NO. 2 of the MCBP (figure 1-35, sheet 3).

WINDSHIELD WIPER SYSTEM

The windshield wiper system is provided to maintain clear areas on both the pilot's and copilot's forward windows during taxi, takeoff, approach and landing in rain and snow. The wipers are driven by variable speed electric motors. Four speed selections are available from a single rotary switch on the overhead panel.

Windshield Wiper Switch

This switch on the overhead panel above the copilot's light and glare shield (2, figure 4-82) marked WINDSHIELD WIPER, has PARK--OFF--LOW--1/2--3/4--HIGH positions. The switch, in any position, controls the applicable speed of the wiper. The switch is spring loaded to OFF from the PARK position only. This allows stowing the wipers before the system is off. Operating power is 28 volt DC, with circuit protection labeled WINDSHIELD WIPERS, PILOT, COPILOT on battery circuit breaker panel (figure 1-35, sheet 1).

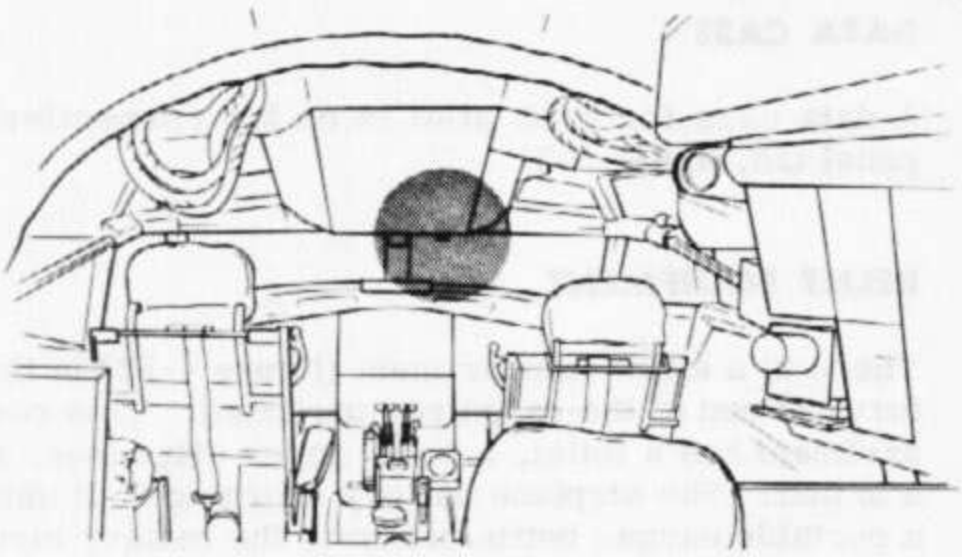
CAUTION

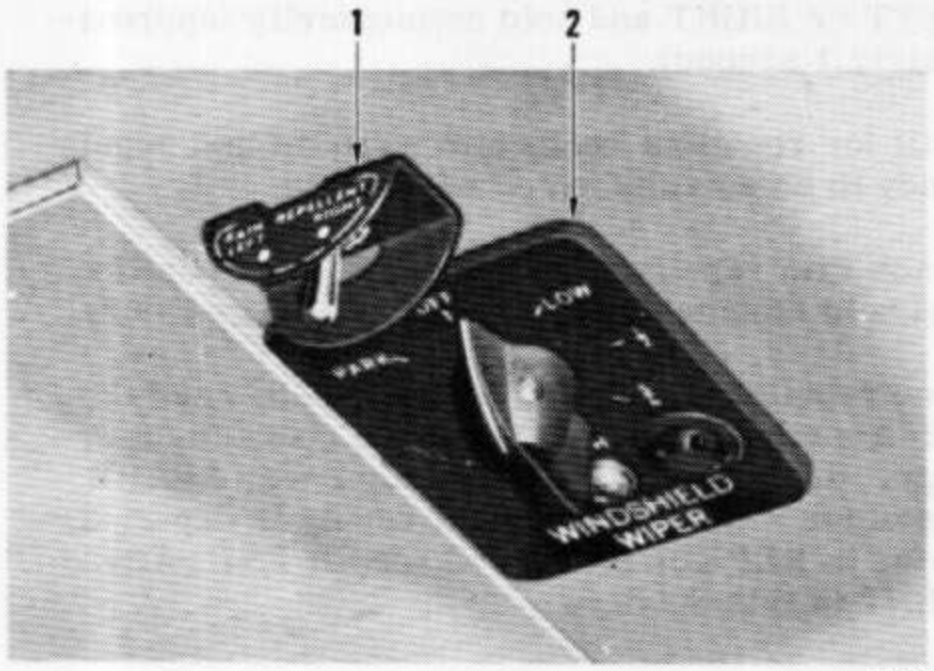
Do not operate windshield wipers on dry windshields.

WINDSHIELD RAIN REPELLENT SYSTEM

A windshield rain repellent system provides improved forward visibility when flying in moderate or heavy rain. The rain repellent system is used in conjunction with the windshield wiper system to improve visibility through the pilot's and copilot's windshield during heavy rain. The solution is spread over almost all of the windshield by the rain and airstream; however, spreading is enhanced within the wiped area of the windshields by the action of the wiper blades. Rain repellent is supplied from one of two pressurized containers, a normal and a spare, located in an enclosure on the floor beneath the navigator's table. Each container supplies enough fluid

WINDSHIELD WIPER AND RAIN REPELLENT SWITCHES





1 RAIN REPELLENT SWITCH
2 WINDSHIELD WIPER SWITCH

Figure 4-82

for 20 to 25 applications to each windshield. Each application provides repellency for 5 to 10 minutes in moderate to heavy rain and for a shorter period in heavier rain. In flight, the repellent impinges low on the windshield and is spread by the water and air flow. A sight gage for the normal container is located on the aft side of the enclosure and indicates when the repellent container needs replacement. The container should be replaced with the spare only when the float falls below the line on the sight gage. A timer, energized by a rain repellent switch, provides the proper amount of repellent by controlling the length of time the normally closed solenoid valves remain open. Repellent is then applied through two nozzles located just forward of each windshield

Rain Repellent Switch

A rain repellent switch (1, figure 4-82), forward of the pilots' overhead panel and on the copilot's side, has LEFT--OFF--RIGHT positions and is spring loaded to OFF. When pressed momentarily to the LEFT or the RIGHT position, a timer and two solenoid valves are energized to supply repellent to the selected windshield. Operating power is 28 volt DC through a circuit breaker marked WINDSHIELD RAIN REPELLENT on the T-R BUS NO. 1 section of the MCBP (figure 1-35, sheet 2).

Windshield Rain Repellent System Operation

An application of rain repellent will last longer in the wiped area than in the unwiped area. The length of time that an application remains effective varies inversely with the rain intensity. Reapplication is repeated as required to maintain repellent effectiveness.

NOTE

The rain repellent system cannot be used as a windshield washer; it should be used only in heavy rain when the windshield wiper system does not provide adequate visibility. Do not apply repellent in very light rain or to a dry windshield. When applied under these conditions, repellent residue may reduce visibility in the impingement and runback areas. In the event of inadvertent application of rain repellent on a dry windshield, do not operate the windshield wipers as smearing will result and visibility will be restricted. Remove repellent or residue by a thorough fresh water rinse at the earliest opportunity.

Repellent Application Procedure

A. Place rain repellent switch (figure 4-82) to LEFT or RIGHT and hold momentarily (approximately 1 second).

B. Wait for repellent residue to wash off and repellency to be established on windshield.

C. Place rain repellent switch to the other position and hold momentarily (approximately 1 second).

D. If no repellent is applied to windshield when the rain repellent switch is actuated, check sight gage. Replace NORMAL container with SPARE container if normal repellent supply is depleted. Refer to REPELLENT CONTAINER REPLACEMENT in this Section.

NOTE

If repellent supply lines from the containers to the nozzles are empty, the rain repellent switch may have to be actuated twice before the repellent is applied.

E. Reapplication of repellent should be made only to re-establish deteriorating repellency, not to build up a coating of fluid on the windshield.

Repellent Container Replacement

NORMAL and SPARE pressurized containers with self-sealing valves are in an enclosure beneath the navigator's table. Replace the container in the NORMAL position only when the float in the sight gage falls below the line. The container in the NORMAL position is threaded into a receptacle with a gasket. The SPARE container should be installed in the NORMAL position finger-tight. A pin in the receptacle automatically opens the container valve during installation.

CURTAINS

Cockpit curtains are installed for the four eyebrow windows above and forward of the pilot and copilot seats. A large blackout curtain (22, figure 4-30) separates the navigator's station from the pilots' compartment. Two small blackout curtains are installed at the celestial observation windows. All curtains are equipped with fasteners which snap to mating fixtures on structure and are rolled and held in place by straps when not in use.

AIRPLANE LOAD ADJUSTER

A load adjuster is used for computing the center of gravity for various load conditions, and is normally located at the boom operators' forward station during flight.

TABLES

A table (11, figure 4-30) with a drawer is at the navigator's station.

DATA CASE

A data case for each pilot is on his respective side panel (26, figure 1-3).

RELIEF EQUIPMENT

There is a toilet compartment (figure 4-83) in the forward end of the cargo compartment. This compartment has a toilet, a toilet paper dispenser, and a urinal. The airplane battery charging T-R unit, a portable oxygen bottle bracket, the battery circuit breaker panel, and an emergency alarm bell are also in the toilet compartment. Two additional urinals (37, figure 1-3), are just forward of the aft pressure bulkhead. These two urinals are provided for troops in the cargo compartment.

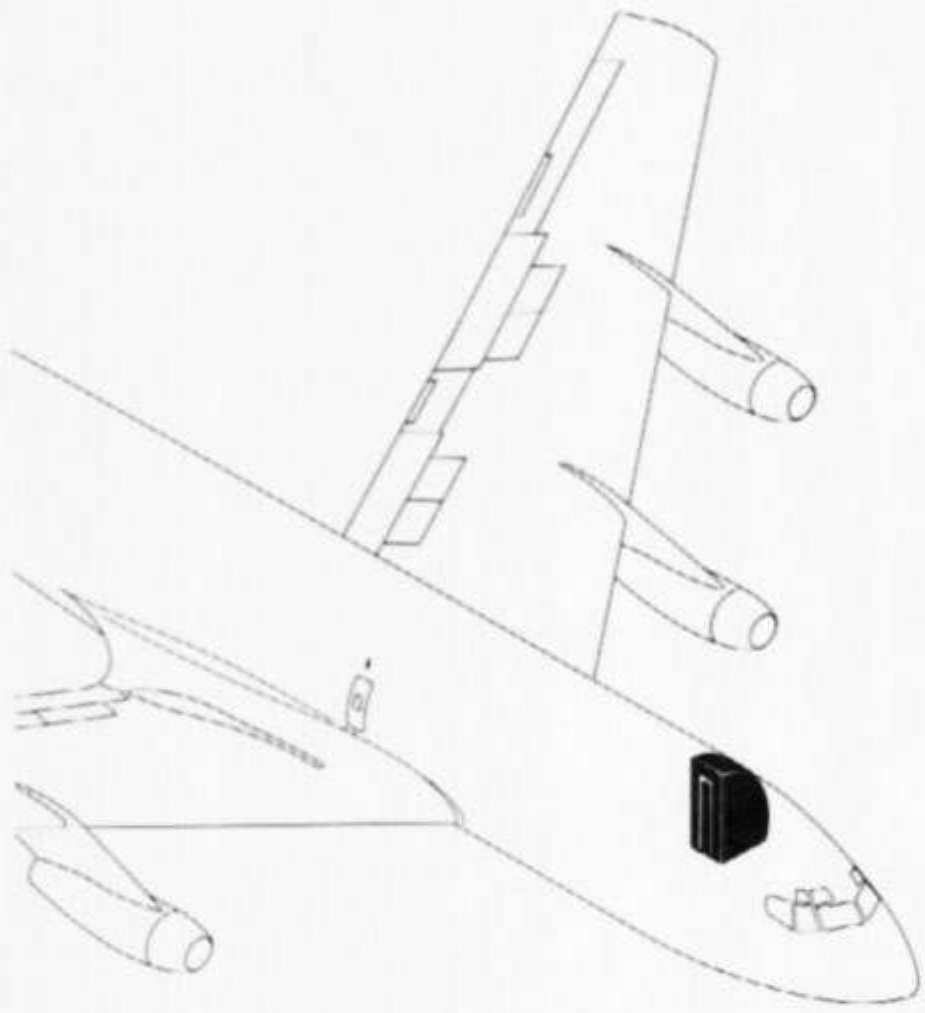
TAKEOFF AND LANDING DATA CARD HOLDER (TCTO 864)

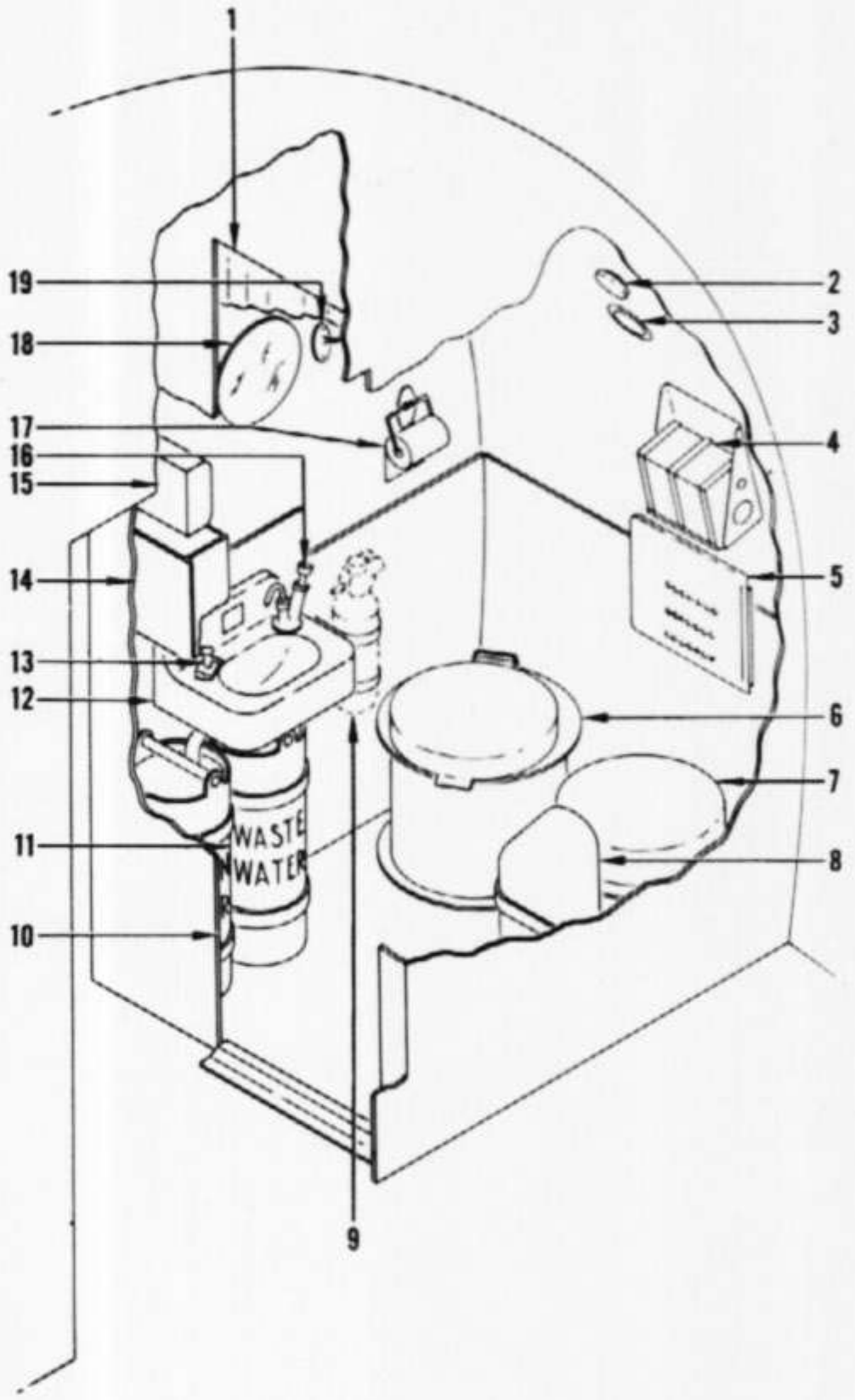
A takeoff and landing data card holder (7A, figure 1-5) is mounted on the pilots' light and glare shield. A two-position ON-OFF switch, located on the holder, is used to control the light for illumination of the takeoff and landing data card. Brightness of the light is controlled by the magnetic compass rheostat on the copilot's overheat light control panel. Operating power for the light is 28 volt DC through a circuit breaker marked MAGNETIC COMPASS LIGHT on the SBCBP.

TAKEOFF AND LANDING DATA CARD (TCTO 864)

A plexiglass takeoff and landing data card is provided for insertion in the takeoff and landing data card holder. The card has space for penciling pertinent takeoff and landing data on the card prior to takeoff. Takeoff data or landing data is portrayed by inserting the card in the holder in an upright or inverted position. The card is inserted in the holder by first placing the lower edge of the card behind the seal in the holder and then pushing the upper edge of the card firmly into the holder. Removal is the reverse procedure.

TOILET COMPARTMENT





1 CURTAIN
2 EMERGENCY ALARM BELL
3 LAVATORY DOME LIGHT
4 T-R UNIT
5 BATTERY CIRCUIT BREAKER PANEL (SEE FIGURE 1-35)
6 TOILET
7 BATTERY
8 URINAL
9 PORTABLE OXYGEN BOTTLE STOWAGE
10 WASH WATER CONTAINER
11 WASTE WATER CONTAINER
12 LAVATORY
13 SOAP DISPENSER
14 WASTE PAPER RECEPTACLE
15 PAPER TOWEL DISPENSER
16 HAND PUMP
17 TOILET PAPER DISPENSER
18 ADJUSTABLE MIRROR
19 UTILITY HOOK

1-322

Figure 4-83



Section V

OPERATING LIMITATIONS

1-323

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MANDATORY FORM 781 ENTRIES . . . 5-40

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 in figure 5-1 since these limitations are not necessarily repeated under their respective sections. The instrument markings are used to indicate to the flight crew, at a glance, that flight operation is being accomplished in a desirable, cautionary or unsafe region. Three colors and intermediate blank spaces are used to indicate unsafe regions, cautionary ranges, and desirable operating regions. Red, if used as a minimum limit marking, usually indicates that a dangerous condition exists. Operation at less than this minimum limit requires special attention. When used as a maximum range marking, red prohibits operation above this marking. Short red radials indicate limits under some conditions of operation, long red radials indicate maximum limits. Green indicates the region for continuous or desirable operation. Yellow indicates caution or that danger may exist in this region under certain conditions. Blank spaces indicate regions to be avoided or regions in which operation is limited. Instrument markings are further explained by the use of legends and in some cases notes under the instrument caption in figure 5-1. Care should be taken not to exceed these limits as damage can result to both equipment and airplane.

MINIMUM CREW REQUIREMENTS

A pilot and copilot constitute the minimum crew required for a normal nontactical flight in this airplane. Additional crew members, as required, will be added at the discretion of the Commander. When the navigator or boom operator are not aboard, the pilot will be responsible to see that the applicable portion of their checklists are performed.

INSTRUMENT MARKINGS

NOTE

The maximum allowable airspeed pointer may be either black and white striped or red and white striped.



AIRSPEED INDICATOR

The instrument setting is such that the striped pointer will remain at 350 knots until an altitude is reached such that the airspeed corresponding to Mach 0.90 is 350 KIAS. As altitude is increased, the striped pointer rotates to a lower airspeed which corresponds to the limiting Mach number.



MACH INDICATOR

0.90 MAXIMUM



ACCELEROMETER

+2g MAXIMUM POSITIVE ACCELERATION

+0.2 MINIMUM ALLOWABLE ACCELERATION

F-32
F 32
F 330
F 32



BATTERY CHARGING AMMETER

0-7 AMPS	NORMAL OPERATING RANGE
7-30 AMPS	BATTERY CHARGE VERY LOW, CHARGE BATTERY BEFORE TAKEOFF EXCEPT FOR EMERGENCY CONDITIONS

NOTE

See BATTERY CHARGE LEVEL in Section VII for battery state of charge at battery ambient temperatures higher or lower than standard day temperature.

Figure 5-1 (Sheet 1 of 6)

APPLICABLE TO ALL FUEL GRADES



TACHOMETER

58% - 65% RPM	IDLE RANGE
80% - 93% RPM	NORMAL CRUISE RANGE
102% RPM	MAXIMUM ALLOWABLE



EXHAUST GAS TEMPERATURE

300° - 570°C	CONTINUOUS OPERATION
450°C	MAXIMUM DURING STARTING
680°C	MAXIMUM DURING ENGINE ACCELERATION (2 Minutes Duration) Wet or Dry

TYPICAL INSTRUMENT



OIL PRESSURE

Fluctuations up to 5 psi total may be observed. These fluctuations are generated in the pressure indicating system and do not indicate abnormal engine operation.

NOTE Minimum oil pressure for takeoff is 40 psi.

35 PSI	MINIMUM FOR FLIGHT
40-50 PSI	CONTINUOUS OPERATION
50 PSI	MAXIMUM FOR FLIGHT



ENGINE PRESSURE RATIO

2.85 TARGET EPR FOR WET TAKEOFF

CAUTION

THIS SETTING MAY NOT BE VALID FOR WET TAKEOFFS AT HIGH ELEVATIONS, HIGH OAT'S, BELOW SEA LEVEL PRESSURE ALTITUDES, OR WITH ANTI-ICING ON.

F 327
F 328
F 3842
F 329

Figure 5-1 (Sheet 2 of 6)

INSTRUMENT MARKINGS (CONT)



DC AMMETER

	0	DANGER
	0-1	NORMAL
	1.0-1.25	CAUTION



AC FREQUENCY METER

	380 CYCLES	MINIMUM
	380-395 CYCLES	CAUTION
	395-405 CYCLES	NORMAL
	405-420 CYCLES	CAUTION
	420 CYCLES	MAXIMUM



POWER METER

	36 KW MAXIMUM	

F-331
F-332
F-335
F-334
F-333



AC VOLTMETER

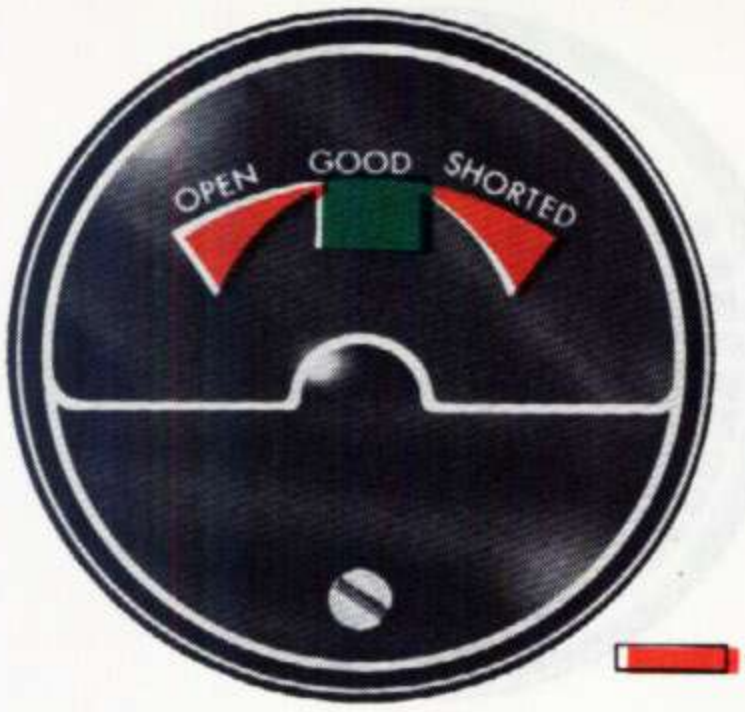
	180 VOLTS	MINIMUM
	180-190 VOLTS	CAUTION
	190-210 VOLTS	NORMAL
	210-220 VOLTS	CAUTION
	220 VOLTS	MAXIMUM



DC VOLTMETER

	22 VOLTS	MINIMUM
	22-26 VOLTS	CAUTION
	26-29 VOLTS	NORMAL
	29-30 VOLTS	CAUTION

Figure 5-1 (Sheet 3 of 6)

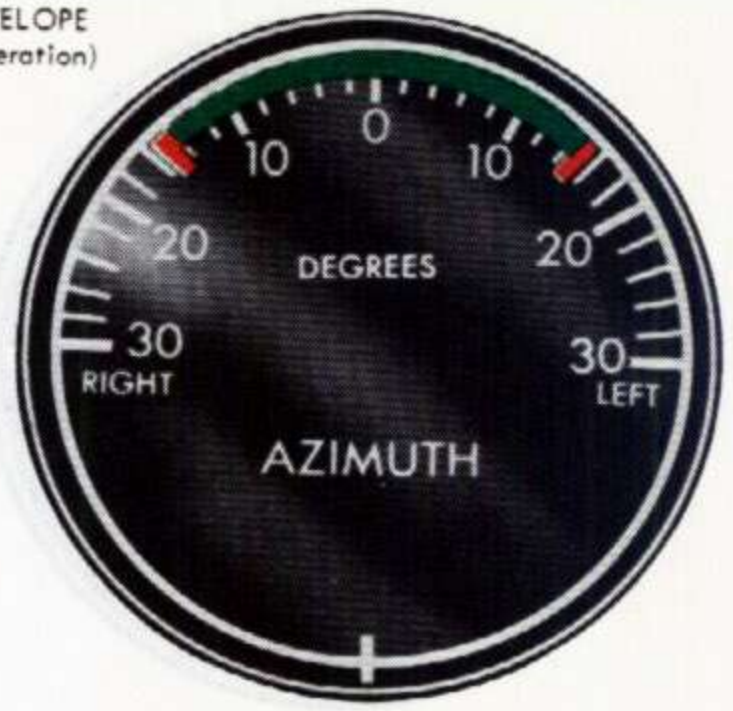


BOOM SIGNAL COIL TEST VOLTMETER

OPEN		BOOM SIGNAL COIL CIRCUIT OPEN
GOOD		BOOM SIGNAL COIL CIRCUIT GOOD
SHORTED		BOOM SIGNAL COIL CIRCUIT SHORTED

BOOM AZIMUTH

15°L - 15°R	NORMAL ENVELOPE (Automatic Operation)
15°L and 15°R	MAXIMUM



BOOM TELESCOPE

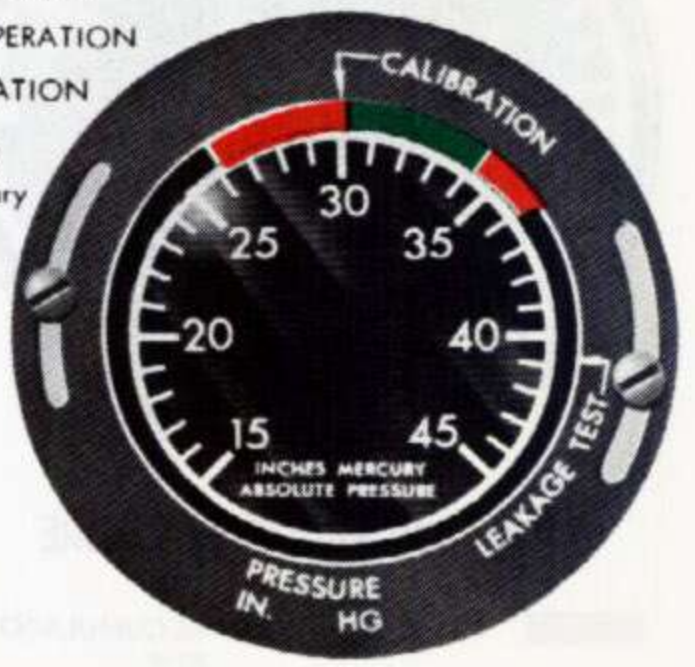
6 FT MINIMUM	
6 FT - 18 FT	NORMAL ENVELOPE (Automatic Operation)
18 FT MAXIMUM	

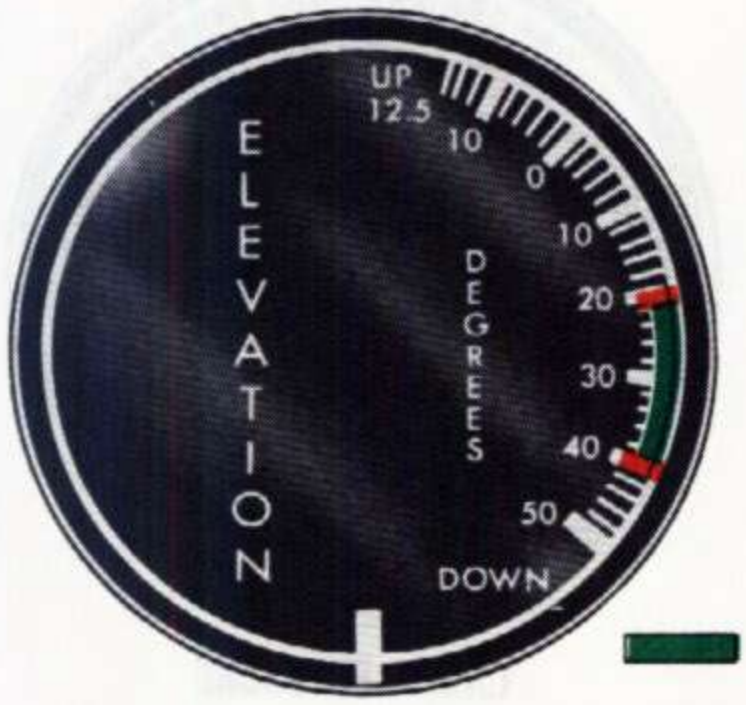


RADAR PRESSURE

26-30 IN HG	MARGINAL OPERATION
30-34 IN HG	CONTINUOUS OPERATION
34-36 IN HG	MARGINAL OPERATION

The given radar pressure values assume sea level calibration of the system. Actual values will vary with the operating field elevation.





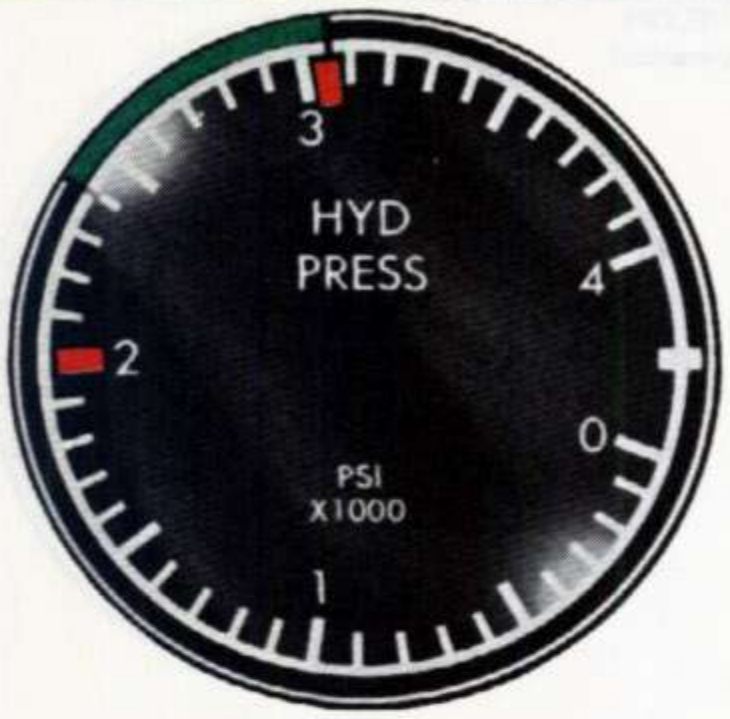
BOOM ELEVATION

	20°-40° DOWN	NORMAL ENVELOPE (Automatic Operation)
	40° DOWN	MAXIMUM
	20° DOWN	MINIMUM

F-336
F-337
F-343
F-338
F-339

Figure 5-1 (Sheet 4 of 6)

INSTRUMENT MARKINGS (CONT)



HYDRAULIC PRESSURE

	2000 PSI	ACCUMULATOR PRELOAD FOR 70°F (See figure 1-65)
	2400-3050 PSI	NORMAL
	3050 PSI	MAXIMUM

NOTE

Because of gage tolerances, hydraulic pressure can read as high as 3200 psi under normal conditions.



PILOT RESERVE BRAKE PRESSURE

	1000 PSI	ACCUMULATOR PRELOAD FOR 70°F (See figure 1-65)
	1300 PSI	ONE BRAKE APPLICATION AVAILABLE
	1300-3050 PSI	NORMAL
	3050 PSI	MAXIMUM



F-340
F-341
F-344
F-342

RUDDER POWER HYDRAULIC PRESSURE

HIGH RANGE

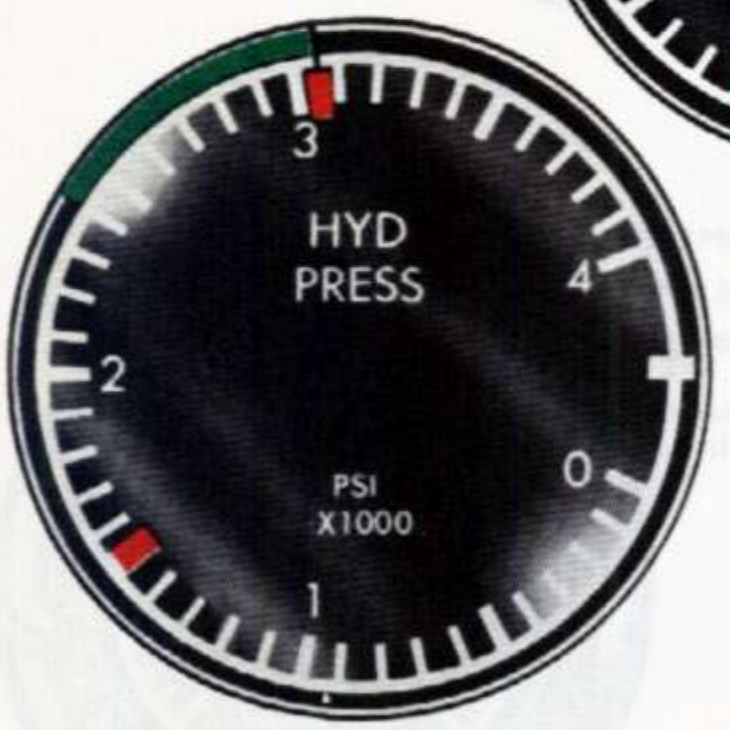
INBOARD FLAPS = MORE THAN 5° DOWN (SEE TEXT)

	2800-3050 PSI	NORMAL
	2400-2800 PSI	CAUTION
	3050 PSI	MAXIMUM
	2400 PSI	MINIMUM

LOW RANGE

INBOARD FLAPS = LESS THAN 5° DOWN (SEE TEXT)

	800-1175 PSI	NORMAL
	1175 PSI	MAXIMUM
	800 PSI	MINIMUM



BOOM HYDRAULIC PRESSURE

	1500 PSI	ACCUMULATOR PRELOAD FOR 70°F
	2400-3050 PSI	NORMAL
	3050 PSI	MAXIMUM



CABIN PRESSURE

	10,000 FT	DANGER (Oxygen required at cabin altitudes above 10,000 ft)

Figure 5-1 (Sheet 5 of 6)



ANGLE OF ATTACK INDICATOR

.85 – .91 CAUTION ZONE
(Approaching buffet)

.91 – 1.10 BUFFET/STALL ZONE

Figure 5-1 (Sheet 5A of 6)



VENTILATING AIR SOLAR A P U

150° C MAXIMUM



EXHAUST TEMPERATURE AIRESEARCH A P U

0 TO 1225° F NORMAL OPERATION

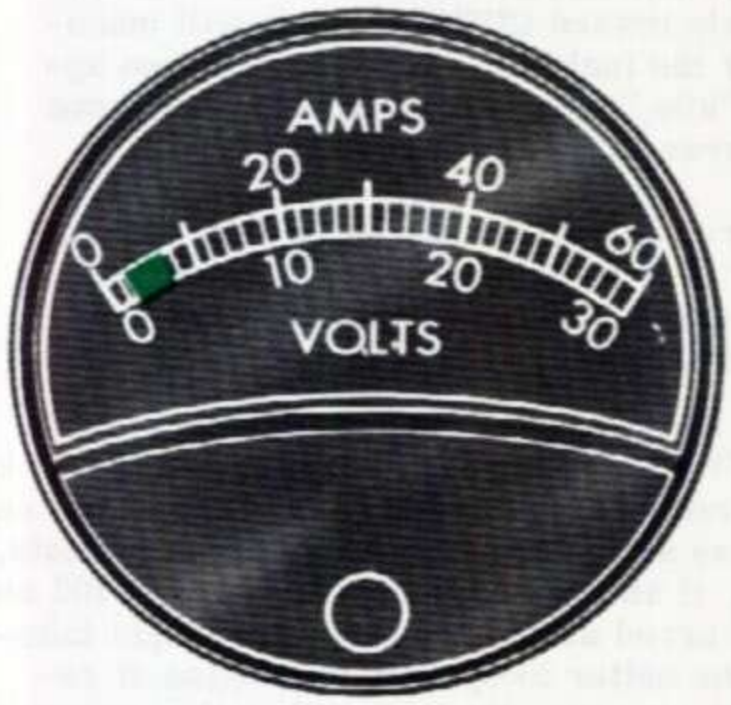
ABOVE 1225° F OVERHEAT

SOLAR APU BATTERY CHARGING AMMETER

3 TO 7 AMPS NORMAL CHARGING BATTERY OVER 50% CHARGED

NOTE

See BATTERY CHARGE LEVEL in Section VII for battery state of charge at battery ambient temperatures higher or lower than standard day temperature.





TACHOMETER SOLAR A P U

100% - 103% NORMAL

ABOVE 103% OVERSPEED



TURBINE DISCHARGE SOLAR A P U

610° C MAXIMUM

F-345
F-346
F-347
F-349
F-349

Figure 5-1 (Sheet 6 of 6)

ENGINE LIMITATIONS

The engine is rated on the basis of thrust. EPR is the only engine parameter that indicates thrust; therefore, the charted EPR values as defined in Parts 2, 4 and 5 of the Appendix, T.O. 1C-135(K)A-1-1, shall not be exceeded except in an emergency. Each engine, when installed, is trimmed to proper exhaust pressure to obtain MRT and TRT. See THRUST RPM RELATIONSHIP, Section VII. The takeoff high pressure compressor rpm will be slightly different for each engine and will vary between 90 and 98% rpm. The overspeed limit of 102% rpm should not be exceeded at any time. During ground operation, if engine rpm exceeds 102% or fuel flow rises rapidly toward 15,000 pph, shut down engine immediately.

NOTE

- When shutting down an engine due to exceeding rpm limits or excessive fuel flow, move the throttle lever rapidly to the idle detent. Lift over detent into the start detent. Retard throttle lever slowly toward CUTOFF which will manually meter the fuel flow. When engine rpm approaches "idle," (approximately 60%), then move throttle lever to CUTOFF.

- Engine ground operation will be limited to a maximum of five minutes at 90% rpm or above when the engine is fully cowled to prevent accessory overheat.

During flight if engine rpm exceed 102% rpm but is less than 104% rpm, consideration should be given to operating on reduced power and shutting down the engine as soon as safety of crew and airplane permits. For example, if an engine overspeed between 102 and 104% rpm occurred during a high gross weight takeoff, it would be better to operate the engine at reduced power during the climbout rather than shutting down the engine; if the engine were shutdown and a go-around became necessary, sufficient power for the gross weight may not be available from the three remaining engines. If an overspeed exceeding 104% rpm occurs, the danger of complete engine failure is more imminent and the engine should be shut down as soon as practical. Engine temperature limits are given in figure 5-2. Cases of overtemperature exceeding the limits shown in figure 5-2 (but not exceeding the values shown in the following table) should be treated the same as an overspeed from 102-104% rpm. Overtemperatures exceeding the following table should be treated the same as an overspeed exceeding the 104% rpm condition:

A. Starting EGT

(1) In excess of 610° C for over 5 seconds

(2) In excess of 700° C for any length of time

B. Inflight EGT - In excess of 730° C for any length of time, the engine should be shut down as soon as possible considering the safety of flight aspects of the specific condition.

CAUTION

Prolonged engine operation at EGT and RPM limits will shorten engine life.

NOTE

- The amount and time of overspeed, overtemperature and time limits exceeding those listed on figure 5-2 must be noted on Form 781.

- For inflight EPR thrust settings above NRT, the MRT time and temperature limits apply. The time limit for use of MRT includes the time limit allowed for operating at TRT dry. It does not include the time allowed for TRT wet.

EPR limits for the flat rated -59W and -43WB engines exist during takeoff or other high power operation. See Parts 2 and 4 of the Appendix, T.O. 1C-135(K)A-1-1 for EPR limits and temperature ranges of these limits. Water injection should be used only when necessary on takeoff. Ground operation at maximum dry or wet power should be held to a minimum. This will forestall sonic structural damage to the airplane.

NOTE

Engine operating limits are the same for all fuel grades.

ENGINE THRUST RATINGS

The following terms are used to define engine thrust ratings and limitations associated with the ratings:

NOTE

Thrust ratings as defined are subject to the applicable time and EGT limits specified in figure 5-2. The time limits apply to the use of the thrust rating and not to the length of time that the engine may be operated at the maximum allowable EGT for that particular thrust rating.

J57-P-59W AND-43WB ENGINES ENGINE OPERATING LIMITS

OPERATION LIMITS

OPERATING CONDITION	TIME LIMIT	SL TO 30,000 FEET	45,000 FT ❺
❶ TAKEOFF RATED THRUST (Wet) (TRT) Water injection useable only below 6000 feet for takeoff and 8000 feet in flight Water injection usable at -6.7°C (+20°F) and above	5 minutes	680 °C→610 °C	
TAKEOFF RATED THRUST (Dry) (TRT)	5 minutes	680 °C→610 °C	
❷ MILITARY RATED THRUST (Dry) (MRT)	30 minutes	610°C	630°C
❸ NORMAL RATED THRUST (NRT)	CONTINUOUS	560°C	570°C
❹ IDLE	CONTINUOUS	340°C	
STARTING (GROUND)	MOMENTARY	450°C	
(INFLIGHT)	MOMENTARY	500°C	500°C
❻ ACCELERATION (ENGINE)(Wet or Dry)	2 minutes	680°C	660°C
❼ → DECREASING	3 minutes	—	—

❶ To be used for takeoff only. Observe prescribed ambient temperature limits and the preheating requirement for the water itself, when using water injection. The use of water injection is restricted to altitudes below 8000 feet.

❷ 30 minute MRT limit includes the 5 minute TRT (dry) limit when TRT (dry) and MRT are used in conjunction. It does not include time used for operation at TRT (wet).

❸ For inflight EPR thrust settings above NRT, the MRT time and temperature limits apply.

❹ This temperature is not a limit. It is given as a guide to indicate the exhaust gas temperature which, if exceeded, may indicate an engine malfunction. The exhaust gas temperature limits for throttle settings below Normal Rated Thrust are the same as those for Normal Rated Thrust.

❺ Between 30,000 and 45,000 feet temperature limits vary linearly with altitude.

❻ Acceleration temperature time limit is defined as the period between advancing the throttle and the time that the EGT is first observed to start falling after reaching its peak.

❼ **NOTE**
Three additional minutes are allowed following an engine acceleration for the EGT to decrease to a stabilized temperature at or below the applicable limit.

Figure 5-2

Takeoff Rated Thrust, Wet (TRT Wet)

Takeoff rated thrust (wet) is the highest value of thrust which the engine will deliver with water injection at specific ground conditions. This rating is restricted to 5 minutes of operation on takeoff and is obtained by positioning the throttle to obtain a predetermined EPR reading. This value is dependent upon prevailing conditions of field barometric pressure and runway ambient temperature (engine inlet), and is obtained from the TAKEOFF THRUST SETTING EPR, WITH WATER chart in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1.

Takeoff Rated Thrust, Dry (TRT Dry)

Takeoff rated thrust (dry) is the highest value of thrust which the engine will deliver without water injection at specific ground or flight conditions. This rating is restricted to 5 minutes of operation on the ground and during takeoff, and is obtained by positioning the throttle to obtain a predetermined EPR reading. This value is dependent upon prevailing conditions of field barometric pressure and runway ambient temperature (engine inlet) and is obtained from the TAKEOFF THRUST SETTING EPR, NO WATER chart in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1.

Military Rated Thrust (MRT)

Military rated thrust is the highest value of thrust (no water) which the engine will deliver in flight. This rating is restricted to 30 minutes of operation and is obtained by positioning the throttle to obtain a predetermined EPR reading. This value is dependent upon prevailing conditions of outside air temperature, altitude and airspeed, and is obtained from the ENGINE RATINGS, EPR charts in Parts 4 and 5 of the Appendix, T.O. 1C-135(K)A-1-1.

Normal Rated Thrust (NRT)

Normal rated thrust is the highest value of thrust at which the engine may be operated continuously. EPR values for NRT are obtained from the ENGINE RATINGS, EPR charts in Parts 4 and 5 of the Appendix, T.O. 1C-135(K)A-1-1.

ENGINE OIL LIMITATION

Under emergency conditions only, when MIL-L-7808F (USAF) engine lubricating oil is not available, MIL-L-7808D or MIL-L-7808E oil may be used in quantities necessary to remain operational. When using alternate oil, the engine oil system must be drained, flushed, and reserviced with MIL-L-7808F (USAF) after completion of the flight or end of the emergency condition.

OIL PRESSURE LIMITATIONS

Oil pressure fluctuations up to 5 psi total are allowable; however, the mean should not be lower than 35 psi or higher than 50 psi. These fluctuations are generally in the pressure indicating system and do not indicate abnormal engine operation. Although the minimum oil pressure required for idle is 35 psi, actual pressure may be greater than 50 psi immediately following engine start when the oil is cold. Normal oil pressure for engine operation above idle is 40 to 50 psi. However, oil pressure at idle of 35 to 40 psi is acceptable after ground start, during flight and after landing.

NOTE

On some engines, oil pressure will have a tendency to follow the throttle due to a modified oil pressure relief valve. This condition is normal provided the pressure stabilizes between minimum and maximum limits.

ENGINE IGNITION LIMITS

To avoid reducing service life of the engine ignition system, do not use continuous ignition except when necessary and not to exceed 10 minutes except in emergencies. If conditions permit, limit ground operation to 5 minutes.

STARTER LIMITATIONS

Starter operation is limited as follows:

CAUTION

- Do not attempt a start in the cartridge mode if starter fails to provide an engine start in the pneumatic mode. The difficulty in the starter system must be determined before another start is attempted.
- If the engine has reached starter cutout speed, pneumatic starter operation will stop even though the start switch remains in the GROUND START position. However, if the engine speed then drops below starter cutout speed, the starter will re-engage. If this occurs, the starter shaft should be inspected for possible failure.

PNEUMATIC STARTER

A. The maximum continuous operation is 2 minutes.

B. The minimum rest after 2 minutes of continuous operation is 3 minutes.

C. The minimum rest after two 2-minute periods of operation is 10 minutes.

CARTRIDGE–PNEUMATIC STARTER

A. Not more than 2 cartridge starts shall be made in any period of 60 minutes.

B. After normal cartridge firing, at least 5 minutes shall elapse before removing the breech cap, inserting another cartridge, and initiating another cartridge start. If the cartridge malfunctioned (misfired or hangfired), wait at least 5 minutes before attempting to remove the cartridge, except as noted below. The time intervals, based on experience and consideration of safety, have been established to minimize the danger associated with misfire or hangfire. Cartridge malfunctions are defined as:

(1) Hangfire. A delay in the functioning of a propelling charge at the time of firing. The amount of delay is unpredictable but in most cases will fall within the range of a split second to several minutes. There will be evidence of smoke at the starter exhaust duct. The engine rpm will increase rapidly and the cartridge will give evidence of nearly normal operation. In this type malfunction the energy is expended and presents no hazard to engine operation.

(2) Misfire. A cartridge that fails to ignite. There is no physical evidence of smoke at the starter exhaust duct and no engine rotation. This type malfunction presents a potential fire and explosive hazard to engine operation until removed.

WARNING

- **The start switches and start selector switch must be in the OFF position prior to the GC removing a misfired cartridge.**
- Do not remove a cartridge that has fired normally, hangfired, or misfired until there is no evidence of exhaust smoke at the starter exhaust duct and minimum time intervals have elapsed since start initiation. Wear asbestos gloves when removing cartridge. Do not point screened end of cartridge at personnel or equipment.

NOTE

For actual EWO or if an impending disaster makes moving the airplane necessary and cartridge malfunctions, the waiting period after a misfire or hangfire may be reduced to not less than one minute after initiation of engine start provided the following conditions are met:

No smoke can be observed from starter exhaust.

Starter breech cover is not hot to the bare hand.

There is no evidence of pressure inside breech chamber (breech cover offers no undue resistance to removal).

Cartridge screen end is pointed away from aircraft, equipment, or personnel.

Cartridge is treated as a potential hangfire (fire hazard) for a period of 10 minutes after removal from breech.

C. **Not more than three pneumatic starts shall be made in any one period of 19 minutes.**

D. If cartridge starts and pneumatic starts are interspersed, no more than 3 starts shall be made within a 15 minute period. Two of these starts may be cartridge start provided that limitations noted previously are not exceeded.

WATER FOR THRUST AUGMENTATION

Normally water with less than 10 parts solids per million parts water will be used in the water injection system. Tap water rarely meets these specifications. Use of water with impurities greater than specified must be restricted to EMERGENCY USE ONLY. Water with impurities exceeding specified limits will coat the compressor blades with deposits which can result in lowering thrust and stall margins of the engine to a dangerous point. This is especially true if the engine is subsequently operated under dry takeoff conditions. Water with impurities exceeding specified limits also causes severe corrosion in the water tanks. When impure water is used this fact will be entered in the Form 781.

FUEL GRADE PROPERTIES AND LIMITS

Alternate fuels are defined as fuels which may be substituted for the recommended fuels with possible restriction to airplane performance. Alternate fuels will not cause permanent damage to the engine or fuel systems; however, they may require engine retrim. Figure 5-3 lists fuels in order of preference.

NOTE

Aviation gasoline and JP-4 fuel mixed in any proportion are suitable for continuous operation from an engine performance standpoint. However, the use of aviation gasoline must be restricted to emergency evacuation or one-time ferry-type missions to minimize undesirable lead deposits in the engines and to avoid damage to the engine driven fuel pump due to the poor lubricating properties of aviation gasoline.

Use of approved kerosene type alternate fuels will not adversely affect engine performance. Generally the full takeoff rating will be more readily available with the denser kerosene type fuels while airplane range performance will be at least as good or slightly better than with JP-4. Only during use of aviation gasoline (avgas) will it be necessary to retrim engines to obtain the full takeoff rating. To determine if retrim is required, perform the dry thrust check on one engine. Inability to obtain rated EPR will probably require retrim of all engines if takeoff is critical. It is recommended that, if a landing is made at a base having only aviation gasoline available and no facilities for engine retrimming, only enough fuel be loaded to accomplish a one-time flight to a base where JP-4 is available. Engines operating on aviation gasoline can be retrimmed to produce the same thrust as obtained with JP-4. The engine operating limitations discussed under ENGINE LIMITATIONS, in this Section, also apply to alternate and emergency fuels.

When using aviation gasoline, the engine driven fuel pump life becomes critical because of the gasoline's poor lubricating properties. In addition, the use of aviation gasoline will leave lead deposits in the burners, turbine section and tailpipe. For these reasons the use of aviation gasoline is to be avoided. When aviation gasoline is used, the rate of climb above the boiling altitude of the fuel must be reduced. This is required as approximately 0.5% of the tank fuel quantity will be evaporated overboard per 1000 feet of tank altitude above the boiling point altitude of the fuel. A rapid rate of climb will result in increased flow of fuel vapor through the tank vent system and excessive pressure in the tank. The kerosene type fuels will not limit airplane climb rate.

Gasoline and JP-4 fuel mixtures that contain less than 10% gasoline in all fueled tanks have no climb rate limitations.

When using fuel mixtures containing more than 10% gasoline in any tank and flying above the following limiting altitudes for the initial fuel temperatures, the rate of climb must be limited to 200 feet per minute. Wing and body fuel tanks are vented separately, resulting in different boiling altitudes.

Fuel in Wing Tanks Only

INITIAL FUEL TEMPERATURE °F	LIMITING ALTITUDE - FEET (BOILING ALTITUDE)
40	unlimited
50	55,000
60	48,000
70	40,000
80	36,000
90	30,000
100	25,000
110	20,000

Fuel in Wing Tanks, Body Tanks and/or Upper Deck Tank

INITIAL FUEL TEMPERATURE °F	LIMITING ALTITUDE - FEET (BOILING ALTITUDE)
40	48,000
50	44,000
60	40,000
70	34,000
80	30,000
90	25,000
100	21,000
110	17,000

NOTE

Correction for loss of range must be made if the boiling altitude of fuel, as indicated in above tables, is exceeded. Allow 0.5% loss of aviation gasoline on board for each 1000 feet of additional altitude.

After 5 or 6 hours of flight the wing fuel temperature, regardless of fuel temperature when loaded, may be assumed equal to the indicated free air temperature (OAT). The OAT gage indicates approximately 25°C (45°F) above ambient static air temperature at Mach 0.8 in ambient air colder than -40°C. This higher temperature is due to airspeed ram effect. The ram heating effect also maintains the airplane and fuel a like number of degrees above ambient static temperature. Therefore, flights through -54°C (-65°F) ambient

FUEL GRADE PROPERTIES AND LIMITS

USE	FUEL TYPE	GRADE	NATO SYMBOL	U.S. MILITARY SPECIFICATION	UNITED KINGDOM SPECIFICATION	SPECIFIC GRAVITY (Max-Min at 60°F)	FREEZE POINT- °F	FREEZE POINT- °C	LIMITS
RECOMMENDED FUEL	WIDE CUT GASOLINE	JP-4	F-40	MIL-T-5624		.802-.751	-72	-57	
ALTERNATE FUEL	WIDE CUT GASOLINE	COMMERCIAL JET B	F-40	NONE	DERD 2486	.802-.751	-56	-49	❷❸
	KEROSENE	JP-5	F-44	MIL-T-5624	DERD 2498	.845-.788	-51	-46	❷
		JP-5B	F-42	NONE	DERD 2488	.845-.788	-40	-40	❷
		JP-6	NONE	MIL-T-25656B		.84-.78	-65	-54	❷
		COMMERCIAL JET A-1	F-34	NONE	DERD 2494	.829-.775	-54	-48	❷❸
		COMMERCIAL JET A	F-30	NONE	DERD 2482	.829-.775	-36	-38	❷❸
EMERGENCY FUEL	AVIATION GASOLINE (AVGAS) PLUS 3% LUBRICATING OIL, SPEC MIL-L-22851, TYPE II	80/87	F-12	MIL-G-5572		.706	-76	-60	❶
		91/96	NONE	MIL-G-5572		.706	-76	-60	❶
		100/130	F-18	MIL-G-5572		.702	-76	-60	❶
		108/135	NONE	NONE		.707	-76	-60	❶
		115/145	F-22	MIL-G-5572		.706	-76	-60	❶

❶ Follow climb restrictions.

❷ Avoid flying at altitudes where indicated OAT is below the freeze point of the fuel.

❸ Prior to using commercial fuel, obtain freeze point from vendor or airline supplying the fuel, then follow limit 2 above. The aircraft commander should exercise caution if he suspects or observes improper fuel handling procedures. If there is any indication that cleanliness is not up to standard, a fuel sample should be taken in a glass container and observed for fogginess, presence of water or rust.

❹ Average value-limits are not controlled by specification.

Figure 5-3

static air temperature at 0.8M will result in integral fuel tank temperature approaching -29°C (-20°F), and in -79°C (-110°F) air, the integral tank fuel temperature will approach -54°C (-65°F). From these temperatures, it can be seen that -40°C to -54°C freeze point fuel could present operational problems. To insure boost pump and engine fuel feed system performance, airplane altitude should be adjusted to insure flying with indicated OAT above the fuel freeze point when using alternate fuel grades. In addition, reserve fuel should be carried in the warmer bladder-cell body tanks for use as required.

Takeoff when using alternate or emergency fuels should not be attempted with boost pumps inoperative. The high vapor pressure of aviation gasoline may result in fuel cavitation within the engine driven fuel pump and loss of thrust. The use of higher viscosity kerosene type fuels will result in higher engine fuel feed system pressure drop and loss of thrust from fuel starvation. The above is not meant to imply that takeoffs should be attempted with boost pump inoperative when using JP-4 fuel, except under emergency conditions.

Engine fuel flow is measured by mass-type flow transmitters and will read correct fuel weight flow regardless of the type of fuel used; however the fuel quantity gage system will read approximately 1% high when using aviation gasoline. Fuel quantity gage system error will be negligible when other alternate grade fuels are used.

AERODYNAMIC AND STRUCTURAL LIMITS

NOTE

All Mach No. data shown as airspeed limits are true Mach unless labeled as indicated Mach No.

AIRSPEED LIMITS

The clean airplane airspeed limitation which represents structural capability is 350 knots equivalent airspeed or Mach 0.90 whichever is lower. The point of intersection for 350 knots equivalent airspeed and Mach 0.90 is approximately 26,500 feet; therefore below 26,500 feet the 350 knots equivalent will be the limiting airspeed and above 26,500 feet, Mach 0.90 is the limiting airspeed. However, because the airspeed indicator is incapable of measuring equivalent airspeed, the airplane maximum speeds are presented in terms of indicated airspeed. The limiting airspeed pointer (striped pointer) is conservatively set at 350 KIAS to cover the most critical situation which is at sea level where 350 knots equivalent and 350 knots CAS are equal. When corrected for position error, the actual maximum indicated airspeed limitation at sea level is 354.5 KIAS. This striped pointer is mechanically restrained from moving above 350 KIAS but will rotate to a lower airspeed when an altitude is reached where 350 knots CAS and Mach 0.90 are equal. The point of intersection where 350 knots CAS and Mach 0.90 are equal is approximately 29,500 feet. If the striped pointer limitation is observed from sea level to 29,500 feet the airplane limitation imposed will be less than the actual airplane limitation; however from the flight crew standpoint, there is no way to determine maximum airplane speed above the striped pointer except to fly by a chart plotted to show equivalent airspeed and Mach number vs indicated airspeed. Attempting to fly by a chart showing the additional airspeed available between striped pointer limitation and actual airplane placard would be rather inconvenient and therefore observing the striped pointer limit may be more practical. It should be noted that the striped pointer limitation is well above normal cruise speeds; therefore observing this limitation will not impose any restriction to cruise speeds. The design

AIRSPEED AND MAX GROSS WEIGHT LIMITATIONS

MAXIMUM GROSS WEIGHT*

CONDITION	LIMITATION
GROUND OPERATION	301,600 LB
INFLIGHT AND LANDING	297,000 LB

MAXIMUM SPEED

CONDITION	LIMITATION
CLEAN CONFIGURATION	355 KIAS AT SL 360 KIAS 10,000 FT 368 KIAS 20,000 FT 376 KIAS 26,500 FT 367 KIAS 28,000 FT M = 0.90 ABOVE 29,500 FT
DURING LANDING GEAR EXTENSION OR RETRACTION	270 KIAS BELOW 38,000 FT M = 0.85 ABOVE 38,000 FT
LANDING GEAR DOWN	320 KIAS BELOW 30,500 FT M = 0.85 ABOVE 30,500 FT
WING FLAPS 50° 40° 30° 20°	180 KCAS ** 200 KCAS ** 210 KCAS ** 220 KCAS **
BOOM STOWED	SAME AS CLEAN CONFIGURATION
BOOM DOWN *** STANDARD BOOM WITH STANDARD OR HIGH SPEED RUDDEVATORS	330 KCAS BELOW 29,100 FT M = 0.85 ABOVE 29,100 FT
HI-SPEED BOOM WITH STANDARD RUDDEVATORS	330 KCAS BELOW 29,100 FT M = 0.85 ABOVE 29,100 FT
HI-SPEED BOOM WITH HI-SPEED RUDDEVATORS	SAME AS CLEAN CONFIGURATION
SPEED BRAKES	SAME AS CLEAN CONFIGURATION
EMERGENCY GEAR EXTENSION, RETRACTION OR GEAR DOWN	SAME AS CLEAN CONFIGURATION
DURING TERRAIN LIGHT EXTENSION OR RETRACTION	270 KIAS BELOW 38,000 FEET M = 0.85 ABOVE 38,000 FEET
TERRAIN LIGHT DOWN	320 KIAS BELOW 30,500 FEET M = 0.85 ABOVE 30,500 FEET

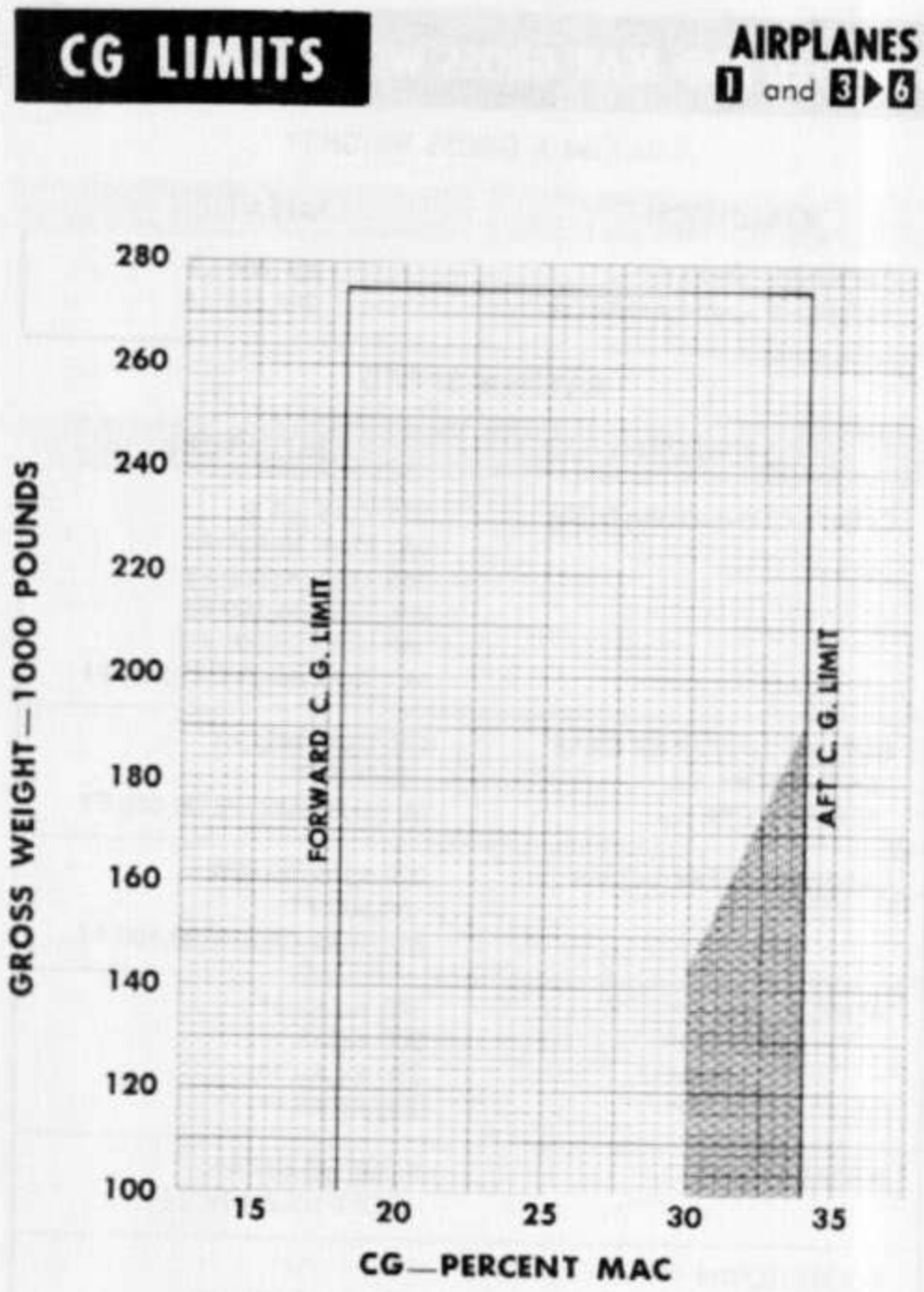
* Also see WEIGHT LIMITATIONS, this Section.

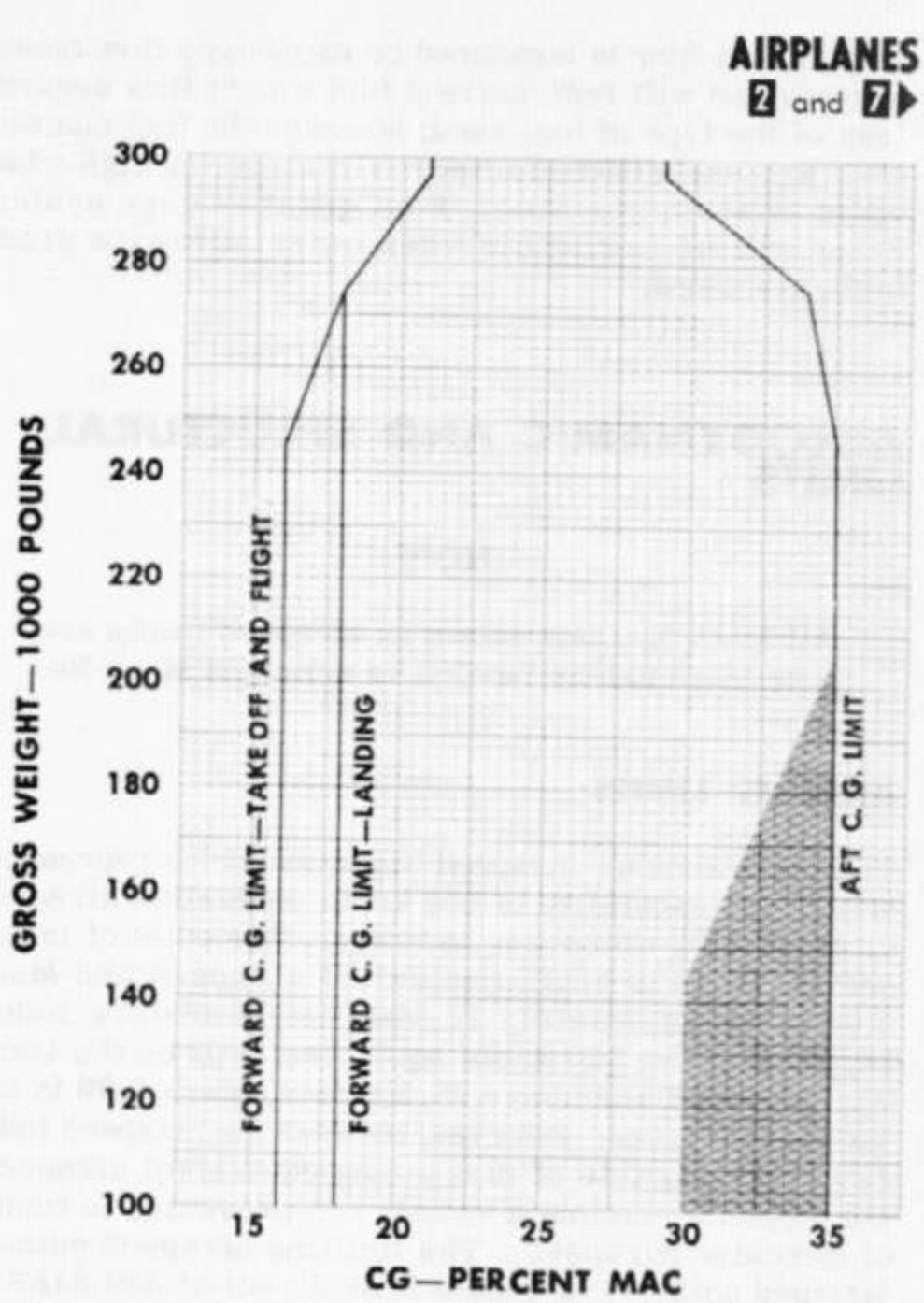
** Airspeed indicator position error varies appreciably with gross weight in this speed range. Therefore to obtain indicated airspeeds corresponding to the wing flap calibrated airspeed limitation, refer to Part 1 of the Appendix, T.O. 1C-135(K)A-1-1.

*** The limiting Mach No. with boom lowered is expressed in terms of true Mach. For indicated Mach, refer to Part 1 of the Appendix, T.O. 1C-135(K)A-1-1.

Figure 5-4

CG LIMITS





TAKEOFF CAUTION ZONE REQUIRING SPECIAL TECHNIQUE, SEE AIRPLANE PITCH-UP DUE TO AFT CG CONDITION, SECTION II.

Figure 5-5

Mach number to which the airplane was cleared for development test flight was Mach 0.95 to provide proof of structural integrity and flutter margins. The Mach indicator, however, does not read true Mach number because of position error of the static pressure source. This error is small until the Mach number is greater than Mach 0.90. As Mach number increases above Mach 0.90, the position error increases rapidly due to a shock wave ahead of the static source. The airplane can reach a true speed of Mach 0.95 with an indicated Mach number of only approximately 0.92. Since this error can vary somewhat with airplanes, the indicated Mach number placard has been set at Mach 0.90.

CG LIMITS

CG limits for airplanes 1, and 3▶6 as shown on figure 5-5, should be within the same cg range throughout the entire range of gross weights, up to a maximum inflight gross weight of 275,000 pounds. Cg limits for airplanes 2 and 7▶ with gross weights up to 300,000 pounds are also shown in figure 5-5. Due to structural limitations at gross weights above 245,000 pounds, the cg limits decrease progressively. The aft cg limit moves forward very sharply above 275,000 pounds due to other structural limits. On all airplanes the cg can be easily controlled by proper

fuel and cargo loading. Improper use of fuel in flight can result in exceeding limits. Therefore, it is important that fuel be used in the sequence outlined in FUEL MANAGEMENT PROCEDURES, Section VII. Refer to T. O. 1C-135(K)A-5 for additional information concerning cg limits, fuel loading and fuel management.

CAUTION

During ground handling, extreme care should be taken to keep the cg at or ahead of 37% MAC to reduce the possibility of the airplane tipping on its tail. The tail support strut should always be installed except when the airplane is moving, engines are operating, the airplane is on alert status or when directed otherwise. For operational purposes, when using the load adjuster, keep the cg at or ahead of 36% MAC.

ACCELERATION LIMITS

The airplane should be operated within the range of 0.2 to +2 g's. Lateral accelerations within airplane placards may cause nuisance tripping of a generator breaker due to temporary loss of oil to a generator drive; however, this is not considered critical. Symmetrical accelerations (0 g's or less) will cause loss of all three generators due to temporary loss of oil to the generator drives. To restore electrical system operation due to negative acceleration, see ELECTRICAL SYSTEM EMERGENCY OPERATION, Section III.

FLOOR LOADING LIMITATIONS

For information on cargo floor limitations, see CARGO LOADING in Section IV.

MANEUVER LIMITS-FLAPS DOWN

Figures 5-6 and 5-7 provide curves which may be used to determine the allowable flaps down maneuver limits to avoid exceeding the structural placard limits. This chart is useful in planning the approach.

RADIUS OF TURN-LOW ALTITUDE

The turn radius curves on figure 5-8 provide information to enable the prediction of distances required to perform low altitude maneuvering such as landing traffic patterns. True airspeed is used on this curve. Calibrated airspeed will be less than true airspeed at altitudes higher than sea level. For example: 200 knots TAS equal 200 knots CAS at sea level, 185 knots CAS at 5000 feet altitude and 171 knots CAS at 10,000 feet altitude.

INITIAL BUFFET IN ONE-G FLIGHT

It is possible with this airplane to fly fast enough under some conditions to cause a progressive air flow separation over the wing which results in an airplane buffet. It is recommended that speed be held low enough to avoid this buffet, although safe controlled flight can be made at higher speeds. The chart on figure 5-9 has been included to aid the pilot in determining when the initial buffet begins. The same information is shown on figure 5-10 in a manner which is more useful for determining initial buffet speeds for any weight and altitude.

NORMAL ACCELERATION LIMITS

An acceleration normal to the airplane flight path, is required to perform maneuvering flight. The airplane lift must be increased or decreased to provide a corresponding increase or decrease in the acceleration from that caused by gravity. These normal accelerations are usually expressed in units of acceleration of gravity from which the terminology "g's" arises. For example, the pilot feels a 2 g load (twice his actual weight) from the normal acceleration in a level, coordinated turn with a 60 degree angle of bank. The g loads applied as above may limit altitude and airspeed if buffet is to be avoided in maneuvering flight. There are sufficient margins during recommended cruise conditions in this airplane to allow normal maneuvering in turns and pullups without entering buffet regions. Figure 5-10 presents curves for determining maneuver boundaries based on initial buffet with flaps up for any combination of altitude, gross weight and airspeed.

TURN RADIUS AND TURN RATE—HIGH ALTITUDE

Figures 5-11 and 5-12 present the radius, turn rate and the normal acceleration obtained at any angle of bank at high altitudes.

MANEUVER LIMITS — FLAPS 30°

DATE: APRIL 1964
DATA BASIS: FLIGHT TEST

CONDITIONS:

FLAPS 30 DEGREES

SEA LEVEL TO 6000 FT

EXAMPLE:

GIVEN:
Gross weight = 160,000 lb
Flaps 30°
Go-around speed = 147 KIAS

FIND:
Maneuver limits at
(1) Recommended downwind leg speed
(2) Go-around speed

SOLUTION:
(1) Recommended downwind leg speed
(a) Maximum normal accel = 1.68G's
(b) Maximum bank angle = 53.3°
(2) Go-around speed
(a) Maximum normal accel = 1.49G's
(b) Maximum bank angle = 48°

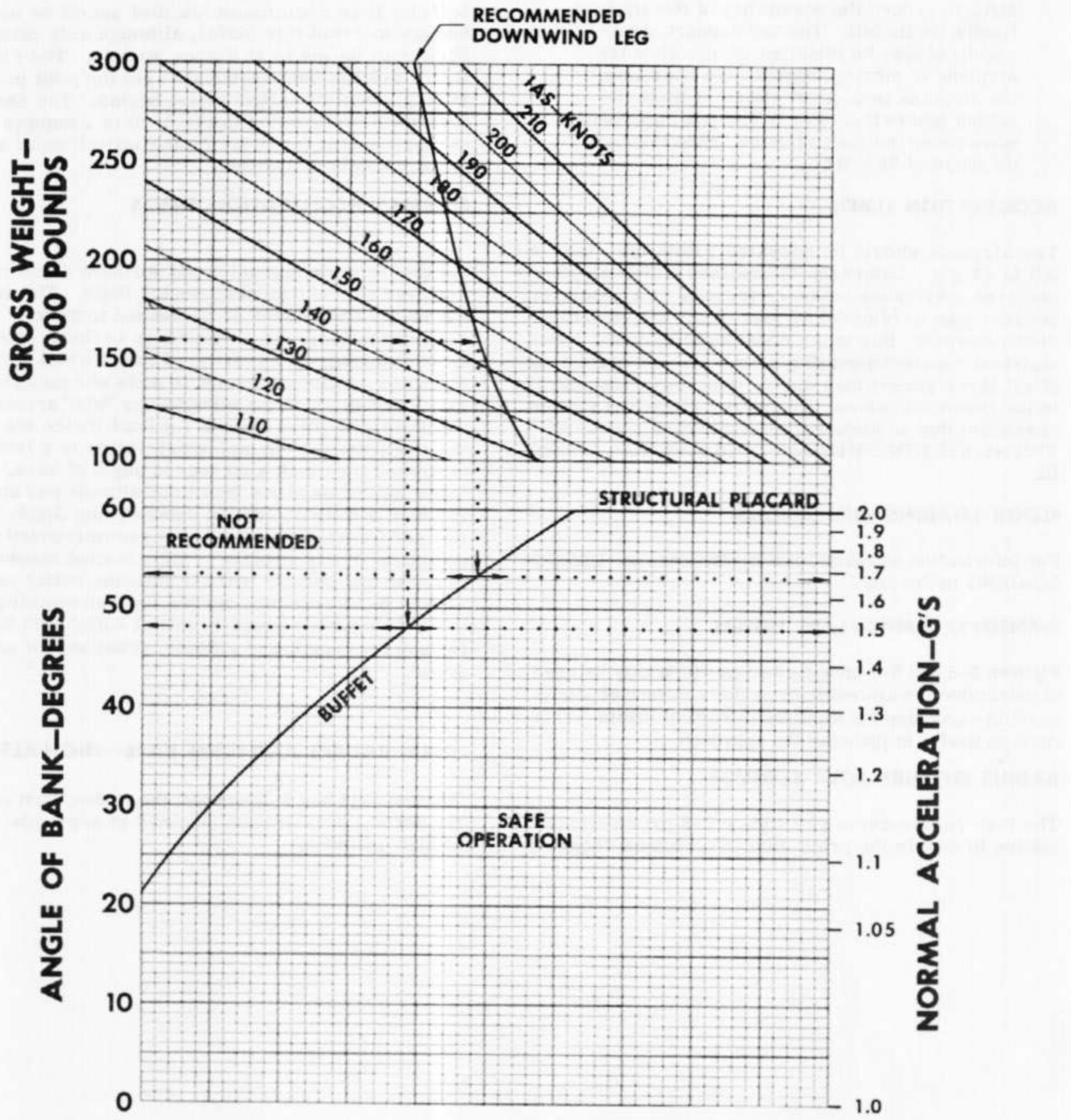


Figure 5-6

MANEUVER LIMITS — FLAPS 50°

DATE: APRIL 1964

DATA BASIS: FLIGHT TEST

CONDITIONS:

SEA LEVEL TO 6000 FT

FLAPS 50 DEGREES

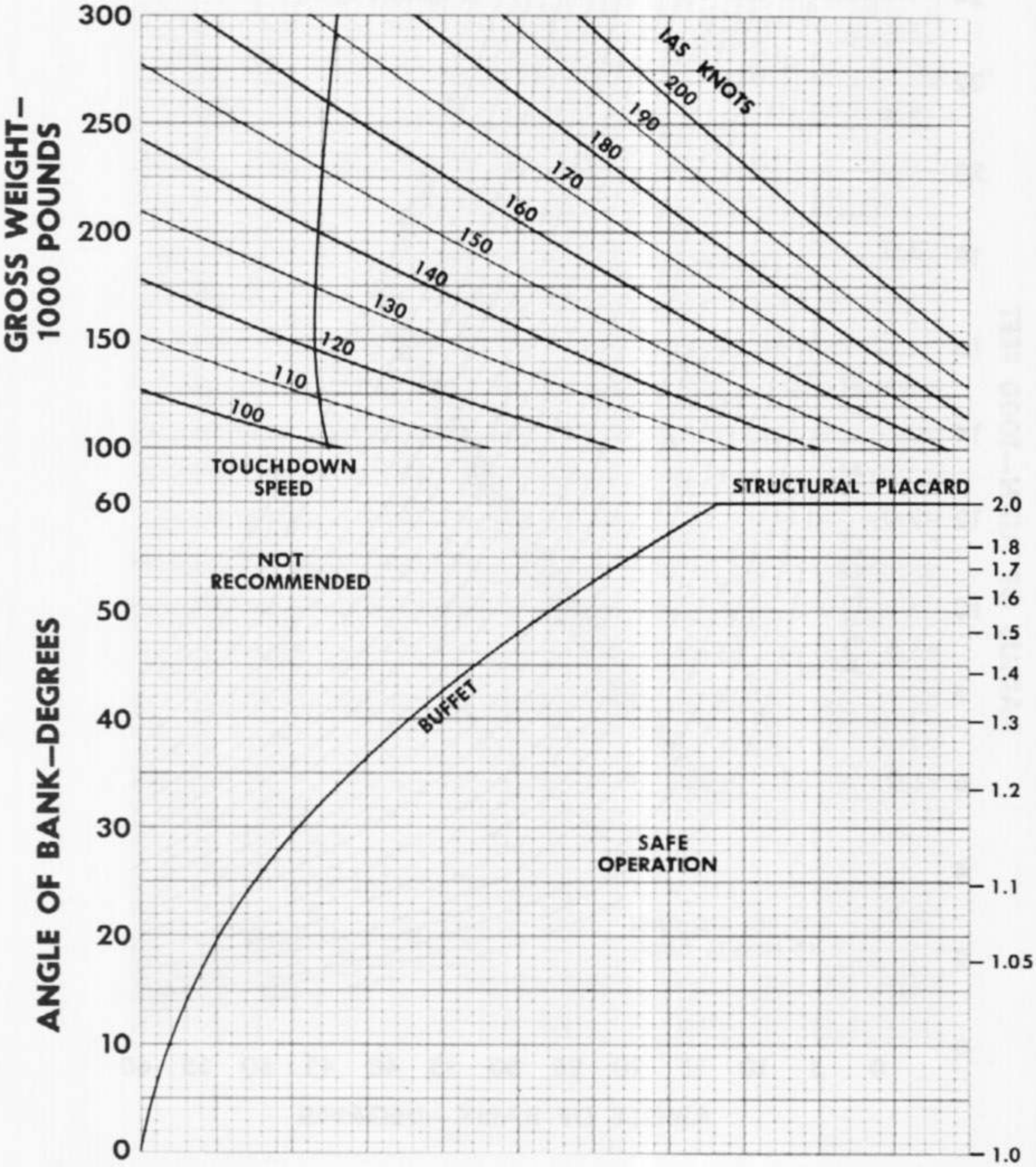


Figure 5-7

RADIUS OF TURN AT LOW ALTITUDES

DATE: MARCH 1960
DATA BASIS: FLIGHT TEST

CONDITIONS:

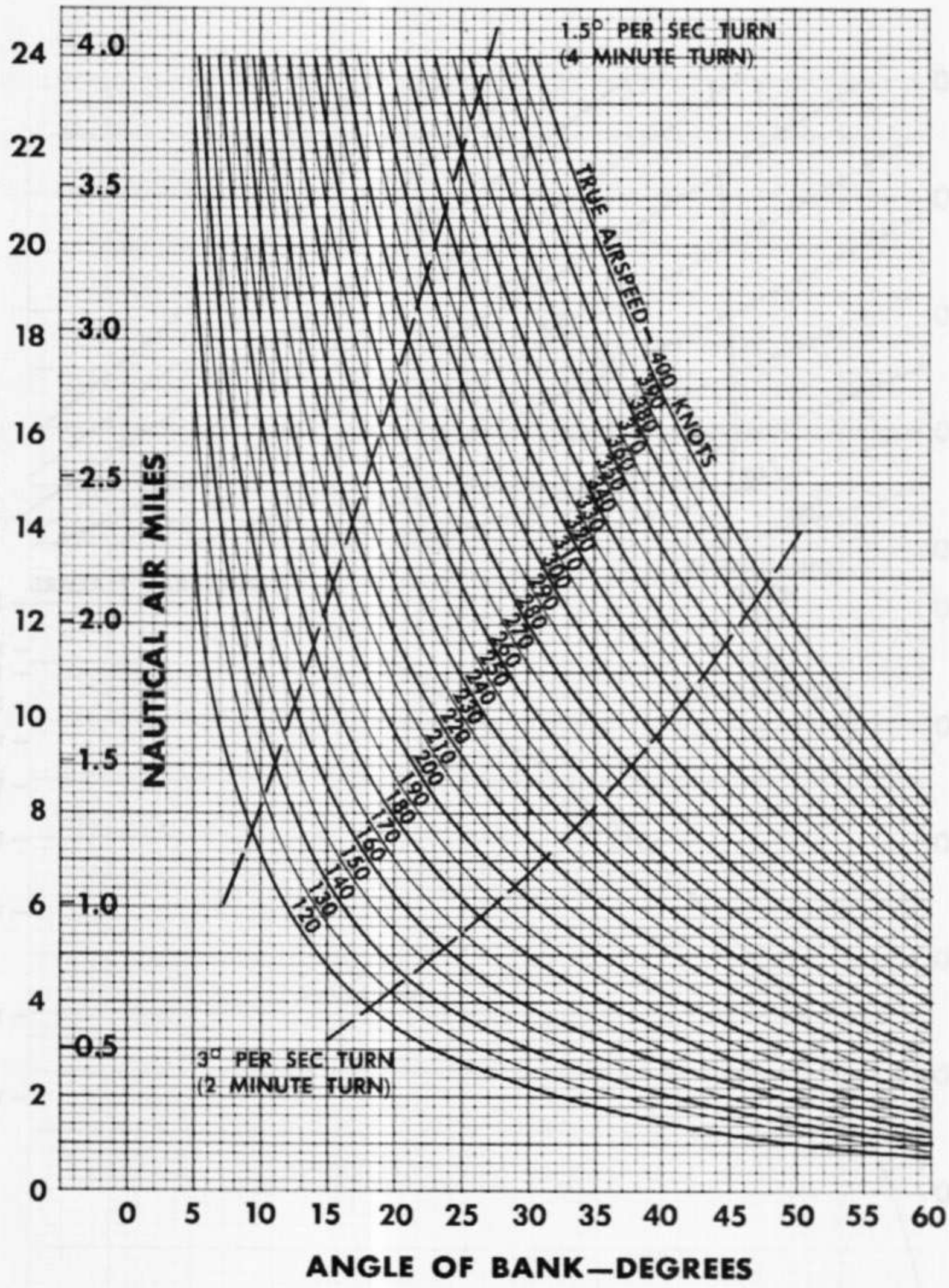
CONSTANT ALTITUDE TURN

NO WIND

REMARKS:

Applicable to any airplane.

Note that speeds are TAS.



F 355

Figure 5-8

INITIAL BUFFET IN ONE-G FLIGHT

DATE: MARCH 1958

DATA BASIS: FLIGHT TEST

CONDITIONS:

CLEAN CONFIGURATION

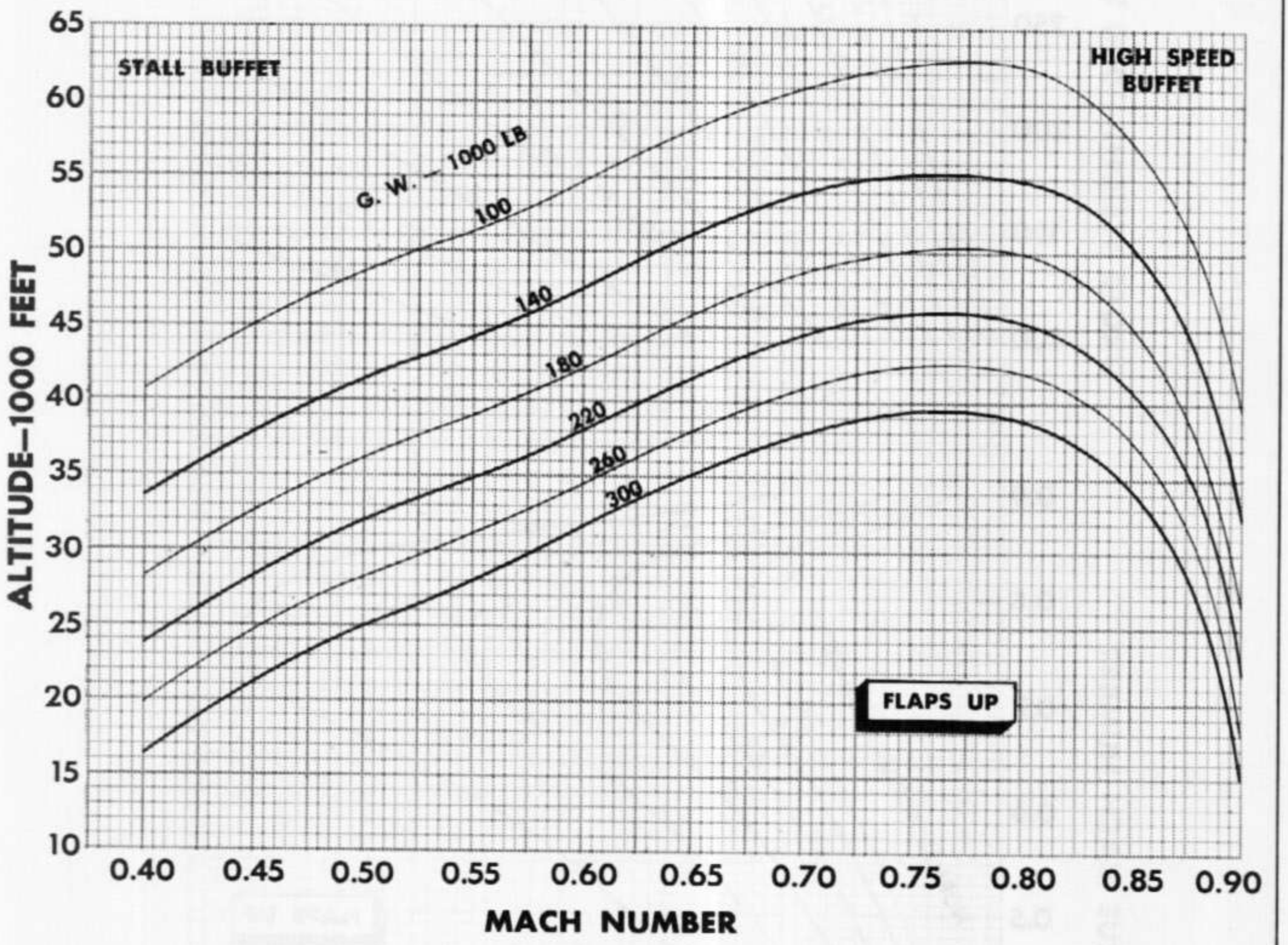


Figure 5-9

F-35A

NORMAL ACCELERATION AT INITIAL BUFFET

DATE: APRIL 1956
DATA BASIS: FLIGHT TEST

CONDITIONS:

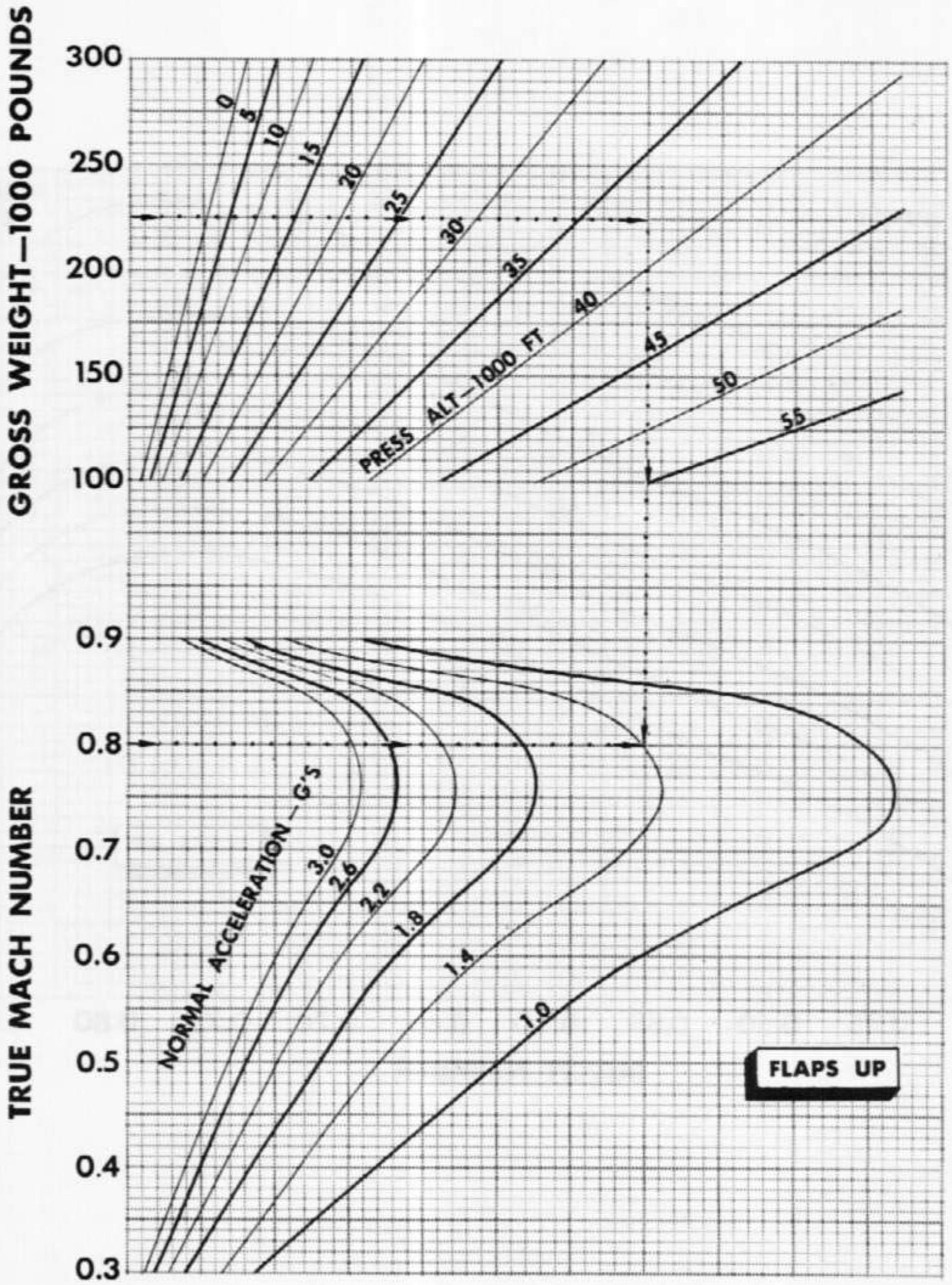
CLEAN CONFIGURATION

EXAMPLE:

GIVEN:
Gross weight = 225,000 LB
Pressure altitude = 37,500 FT
Mach number = 0.80

FIND:
Normal acceleration at initial buffet

SOLUTION:
Normal acceleration = 1.4 g



F 357

Figure 5-10

RADIUS OF TURN AT HIGH ALTITUDES

DATE: MARCH 1958
DATA BASIS: FLIGHT TEST

CONDITIONS:

35,000 FT AND ABOVE

CONSTANT ALTITUDE TURN

ICAO STANDARD DAY

NO WIND

EXAMPLE:

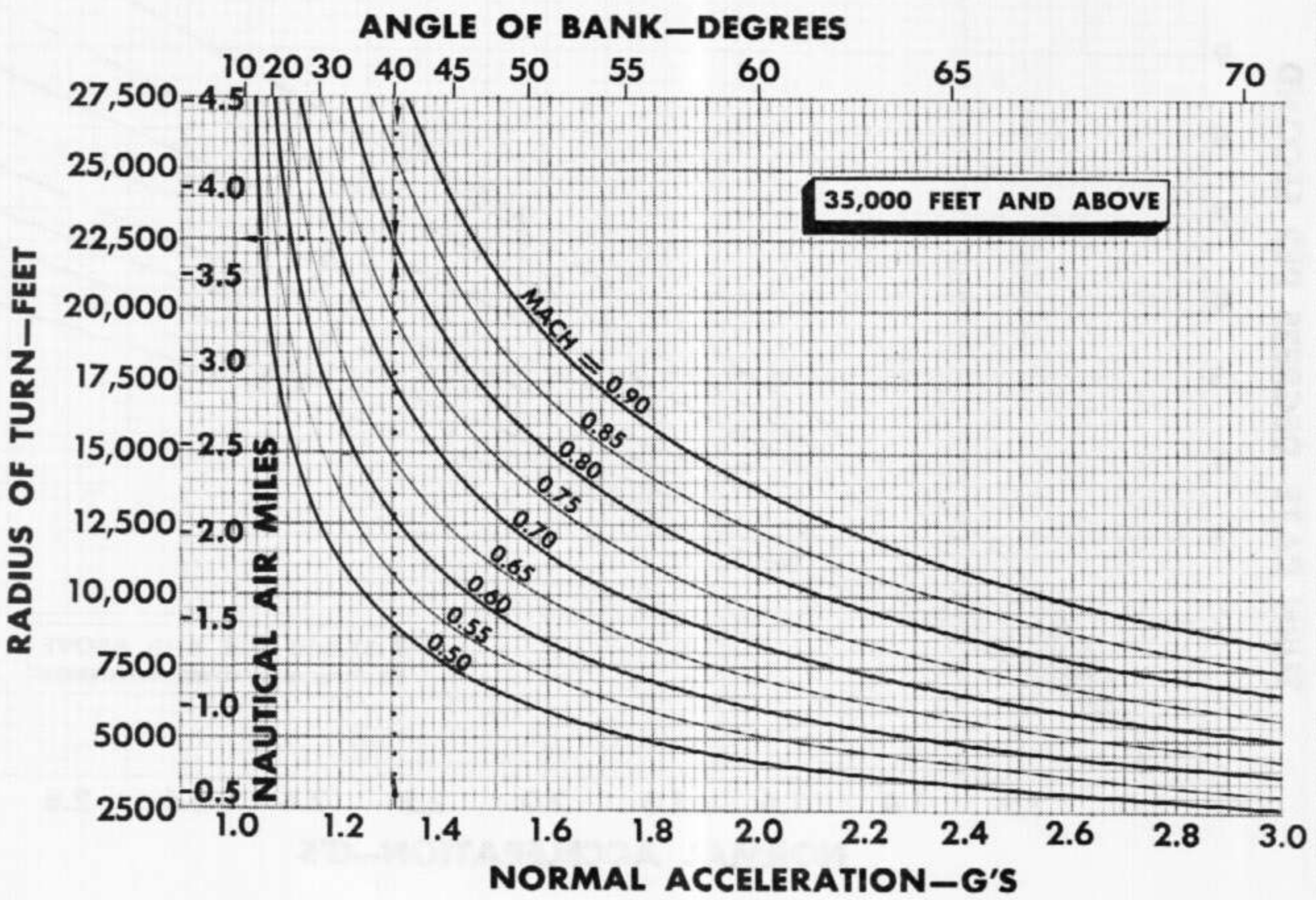
GIVEN:
Mach number = 0.80
Normal acceleration = 1.3 g (bank = 40°)

FIND:
Radius of turn

SOLUTION:
22,500 feet.

REMARKS:

Applicable to any airplane



F-358

Figure 5-11

TURN RATE AT HIGH ALTITUDES

DATE: APRIL 1956

DATA BASIS: FLIGHT TEST

CONDITIONS:

35,000 FT AND ABOVE

CONSTANT ALTITUDE TURN

ICAO STANDARD DAY

EXAMPLE:

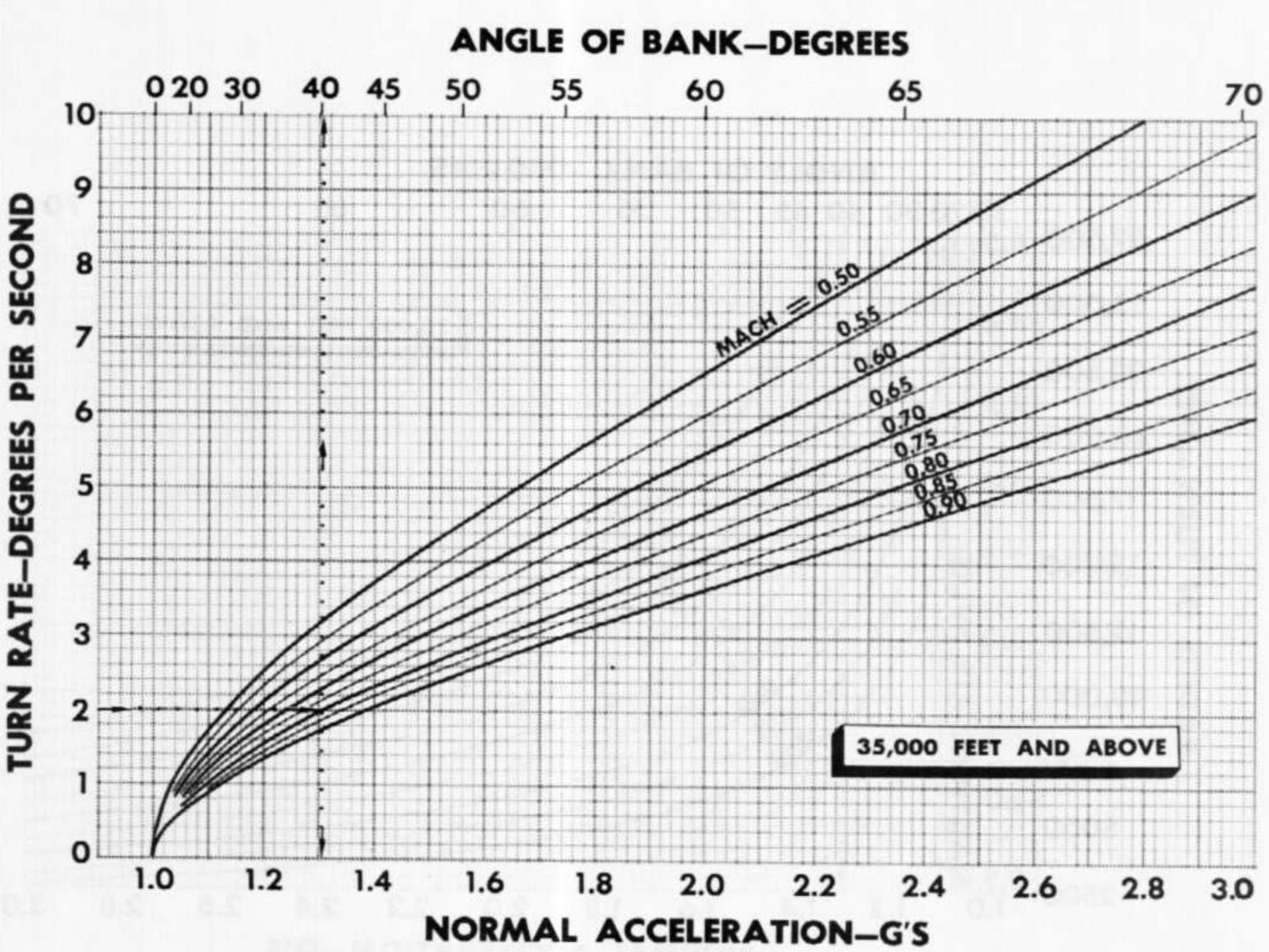
GIVEN:
Mach number = 0.80
Turn rate 2° per second

FIND:
Normal acceleration
Angle of bank

SOLUTION:
Normal acceleration = 1.31 g's
Angle of bank = 40°

REMARKS:

APPLICABLE TO ANY AIRPLANE



F-359

Figure 5-12

EXAMPLE PROBLEM 1

LOW ALTITUDE MANEUVER LIMITS

Given: Gross weight = 150,000 pounds
Flaps 30 degrees
Speed entering traffic pattern= 151 KIAS
Touchdown speed = 121 KIAS

Find: 1. Maneuver limits in traffic pattern
2. Radius of turn

Solution: 1. Maneuver Limits. The chart on figure 5-6 shows that for a 150,000 pound airplane at a pattern speed of 151 KIAS, a normal acceleration of 1.70 g's, or 54 degree bank angles are possible. However, at a touchdown speed of 121 knots, with no speed brakes and flaps 50 degrees, figure 5-7 shows that initial buffet would be encountered at 31.5 degrees angle of bank or at a normal acceleration of 1.18 g's.

2. Radius of Turn. Radius of turn is a function of TAS and bank angle. If the atmospheric conditions are such that the pattern speed of 151 KIAS is equal to 153 knots TAS, then figure 5-8 shows that a bank angle of 25 degrees will result in a radius of turn of 4500 feet with no wind, and at constant altitude.

EXAMPLE PROBLEM 2

HIGH ALTITUDE MANEUVER LIMITS

Given: The pilot wishes to make a 2.0 degree per second turn with the following airplane configuration:
Gross weight = 180,000 pounds
Altitude = 42,300 feet
Speed = Mach 0.80

Find: 1. Normal acceleration at initial buffet
2. Angle of bank
3. Turn radius

Solution: 1. Normal Acceleration at Initial Buffet. Entering the chart on figure 5-10 for the conditions given, it is seen that initial buffet should begin in a 1.4 g turn. This corresponds to approximately a 44.5 degree bank angle in constant altitude flight.

2. Angle of Bank. Entering the chart on figure 5-12 at a turn rate of 2.0 degrees per second, it is seen that a 40 degree angle of bank is required. This turn may be safely made since the resulting 1.31 g loading is less than the limits determined previously from figure 5-10.

3. Turn Radius. The chart on figure 5-11 shows that a 22,500 foot radius of turn is available with a 40 degree angle of bank at Mach 0.80.

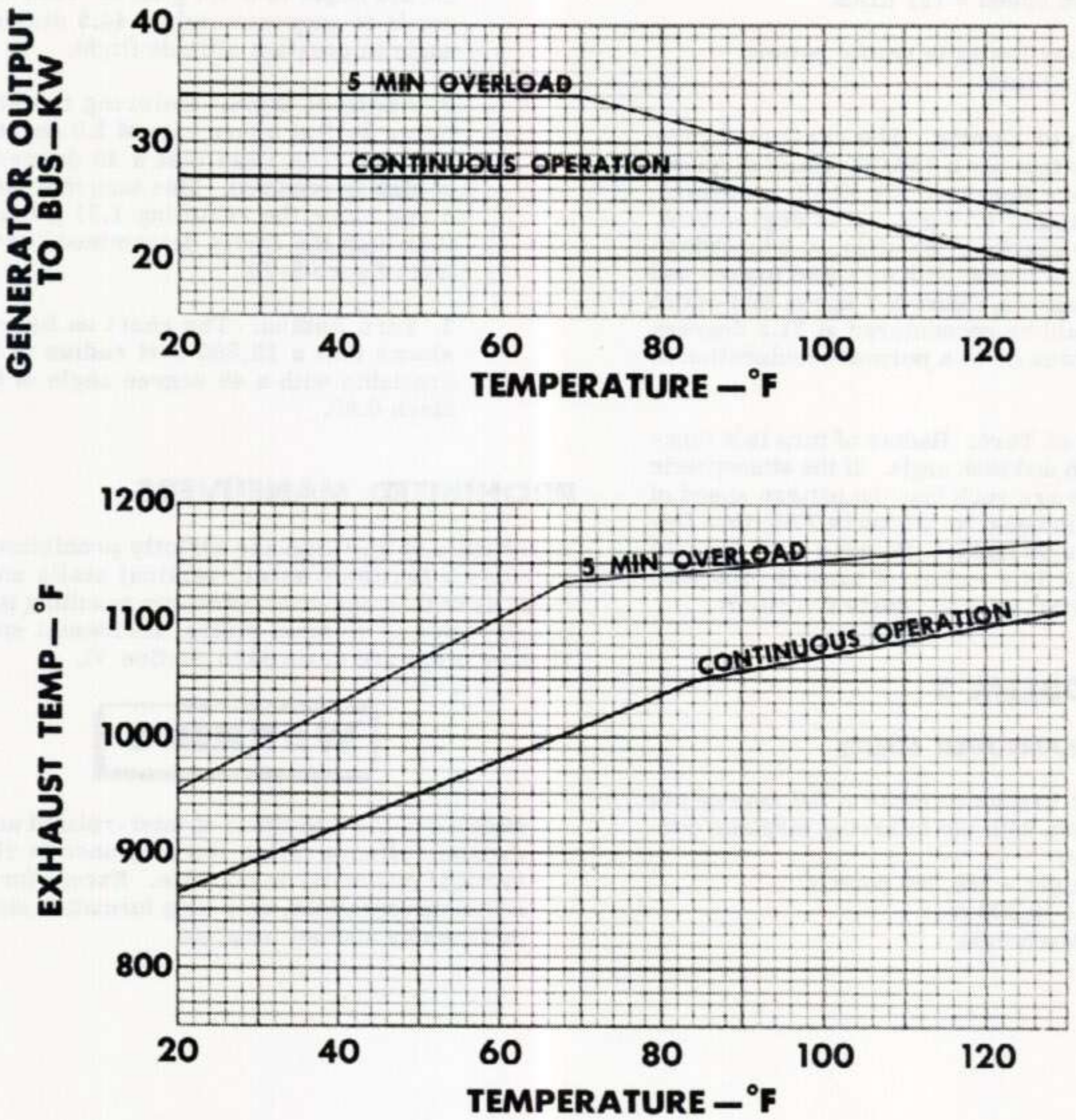
PROHIBITED MANEUVERS

Acrobatics of any kind are strictly prohibited. This includes intentional spins, vertical stalls and steep dives as well as any other maneuver resulting in abrupt accelerations. Normal stalls, accidental spins and shallow dives are covered in Section VI.

WARNING

Because of the magnitude of inter-related aerodynamic effects, flying two airplanes in close vertical proximity is not safe. Except for air refueling operations, only wing formation should be flown by another airplane.

APU OPERATING LIMITS (AiResearch)



F-360
F-361

Figure 5-13

EQUIPMENT LIMITATIONS

APU (AIRESEARCH)

The AiResearch APU is limited in electrical output depending on the ambient inlet air temperature; see figure 5-13.

APU STARTER (AIRESEARCH)

The duty cycle of the AiResearch starter motor is one minute of continuous cranking. After a one minute duty cycle allow the starter motor to cool for four minutes before repeating duty cycle.

NAVIGATION AND COMMUNICATIONS EQUIPMENT

The navigation and communications equipment is designed to operate satisfactorily in a pressurized cabin at all altitudes at which the airplane is capable of flying. On airplanes 186▶ , the AN/ARC-58 liaison radio transmitter must be kept at a cabin altitude of 20,000 feet or less. Refer to LIAISON RADIO (AN/ARC-58) in Section IV.

NOTE

Certain line of sight communication and navigation systems may be impaired or inoperative if the attitude of the airplane is such that the antenna is shielded, by airplane structure, from the ground station. This effect applies particularly to SIF, TACAN and UHF. This is to be considered as normal operation. Before a system is written up for malfunctioning, it should be checked with the airplane flying at different attitudes to verify whether or not there is a malfunction.

LIGHTS

Landing Lights

Do not operate the landing lights more than 5 minutes on the ground. This will prevent damage to the plastic fairing that covers the lights.

During ground operation of the taxi lights, try to avoid light operation of more than 15 minutes. Taxi light ground operation during hot day conditions in excess of 15 minutes may cause the plastic fairing to blister.

Nacelle Illumination Lights

Limit nacelle illumination lights ground operation to 15 minutes to prevent distortion of the pressure windows covering the lights.

Terrain Light

To avoid structural damage the terrain light should not be extended at airspeeds higher than those shown in figure 5-4.

OXYGEN REGULATOR

The D-2A oxygen regulator is suitable for routine use up to 42,000 feet and for emergency use up to 50,000 feet. In case of loss of cabin pressurization during flights above 42,000 feet, descend to an altitude of 42,000 feet or below within 5 minutes.

SEATS

The crew instructor's seat on airplanes 216▶ is stressed only to withstand normal acceleration loads experienced during flight; therefore, this seat is not designed for use during takeoff and landing. The load limit for this seat is 1420 pounds maximum, e.g.

$$\frac{1420 \text{ pounds}}{250 \text{ pounds/man}} = 5.68 \text{ g's}$$

TIRE LIMITATIONS

TAKEOFF WITH BADLY UNBALANCED TIRE

Serious damage to the landing gear can result from high speed ground operation with a badly unbalanced tire. Partial tread loss or a blowout during high speed wheel rotation with resulting partial disintegration of the tire could cause such an unbalance. Prior to every takeoff following a heavy braked landing or a refused takeoff, make a visual inspection of the tires to determine if their condition is safe. If a tire failure is encountered on takeoff before S_1 is reached, discontinue the takeoff.

MAXIMUM GROUND SPEED

All tires are capable of 199 knots IAS ground speed and have "195 knots" molded in the sidewall of both sides of the tires. The "195 knots" molded on the sidewall of the tires refers to the actual speed of the tires; however, the pilot has only the airspeed indicator for speed reference. When the airspeed indicator is corrected for position error the 195 knots becomes 199 knots IAS for standard day conditions. Airplanes will limit ground speed to 199 knots IAS for standard day conditions. See the TAKEOFF SPEEDS chart in Part 2 or the TOUCHDOWN SPEEDS chart in Part 9 of the Appendix, T.O. 1C-135(K)A-1-1 for corrections to IAS for various nonstandard conditions of altitude and temperature and for varying wind conditions.

ICE GRIP TIRES

The main and nose gear may be equipped with ice grip tires. These tires have steel wire imbedded in the tread to reduce skidding and improve steering on wet and icy runways. All ice grip tires are capable of 195 knots ground speed.

WARNING

Avoid brushing against or running hands across the tread of ice grip tires. Torn clothing and serious scratches can be inflicted by the steel wire imbedded in the tread.

BRAKE LIMITATIONS

The brakes are limited in the amount of work they can perform and still function properly. A measure of the amount of heat absorbed by the brakes is the amount of work performed by the brakes. The amount of work done is the kinetic energy expended, measured in millions of foot-pounds per brake. The amount of heat added to the brakes for each braking effort is cumulative and is determined by the speed of the airplane and its gross weight at the time the brakes are applied (figure 5-14). See BRAKE SYSTEM OPERATION in Section VII.

NOTE

- The effect of aerodynamic braking has been considered in the BRAKE LIMITS Chart, figure 5-14. This aerodynamic braking will slow the airplane 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 within a given stopping distance, 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 15 minutes or more whereas the 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 ground roll.

Some airplanes are equipped with wheel assemblies incorporating thermal fused screws and heat shields. The thermal fused screws are designed to release air pressure in the tires when the tie bolt radius temperature reaches approximately 300° F. This temperature will be reached in any stop or series of stops totaling approximately 20 million foot-pounds kinetic energy per brake on airplanes without 1C1B 622 or 22 million foot-pounds kinetic energy per brake on airplanes with 1C1B 622 . The heat shields delay the time required to melt the thermal screws from approximately 8-9 minutes without heat shields to approximately 16-17 minutes with heat shields. Observe brake cooling requirements as follows:

The pilot will note in Form 781 the foot-pounds of kinetic energy absorbed per brake for all stops of 15 million foot-pounds or more on airplanes without 1S18 622 or 20 million foot-pounds or more on airplanes with 1S18 622 .

MAXIMUM EFFORT STOP

Maximum effort stops may be required during a refused takeoff or during landing when it is necessary to stop in a minimum distance. Figure 5-14, sheets 1 and 3, give the foot-pounds of kinetic energy required to stop under variables of gross weight, airspeed, pressure altitude, runway OAT and flap setting. A maximum effort stop made as a result of refused takeoff requires more foot-pounds of energy than does a stop from a landing condition due to the thrust output of the engines. For maximum effort stop braking technique, refer to BRAKE SYSTEM OPERATION in Section VII.

Refused Takeoff

Determine the amount of work done by the brakes from figure 5-14, sheet 1 or sheet 3. If this does not exceed 5 million foot-pounds per brake on airplanes without 1C1B 622 or 6 million foot-pounds per brake on airplanes with 1C1B 622 , another takeoff may be attempted immediately.

NOTE

If low energy stops up to these energy levels 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.

On airplanes without 1C1B 622 , if the amount of work exceeds 5 million foot-pounds but is less than 15 million foot-pounds, it is recommended that takeoff be delayed 7 minutes for each one million foot-pound in excess of 5 million foot-pounds. When the urgency of the mission demands another takeoff and the work done exceeds 5 million foot-pounds but is less than 15 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 cleanup height is reached and the flaps are fully retracted. The gear should be extended 2 minutes for each one million foot-pounds above 5 million foot-pounds.

On airplanes with 1C1B 622 , if the amount of work exceeds 6 million foot-pounds but is less than 20 million foot-pounds, it is recommended that takeoff be delayed 5 minutes for each one million foot-pounds in excees of 6 million foot-pounds. When the urgency of the mission demands another takeoff and the work done exceeds 6 million foot-pounds but is less than 20 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 cleanup height is reached and the flaps are fully retracted. The gear should be extended 2 minutes for each one million foot-pounds above 6 million foot-pounds.

WARNING

Before a second takeoff is attempted, the possibility of a second refused takeoff must be considered. The cumulative effect of two refused takeoffs may exceed the brake energy limits causing tire explosion and fire which could endanger the crew and airplane.

During a full stop training mission landing, determine the amount of work done by the brakes. On airplanes without ISIS 622, if this does not exceed 5 million foot-pounds, another takeoff may be made. If the amount of work exceeds 5 million foot-pounds but is less than 15 million foot-pounds, takeoff should be delayed seven minutes for each one million foot-pounds in excess of 5 million foot-pounds. On airplanes with ISIS 622, if the work done does not exceed 6 million foot-pounds, another takeoff may be made. If the amount of work exceeds 6 million foot-pounds but is less than 20 million foot-pounds, takeoff should be delayed 5 minutes for each one million foot-pounds in excess of 6 million foot-pounds.

High Energy Refused Takeoffs or Braked Landings

Any braking effort between 15 and 22 million foot-pounds on airplanes without ISIS 622 or between 20 and 28 million foot-pounds on airplanes with ISIS 622 must be handled with caution. Park airplane, cut engines and do not set brakes.

WARNING

- If a second braking attempt is made before heat is dissipated from the first attempt, the brake energy limits may be exceeded causing tire explosion and fire that could endanger the crew and airplane.
- After the brakes have been used excessively for an emergency stop and are suspected to be in an overheated condition, the airplane should not be taxied any more than is necessary to clear the active runway. The airplane should not be maneuvered into a crowded parking area and the parking brakes should not be set. Do not approach overheated brakes for one-half hour.

NOTE

Peak temperatures are reached in the brake housing approximately 15 minutes after braking.

Visually check brakes for hydraulic leaks and tire bead seat damage. Inspect brakes per T.O. 1C-135(K)A-2-7 for brake wear check. Delay takeoff for one and one-half hours or until hand can be held on brake housing. Braking efforts above 22 million foot-pounds on airplanes without ISIS 622 or 28 million foot-pounds on airplanes with ISIS 622 will possibily cause damage to the brakes and tire explosion or fire. Braking efforts significantly above 28-1/2 million foot-pounds on airplanes without ISIS 622 or 35 million foot-pounds on airplanes with ISIS 622 will melt wheel and brake assemblies and probably cause extensive damage to landing gear structure. 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.

LANDING ROLLOUT STOP

The landing rollout stop is the normal landing. Figure 5-14, sheets 2 and 4, give foot-pounds of kinetic energy required to stop under variables of pressure altitude, runway OAT, airspeed, gross weight and braking distance. The limitations on brake energy are the same as for maximum effort stops. For the correct braking technique in making a landing rollout stop, see BRAKE SYSTEM OPERATION in Section VII.

EXAMPLE PROBLEM

Given:
1. Full stop landing, 4-rotor brakes (without ISIS 622)
2. Gross weight = 200,000 pounds
3. Airspeed when brakes applied = 125 KIAS
4. Reported wind = 10 knot headwind
5. Pressure altitude = 4000 ft
6. Runway OAT = -22° F

Find: Compare maximum effort stop with landing rollout stop = 8000 ft

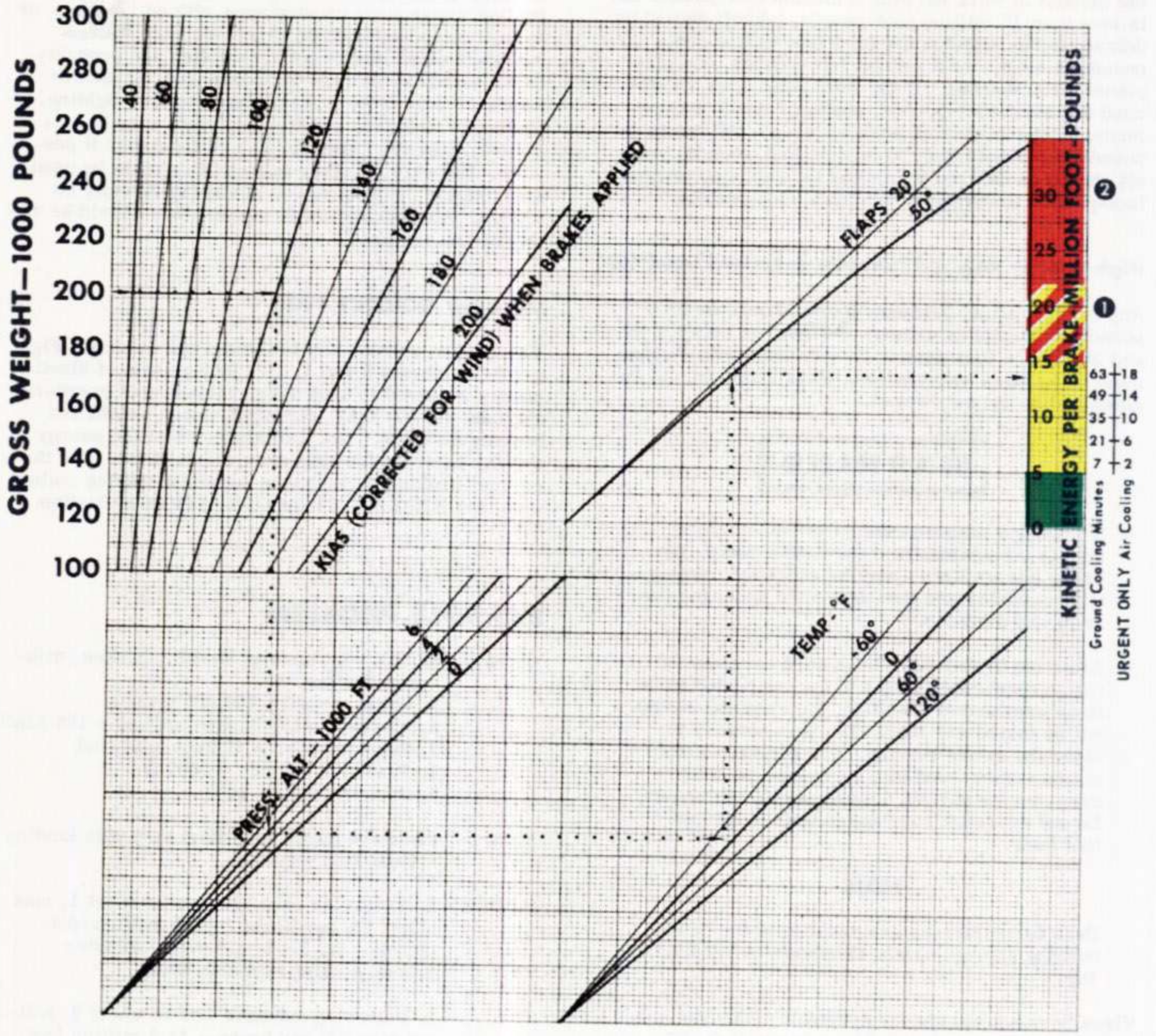
Solution:
1. Following example line on sheet 1, max effort KE per brake = 13.5 million foot-pounds. (13.5 - 5) x 7 = 59.5 minutes ground cooling recommended.

2. Following example line on sheet 2, rollout stop KE per brake = 11.8 million foot-pounds. (11.8 - 5) x 7 = 47.6 minutes ground cooling recommended.

BRAKE LIMITS

DATE: OCTOBER 1966
DATA BASIS: FLIGHT TEST

AIRPLANES WITHOUT 118 330 AND 510 627
MAXIMUM EFFORT STOP



❶ Thermal fused screws will melt to release air pressure in tires (see text).

❷ 31 million foot pounds kinetic energy per brake is the maximum design capability for one stop. See maximum braking speed in Part 9 of Appendix, T.O. 1C-135(K)A-1-1 for exact values of upper limit.

NOTE

50% of the headwind component is subtracted from the IAS, 150% of the tailwind component must be added to the IAS.

NORMAL ZONE – 0 TO 5 MILLION FT-LB

If stop does not exceed 5 million ft-lbs no special procedure is required.

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Figure 5-14 (Sheet 1 of 4)

NORMAL ZONE – 5 TO 15 MILLION FT-LB

1. If stop exceeds 5 million ft-lb, delay subsequent takeoff 7 minutes for each one million ft-lb in excess of 5 million.
2. If stop exceeds 5 million ft-lb and immediate takeoff is made:
   (A) Make normal takeoff.
   (B) After clean-up height is reached and flaps are retracted, extend gear and leave down for 2 minutes for each one million ft-lb in excess of 5 million.
   (C) Loss in rate of climb of approximately 300 FPM can be expected.

CAUTION ZONE - 15 TO 22 MILLION FT-LB

1. Clear runway; do not set brakes.
2. Request fire fighting equipment. Hydraulic fluid fire and tire explosions are possible.
3. Evacuate airplane by moving forward from the main crew entrance to avoid main wheels.
4. Leave immediate vicinity.
5. Do not approach airplane for ½ hour.
6. Inspect for tire bead seat damage and hydraulic leaks.
7. Delay subsequent takeoff for 1½ hours or until hand can be held on brake housings.
8. Enter KE/brake in Form 781.
9. Have brakes inspected per T.O. 1C-135(K)A-2-7 for brake wear.

DANGER ZONE - OVER 22 MILLION FT-LB

1. Clear runway; do not set brakes.
2. Request fire fighting equipment. Hydraulic fluid fire and tire explosions are imminent.
3. Evacuate airplane by moving forward from the main crew entrance to avoid main wheels.
4. Leave immediate vicinity.
5. After brakes have cooled, have inspected per T.O. 1C-135(K)A-2-7.
6. Enter KE/brake in Form 781.
7. Have tires removed and checked per T.O. 4T-1-3.

AIRPLANES WITHOUT VIB 550 AND VIB 622

LANDING ROLLOUT STOP

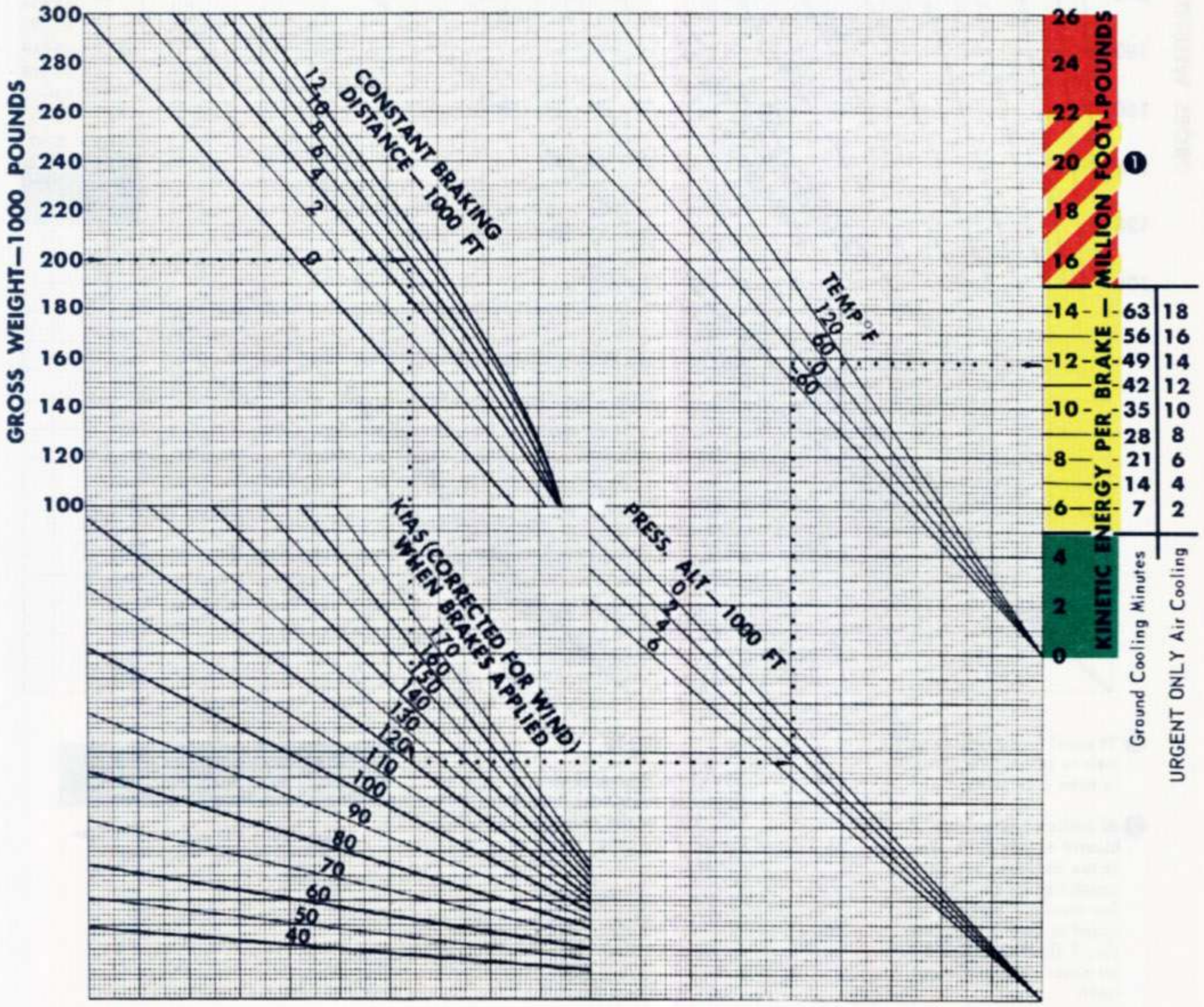


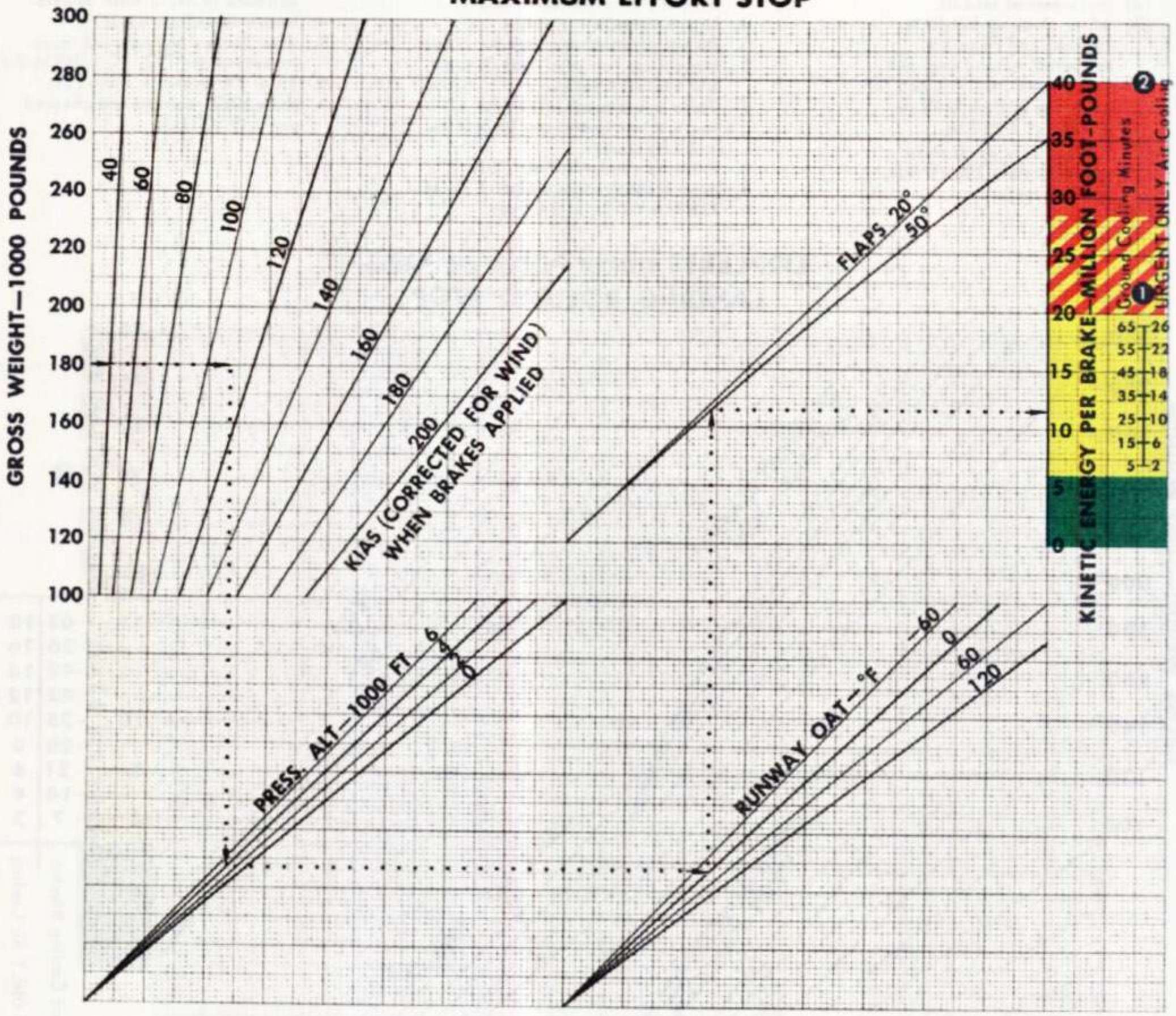
Figure 5-14 (Sheet 2 of 4)

BRAKE LIMITS (CONT)

DATE: FEBRUARY 1966
DATA BASIS: FLIGHT TEST

AIRPLANES WITH 1C-135 550 **AND** 1C-135 622

MAXIMUM EFFORT STOP



❶ Thermal fused screws will melt to release air pressure in tires (see text).

❷ 40 million foot-pounds kinetic energy per brake is the maximum design capability for one stop. See maximum braking speed in Part 9 of Appendix, T.O. 1C-135(K)A-1-1 for exact values of upper limit.

NOTE

50% of the headwind component is subtracted from the IAS, 150% of the tailwind component must be added to the IAS.

NORMAL ZONE - 0 TO 6 MILLION FT-LB

If stop does not exceed 6 million ft-lbs no special procedure is required.

Figure 5-14 (Sheet 3 of 4)

NORMAL ZONE - 6 TO 20 MILLION FT-LB

1. If stop exceeds 6 million ft-lb, delay subsequent takeoff 5 minutes for each one million ft-lb in excess of 6 million.
2. If stop exceeds 6 million ft-lb and immediate takeoff is made:
   (A) Make normal takeoff.
   (B) After clean-up height is reached and flaps are retracted, extend gear and leave down for 2 minutes for each one million ft-lb in excess of 6 million.
   (C) Loss in rate of climb of approximately 300 FPM can be expected.

CAUTION ZONE - 20 TO 28 MILLION FT-LB

1. Clear runway; do not set brakes.
2. Request fire fighting equipment. Hydraulic fluid fire and tire explosions are possible.
3. Evacuate airplane by moving forward from the main crew entrance to avoid main wheels.
4. Leave immediate vicinity.
5. Do not approach airplane for ½ hour.
6. Inspect for tire bead seat damage and hydraulic leaks.
7. Delay subsequent takeoff for 1½ hours or until hand can be held on brake housings.
8. Enter KE/brake in Form 781.
9. Have brakes inspected per T.O. 1C-135(K)A-2-7 for brake wear.

DANGER ZONE - OVER 28 MILLION FT-LB

1. Clear runway; do not set brakes.
2. Request fire fighting equipment. Hydraulic fluid fire and tire explosions are imminent.
3. Evacuate airplane by moving forward from the main crew entrance to avoid main wheels.
4. Leave immediate vicinity.
5. After brakes have cooled, have inspected per T.O. 1C-135(K)A-2-7.
6. Enter KE/brake in Form 781.
7. Have tires removed and checked per T.O. 4T-1-3.

AIRPLANES WITH 1C135-550 AND 1C135-622

LANDING ROLLOUT STOP

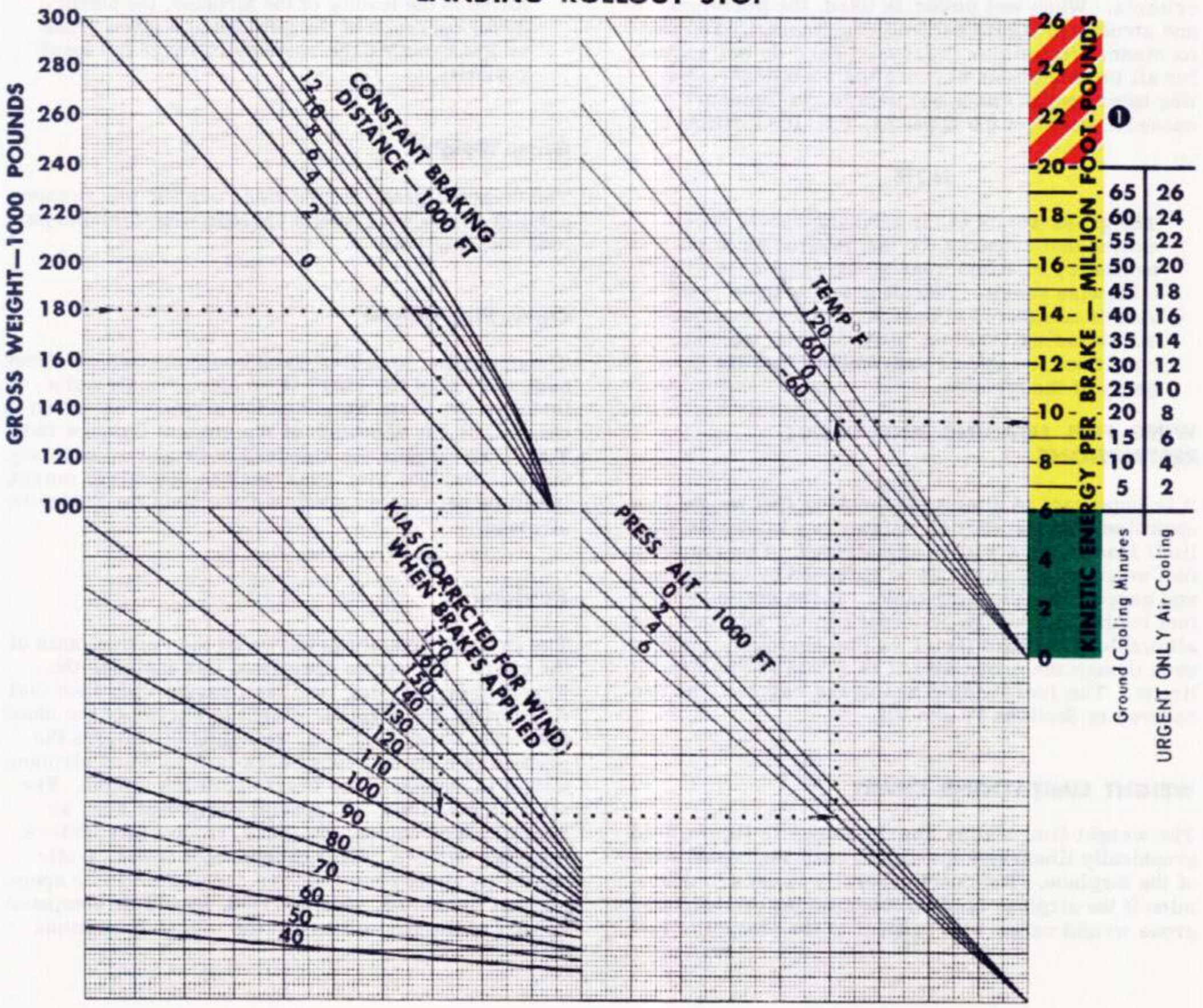


Figure 5-14 (Sheet 4 of 4)

WEIGHT 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 rate of climb, 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 with dry power are determined by performance criteria. When wet power is used, the performance and structural limits become coincidental. The performance limitations discussed here do not account for all the variations in operating conditions. Operating takeoff performance and field length limits are discussed in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1.

NOTE

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

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. The spanwise fuel weight distribution can be governed by fuel loading and 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 covered in Sections IV and VII.

WEIGHT LIMITATIONS CHART

The weight limitations charts shown in figure 5-15 graphically illustrates the weight carrying capabilities of the airplane. The chart generally is used to determine if the airplane is in a recommended or restricted gross weight range with respect to the amount of fuel carried in the fuel tanks versus the payload. It will be noted that center wing tank fuel is plotted on the payload axis for the cargo configuration. This is done to give a more flexible loading arrangement; that is, maximum cargo for short ranges with lesser amounts for longer ranges. Use of body tank fuel for range extension of cargo operations is not recommended although it is not prohibited. During cargo operations, with usable fuel in the body tanks, the airplane must be operated in the cautionary range because of the higher gross weights encountered and the reduced fuel dumping capacity. On the air refueling charts, center wing tank fuel is plotted on the wing fuel axis. Center wing tank fuel is plotted this way to more clearly illustrate the body tank structural limitations that apply when body tank fuel is carried during air refueling operations. Various components of the charts are explained in the following paragraphs.

NOTE

Although the charts indicate the limitations involved in the loading of the airplane, the authority for operation of the airplane at a given gross weight remains the responsibility of the local authority.

Gross Weight

The diagonal gross weight lines are for use in interpolating gross weight with various wing fuel and payload combinations.

Operating Weight

The operating weight of each configuration as shown near the top of the chart is an approximate value. It includes the basic weight of the airplane as shown in Chart C of the Handbook 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.

Payload

The payload capacity is shown on the vertical axis of the chart. For cargo operation, this includes the weight of center wing tank fuel, cargo, body tank fuel (if carried) and airplane weight in excess of the chart operating weight. For air refueling operations the payload is body and upper deck tank fuel and airplane weight in excess of the chart operating weight. For all configurations, any special equipment such as cargo loading equipment, jacks, troop seats, litters, tie-down devices, wheel chocks, tool boxes, arctic capability equipment etc., are considered to be special load items and, when carried, should be computed as part of the payload to use the weight limitations

chart. If the true operating weight is less than that given at the top of the chart the allowable payload is increased by the difference between the chart figure and the true operating weight. (See the example problem.)

Wing Fuel Capacity

The wing fuel capacity is shown on the horizontal axis of the chart. For cargo operations this includes the weight of fuel in the four main tanks and reserve tanks; for air refueling operations the wing fuel capacity includes fuel in the four main tanks, reserve tanks and the center wing tank.

NOTE

The load factor lines on the chart are valid only when the FUEL MANAGEMENT PROCEDURES in Section VII are followed.

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 figure 5-15 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. Figure 5-16 illustrates the limitations imposed on the maneuver-critical or gust-critical limit load factors (refer to legend on figure 5-16) by the structural design of the airplane. The solid line represents the tanker airplane and should not be used when cargo is carried on the upper deck. The dashed line represents the cargo airplane and should not be used when any fuel is carried in the forward or aft body tanks. The limit maneuver load factor for a flaps-down configuration is +2.0 g's except where governed by the maximum lift coefficient ($C_{L_{max}}$) to a smaller value.

NOTE

The leading edge flaps, when extended and in certain speed ranges, have an allowable load factor lower than airplane allowable load factor. Refer to LEADING EDGE FLAPS MALFUNCTIONS in Section III.

Airplane Flight Load Factors

NOTE

The weight limitations charts are divided into two areas of operation; cargo operation (figure 5-15, sheets 1 and 3) and air refueling operations (figure 5-15, sheets 2 and 4). The limited gross weight airplanes weight limitations are shown on figure 5-15, sheets 1 and 2; the full gross weight airplanes weight limitations are shown on figure 5-15, sheets 3 and 4.

Cargo Operations

The green and yellow areas on the weight limitation charts indicate allowable load factors for various combinations of fuel and payload. The green area indicates combinations of wing fuel and payload that may be flown up to a 2.5 g load factor without danger of permanent set. In the green area, limited gross weight airplanes can carry 67,978 pounds corrected payload including up to 47,489 pounds of center wing tank fuel with forward and aft body tanks empty, and combinations of wing fuel and payload up to 230,000 pounds gross weight. Full gross weight airplanes can carry 83,000 pounds of corrected payload including 47,000 pounds of center wing tank fuel with the forward and aft body tanks empty, and combinations of wing fuel and payload up to 245,000 pounds gross weight. The yellow area indicates a 2.0 g load factor and any combination of fuel and payload which increases the gross weight above 230,000 pounds for limited gross weight airplanes and above 245,000 pounds for full gross weight airplanes should be flown with caution, especially when making turns or pullouts, or flying in turbulence.

CAUTION

With any usable fuel in the forward or aft body tanks the airplane must be operated in the cautionary range (2.0 g load factor) because of body structural limitations.

Air Refueling Operations

The green and yellow areas on these weight limitations charts indicate allowable load factors for various combinations of wing fuel and body fuel. The green area indicates a 2.5 g load factor and limited gross weight airplanes can carry up to 20,489 pounds of body fuel and full gross weight airplanes can carry up to 35,000 pounds of body fuel. The yellow area indicates 2.0 g load factor. Any combination of wing and body tank fuel that increases the gross weight

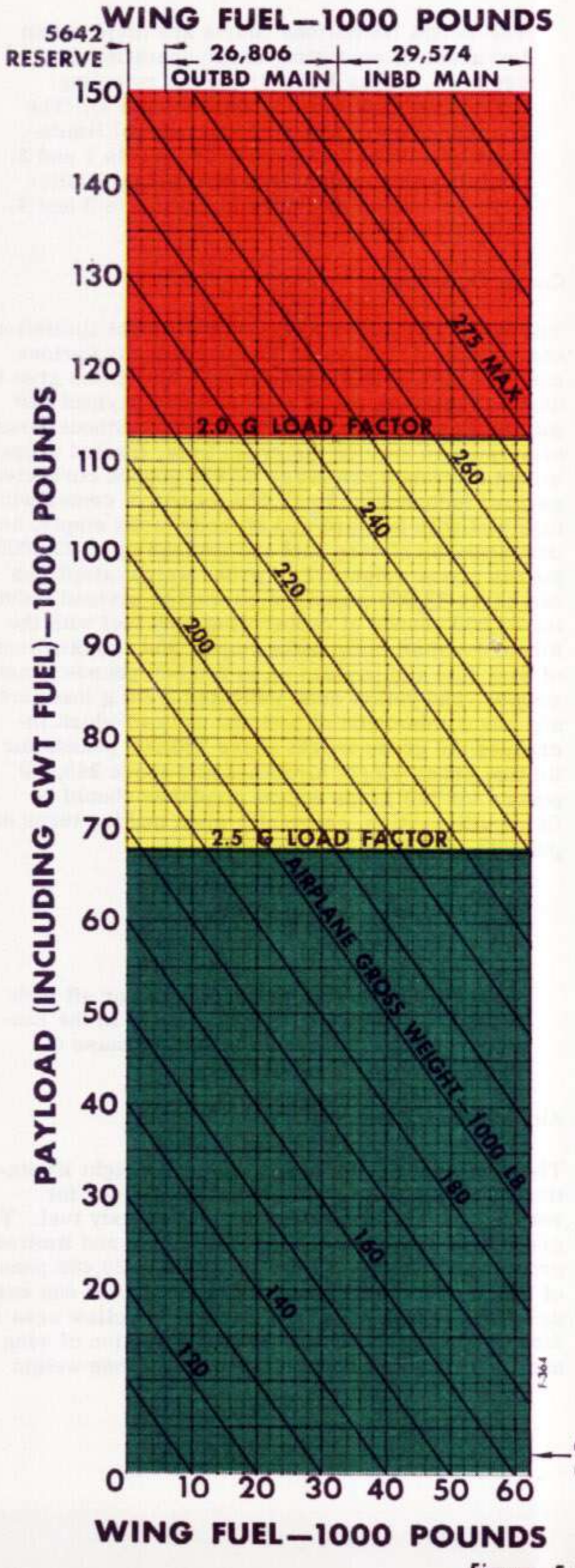
WEIGHT LIMITATIONS

DATE: MAY 1958

CARGO LOADING (FWD AND AFT BODY TANKS EMPTY)

AIRPLANE OPERATING WT—100,000 POUNDS

AIRPLANES 1 AND 3▶6



CAUTION

- This chart shows limits only with proper fuel distribution and usage given under FUEL SYSTEM OPERATION AND MANAGEMENT in Section VII.
- Because of the variety of cargo and body fuel loading combinations possible, this chart should not be used to interpolate load factors, but only to determine areas of operation. All points between 2.0 and 2.5 g lines must be considered as 2.0 g. For maximum allowable flight load factors at a specific gross weight, refer to Figure 5-16. For takeoff and landing performance data, see Parts 2 and 9 of the Appendix, T.O. 1C-135(K)A-1-1.
- The weight limitations charts are valid only for the tanker or cargo configuration. Airplanes in other configurations may have additional restrictions covered in separate publications.

NOTE

- All fuel tank weights are usable fuel.
- If Compartments "D" thru "S" (figure 4-53) contain the following equipment, their weight must be added as payload:
  - Arctic equipment
  - Cargo loading equioment
  - Removable floor
  - Seats
  - Safety belt
  - Shoulder harness
  - Wainscoting and scuffplates
  - Tie down devices and shackles
  - Troop urinal and spray guard

Refer to T.O. 1-1B-40 for weights of this equipment and allowances to be made in weight and balance clearance Form 365F.

RECOMMENDED OPERATION RANGE
CAUTIONARY OPERATION RANGE
NOT RECOMMENDED

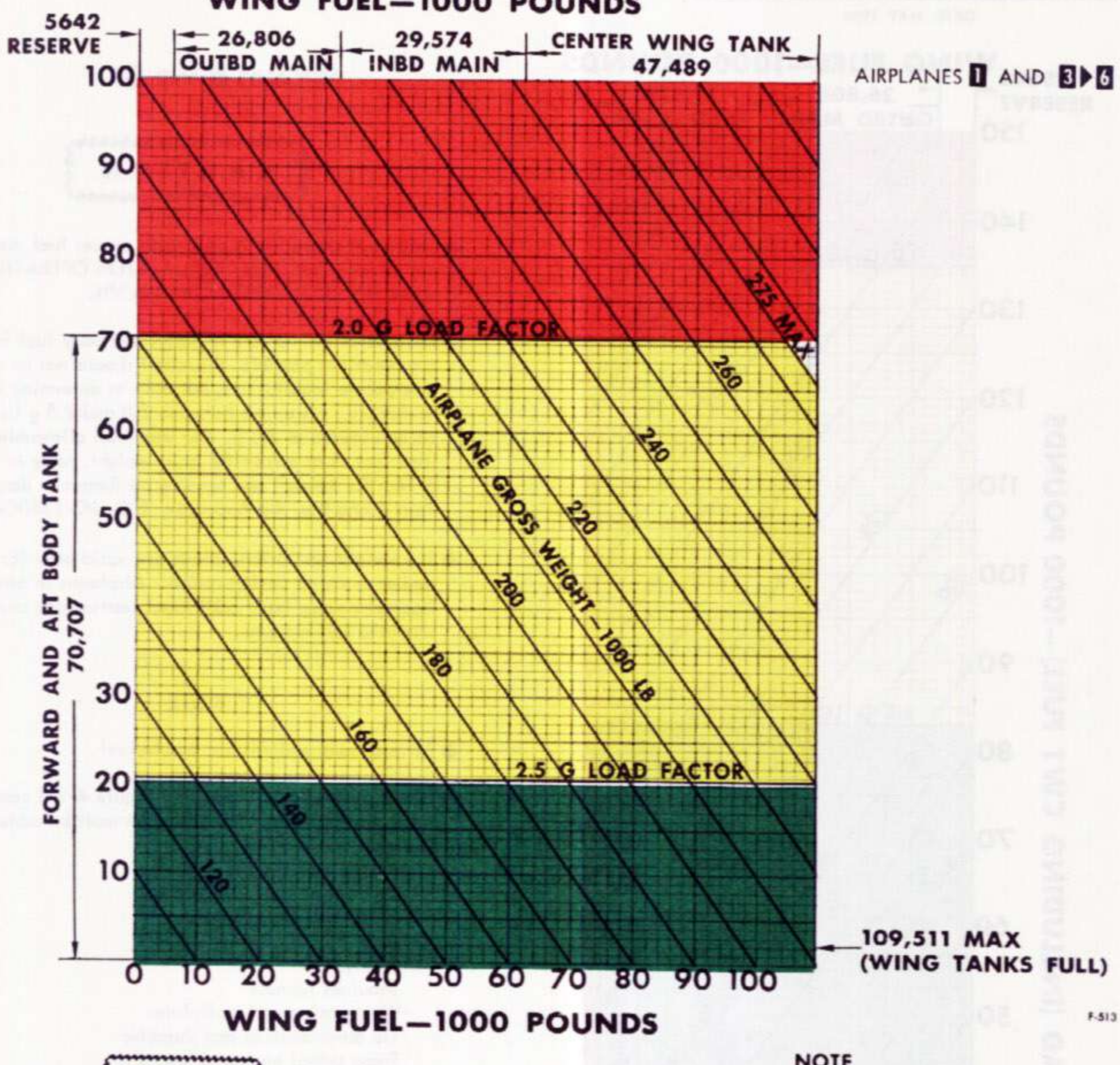
F-364

Figure 5-15 (Sheet 1 of 4)

AIR REFUELING (ALL FUEL TANKS IN USE)

AIRPLANE OPERATING WT – 100,000 POUNDS

AIRPLANES 1 AND 3▶6



F-513

CAUTION

- This chart shows limits only with proper fuel distribution and usage given under FUEL SYSTEM OPERATION AND MANAGEMENT in Section VII.
- Because of the variety of cargo and body fuel loading combinations possible, this chart should not be used to interpolate load factors, but only to determine areas of operation. All points between 2.0 and 2.5 g lines must be considered as 2.0 g. For maximum allowable flight load factors at a specific gross weight, refer to Figure 5-16. For takeoff and landing performance data, see Parts 2 and 9 of the Appendix, T.O. 1C-135(K)A-1-1.
- The weight limitations charts are valid only for the tanker or cargo configuration. Airplanes in other configurations may have additional restrictions covered in separate publications.

NOTE

- All fuel tank weights are usable fuel.
- If Compartments "D" thru "S" (figure 4-53) contain the following equipment, their weight must be added as payload:
  - Arctic equipment
  - Cargo loading equipment
  - Removable floor
  - Seats
  - Safety belt
  - Shoulder harness
  - Wainscoting and scuffplates
  - Tie down devices and shackles
  - Troop urinal and spray guard

Refer to T.O. 1-1B-40 for weights of this equipment and allowances to be made in weight and balance clearance Form 365F.

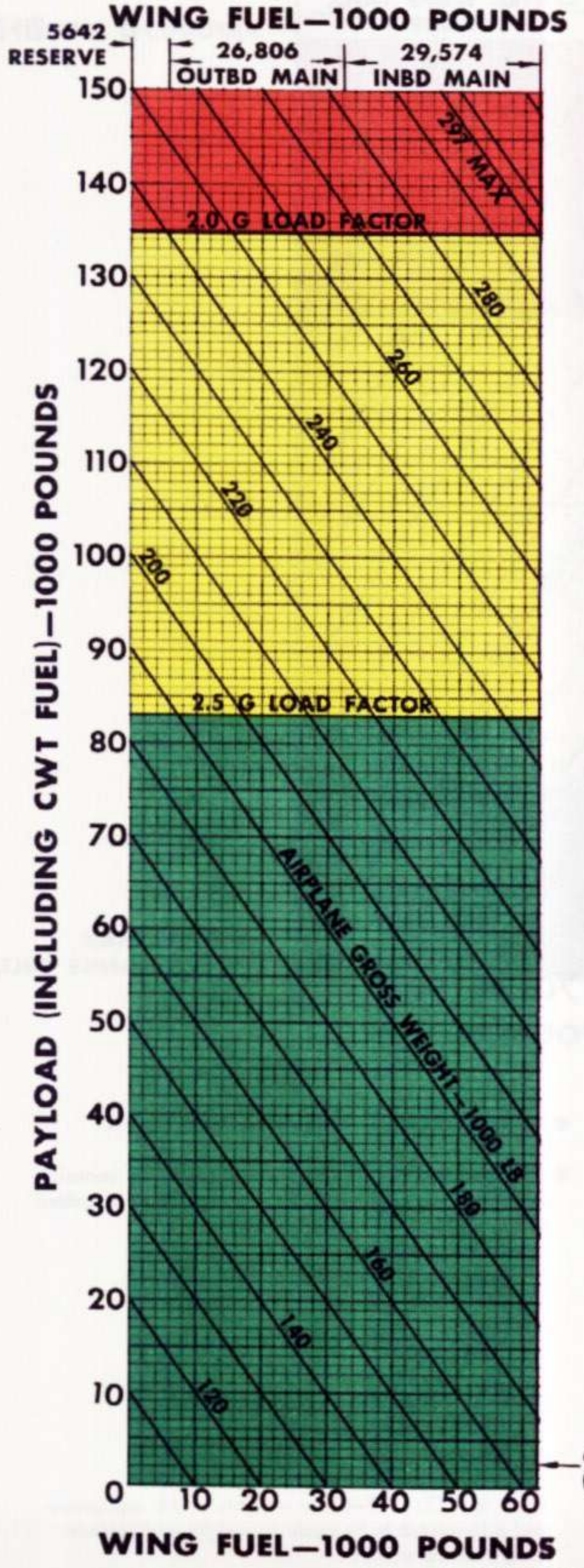
Figure 5-15 (Sheet 2 of 4)

WEIGHT LIMITATIONS (CONT)

DATE: MAY 1958

CARGO LOADING (FWD AND AFT BODY TANKS EMPTY)

AIRPLANE OPERATING WT—100,000 POUNDS



AIRPLANES 2 AND 7▶

CAUTION

- This chart shows limits only with proper fuel distribution and usage given under FUEL SYSTEM OPERATION AND MANAGEMENT in Section VII.
- Because of the variety of cargo and body fuel loading combinations possible, this chart should not be used to interpolate load factors, but only to determine areas of operation. All points between 2.0 and 2.5 g lines must be considered as 2.0 g. For maximum allowable flight load factors at a specific gross weight, refer to Figure 5-16. For takeoff and landing performance data, see Parts 2 and 9 of the Appendix, T.O. 1C-135(K)A-1-1.
- The weight limitations charts are valid only for the tanker or cargo configuration. Airplanes in other configurations may have additional restrictions covered in separate publications.

NOTE

- All fuel tank weights are usable fuel.
- If Compartments "D" thru "S" (figure 4-53) contain the following equipment, their weight must be added as payload:
  - Arctic equipment
  - Cargo loading equipment
  - Removable floor
  - Seats
  - Safety belt
  - Shoulder harness
  - Wainscoting and scuffplates
  - Tie down devices and shackles
  - Troop urinal and spray guard

Refer to T.O. 1-1B-40 for weights of this equipment and allowances to be made in weight and balance clearance Form 365F.

RECOMMENDED OPERATION RANGE
CAUTIONARY OPERATION RANGE
NOT RECOMMENDED
GUST CRITICAL AREA - Reduce speed to turbulent air penetration speed if turbulence is encountered

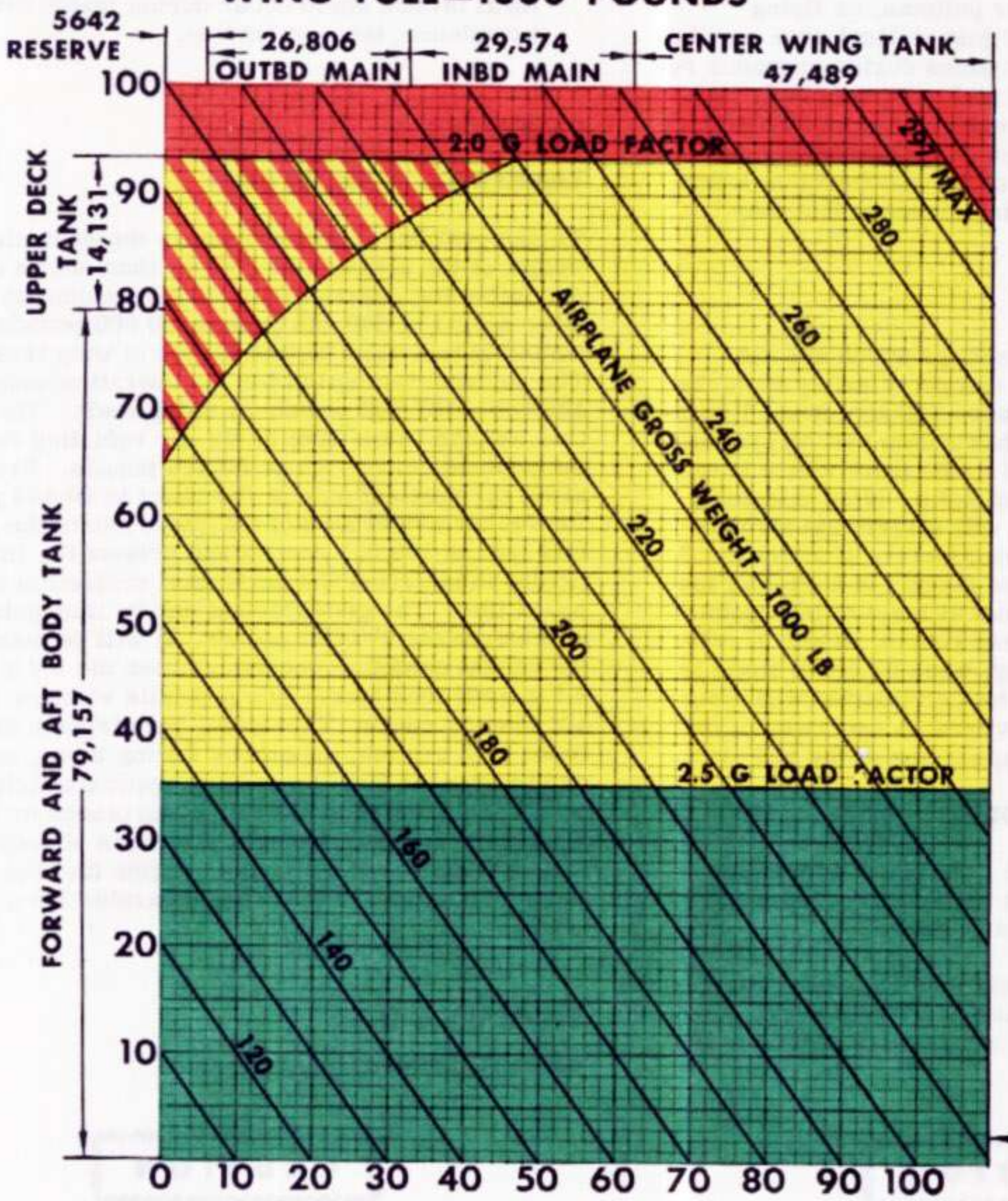
F-365

Figure 5-15 (Sheet 3 of 4)

AIR REFUELING (ALL FUEL TANKS IN USE)

AIRPLANE OPERATING WT — 100,000 POUNDS

AIRPLANES 2 AND 7 ▶



WING FUEL—1000 POUNDS

CAUTION

- This chart shows limits only with proper fuel distribution and usage given under FUEL SYSTEM OPERATION AND MANAGEMENT in Section VII.
- Because of the variety of cargo and body fuel loading combinations possible, this chart should not be used to interpolate load factors, but only to determine areas of operation. All points between 2.0 and 2.5 g lines must be considered as 2.0 g. For maximum allowable flight load factors at a specific gross weight, refer to Figure 5-16. For takeoff and landing performance data, see Parts 2 and 9 of the Appendix, T.O. 1C-135(K)A-1-1.
- The weight limitations charts are valid only for the tanker or cargo configuration. Airplanes in other configurations may have additional restrictions covered in separate publications.

NOTE

- All fuel tank weights are usable fuel.
- If Compartments "D" thru "S" (figure 4-53) contain the following equipment, their weight must be added as payload:
  - Arctic equipment
  - Cargo loading equipment
  - Removable floor
  - Seats
  - Safety belt
  - Shoulder harness
  - Wainscoting and scuffplates
  - Tie down devices and shackles
  - Troop urinal and spray guard

Refer to T.O. 1-1B-40 for weights of this equipment and allowances to be made in weight and balance clearance Form 365F.

Figure 5-15 (Sheet 4 of 4)

above 230,000 pounds for limited gross weight airplanes, and above 245,000 pounds for full gross weight airplanes should be flown with caution especially when making turns or pullouts, or flying through turbulent air. The gust critical area may be encountered for very short times during missions requiring minimum wing fuel and maximum body fuel. If the gust critical area is entered and any turbulence is encountered, adjust speed to approximately 280 KIAS or cruise Mach (.77 to .80) whichever is lower to prevent above normal wing stresses that may occur at higher speeds.

All Operations

The red area represents loadings which are not recommended because the margin of safety from the standpoint of both performance and structural limitations is less. Experience has shown that an airplane should never be overloaded to the point where it cannot make good load factor of 2.0 g. Most missions, even with ideal conditions, will subject the airplane at one time or another to load factors of at least 2.0 g. Because of the variety of cargo and body fuel load combinations possible, do not attempt to interpolate flight load factors from these charts. Under conditions of extreme emergency, when safety of flight is of secondary importance, the Commander will determine if the degree of risk warrants operation of the airplane at gross weights appearing in the red area.

NOTE

Whenever flights are conducted at weights shown in the red area of the chart, entry of this fact in Form 781 is required.

Maximum maneuver and gust load factors at various gross weights for each phase of a mission can be obtained from the limit load factor chart, figure 5-16.

CAUTION

- Limited gross weight airplanes should not be flown at any gross weight exceeding 275,000 pounds except under conditions of extreme emergency.
- Full gross weight airplanes should not be flown at any gross weight exceeding 297,000 pounds except under conditions of extreme emergency.
- When loading the airplane to high gross weights, observe the 2.0 g limit line. If the 2.0 g limit line is exceeded, possible structural failure could occur during maneuver, turbulence, taxi, or landing.

EXAMPLE 1

TANKER CONFIGURATION

To demonstrate a problem where the operating weight of the airplane is greater than shown on the Air Refueling charts (figure 5-15) assume an operating weight of 100,489 pounds, 60,000 pounds of air refueling fuel and 109,511 pounds of wing tank fuel. The payload correction for the operating weight is 100,489 - 100,000 pounds or 489 pounds. The effective payload is the sum of the air refueling fuel and the payload correction or 60,489 pounds. Proceed along the vertical axis of the chart to 60,489 pounds. On the horizontal axis of the chart locate the wing fuel load of 109,511 pounds and project the line vertically to intersect the horizontal projection of 60,489 pound line. The gross weight can be interpolated at approximately 270,000 pounds. It will be noted that the weight condition occurs between the 2.0 g and the 2.5 g limit load factor line and falls within a cautionary loading range. Therefore, the airplane should be flown with caution, especially during turns, pullouts, or in turbulent air. As soon as approximately 45,000 pounds for limited gross weight airplanes or 25,489 pounds for full gross weight airplanes of body tank fuel is transferred or used as engine fuel the loading range will return to the more desirable 2.5 g loading range.

EXAMPLE 2

CARGO CONFIGURATION

CAUTION

Loading more than 67,978 pounds for limited gross weight airplanes, or 83,000 pounds for full gross weight airplanes, of effective cargo weight on the upper deck will put the landing in the cautionary loading range.

To demonstrate a problem where the operating weight is less than that shown on the Cargo Loading Chart (figure 5-15), consider an operating weight of 97,800 pounds, 60,000 pounds of cargo, 16,000 pounds of

LIMIT LOAD FACTOR

DATE: APRIL 1956
DATA BASIS: FLIGHT TEST

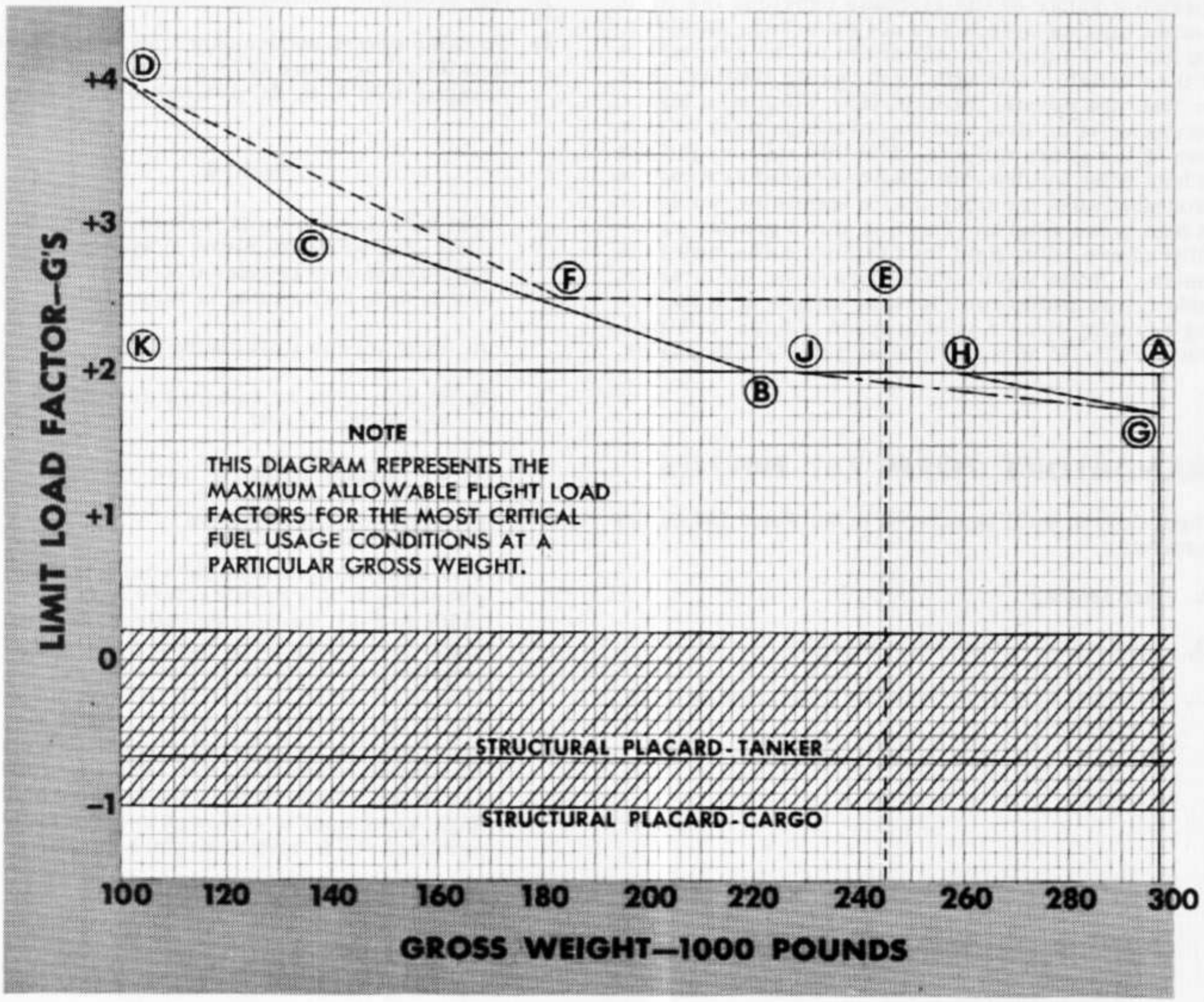
AIRPLANE USAGE	CRITICAL LOAD FACTOR CONDITION
(A)(B) TANKER - FULL BODY FUEL	MANEUVER
(B)(C) TANKER - REDUCED BODY FUEL	GUST
(C)(D) TANKER - BODY TANKS EMPTY	GUST
1 (E)(F) CARGO - MAXIMUM PAYLOAD	MANEUVER
1 (F)(D) CARGO - REDUCED PAYLOAD	GUST
2 (G)(H)(K) FLAPS DOWN 40° - MAXIMUM WING FUEL	MANEUVER
2 (G)(J)(K) FLAPS DOWN 40° - MINIMUM WING FUEL	MANEUVER

LEGEND

- ---- CARGO
- —— TANKER
- AREA OF PROBABLE GENERATOR TRIPPING DUE TO NEGATIVE "g" LOADS

1 PAYLOAD INCLUDES CENTER WING TANK FUEL

2 FLAPS DOWN FACTORS ARE CRITICAL AT FLAP PLACARD SPEED. ANY SPEED ABOVE FLAP PLACARD REDUCES THE ALLOWABLE LOAD FACTOR



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Figure 5-16

center wing tank fuel and 62,022 pounds of wing fuel. The payload correction for the operating weight is 97,800 - 100,000 or -2200 pounds. The effective payload is the sum of the cargo and center wing tank fuel less the payload correction (60,000 + 16,000 -2200) = 73,800 pounds). Locate the effective payload ordinate of 73,800 pounds on the vertical axis and project horizontally to intersect the vertical projection of the 62,022 pound wing fuel ordinate where a gross weight of approximately 235,000 pounds can be interpolated. On limited gross weight airplanes this loading will be in the cautionary range but will improve to the desired 2.5 g loading area as soon as cruise is established and approximately 5000 pounds of center wing tank fuel is burned. On full gross weight airplanes the loading is in the desired 2.5 g loading range and will remain there throughout the mission.

LANDING WEIGHT

The airplane may be landed at any weight within the operating range of the airplane provided the limit contact sinking speeds are not exceeded. However, the life of the gear is influenced by the percentage of the available strength used during landing. For an "average normal landing" (150-175 fpm) a higher percentage of the limit load is used at high gross weights than at low gross weights. For this reason landings at high gross weights should not be planned as a routine procedure since the limit sinking speeds become lower at high gross weights. There is also a greater possibility of exceeding limit load with an inadvertent hard landing. Design specifications require that the airplane, under given loading conditions, be capable of withstanding a landing contact sinking speed of 9 fps (540 fpm). For the KC-135 airplane, this weight is 185,000 pounds.

MANDATORY FORM 781 ENTRIES

The following shall be entered in the Form 781 by the aircrew:

A. Hard landing

B. Acceleration limits exceeded (g's)

C. Airspeed limits exceeded for flaps, landing gear, or airframe

D. Engine overspeed, overtemperature, TRT time or MRT time exceeded. Failure to reach charted EPR settings at full throttle.

E. Impure water used for water injection

F. Engine surge or stall

G. Taxi turn made away from flat outboard rear tire at weights in excess of 250,000 pounds

H. Excessive trim required

J. Elevator forces in excess of 100 pounds

K. Braking limits exceeded

L. Hydraulic pump isolation time

M. Brute force disconnect/boom mechanical limits exceeded/boom exceeded 20 degrees azimuth

N. Any system or component defect or malfunction

O. Portable oxygen bottles observed to have less than 50 psi pressure to be purged prior to recharging IAW T.O. 1C-135(K)A-2-3.

NOTE

The following abnormal performance problems may be due to airplane system malfunction and must be entered on the Form 781 if a system malfunction is suspected:

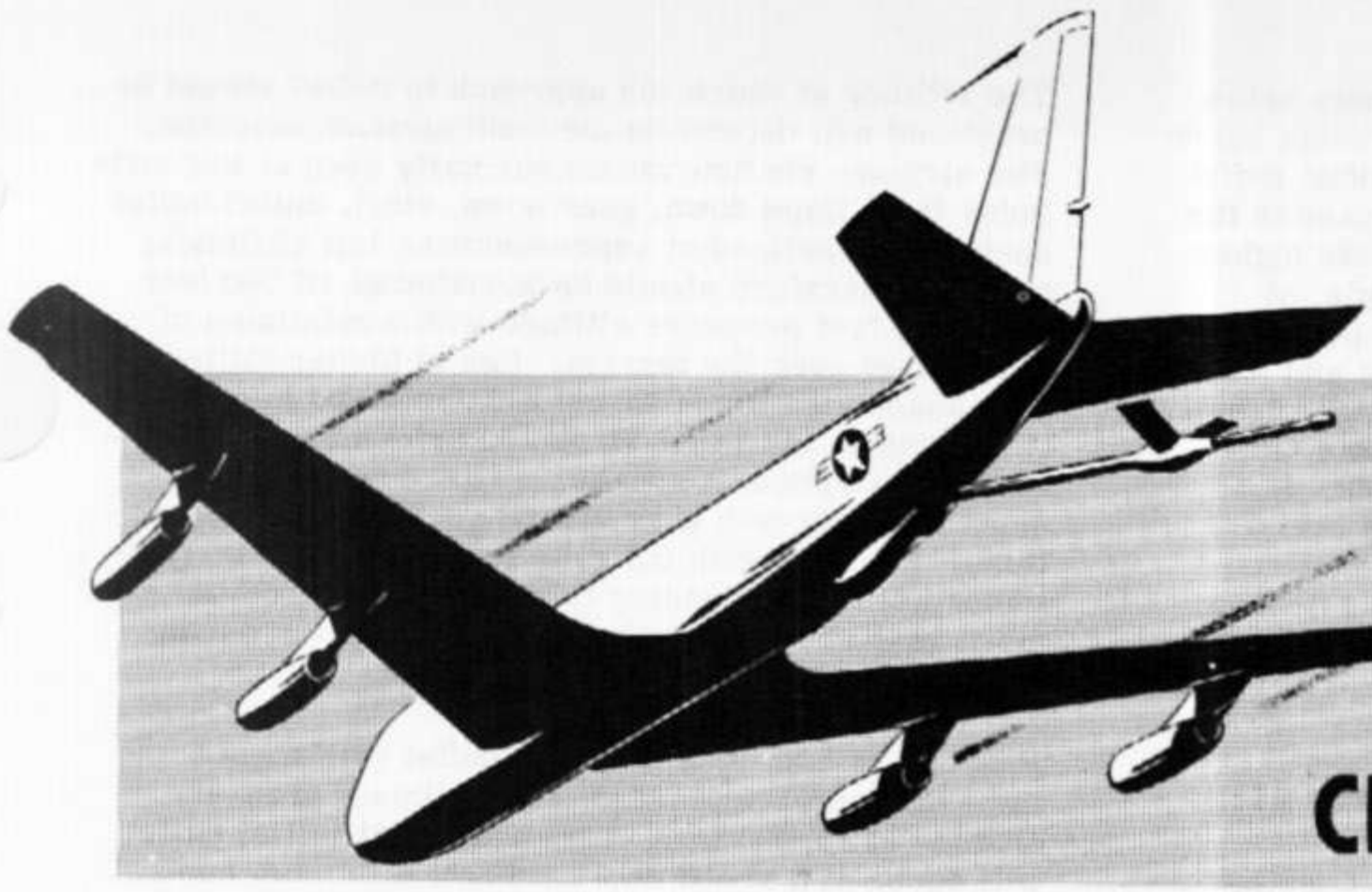
A. Slow acceleration during takeoff

B. Overrotation or control force lightening during takeoff

C. Porpoising, bounce or yaw

D. Abnormal landing flare

The exact airplane flight configuration peculiar to the problem (see T.O. 1C-135(K)A-2-8), weather conditions, and the flight crew action taken should be recorded completely and as soon as possible after the abnormal condition occurs. The recorded history will be very valuable if a flight test under duplicate conditions is necessary or assistance is later requested. Close coordination and cooperation of both ground and flight personnel is required to solve such problems and to reduce airplane downtime.



Section VI

FLIGHT CHARACTERISTICS

F 369

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The airplane has been designed as a high altitude, high performance jet tanker transport. The operational altitudes are higher and speeds are greater than those of tanker type reciprocating engine airplanes. The characteristics are normal and no unusual traits are exhibited in handling the airplane.

INITIAL BUFFET AND STALL

The airplane has adequate stall warning and normal stall characteristics. With flaps up the stall warning will first appear as a very gentle buffet or "tremor" 15 to 20 knots above initial buffet speed. As the speed is reduced the tremor intensity gradually increases until a definite airframe buffet occurs. This speed is defined as initial buffet speed. With the flaps down the tremor is masked by the normal flap buffeting and the first obvious stall warning comes with the definite airframe buffeting at initial buffet speed. If the speed is reduced further toward a complete stall the rate of descent and level of buffeting will increase significantly. (Stall buffet is more pronounced with flaps up but at high gross weights it is severe in all configurations). A mild pitch-up tendency, easily controlled by elevator, occurs as the stall is approached. At the minimum speed with elevator control column full back, the nose pitches down after which effective recovery may be made in the conventional manner. The loss of altitude during stalls will vary with configuration and will average about 1500 feet. Lateral control is effective throughout the stall and recovery; the use of spoilers will have a negligible effect on buffet and stall speeds, but spoiler buffet will tend to mask the stall buffet. Power normally used for practice approach to initial buffet will also have a negligible effect on these speeds; however, the use of full power can result in excessive nose high attitudes, particularly at the lighter gross weights.

The initial buffet speeds shown in figure 6-1 are the minimum usable flying speeds. Below these speeds, stable flight at constant altitude cannot be maintained. To obtain the effect of altitude on initial buffet speed, enter sheet 3 of figure 6-1 with the speed, obtained from either sheet 1 or 2, as applicable, for the proper gross weight and flap setting. Correct for altitude by paralleling the guide lines as shown in the example problem on the chart. At high gross weights

with flaps up, full stall occurs 15 to 20 knots below initial buffet speed and approximately 10 knots below this speed for flaps down. In turns the initial buffet and stall speeds are higher with any increase in the angle of bank resulting in disproportionately higher initial buffet and stall speeds. For example, at 30,000 feet and a gross weight of 185,000 pounds, the initial buffet speed is 160 KIAS in straight and level flight, and increases only 3 knots (163 KIAS) when using a 15 degree angle of bank and 15 knots (175 KIAS) when using a 30 degree angle of bank. However, a 45 degree angle of bank increases initial buffet speed 40 knots (200 KIAS) and a 60 degree angle of bank increases initial buffet speed 85 knots (245 KIAS). See figure 6-2 for bank angles at initial buffet and Section V for maneuver limits.

ANGLE OF ATTACK AND STALL RELATIONSHIP

When maintaining a constant altitude or a constant rate of climb/descent (1.0 "G" flight), lift is equal to the gross weight of the airplane. If airspeed is decreased, AOA must be increased to compensate for the resultant loss of lift. The same rationale applies if "G" loading is increased above 1.0 as would be required to arrest a rate-of-descent. The airspeed and/or AOA must be increased to provide additional lift required to stop the descent. Either condition (airspeed decrease or "G" increase) could produce an AOA increase toward the point where airflow separation over the wing would occur and the wing would stall. The AOA indicator can provide a reference for the airplane AOA and may be used in conjunction with airspeed, the speed deviation pointer and other attitude instruments to prevent operation in the critical AOA range. It is important to understand, however, that at high airspeeds/low AOA (.2 - .4), a large airspeed or "G" load change is required for a small AOA change. At relatively low airspeeds/high AOA (.6 or more), a small airspeed or "G" load change will result in a significantly large and rapid AOA change. Maintaining the proper airspeed, therefore, is especially critical when operating near the ground at the higher angles of attack required for takeoff, climbout and landing, since the AOA will increase rapidly, and possibly unnoticed, with a relatively small decrease in airspeed. If the critical AOA is exceeded during these maneuvers, sufficient altitude for recovery may not be available.

PRACTICE APPROACH TO INITIAL BUFFET

The purpose of practicing approach to initial buffet is to familiarize the pilot with the flying qualities of the airplane as a stall is approached and to teach recognition of stall warnings in sufficient time to prevent entering a full stall. Consistent with this, it is not advisable to decrease airspeed below initial buffet so as to expose the airplane to unnecessary buffeting for an extended period of time. It is recommended that airplane weight be below 170,000 pounds; fuel distribution should be equalized across the wings and the forward and aft body tanks must be empty.

The altitude at which the approach to buffet should be practiced will depend on the configuration selected. For airplane configurations normally used at low altitudes (i.e., flaps down, gear down, etc.), initial buffet should be practiced at representative low altitudes; practice therefore should be initiated at 10,000 feet to 15,000 feet pressure altitude with a minimum of 10,000 feet over the terrain. Use of higher altitudes with associated lower thrust available and high drag can result in marginal airplane performance with unrealistic airplane response. Flaps down practice should include both gear up and gear down configurations. Practice with the gear down is particularly important for the landing flap settings to provide more realistic performance characteristics during the recovery.

Practice of approach to initial buffet with main wing flaps up should be limited to a minimum pressure altitude of 15,000 feet. To ensure that initial buffet will occur at a speed above inflight minimum control speed, the minimum gross weight at 15,000 feet should be 125,000 pounds. As altitude is increased, the minimum control speed decreases; therefore, the minimum gross weight may be reduced. At 20,000 feet the minimum gross weight should be 105,000 pounds.

The practice of approach to buffet at the higher altitudes (20,000 feet pressure altitude and above) should be restricted to the clean configuration only.

WARNING

Do not practice approach to initial buffet with known malfunctions in any of the following systems: powered rudder, autopilot rudder axis, spoilers, stabilizer trim, engines, and/or any other malfunction that could affect the controllability of the airplane. Ensure that the boom is up and latched, rudder power is operating and the autopilot rudder axis is on.

The airspeed margins between climbout speed, pattern speed or approach speed, and initial buffet should be noted for each configuration, to give an appreciation for the existing safety margins during normal operation.

Low Altitude Practice Approach to Initial Buffet

Perform the entry maneuver from level flight. Establish the airplane configuration, rudder power on, autopilot rudder axis engaged, desired flap setting and gear position. Adjust thrust (60 to 85% rpm) as required to decrease airspeed at a rate of about one knot per second; thrust will have no appreciable effect on initial buffet speed. Hold altitude constant so as to assure a 1 g condition. While the airspeed decreases, continually trim the stabilizer for zero stick force until reaching threshold speed for the condition. Do not trim further until after recovery

and threshold speed has been regained. This trim condition will allow adequate elevator control for recovery. Maintain wings level throughout the entry, buffet, and recovery; adequate lateral control is available with spoilers and ailerons.

WARNING

If, during practice of these mancuvers, an unusual attitude develops in controlling the airplane, dutch roll is encountered, or a noticeable degree of aileron control in a sustained direction becomes evident, do not proceed with the entry.

Increase elevator back pressure to maintain altitude and 1 g flight condition until a well defined initial buffet is felt. Then initiate the recovery by simultaneously accomplishing the following:

A. Lower the nose to slightly below the horizon. If a wing should drop at initial buffet, or if initial buffet occurs in a turn, lower the nose before attempting to roll the wings level. Do not use the rudder during these conditions as improper rudder application can initiate excessive roll due to yaw.

B. Add power by advancing the throttles to the vertical position momentarily, then gradually increase thrust to the maximum allowable. This procedure minimizes yaw due to unequal thrust and facilitates uniform engine acceleration. The use of thrust during the recovery results in minimum altitude loss. However, the thrust application can cause some pitch-up. Consequently some elevator will be required to keep the nose below the horizon to prevent the airplane from entering secondary buffet.

C. Position the flaps to thirty degrees. When practicing approach to buffet with flaps less than thirty degrees, the flaps are lowered to thirty degrees at initiation of recovery to decrease the stall speed. When practicing with flaps greater than thirty degrees, the flaps are retracted to thirty degrees. This reduces the high drag associated with the high flap settings and facilitates acceleration during the recovery.

If the entry has been made with the landing gear extended, do not retract gear until the recovery is complete and a positive rate of climb has been established. Opening the gear doors during retraction increases the drag and will delay airplane acceleration during recovery.

NOTE

If dutch roll develops because the autopilot rudder axis was inadvertently left off, discontinue the maneuver, turn the autopilot rudder axis on, allow the dutch roll to damp.

Return the airplane to level flight and establish the configuration for next phase of flight observing normal procedures.

High Altitude Practice Approach to Initial Buffet

The practice of initial buffet at high altitudes, 20,000 feet and above, should be conducted with the clean configuration only. The maneuver is the same as that described for the low altitude practice with the exception that the flaps remain retracted during the recovery.

NOTE

The indicated initial buffet speed for any given weight will increase with altitude because of Mach effect. These speeds can be obtained by correcting the low altitude initial buffet speeds for altitude using figure 6-1, sheet 3.

Summary of Practice Approach to Initial Buffet

A. Fuel - Forward and aft body tanks - Empty.
Wing tanks - Equalized across the wings.

B. Pressure Altitude - Low altitude - 10,000 feet to 15,000 feet with a minimum of 10,000 feet above the terrain.
High altitude - 20,000 feet and above.

C. Boom - Up and latched. Check boom latched as outlined in Section VIII.

D. Crew Members - Inform and receive acknowledgement, all crewmembers in position with belts and harnesses fastened.

E. Rudder Power - On.

F. Autopilot Rudder Axis - Engaged.

G. Data - Compute threshold speed, initial buffet speed (corrected for altitude if applicable), maximum power setting.

H. Flaps - Low altitude - As desired (observe placard speeds).
High altitude - Flaps up only.

J. Gear - Low altitude - As desired.
High altitude - Gear up.

K. Throttles - 60% to 85% rpm, as required to maintain altitude and a one knot per second deceleration rate.

L. Trim - Trim as speed decreases until threshold speed is reached; do not trim further until after recovery when threshold speed has been regained. Maintain level flight with elevator. Rudder and aileron trim are not adjusted during the maneuver; if either of these appear abnormal do not attempt the maneuver.

M. Airspeed - Decrease at approximately one knot/second, observing tremor or "buzz" as initial buffet is approached. At first indication of definite buffet, note indicated airspeed and initiate recovery.

N. Attitude - Lower nose to slightly below horizon.

P. Power - Gradually add power to maximum permissible. Use elevator as necessary to prevent the nose from rising and possibly entering secondary buffet.

Q. Flaps - Low altitudes - Position flaps to 30 degrees. If flaps are less than 30 degrees, lower them to 30 degrees; if flaps are greater than 30 degrees, retract them to 30 degrees.
High altitude - Do not lower flaps to 30 degrees but retain the zero degrees flap setting.

R. Gear - Do not retract gear until recovery is complete and a positive rate of climb has been established.

S. Airspeed - Accelerate until reaching threshold speed before re-establishing level flight. After reaching threshold speed, trim as required.

T. Configuration - Observe normal procedures to establish configuration for next phase of flight.

SPINS

The ability of an airplane to spin is dependent upon cg location, distribution of mass, basic aerodynamic configuration, and control deflections. Forward cg's tend to make spinning less likely while aft cg's promote spinning. Extended gear and/or flaps have no appreciable effect on spin recovery; however, extended gear will reduce speed buildup during dive recovery after spin rotation stops. In a developed spin, the indicated airspeed is unreliable.

STANDARD SPINS

Intentional spins are prohibited. In case an inadvertant yaw or roll is encountered, equalize power and use corrective rudder and lateral control, plus forward elevator control immediately. In case a spin is entered accidentally, reduce power to idle, supply full opposite rudder immediately followed by forward elevator control with neutral lateral control. Apply some nose down trim and retract the speed brakes if they are extended. Extend the gear. If the spinning is not diminished or stopped, as a last resort to augment the rudder, apply throttles asymmetrically to develop thrust against the spin. As spin rotation stops, set all throttles to IDLE and neutralize rudder. Recover from the dive attitude by using elevator and/or stabilizer as necessary. Speed brakes should be extended to prevent speed from building up rapidly during the recovery.

WARNING

The body and engine strut side loading at high sideslip angles can be critical and there may be a possibility of aft fuselage and empennage failure or engine separation in the fully developed spin condition. In the event of structural failure, emergency egress must be attempted immediately.

INITIAL BUFFET SPEEDS (MINIMUM USABLE FLYING SPEEDS)

CONDITIONS:

LEADING EDGE FLAPS EXTENDED

NO GROUND EFFECT

SEA LEVEL TO 10,000 FT ALTITUDE

NOTE

REFER TO TEXT FOR DISCUSSION OF STALL WARNING

DATE: FEBRUARY 1966

DATA BASIS: FLIGHT TEST



LEADING EDGE FLAPS OPERABLE

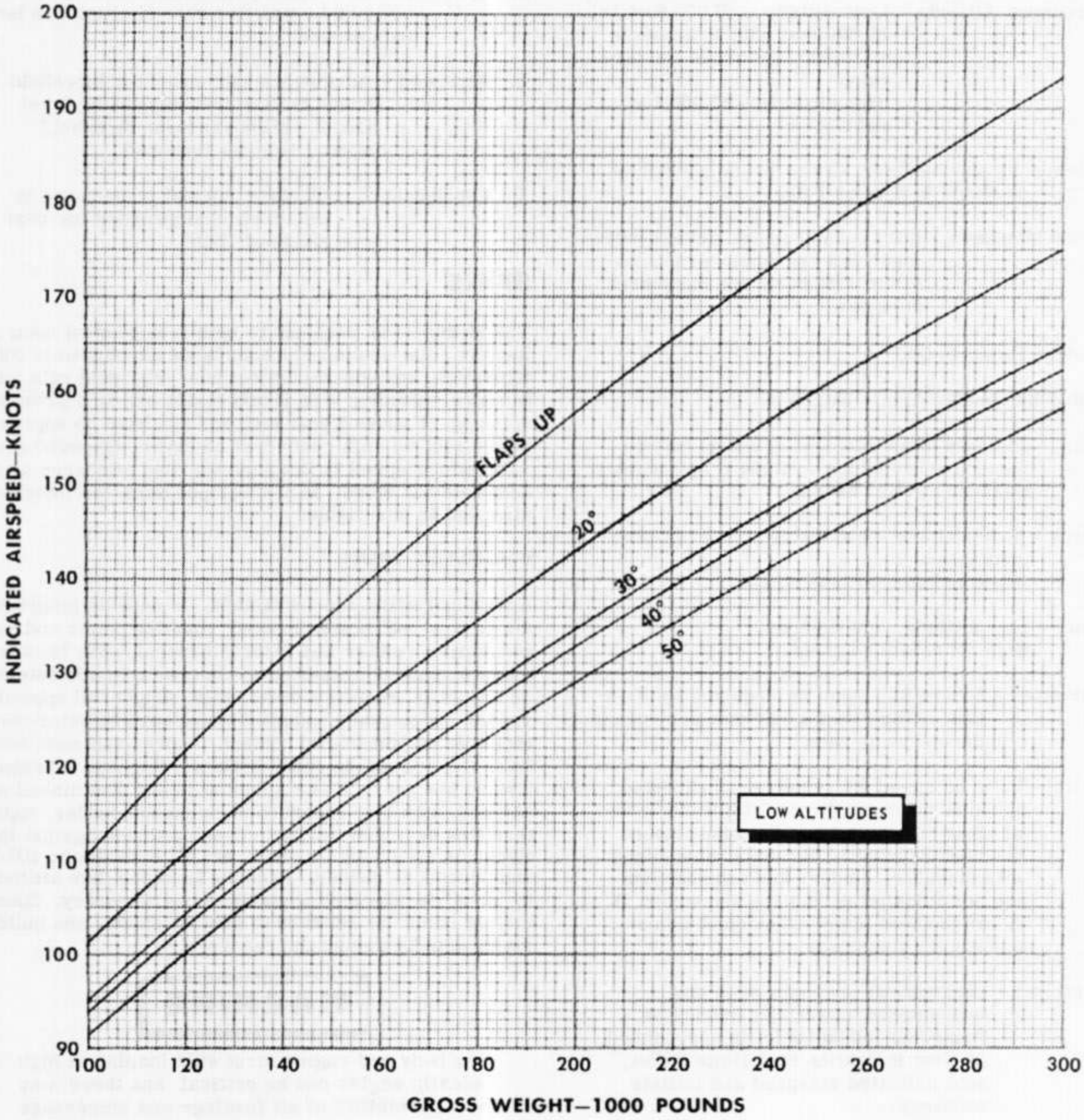


Figure 6-1 (Sheet 1 of 3)

NOTE

REFER TO TEXT FOR DISCUSSION OF STALL WARNING

CONDITIONS:

LEADING EDGE FLAPS NOT EXTENDED

NO GROUND EFFECT

SEA LEVEL TO 10,000 FT ALTITUDE

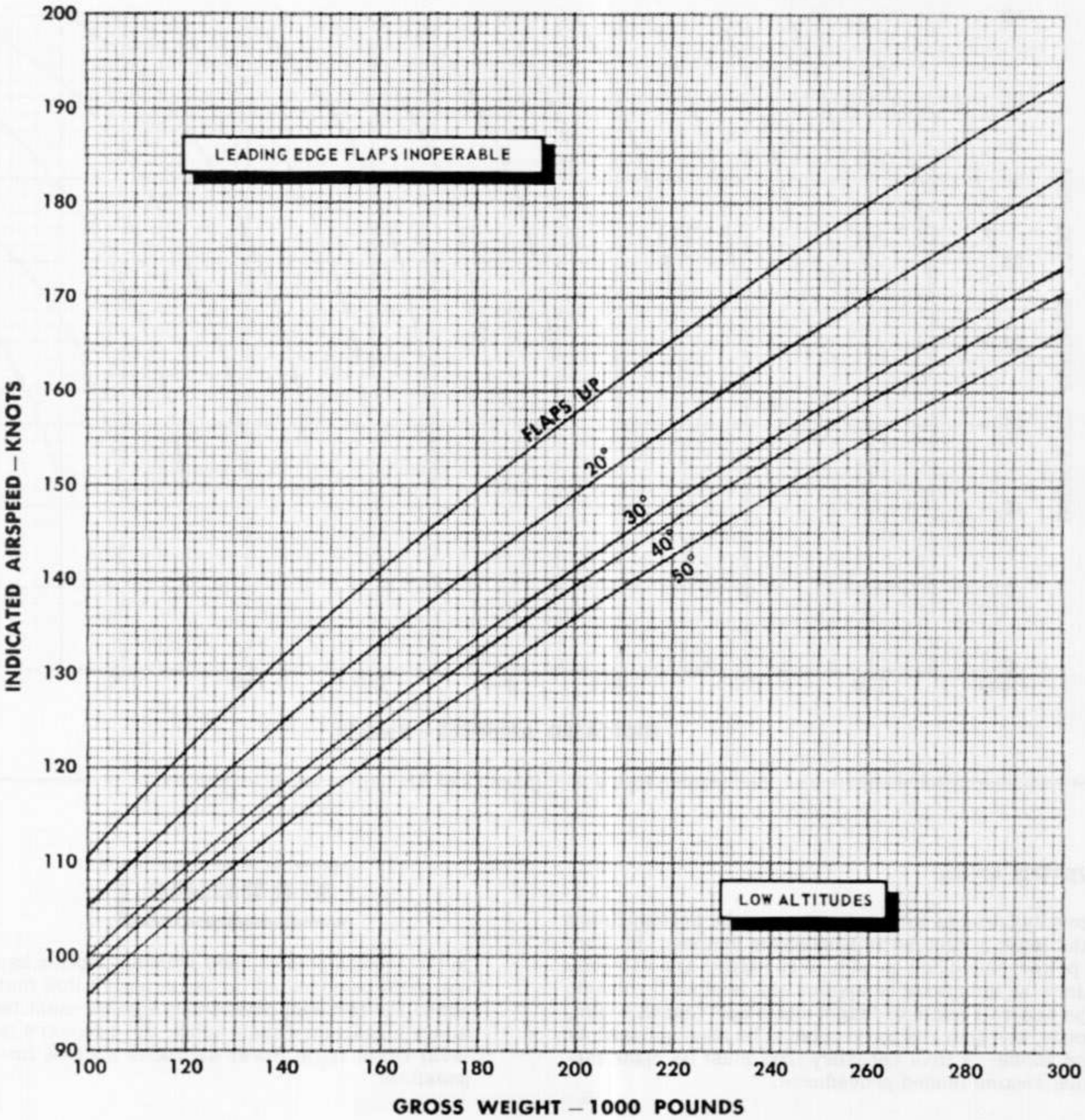


Figure 6-1 (Sheet 2 of 3)

INITIAL BUFFET SPEEDS (MINIMUM USABLE FLYING SPEEDS) (CONT)

DATE: FEBRUARY 1966

CONDITIONS:

ALL FLAP SETTINGS
WITH OR WITHOUT LE FLAPS
ONE "g" FLIGHT

EXAMPLE:

GIVEN:
Gross weight = 168,000 lb
Indicated altitude = 27,000 ft
Flaps 30° with LE flaps

FIND:
Initial buffet speed

DATA BASIS: ESTIMATED

SOLUTION:
From sheet 1 find initial buffet speed for low altitudes = 123.2 KIAS
Enter this chart with speed = 123.2 KIAS and following guide line to 27,000 ft read corrected initial buffet speed = 125 KIAS

NOTE

REFER TO TEXT FOR DISCUSSION OF INITIAL BUFFET AND STALL

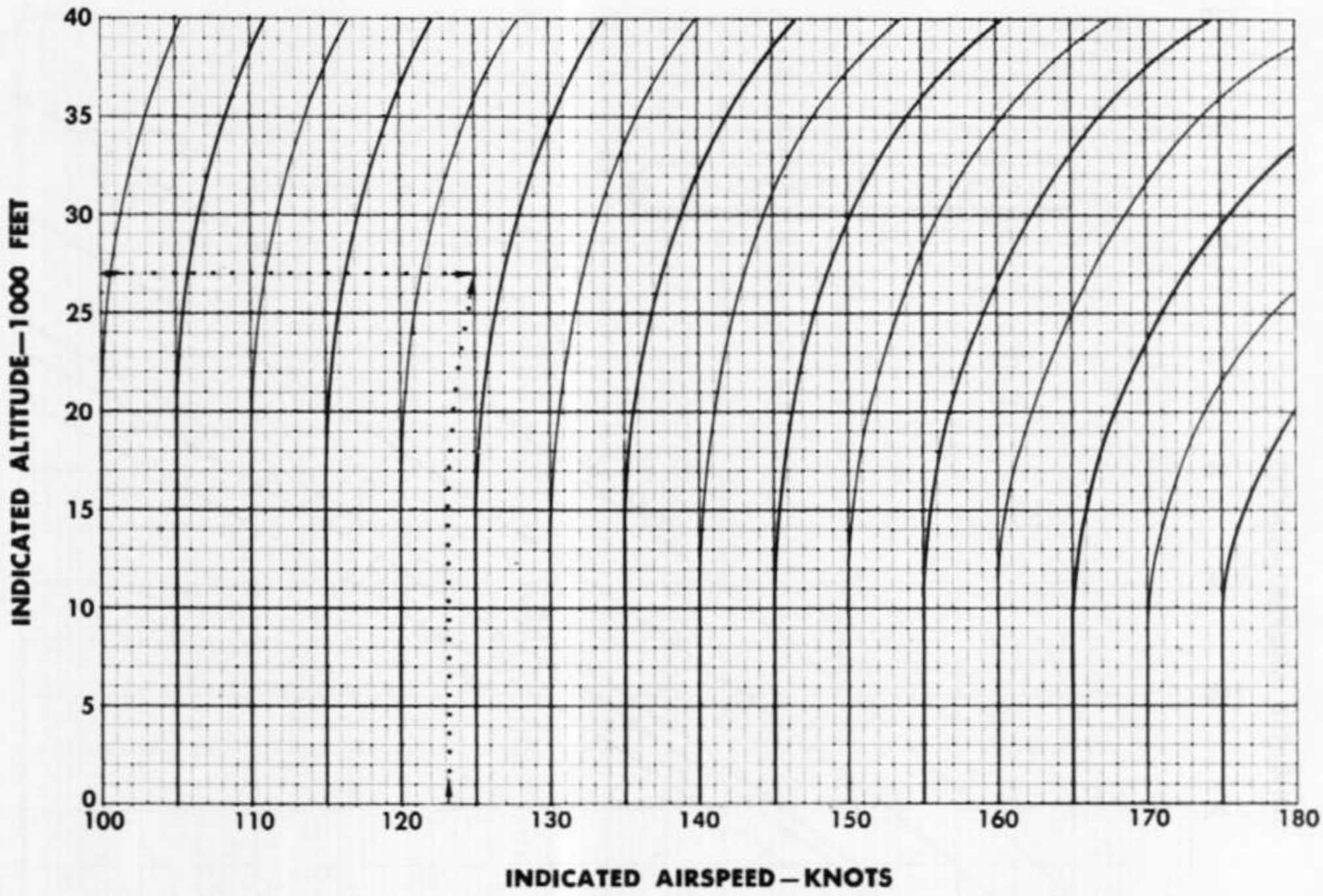


Figure 6-1 (Sheet 3 of 3)

INVERTED SPINS

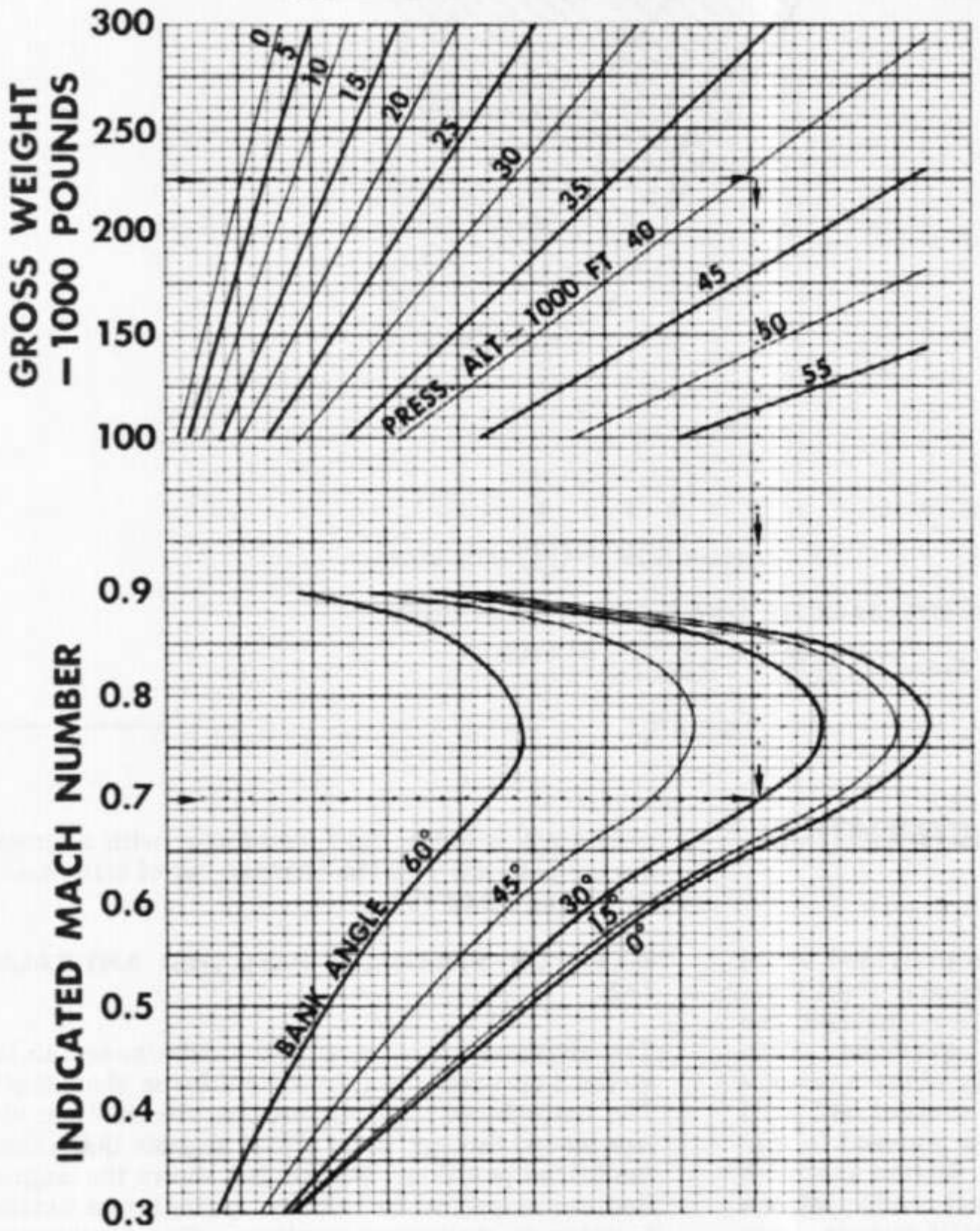
Recovery from an inverted spin must be accomplished by the least structurally hazardous method. Following power reduction to idle, full rudder and ailerons against the spin must be applied and held until rotation stops and roll made to "right-side-up." Speed brake, throttle, and gear utilization should be accomplished as noted above. A dive recovery then must be made following recommended procedures.

WARNING

In the event any developed spinning motion has not been terminated on reaching 15,000 feet above the terrain, emergency egress must be attempted immediately since the recovery to level flight from lower altitudes may be impossible.

BANK ANGLE AT INITIAL BUFFET

DATE: JUNE 1963
DATA BASIS: FLIGHT TEST



CONDITIONS:

CLEAN CONFIGURATION

EXAMPLE:

GIVEN:
- Gross weight – 225,000 lb
- Pressure altitude = 40,500 ft
- Indicated Mach No. = 0.70

FIND:
- Bank angle at initial buffet

SOLUTION:
- Angle – 30°

Figure 6-2

CONTROL TABS

The control tabs for all three controls may be classified as spring tabs with positive follow-up. See figure 6-3. In addition to adding to surface stability during steady flight, the positive follow-up permits the control surface as well as the tab to be moved by the pilot while on the ground for a positive preflight check of control surface and tab freedom of motion.

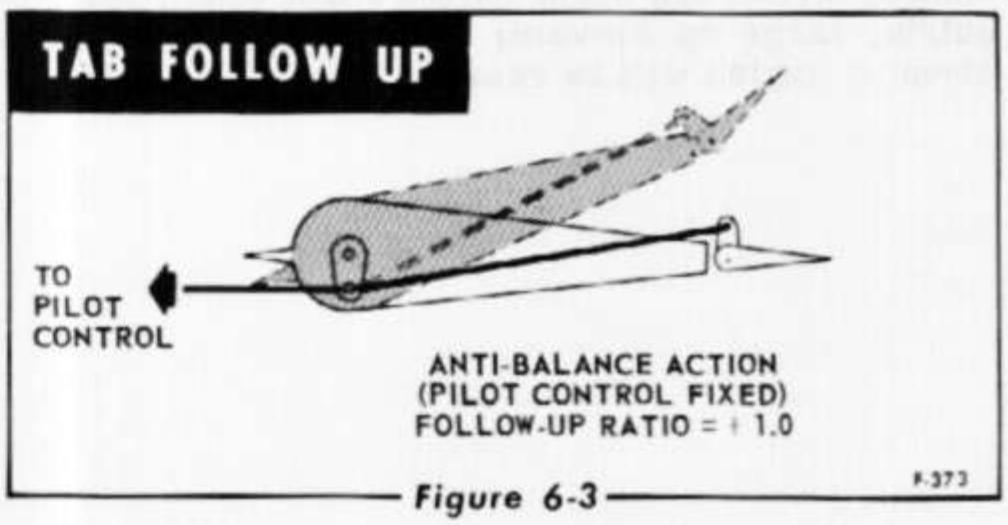


Figure 6-3

ANTIBALANCE TAB OPERATING ENVELOPE

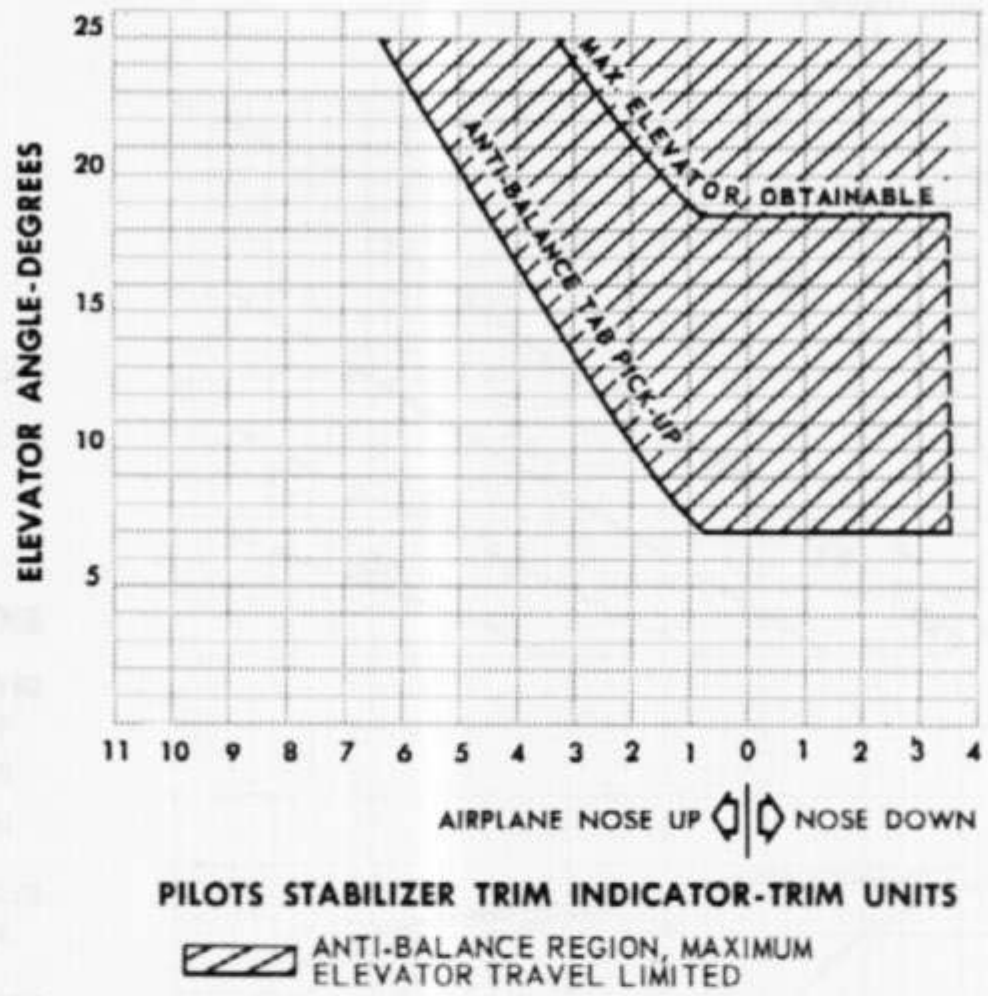


Figure 6-4

FLIGHT CONTROL CHARACTERISTICS

STABILIZER AND ELEVATOR

Control on the longitudinal axis is provided by an elevator mounted on the movable horizontal stabilizer. The elevators are not bussed together; instead, the control tabs have a common control quadrant. This arrangement provides greater safety since approximately a quarter of the longitudinal control will still remain in case the elevator becomes jammed on one side. The elevator control system forces are such that one-handed operation in the airport traffic pattern can be accomplished without undue pilot fatigue. For cruising flight, one-hand control is also possible with it being progressively harder to overstress the airplane as speed builds up. A lightening of elevator control forces can occur during flight conditions requiring large up-elevator angles. Normally, such elevator angles will be reached only during pull-ups near 100% positive limit load factor with a forward cg, during pull-ups with the airplane out of trim nose down, or during steep turns.

ELEVATOR-STABILIZER ACTUATED ANTIBALANCE TAB

The airplane has a modified antibalance tab linkage giving improved elevator control force characteristics. The antibalance tab does not operate until the elevator has moved through some initial angular deflection from the faired position. Figure 6-4 shows the angular deflection required to initiate antibalance action as a function of stabilizer position. The antibalance tab does not actuate until the elevator has been moved upward at least 7 degrees from the faired position when in the trim range from about 1 unit nose-up to 3 units nose-down. This reduces the tendency to over control at higher speeds. At lower speeds, with the airplane trimmed nose-up more than 1 unit, the antibalance

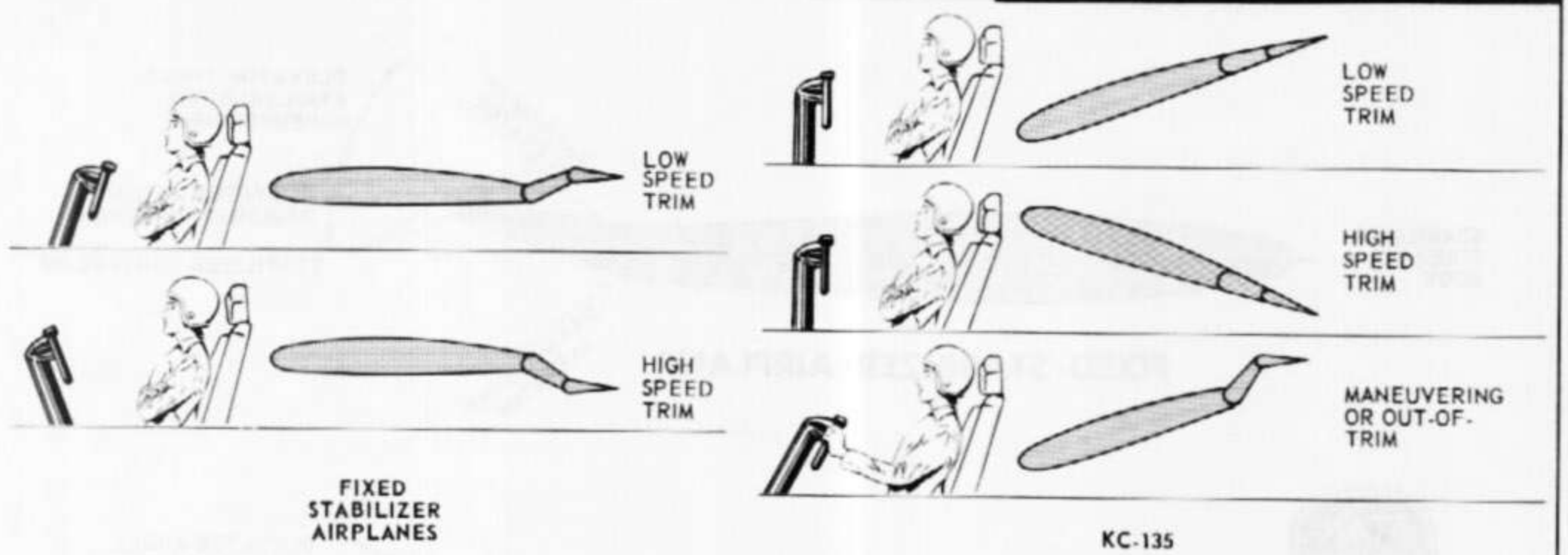


Figure 6-5

motion is delayed proportionally until the stabilizer has reached about 6-1/2 units nose-up trim. With the stabilizer set at more than 6-1/2 units nose up, the antibalance action does not occur. This allows more up-elevator travel at lower speeds as in the landing phase of flight. See EFFECTS OF MISTRIM ON AVAILABLE ELEVATOR ANGLE, this Section.

PITCH TRIM CONTROL COMPARISON

First of all trim must be defined. To the airplane, trim means flying at a constant airspeed. To the pilot, trim means flying hands off. When an airplane is flying at a constant speed flight condition, it may or may not be in trim as far as the pilot is concerned. The trim system balances the airplane for the flight condition desired so that the pilot does not have to apply control force to maintain this condition. The fixed stabilizer airplane achieves trim by positioning a trim tab on the elevator. The movable stabilizer airplane achieves trim by adjusting the angle of the stabilizer itself. Since many pilots have had previous experience in fixed stabilizer airplanes, a comparison of the two will clarify the differences in operational technique of the pitch trim.

Fixed Stabilizer With Elevator Trim Tab

A fixed stabilizer airplane generally employs a trim tab to position the elevator for pitch trim. The trim tab on the fixed stabilizer airplane effects control forces but has no effect on the maximum elevator angle obtainable. With this type trim system, as the pilot trims to relieve control forces, the control column remains in the same position it was in prior to trimming. See figure 6-5. Operation of the trim tab is felt as a lightening of control forces as the column is held in a fixed position. It should be understood that the fixed stabilizer airplane control column has many neutral (hands off) positions but only one centered position.

Movable Stabilizer

The KC-135 has a wide range of operational speeds and cg's; therefore, it is necessary that the airplane have a movable stabilizer for the increased trim capability. With the KC-135 trim system, as the pilot trims to relieve control forces, the control column must be allowed to move toward the centered (neutral-hands off) position as the airplane is trimmed. Trimming (movement of the stabilizer) is sensed by the tendency of the airplane to change attitude rather than by a reduction of force on the control column. The control column must be allowed to return to the centered (neutral-hands off) position as the airplane is trimmed, in order to maintain the desired flight condition. See figure 6-5. The pilot will experience trimmed, hands off flight, in this airplane only with the control column in the centered position.

EFFECTS OF MISTRIM ON AVAILABLE ELEVATOR ANGLE

The stabilizer-elevator control system uses stabilizer position to control the anti-balance motion of the stabilizer actuated tab. This affects both control forces and maximum elevator obtainable. Figure 6-6 shows that if the airplane is trimmed properly (hands off), the up elevator available is not affected for the approach trim range. However, if the trim setting is less than 6-1/2 units airplane nose up and the airplane is out of trim such that the pilot is exerting an appreciable pull force, it can be seen from figures 6-4 and 6-6 that available up-elevator will be limited by the premature anti-balance motion of the stabilizer actuated tab. It is also true that the elevator available for maneuver will be reduced, when out of trim, because part of the actual elevator travel is being used to counteract the out of trim condition. These two effects can add up such that it is impossible to flare or pull up the airplane.

EFFECT OF STABILIZER MISTRIM

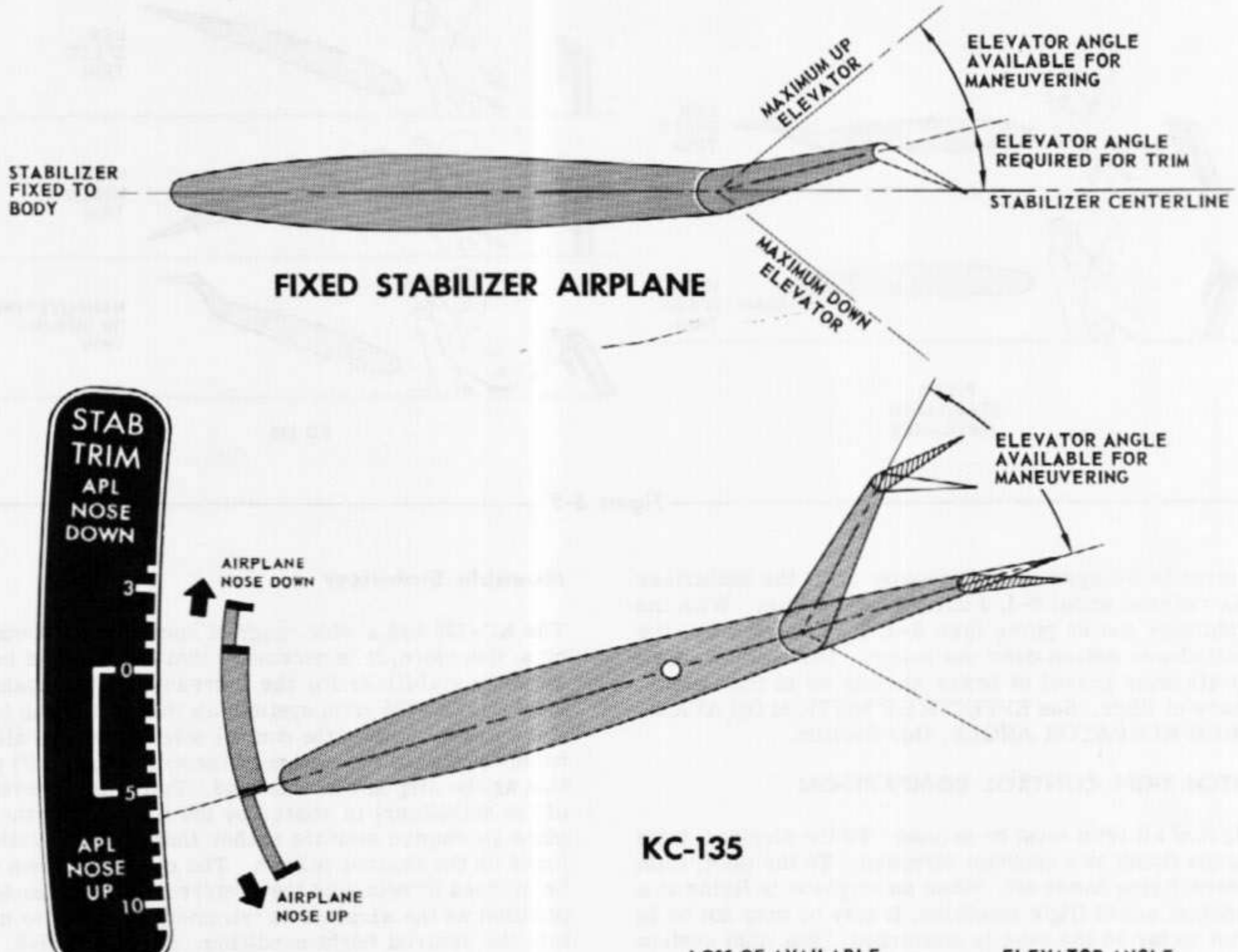


Figure 6-6

AILERON AND SPOILER

Roll control is provided by a combination of ailerons and spoilers. This provides dual reliability (mechanical and hydraulic) and ample control for crosswind landings in gusty weather. In actual flight, roll rates of 35 degrees per second during approach and 45 degrees per second during cruise can be obtained without control forces exceeding 40 pounds at the control wheel. Some lightening of control wheel forces will be noted at Mach numbers above 0.90 but at no time will a reversal occur. The spoilers are located on the wing such that very slight pitch tendencies prevail; consequently, elevator and aileron coordination during entries to and from turns is normal. The spoilers deflect symmetrically for speed brake operation with the ability built in to have lateral control motion superimposed directly on speed brake motion up to approximately 40 degrees of speed brake. A maximum spoiler deflection of 60 degrees can be obtained up to an airspeed of approximately 188 KIAS. Above this speed, the available hinge moment, which is determined by hydraulic system pressure and actuator size, is not sufficient to obtain full throw with the higher air loads. Figure 6-7 shows the spoiler and speed brake angle that can be maintained for a given airspeed. Speed brakes are normally used for two flight conditions: descent from altitude and decrease of speed in turbulent air. Speed brakes are not used during approach and the flare-out. Inflight speed brake settings of 40 degrees or more are recommended for extended periods of speed brake operation. These inflight speed brake settings are recommended for use in order to obtain good descent control while not obtaining excessively sensitive roll control. Actual speed brake angles above 30 degrees may be accompanied by buffeting which is caused by the spoiler wake impinging on the horizontal stabilizer; this buffeting is not noticeable during lateral control operation. Full 60 degree speed brakes are to be used during the landing ground roll after the nose wheel is on the runway to reduce wing lift and put more weight on the landing gear for more effective brake action and to cause more air drag.

SPOILER BLOWDOWN ANGLES

DATE: JUNE 1961
DATA BASIS: ESTIMATED

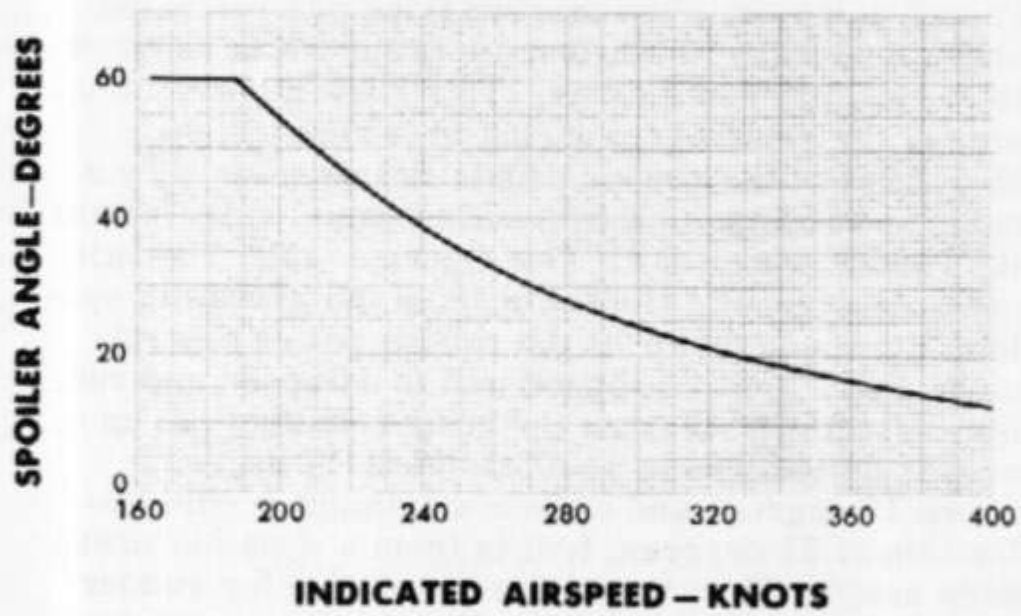


Figure 6-7

NOTE

- Spoiler rise, commonly known as "spoiler float," is often observed in flight; it usually occurs at low speeds with 40-50 degrees flaps. Aerodynamic loads on the spoiler surfaces overcome the hydraulic pressure holding the spoilers closed and cause the spoilers to rise slightly above the closed position. Also, if the spoiler switches are in CUT-OFF, or hydraulic pressure is lost, "spoiler float" will occur in any phase of flight. "Spoiler float" is not detrimental to airplane flight characteristics; it does not require rigging adjustments unless it occurs continuously throughout flight regardless of flap settings.
- Continuous "spoiler float," due to loss of hydraulic pressure or spoiler switches in CUT-OFF, may result in a range penalty of up to 10 to 12 percent.

POWERED RUDDER

The hydraulically powered rudder is effective throughout the speed range of the airplane. When inboard flaps are extended beyond 5 degrees, hydraulic fluid in the high pressure range is supplied to the rudder actuator; when inboard flaps are retracted above 5 degrees, the hydraulic pressure is reduced to the low pressure range. This prevents overstressing of the vertical fin during high speed flight. Movement of the rudder pedals is transmitted by a cable and linkage to a hydraulic control valve within the rudder power unit. (See figure 1-43.) The valve controls hydraulic fluid flow from the hydraulic system into the actuator of the rudder power control unit. Pilot "feel," proportional to airspeed and rudder deflections, is from the rudder control tab up to rudder deflections of approximately 17 degrees; above 17 degrees and up to a maximum rudder deflection of 25 degrees, feel is from a dynamic pressure sensor (Q-spring). See figure 6-9 for rudder angles obtainable with a 200 pound rudder push force within the speed range of the airplane. Refer to Section III for rudder operation during hydraulic malfunction.

POWERED RUDDER CHARACTERISTICS

Under certain conditions, the powered rudder exhibits reactions which do not occur with a nonpowered rudder. These reactions, if small in magnitude, are not dangerous but may cause discomfort and undue concern to the personnel aboard the airplane. These reactions can be briefly described as "unscheduled yawing motions of the airplane," and may be caused by: (1) pilot technique, (2) system malfunction, or (3) cold soaked hydraulic components.

Reactions Due to Poor Technique

The pedal forces and trim requirements are greater for rudder power OFF operation. False rudder lock, hardovers, and lurching may occur if the differences in pedal force and trim required are not anticipated when the rudder power switch is actuated.

False Rudder Lock

If rudder power is turned OFF while pedal force is being applied, the sudden increase in pedal resistance momentarily makes the rudder appear to be locked.

Hardover

If rudder power is turned ON while pedal force is being applied, the sudden reduction in force required leads to a rapid overcontrolling motion of the pedals. Hardover is the reverse situation of false rudder lock.

Pedal Kickback

Pedal kickback can occur anytime the autopilot is engaged or disengaged or the rudder is changed from either the manual mode or the powered mode. These reactions may not be noticed each time the rudder mode is changed. The most probable cause of pedal kickback is that sustained trim forces are being held either through the autopilot or through the pilot holding rudder pedal pressure. To minimize pedal kickback, the pilot should make sure the airplane is in trim before changing from either the manual or the powered mode and that no sustained control forces are inadvertently being held. Before engaging or disengaging the autopilot check rudder trim indicator to determine that the rudder servo is not holding a sustained torque (refer to AUTOPILOT OPERATION, Section IV).

Figure 6-8. Deleted

RUDDER ANGLE VS AIRSPEED

(POWERED RUDDER OPERATIVE)

DATA BASIS: FLIGHT TEST
DATE: JUNE 1961

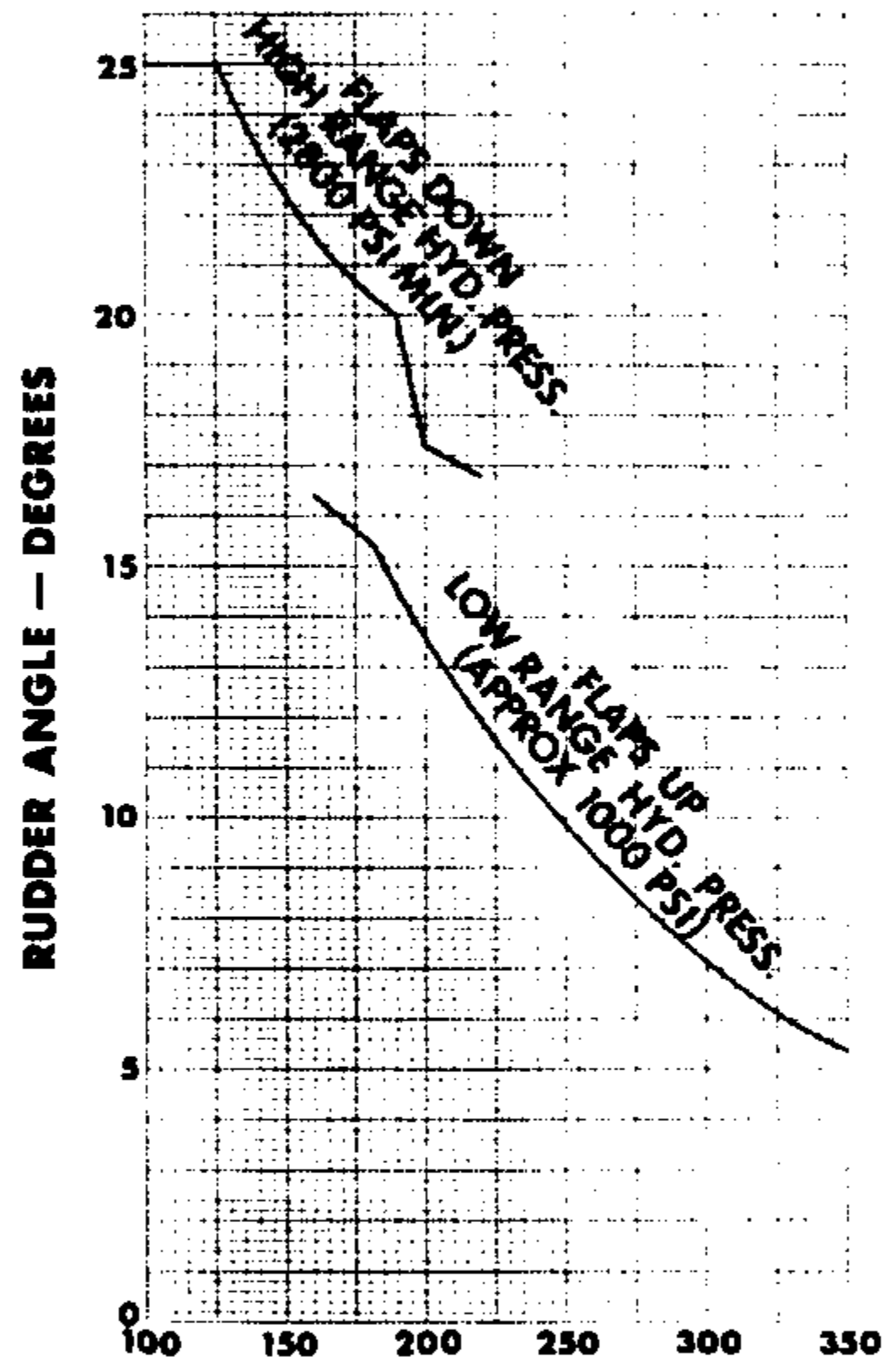


Figure 6-9

Lurching

In the event that the rudder trim is adjusted while the autopilot rudder axis is engaged, lurching may occur when the rudder axis is disengaged.

NOTE

- Although the airplane may be safely flown during cruise with the rudder power OFF, pedal forces and trim requirements are significantly increased.
- The autopilot rudder axis must be disengaged while the rudder trim setting is being adjusted.
- Engaging or disengaging the rudder axis and/or turning the rudder power ON or OFF, during turns, may cause erratic yawing motions of the airplane.

Reactions Due to System Malfunction or Cold Soaked Hydraulic Components

Although reactions due to cold soaked components should not be considered malfunctions, the effects of cold soaked components and the effects of system malfunction must be analyzed jointly to determine the cause since the effects are similar. System malfunctions may be due to: (1) binding mechanisms, (2) out of tolerance EPR gages (unbalanced thrust), or (3) out of tolerance control rigging. The reactions which may be caused by the above reasons are excessive rudder trim, rudder induced snaking, and pedal kickback.

Excessive Rudder Trim

Excessive rudder trim is defined as more than 1.5 trim units left or right provided that:

(1) Airplane is flying at normal cruise condition,

(2) Ailerons are trimmed for straight and level flight,

(3) Lateral fuel weight is equalized, and

(4) All engines are operating at the same EPR setting and fuel flow rate.

If rudder trim is between 1.5 and 3 units for several flights or more than 3 units for a single flight, the factors affecting airplane trim should be investigated. When excessive friction is present, the PCU metering valve must be moved farther than normal, for a given rudder deflection, to overcome the frictional force. However, when the friction is due to a cold soaked component, vibration will tend to overcome the frictional force and allow the metering valve to seek its normal position, thus increasing the rudder deflection. This action is called trim wandering and is most likely to be caused by cold soaked components. Excessive trim, not associated with trim wandering, is probably an indication of system malfunction.

Rudder Induced Snaking

Rudder induced snaking may be distinguished from dutch roll in two ways: (1) snaking is a yaw oscillation which may occur only when the rudder power is ON and the autopilot rudder axis is engaged and (2) the frequency of oscillation is faster (approximately 2 seconds per cycle). If snaking occurs during cruise, the rudder power may be turned OFF.

NOTE

- If the rudder power has been turned OFF during cruise, rudder power should be turned ON before descending to lower altitudes or reducing air speed below approximately 250 KIAS.
- In the event that a Form 781 entry is made because of excessive rudder trim, snaking, or other irregularities, the following information should be included for analysis:

  (1) OAT at cruise altitude,
  (2) Time at cruise altitude,
  (3) EPR readings,
  (4) Main and reserve tank quantity readings,
  (5) Hydraulic pressure indications, and
  (6) Amount and direction of excessive trim, if applicable.

AIRPLANE TRIM PROCEDURE

The airplane should be trimmed with the control wheel centered. If this is not done, spoiler response, and therefore airplane response to control wheel movement, will be unsymmetrical.

To trim the airplane, use the following procedure:

1. Disengage the autopilot in all axes. Never try to trim the airplane with the autopilot engaged because the autopilot will make corrections for these trim inputs and consequently keep the airplane out of trim.
2. Move the rudder and aileron trim wheels to zero.
3. Engage the power rudder if it is not already on.
4. Use the EPR gages to adjust engine power so that it is symmetrical.

5. Center the control wheel and apply rudder pedal pressure so that the airplane is flying with the wing tips level using the horizon as a guide. The airplane should now maintain a steady heading if it is properly rigged.

NOTE

The ball of the slip indicator is not a reliable yaw trim device. For this reason, do not trim the airplane to keep the ball centered, instead trim the airplane to hold a heading. If the ball of the slip indicator is more than 1/8 inch off center, check indicator alignment.

6. Crank in rudder trim to relieve rudder pedal forces.
7. Adjust aileron trim if necessary.

Rudder trim also affects airplane movement in its roll axis. If the airplane is out of trim in its yaw axis, it will also be out of trim in its roll axis. This gives a false indication that the roll axis needs trimming and may lead to cross-trimming.

It is desirable to have the control wheel centered and aileron trim as near to zero as possible. Excessive aileron trim can overwork the autopilot.

LEADING EDGE FLAPS

The leading edge flaps operate in conjunction with the main wing flaps. When the main flaps extend beyond approximately 9.5 degrees the leading edge flaps open to their fully extended position. As the main flaps are retracted to approximately the 6 degree position the leading edge flaps retract flush with the lower wing surface. The purpose of the leading edge flaps is to improve the lift-drag characteristics of the wing at high angles of attack, thus allowing a positive rate of climb at lower airspeeds than would otherwise be possible. Local areas of leading edge airflow separation are characteristic of this type of airplane during flaps down, low speed flight conditions, because of the difference in airfoil requirements for low speed and high speed flight. The addition of leading edge flaps delays that area of airflow separation which occurs first, namely just inboard of the outboard engine strut. A microswitch on the leading edge flap hinge will actuate the warning horn if the leading edge flaps are not fully extended and the No. 3 throttle is advanced near OPEN and the airplane is on the ground.

UNSCHEDULED YAWING, PITCHING AND ROLLING DUE TO FLIGHT CONTROL MALFUNCTION

The importance of correct analysis of abnormal flight characteristics cannot be overemphasized. This is because the effects of engine, electrical, hydraulic or mechanical malfunction can be similar. It is important that the pilots understand that full, combined control forces as necessary and without restraint, as well as asymmetric thrust if required, should be used to counter all flight control problems. The relationship between flap settings and roll control at airspeeds below flap placard should be understood in that outboard aileron control is not available when flaps are fully retracted. Therefore, at speeds below flap placard speed with flaps full up, lateral control can become marginal if extreme directional control problems are encountered.

Unscheduled Yaw

At takeoff flap settings during climbout after takeoff, there is sufficient lateral control to compensate for maximum rudder deflection. Following flap retraction a 25 knot speed range exists where full lateral control must be augmented with asymmetric thrust to compensate for a maximum rudder deflection.

Unscheduled Roll

In correcting for a jammed aileron, a steady deflection of the rudder and use of asymmetric thrust, if necessary, will counter an undesired bank angle.

Unscheduled Pitch

Pitch trim variations are thoroughly covered in STABILIZER TRIM EMERGENCY OPERATION in Section III.

Autopilot Malfunction

Any axis of the autopilot can be overcome with a moderate amount of control force by the pilot. See AUTOPILOT TRIM MALFUNCTIONS, Section III and AUTOPILOT OPERATION, Section IV.

DUTCH ROLL

"Dutch roll" is a yawing motion of the airplane. It is characteristic of most swept wing airplanes and may be considered only a nuisance unless allowed to progress to large bank angles. Large rolling yawing motions may become dangerous unless properly damped. It is caused primarily by sideslip or yaw of the swept wing. Straight wing airplanes are less prone to dutch roll. Dutch roll is most evident at low indicated airspeeds and high altitudes; during these conditions a longer period of time is required to damp the oscillations. The principle factor affecting dutch roll damping is angle of attack of the wing - the higher the angle of attack, the lower the damping. The highest angles of attack are reached during takeoff, landing, high altitude and any low speed flight

condition approaching initial buffet. For the same speeds, higher gross weights also require higher angles of attack.

Dutch roll is usually induced by rough air, or by lateral-directional control (for example in turn entry). The period of oscillation is relatively long (4 to 7 seconds) and can be controlled by stopping either the roll or the yaw; dutch roll cannot exist without both roll and yaw. Even with autopilot rudder axis inoperative, the airplane is naturally damped in all flight conditions.

DUTCH ROLL CONTROL

Dutch roll can be stopped by 1) engaging the autopilot rudder axis, by 2) engaging the full autopilot, or by 3) manual use of the control wheel. The primary method is with the autopilot rudder axis. Operation of the rudder axis is covered in Section IV. The autopilot rudder axis is designed to apply the proper amount of rudder at exactly the right time to damp dutch roll, and in doing so, applies very small deflections before the yaw angles become large. Since the autopilot rudder axis drives the same control tab as the rudder pedals, the autopilot rudder axis inputs can be felt in the pedals especially when entering a bank or in rough air. Rudder axis inputs should not be resisted by foot pressure since these inputs are normal. The pilot should continue to control the airplane with the control wheel and ignore the small rudder pedal movements. The full autopilot recovery from dutch roll is accomplished through both the yaw and roll axes. The initial inputs may result in crossed controls as shown by the autopilot turn indications. The autopilot recovery is the easiest, eliminating the need for pilot action but is impractical under some conditions.

Manual damping of dutch roll may be required in takeoff and landing (when the autopilot rudder axis is off) or in the event of an autopilot rudder axis failure. Neither of the methods used by the autopilot is used manually to damp dutch roll. Manual damping of dutch roll is accomplished with the lateral controls only. Figure 6-10 shows how the lateral controls are moved to stop the rising wing. As a first approximation, use a control wheel input roughly equal to the degree of oscillation. For example, if the bank angle oscillations are + 10 degrees, use about 10 degrees of control wheel. Lateral control inputs should not be large and should be centered quickly as the rolling motion stops. If the input is held too long, it may excite another larger oscillation in the opposite direction. Several cycles may be required to damp out dutch roll. If an input opposing the roll should be too small to stop the rising wing a second pulse in the same direction as the first should not be applied as that could be out of phase and increase the oscillations. The next lateral control input should be delayed until the start of the next bank oscillation and then be applied to stop the rising wing, quickly centering the wheel as the roll stops. Once the bank oscillations are small, it should be easy to apply control smoothly to reach a desired bank angle for turns or level flight.

Although some pilots have learned to damp dutch roll effectively using the rudder, experience has shown that this is undesirable. Applying correct rudder to properly damp dutch roll in a turn, particularly in rough air, can be difficult. Wrong rudder application may result in extreme bank angles with excessive sideslip and possible high rates of roll. Attempts to recover with improper rudder inputs in combination with sideslip can cause large fin loads and possible structural damage. Use of a combination of lateral control and rudder can even be more dangerous if incorrectly applied.

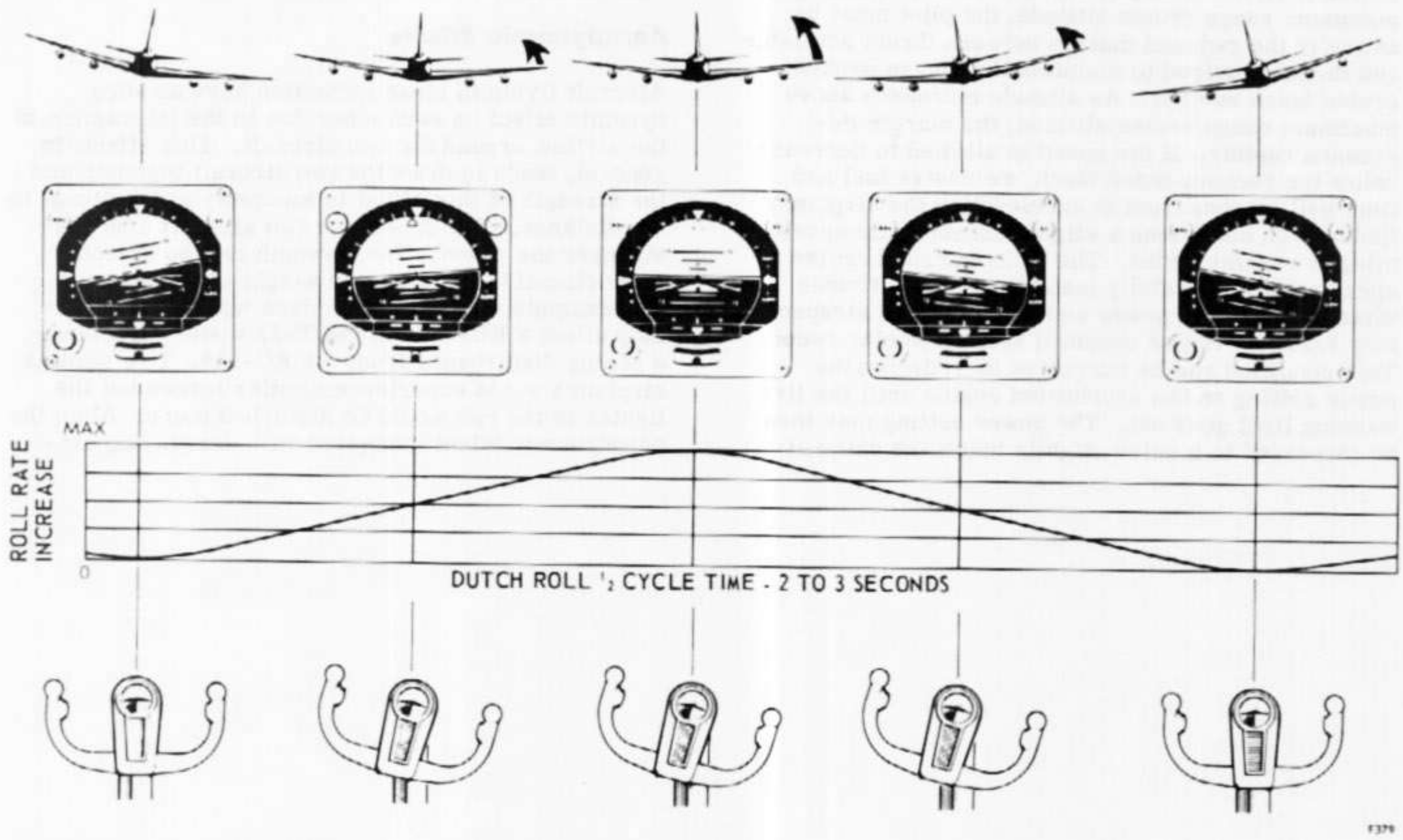
Use of lateral control only will result in normal control responses that are useful and safe under all conditions whether flying visually or on instruments. If in normal operation the pilot concentrates on maintaining the desired bank angle, the combination of lateral control and natural damping will not permit severe dutch roll to develop.

If inadvertent dutch roll occurs as a result of improper control, or if an excessive bank angle is reached, the autopilot rudder axis should be engaged followed by manual lateral control to recover the desired bank angle.

WARNING

- Intentionally induced dutch roll maneuvers are prohibited. Improper excitation and recovery techniques cause higher than normal cumulative stresses in the vertical stabilizer.
- Large amplitude dutch roll oscillations coupled with improper control can cause engine separation due to excessive rates of roll.
- Manual damping of dutch roll is to be accomplished with the lateral controls only. Do not attempt to damp dutch roll manually with the rudder.

DUTCH ROLL DAMPING TECHNIQUE



PILOT ACTION				
ROLL MOTION TO RIGHT STOPPED WHEEL CENTERED	ROLLING MOTION TO LEFT BEGINNING WHEEL TO RIGHT TO COUNTERACT ROLLING MOTION TO LEFT	WINGS LEVEL ROLL RATE TO LEFT AT MAXIMUM WHEEL TO RIGHT APPROXIMATELY EQUAL TO MAX BANK ANGLE TO LEFT EXPECTED	ROLL RATE TO LEFT REDUCING WHEEL TO RIGHT REDUCED	ROLLING MOTION TO LEFT STOPPED WHEEL CENTERED

Figure 6-10

CRUISE CHARACTERISTICS

The airplane handling characteristics are good at the recommended speeds and altitudes for cruise flight.

FLIGHT ABOVE RECOMMENDED CRUISE ALTITUDE

Should it be necessary to fly above the recommended maximum range cruise altitude, the pilot must be aware of the reduced margin between thrust available and thrust required to maintain the recommended cruise Mach number. As altitude increases above maximum range cruise altitude, the margin decreases rapidly. If the speed is allowed to decrease below the recommended Mach, excessive fuel and time will be consumed in accelerating the airplane. Under such conditions a slight descent while accelerating is recommended. The recommended cruise speed must be carefully maintained. At altitudes where high engine power and low indicated airspeeds may exist, an engine overheat indication may occur. This condition can be corrected by reducing the power setting on the overheated engine until the fire warning light goes out. The power setting may then be increased to a value slightly below the value at which the overheat occurred. Other effects as altitude increases are briefly as follows: Dutch roll becomes progressively more evident; roll response to manual or autopilot inputs is more abrupt; the margin between high speed and low speed buffet diminishes. When descending, more consideration of cabin pressurization power requirements is necessary.

FORMATION FLYING

Aerodynamic Effects

Aircraft flying in close formation have an aerodynamic effect on each other due to the interaction of the airflow around the two aircraft. This effect, in general, tends to draw the two aircraft together and the strength of this effect is inversely proportional to the distance. The closer the two aircraft are, the stronger the effect. The strength is also directly proportional to the size and weight of the aircraft. For example, a T-33 chase plane would not noticeably affect a KC-135 but the T-33 would experience a strong disturbance from the KC-135. Two similar airplanes would experience similar forces but the lighter of the two would be disturbed more. Also, the aerodynamic effect increases with decreasing air-

speed since, for the same weight aircraft, the distortion in the airflow is greater at slower speed. The extension of wing flaps distorts the airflow in a manner to increase the disturbance so that it is more hazardous to fly formation at low speeds with the flaps extended on the lead aircraft. In addition, formation flying at high Mach numbers can introduce large unfavorable interactions between the two aircraft. The pilot feels all of these aerodynamic effects as changing control force requirements as the two aircraft maneuver near each other. These control force variations become more rapid and pronounced when the airplane's position in formation is changed rapidly. The control force variations experienced during rapid changes in position can produce rolling and pitching moments that cannot be immediately controlled with full control displacement. The formation position must be changed gradually and smoothly to allow the pilot adequate time to compensate for the variations. The direction of the disturbing force is different for every relative position, but generally, the force is in the direction to bring the two aircraft closer together. Consider a B-52 under running a KC-135 during an attempt to formate for refueling. If the center lines of the two aircraft coincide, they will tend to fly together and the B-52 pilot must push on the control column to maintain clearance.

As the B-52 wing passes forward of the KC-135 wing, it passes from a region of downwash to a region of upwash and the lift is suddenly increased; therefore, the B-52 pilot must strongly increase the push force at this time to prevent pitching up into the tanker. If the B-52 were to underrun the tanker to one side so that their wings overlapped on one side only, the pitching tendency would not be quite as strong, but the overlapping wings would pull together unless checked by opposite aileron.

Limitations

To prevent possible mid-air collision, intentional close formation flying is prohibited except during air refueling conducted in accordance with applicable air refueling flight manuals and authorized formation flying conducted in accordance with major air command directives. Prior to participating in air refueling operations or formation flights, all crews will be properly briefed on formation tactics and procedures that will be used and to (1) never fly over or under the other aircraft and (2) maintain safe separation in all directions as specified in the applicable air refueling flight manual or the major air command formation flying directives. If an emergency requires a chase aircraft for airspeed reference or a visual inspection, the pilot of the chase aircraft will be briefed on command chase aircraft procedures prior to engaging in chase operations.

AIR REFUELING CONTACTS

Refueling a receiver airplane from this airplane is very similar to refueling an airplane from a reciprocating engine tanker in spite of the higher speeds and altitudes. While the tanker and receiver are making contact, a few effects become evident in the airplane flight characteristics. A nose down attitude occurs as the receiver moves into the refueling position. The untrimmed stick forces may reach a value of approximately 30 to 40 pounds, but may be trimmed out at any time during or after contact is made. Altitude changes should be kept to a minimum. With a large fuel transfer, the weight change will result in a change of both trim and power settings during contact since contact is to be continued in level flight and at a constant airspeed. These changes will occur gradually which means that both tanker and receiver pilots will also be able to make the compensations for weight changes slowly. Turns and banks can be made while in contact provided entry is gradual. The airplane will respond to motion of the ruddevators and boom, but at no time is the coupling of motions very pronounced. By using the rudder axis of the autopilot the coupling of motions can be almost completely eliminated. Normal boom operation during contacts will be perceptible but not bothersome to the pilot. When a disconnect is made with the receiver in the lower portion of the refueling envelope, the boom will swing upwards to trail position but this will induce only a slight pitch motion. The airplane is more responsive to abrupt azimuth motions of the boom, but these are easily damped.

MANEUVERING AND HIGH SPEED FLIGHT

AIRPLANE BUFFET CHARACTERISTICS

Buffeting may be either the low speed stall type or the high speed compressibility type. Low speed buffet occurs when the airflow over the wing begins to break down (separates) due to the high angle of attack required by the low speed. High speed buffet occurs when the airplane reaches a Mach number at which shock induced separation causes turbulent airflow over the wing. As Mach number increases, the separation gets more pronounced which in turn builds up the magnitude of buffet and airplane vibration. It is possible while flying at a given weight and constant altitude (figure 6-11, Point A) to decrease speed (increase angle of attack) and enter low speed stall buffet, Point B, or to increase speed (lower angle of attack) and obtain high speed buffet, Point C. These points determined for a number of gross weights, altitudes, and speed conditions, define the buffet boundary (figure 6-11). The effect of positive accelerations resulting from pull-ups or coordinated turns is to increase load factor which has the same effect as adding weight to the airplane. Starting from level flight at Point A, and pulling load factor, buffet is encountered at Point D. Level flight operation near the high speed buffet boundary is not dangerous provided the pilot understands the cause of buffeting and knows the quickest way to get out of the buffet region. The recommended procedure is to reduce speed or altitude or both by reduction of thrust and use of airplane speed brakes. A slight increase of back pressure on the control column will aid in losing speed but the airplane response characteristics cause a momentary increase in load factor with an increase in buffet intensity prior to a loss in speed. The aileron characteristics are such that an aileron buffet occurs prior to the onset of high Mach number wing buffet. The aileron and tab experience a flow oscillation due to the local shock induced separation and this oscillation reacts through the control system with a subsequent control wheel movement. If buffet is experienced during a turn, it is recommended that the bank angle be decreased while easing off on control column pressure; if during a pull-up, nose the airplane over slightly.

BUFFET BOUNDARY LIMITS

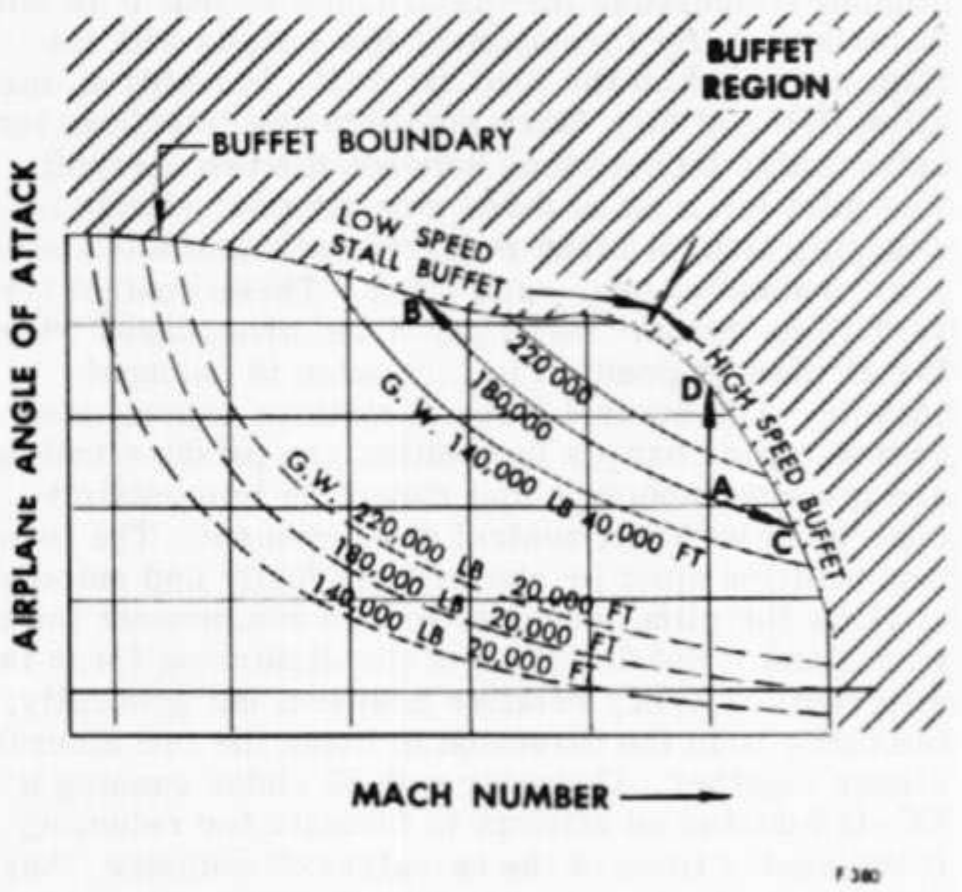


Figure 6-11

HIGH SPEED TRIM CHARACTERISTICS

During normal flight, the speed is increased when the airplane is retrimmed by nose down trim or control column push. However, like many other high speed airplanes, the trim requirements reverse as the buffet region is entered and nose up trim is required to hold increased speed. This trim tendency is not considered critical on this airplane as the horizontal stabilizer provides ample longitudinal control to handle any condition within airplane structural capabilities. The cause of this trim tendency is the rearward shift of the center of lift on the wing with Mach number increase. The trim changes are gradual as speed increases and will not require more than 50 to 60 pounds of pilot effort at 35,000 feet and 90 pounds at 26,000 feet if no stabilizer trim is used to decrease this force. It will be noticed that while the trim is reversed the airplane response to maneuvering forces is normal.

DIVES

Because of the normal margin, at cruise, between cruise Mach number and the buffet boundary, a shallow dive may be made without entering buffet. Because of the extremely low drag of the airplane when in the cruise configuration, the speed increases rapidly at any time the nose is dropped or a dive is entered. If the buffet region is entered while in a dive, recovery should be made promptly by retarding the throttles to IDLE and setting speed brakes to 60 degrees. At the same time leveling may be started but a large increase in load factor should be avoided. This would aggravate buffet and could possibly result in damage to the airplane. In cases where a rapid rate of descent is desired see EMERGENCY DESCENT, Section III.



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ENGINE OPERATION

For a description of the engines and components, see Section I.

THRUST-RPM RELATIONSHIP

The J57 engine employs a split, 16-stage, axial-flow compressor. The compressor section consists of a 9-stage, low-speed, low-pressure rotor unit and a 7-stage, high-speed, high-pressure rotor unit. Both rotor assemblies are mechanically independent and therefore do not rotate at the same speed. The tachometer, however, indicates the rpm of the high-pressure compressor rotor only. A tachometer reading of 100% rpm for the J57 engine, unlike that for other jet engines, is not intended to indicate proper thrust output. In fact, on the J57 engine, 100% rpm is considerably above the rpm at which rated thrust is obtained. During the calibration run of the engine at the factory, high-pressure rotor rpm for military rated thrust (MRT) is determined for a standard day. This rpm is then computed for engine rpm % and this value and the rpm are stamped on the engine data plate. This "data plate" rpm and % will vary from engine to engine by as much as 5%. However, as the engine accumulates operating time, some loss of performance occurs, and the engine speed may be increased progressively above the original "data plate" rpm and %, by adjustments (retrimming) to restore MRT. It is apparent, then, that each engine must be treated individually with respect to the rpm at which MRT is obtained. The tachometer (figure 5-1) has a maximum rpm index of 102% that will be the same for each engine and represents the structural rpm limit of the engine.

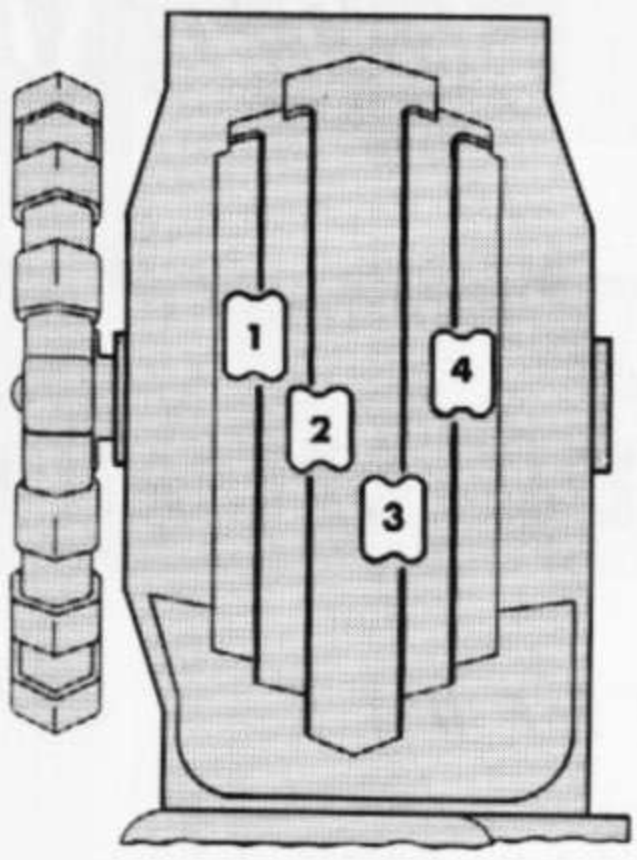
EPR SYSTEM OPERATION

The EPR gage indicates the ratio of turbine discharge pressure to inlet pressure. As the pressure differential is a direct function of engine output, the EPR gages are used to give a more accurate indication of engine thrust. An EPR check will be essential during takeoff in order to be assured of proper takeoff thrust settings. For the same reason the engine is trimmed with reference to turbine discharge pressure rather than rpm. Refer to the Appendix, T.O. 1C-135(K)A-1-1, for more information on the EPR gage readings for different conditions of engine operation. Oscillation of the subdial during low engine thrust settings is caused by the functioning of the electrical stops within the transducer and is not a cause for alarm. Advancing the thrust setting on the engine to a pressure ratio above 1.2 will usually cause the oscillation to cease. Assuming that

THROTTLE ALIGNMENT

NOTE

See text for explanation



F-382

Figure 7-1

all other instruments are reading the same and are correct, the allowable difference between two pressure ratio indicators may be as much as 0.140 depending upon the flight condition. Erratic operation of EPR units can be caused by several factors. The effects of some of these conditions do not form valid reasons for rejection of the units. Inflight air turbulence can cause EPR fluctuations as great as 0.05 EPR units. Air turbulence is magnified because after the inlet pressure pickup senses the pressure change, the engine senses the same change and it is again reflected in the exhaust pressure probe. Engine bleed air can also cause some fluctuation in pressure ratio where the bleed air demands vary. During a slow engine acceleration or deceleration, a rapid winding up or unwinding of the subdial on the EPR gage (approximately a 0.2 EPR unit change) will indicate operation of the engine surge bleed valve. Because different surge bleed valve governors are used on the J57-P-59W and -43WB engines, the surge bleed valves on -43WB engines will actuate at a lower range of EPR settings. Actual engine fuel feed fluctuations will also cause some fluctuation in the EPR indication. The EPR system is of necessity sensitive and for that reason will reflect subtle changes of pressure and air turbulence.

NOTE

Check that fuel flow, rpm, and EGT are approximately equal on all engines at charted EPR settings prior to takeoff. Small variations in fuel flow, rpm and EGT will exist between engines. However, an engine which has a low thrust output will generally indicate both low fuel flow and EGT, and possibly low rpm. The loss of water to an engine during takeoff would result in an EPR loss of 0.3 to 0.45 depending upon the OAT.

THROTTLE ALIGNMENT

Throttle misalignment may result from a combination of trimming tolerances, engine deterioration, and rigging tolerances. Throttle misalignment in excess of one knob-width between extreme throttles is not necessarily cause for abort, but should be recorded in the Form 781. See figure 7-1 for an illustration of throttle alignment. In this figure, throttle No. 2 is considered to be one knob-width out of alignment with throttle No. 1. The extreme throttles, Nos. 1 and 3, are two knob-widths out of alignment.

ENGINE STARTING FUEL FLOW INDICATIONS

Figure 7-2 shows the approximate normal fuel flow versus rpm during starting. Any deviation above these flow rates will be the first indication of a hot start. Any deviation below these flow rates will be an indication of insufficient fuel for starting. Since ignition will be energized throughout the throttle range from just out of CUT-OFF to the START position, control of abnormally high fuel flows may be accomplished by retarding the throttle slightly within the START range. If this procedure does not retard the flow, move the throttle into the CUT-OFF position, allow 1 minute for drainage, then investigate.

ENGINE STARTERS

The pneumatic starters normally cut out at an engine rpm between 43 and 54% depending on the pneumatic starter used. It is possible to obtain a normal engine start even though the starter cutout occurs below the minimum specified rpm. This is possible if the starter has supplied enough energy to accelerate the engine over the "hump" where the engine becomes self-sustaining. However, if the starter has cut out appreciably early, then not enough energy from the starter will be available and the engine may tend to "hang up." This can cause EGT to rise. It still may be possible to get the engine started under this condition and not exceed temperature limits; however, high EGT during starting may have a greater effect on engine life than high EGT during any other phase of engine operation. See ENGINE LIFE this Section. If the EGT, during successive engine starts, exceeds the normal starting EGT appreciably (but does not exceed the starting EGT limit), and it is determined that the starter cuts out early, recording this on the Form 781 should be considered. A normal start is defined as one where the starting EGT does not exceed approximately 400°C (450°C maximum temperature limit during starting) and the engine accelerates smoothly from start to engine idle in 40 to 50 seconds during a pneumatic start. The cutout speed of the cartridge-pneumatic starter, during a cartridge start, cannot be detected by external observation or by engine instruments. The starter will operate until the cartridge is expended. Burning time of the cartridge is approximately 15 to 20 seconds; however, exhaust products will be evident for a slightly longer period. Normally the cartridge-pneumatic starter, during a pneumatic start, will cut out between 40 and 45% engine rpm.

APPROXIMATE FUEL FLOW VS RPM-STARTING

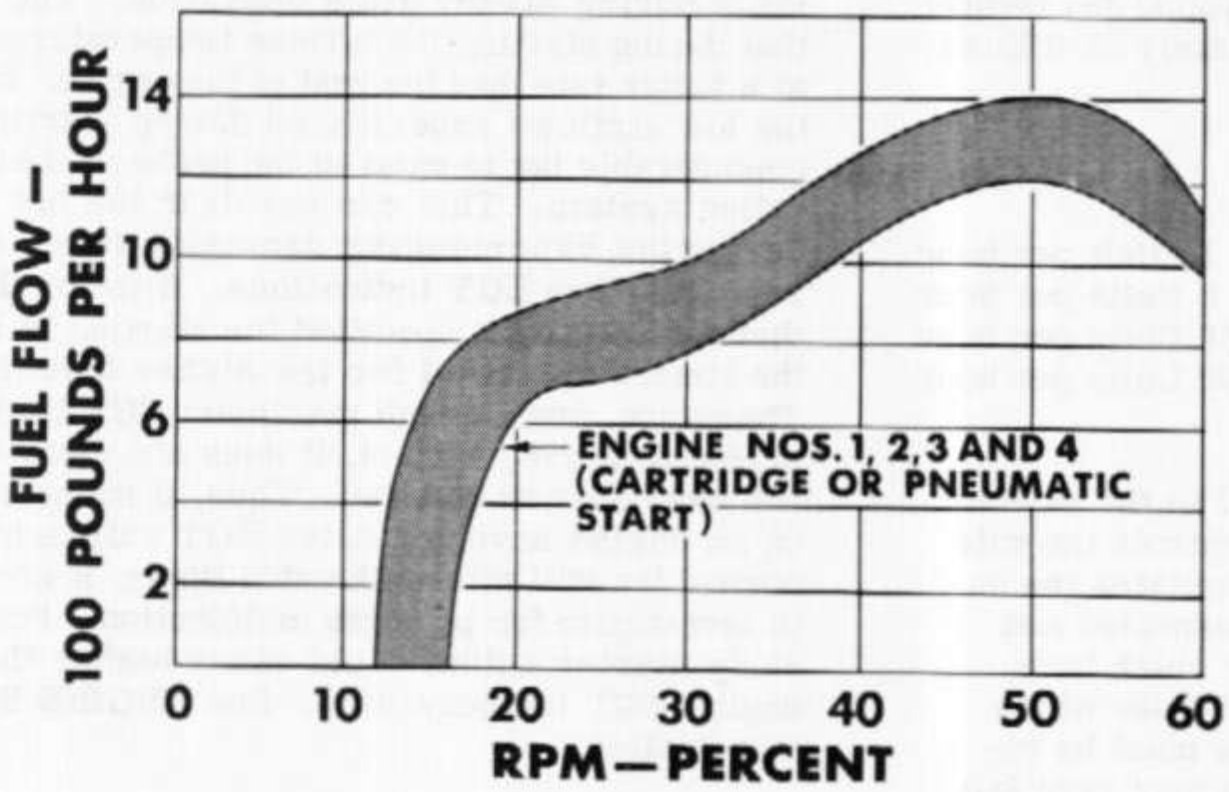


Figure 7-2

HOT STARTS

A hot start is usually the result of an over-rich mixture entering the combustion chamber. The condition may be the result of advancing the throttle too soon before the compressors have attained sufficient rpm to provide an adequate amount of air to the burners. Ice, frost or other restrictions at the compressor inlet can cause a hot start. The hot start appears as a normal start except that the EGT increases rapidly beyond the limits specified in Section V, figure 5-2.

ENGINE LIFE

Time-Temperature-RPM

The "Time-temperature-rpm" relationship within the engine is the main factor in engine life. The most important of these is temperature. The strengths of the materials used in the engine decrease as high internal temperatures approach the melting points of the metals, even though the danger point may not be closely approached. There is a tendency for any material to take a permanent set, stretch or bend; this tendency increases with both the load and the temperature. The amount of permanent set increases with the length of time that the load and/or temperature is applied. After a certain amount of permanent set is attained, the fibers or grains of the material begin to pull apart. Under inspection with a high powered microscope, the beginnings of fine cracks may be seen. With additional time, the material begins to elongate at faster rates as the cracks become bigger and deeper. Finally, the material breaks. This process is so slow that elongation is perceptible only with careful measurement. The term "creep" has been applied to the process because of the length of time required for elongation to become significant. In a turbine engine, high load and high temperature are usually experienced at the same time. The loading on the turbine and compressor blades is principally the combined result of the centrifugal force, associated with rpm, and some gas or air load, associated with engine internal pressure. When the turbine discharge pressure, which is indicative of other internal pressures, is high, the EGT is also high. This means that when the turbine blades are subjected to their heaviest load, the material of which they are constructed will be at its weakest. The compound effect of high rpm and high temperature results in an astounding increase in the rate of creep at very high thrust settings when the centrifugal load is the greatest. The ends of the compressor blades and the rims of the

turbine wheels tend to travel outward. The rate of creep, which is measured in millionths of an inch per hour, increases tremendously as the rpm and EGT approach maximum. Numbers can be assigned to the relative amounts of creep to show what actually happens at varying EGT and rpm. For a typical J57 turbine blade, the rate of creep is approximately as follows:

EGT - °C	RPM (N_2)	CREEP
500	92%	1 Unit per hour
580	94%	5 Units per hour
620	97%	50 Units per hour
655	98%	2500 Units per hour

Turbine life is inversely proportional to the number of creep units per hour. The pilot controls the rate of creep by the manner in which he operates the engine. Turbine blades are carefully inspected and measured at engine overhaul. Those which have elongated beyond tolerable limits and those which show evidence of distortion or cracks must be replaced. In extreme cases, the blades may even fail before the engine becomes due for overhaul. It can be readily seen from the foregoing creep rate table that when an engine is operated at the lowest temperature and rpm shown, the turbine blades will last 2500 times as long as they will if the engine is operated at the highest temperature and rpm shown. This is the reason that EGT during engine acceleration is time limited. Although the pilot cannot "read" the creep rate of turbine blades, he can "read" the operating temperature of the engine as EGT. Figure 7-2A shows EGT as related to engine life. It can be readily seen from figure 7-2A that if the engine is operated continuously, only half way between the EGT gage "green range" and the "red line " the life expectancy of the engine will be reduced by 90%. For example, if an engine is expected to operate 2000 hours at a conservative EGT but was in fact operated continuously midway between the green and red, the life expectancy of the engine would be reduced to only 200 hours. Also, from figure 7-2A, it can be seen that operating continuously only 10% above the recommended temperature range will reduce engine life by one-half. Although an engine will operate satisfactorily at the maximum allowable temperature and rpm, it is obvious that the operating time between turbine blade replacement and other engine hot section difficulties will be greatly increased if conservative engine operation is the rule and not the exception.

Engine Starting

Tests have been conducted which indicate that high EGT during low engine starting rpm may damage the engine more than high EGT, high rpm and high turbine loads during steady state operation. The reason is that during starting the turbine temperature increases at a faster rate than the rest of the engine. In addition, the low airflows experienced during starting cause a considerable lag to exist in the probe of the EGT indicating system. This can result in the hot section of the engine experiencing damaging temperatures at relatively low EGT indications. It is for this reason that the EGT limit specified for starting is lower than the limits specified for the higher thrust regimes. Therefore, even though maximum EGT limits are not exceeded during a start, it does not mean the engine life has not been reduced. Thus, if successive starts on an engine have indicated EGT values higher than normal but still within allowable limits, it would be wise to investigate for possible malfunction. For instance, early starter cutout could cause higher than normal engine EGT temperatures. See ENGINE STARTERS this Section.

NOTE

When engine acceleration is excessively slow during a pneumatic start it may be suspected that the emergency pressurization and heat valve has failed in the open position. An excessive heat condition may be encountered during takeoff.

Normal Engine Operation

Operating the engine within the specified limits of EGT, rpm and EPR should become an instinctive technique. It is just as important from an engine life standpoint to operate the engine at or within the EPR limits as defined in the Appendix, T.O. 1C-135(K)A-1-1, as it is to not exceed rpm or EGT limits. The EPR settings given in the Appendix are those which give rated engine specification thrust. Therefore, it is obvious that if the EPR settings are exceeded the engine thrust rating has also been exceeded and as a result engine life will be reduced. On this engine, EGT will increase with altitude for a given throttle position. Retarding the throttle will usually maintain the temperature within allowable limits whenever overtemperature is encountered. It is sometimes possible to control excessive acceleration temperatures by means of slower throttle movement. See Section V for EGT limits. Note that the

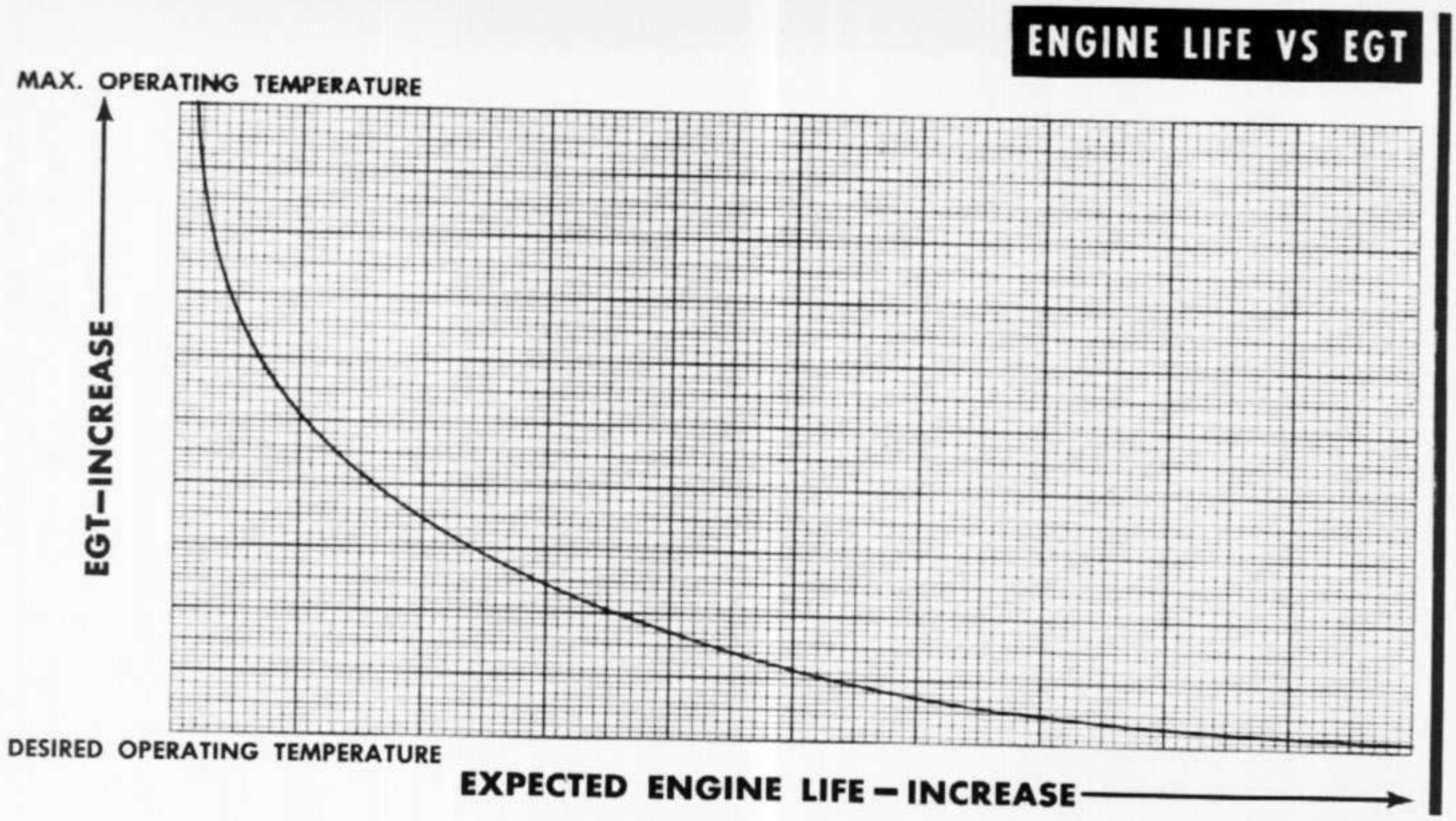


Figure 7-2A

maximum EGT during engine acceleration is time limited. Whenever allowable temperatures cannot be maintained or controlled, the engine should either be shut down or a landing should be made as soon as possible.

NOTE

- Whenever, in an emergency, it becomes necessary to advance throttles to "full open" and the EPR ratings as defined in the Appendix, T.O. 1C-135(K)A-1-1, have been exceeded the applicable engine(s) must be written up in the Form 781 as a flight discrepancy.
- Overtemperatures must be written up in the Form 781 as a flight discrepancy. Record peak temperature reached and length of time that the overtemperature existed so that correct maintenance inspections may be made after landing.

Effects of Overtemperatures

Do not treat overtemperaturing lightly. Just because the turbine does not fly apart or the engine melt away, there is no reason to assume that the engine cannot be or has not been damaged. Overtemperatures are additive; several momentary high overtemperatures will have just as much effect on the engine as a single prolonged one of lesser degree. Excessive internal temperatures aggravate conditions such as creep and deformation of sheet metal parts.

Temperature Sense

A definite relationship exists between excessive EGT and premature engine removals. The fuel control normally maintains EGT within a safe margin. However, the control cannot compensate for operational malpractices. Furthermore, under extreme flight conditions or in the event of a malfunction, the regulation of engine internal temperatures can be marginal or even above desired limits. Therefore the pilot must develop a "temperature sense" by thinking in terms of the inter-relationship of the engine control factors. By so doing one can learn either to avoid excessive temperatures altogether or to take immediate corrective action should they occur. Do not use a thrust or power setting higher than is necessary to accomplish the assigned mission. There is no hard and fast rule for reducing the throttle setting to NRT when operating at MRT for any specific length of time before the higher thrust rating may be used again. Obviously, nothing is to be gained by reducing a thrust setting for only a moment or two before repeating the setting again, just to be able to say that a thrust rating was not continuously used longer than the specified time limit.

NOTE

After operating at MRT, it is recommended that the engines be operated at NRT for a time period equal to the period the engines were operated at MRT before returning to MRT operation.

ENGINE COMPRESSOR STALL

Engine compressor stall is possible in the jet engine because of the airfoil characteristics of the compressor blades. Compressor stall is an aerodynamic stall, occurring in the same manner as that in which an airplane wing stalls. This condition is caused by a reduction of airflow through the engine, which increases the effective angle of attack of the compressor blades, resulting in a compressor blade stall. The reduction of airflow through the engine is induced by rapid engine throttle movements or continuous abnormal airplane attitudes with airspeeds below acceptable minimum. The most common of these conditions is the too rapid advancement of the throttles, which in turn increases the burner can pressures to a level above the capacity of the turbine. This excess pressure within the burner cans resists the compressor output, thereby reducing airflow through the engine. Additional causes of compressor blade stall are low air temperatures and density, and the adjustment and condition of such engine components as the fuel control unit and overboard air bleeds. Compressor blade stalls vary in severity, depending on whether the stall involves only a portion of a stage, a complete stage, several stages, or an entire compressor. Incipient stall may produce roughness in engine operation with or without audible accompaniment of rumble, drone, etc. More pronounced stalls may produce audible pulsations similar to pistol shots or even cannon fire. Extremely bad stalls may produce pulsations which cause flame, vapor or smoke to appear at the engine exhaust, in the surge bleed valves and even at the engine inlet. This may cause undue concern to flight crews inexperienced with this phenomenon. It is important that the type of engine irregularity be recognized by the operational symptoms. With this recognition it is possible to either correct the malfunctions, or take corrective action in time to minimize the possibility of damage. This may be accomplished by observing the following: avoid abnormal airplane attitudes and maintain airspeeds above acceptable minimums. By smoothly retarding the throttles to IDLE, reducing altitude and increasing airspeed as necessary, recovery from compressor blade stall will be expedited as advantage will be taken of denser air and increased compressor inlet temperatures. These conditions are generally applicable to the discussions on engine choo-choo, acceleration hang-up, engine surge, and engine flameout.

ENGINE CHOO-CHOO

Engine choo-choo is a mild form of engine compressor stall and sounds surprisingly like a steam locomotive under load. Choo-choo occurs on the ground only and is the result of accelerating the engine out of idle position with rapid throttle movement. This unstable condition is of very short duration and ceases after a slight rpm increase above the idle position. Occasionally, choo-choo is inaudible, in which case it can be identified by erratic fuel flow fluctuations.

ACCELERATION HANG-UP

Acceleration hang-up is a type of malfunction in which the engine fails to accelerate past a specific rpm. This hang-up sometimes occurs after the throttle has been retarded and an attempt has been made to accelerate to a higher rpm. Acceleration hang-up can be attributed primarily to a faulty fuel control unit causing continuous engine stall. In case of a faulty fuel control unit, engine shutdown may be necessary. In the case of continuous engine stall, it may be necessary to reduce power, increase airspeed, or decrease altitude.

ENGINE SURGE

Engine surge, which is an intermittent engine compressor stall, produces thrust variations which may be indicated by fuel flow fluctuations or a marked rise in EGT. Shock and pulsation can frequently be felt, sometimes heard, in the control cabin during flight. Although there have been occasions when engine surge has occurred on the ground, it usually manifests itself above 40,000 feet. It generally occurs during rapid throttle movements, or during slow speed, high angle of attack flight at these high altitudes. Surging which occurs during engine acceleration usually ceases as the engine speed increases. If it does not, a power reduction, followed by a slower rate of throttle advance will usually give satisfactory results. Surging which occurs during slow speed, high angle of attack

flight (usually with fixed throttles) may require throttling the affected engines or an increase in airspeed to furnish relief. Persistent or severe surge occasionally results in engine flameout, unless very prompt corrective actions are taken.

ENGINE FLAMEOUT

Engine flameout is the complete loss of combustion. In most cases it occurs at altitudes above 40,000 feet as a result of a too rapid throttle movement. It can also be caused by a change in the inlet air pressure gradient of the engine at high angles of attack. Following a flameout, the rpm and EGT will begin decreasing at once. Generally, engine flameout can be remedied by merely restarting the engine. See ENGINE AIR STARTING under ENGINE FAILURE in Section III for additional information and proper inflight restarting procedures.

ENGINE OVERSPEED

Engine overspeed is indicated by excessive rpm, fuel flow and EGT compared to other engines or by exceeding the engine EGT or rpm limits. Retarding of the throttle may be necessary to return engine readings to safe limits.

ENGINE SPEED FLUCTUATIONS

Engine instability may occur because of some malfunction in the engine or fuel control unit and may be recognized if any of the following are noted:

A. Erratic increase of turbine exhaust gas temperature.

B. Rapid reduction or fluctuation of rpm at constant throttle setting, or failure of rpm to continue to increase during acceleration.

C. Shock of compressor pulsation felt in the airplane structure.

D. Loss of power reflected in airplane instruments.

E. No response of pressure ratio to throttle movement.

Corrective Measures

Acceleration

A. Retard throttle to IDLE.

B. Obtain stable operation.

C. Slowly advance throttle to the desired power condition.

Steady State Operation

A. Slowly retard throttle to a more stable power range.

B. Reduce altitude.

Deceleration

A. Continue to retard the throttle to the IDLE position.

B. Obtain stable operation.

C. Slowly advance throttle to desired power condition.

Varying Exhaust Gas Temperature

Varying exhaust gas temperature will be accompanied by a corresponding engine rpm fluctuation. Depending on the magnitude of the EGT fluctuations, the indications will be the same as those for engine speed fluctuations; the same corrective procedures will apply. Monitor the engine operation within operating limits of rpm and EGT.

ENGINE MALFUNCTION ANALYSIS

Fortunately, incipient engine trouble is often predicted by the engine instruments well in advance of serious difficulty. Many situations can be quickly and correctly analyzed and timely corrective action taken if the engine instrument readings and the engine malfunction symptoms are interpreted properly. Conversely, misinterpretation of apparent abnormal engine operation and subsequent improper corrective action may possibly cause a more serious situation than was present in the first place. The possibility of an instrumentation malfunction reflecting false indications of trouble should also be considered.

The following guide to engine malfunction symptoms (figure 7-3) represents many (but not necessarily all) of the situations which might conceivably be encountered.

This malfunction analysis guide is not intended to serve as a maintenance trouble shooting chart. The malfunction symptoms which are mentioned are only those which would be apparent to a pilot and his flight crew. Similarly, the action recommended is only that which the flight crew may initiate themselves. Sometimes the only action possible may be to shut down the engine as soon as possible and to report the incident to the maintenance personnel. In the case of a malfunction of any type, care must be exercised to note all pertinent information accurately in the Form 781. Whenever possible, instrument readings before, during, and after

a malfunction should be noted. Specific information is needed by ground maintenance personnel rather than, for example, an entry which simply says "No. 3 EGT too high." When the situation warrants, the ground crew will also need to know the corresponding readings of the other primary engine instruments for both the malfunctioning engine and the other engines on the airplane at the time that the malfunction occurred. Properly reported engine discrepancies make for more positive malfunction analysis on the ground and for faster, better corrective maintenance.

The primary and most important group of engine instruments consists of the exhaust gas temperature (EGT) gage, the high pressure compressor (N_2) tachometer, engine pressure ratio (EPR) gage and the fuel flowmeter. These four instruments should be monitored simultaneously because the interrelationship of their readings provides the best key to recognizing trouble and determining the cause of a malfunction.

The turbine inlet temperature, which the EGT gage serves to indicate indirectly, is the most critical of all of the engine variables. EGT should therefore be closely observed at all times. Imminent malfunction of a serious nature will often be indicated by a rise in EGT. Continued engine operation at an abnormally high EGT will reduce the useful life of the engine or the time between overhaul. Ignoring an exhaust gas temperature that is above the allowable limit may lead to complete engine failure. Exhaust gas temperature sense and compressor stall are discussed in detail in this Section.

As a general rule of thumb, whenever any one of the four primary engine instruments, by itself, indicates an abnormal reading, the probable cause is most likely an instrumentation system malfunction.

WATER HEATER OPERATION

Refer to WATER INJECTION SYSTEM, Section I, for a description of the water heating system components. Water injection may be used when both the ambient and water temperatures are 40° F (4.4° C) and above. Water injection can be used down to 20° F (-6.7° C) with the water temperatures not lower than 60° F (15.6° C). The water tank heater master switch must be in the ON position to supply power to the water heaters and the heated drain mast. When the master switch is in the ON position the No. 1 keel beam tank heater, the two saddle tank heaters and the heated drain mast are energized, provided the water tank contains more than 500 gallons and the water temperature is less than approximately 130° F (54.4° C). The remaining tank heater switches have similar protection. The power source is either from external power or the auxiliary power unit. The water heating system is operative only on the ground.

See figure 7-4 for water heating and cooling rates and Section I, figure 1-11, for water heater power panel. The operating procedure is as follows:

A. Before Turning Heaters On:

(1) Water Tank Quantity - Check minimum of 500 gallons.

NOTE

The water tank quantity can only be assured of being above 500 gallons by filling the tank to the overflow.

(2) Loadmeters at Power Source - Check to avoid overloads.

B. Water Tank Heaters Master Switch - ON

NOTE

When using water heating, the landing gear doors should be kept closed as much as possible. Open doors will greatly lengthen the heating time and shorten the cooling time.

C. Additional Heaters - ON, in numerical sequence

CAUTION

The number of heaters (5 KW each) that may be operated at one time with APU power is limited by APU maximum power output of approximately 27 KW. All eight heaters may be used on external power.

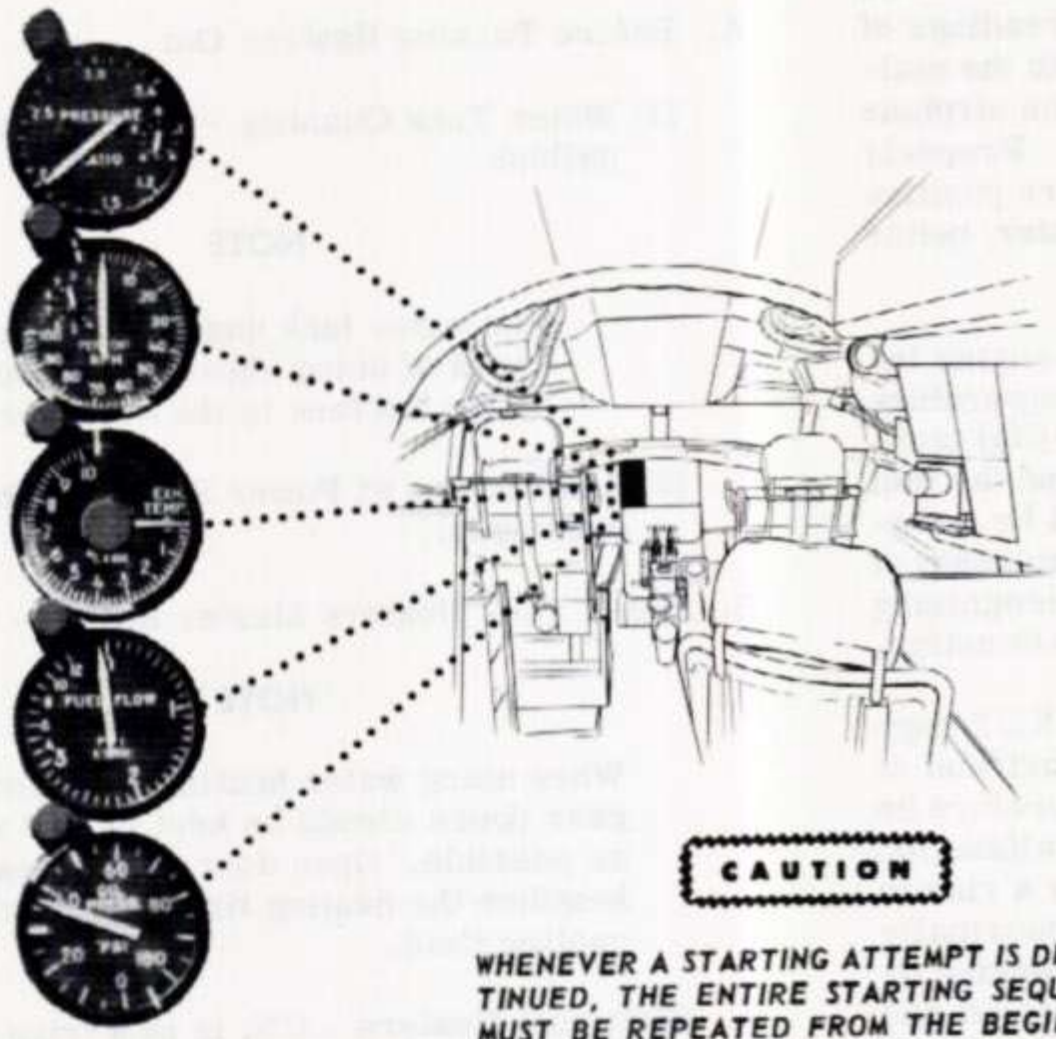
NOTE

- If external power is to be used for the power source, the water tank heaters master switch and additional switches 2, 3, 4 and 5 may be prepositioned to the ON position when cocking airplanes for alert. Pull the BATTERY CHARGE circuit breakers on the APU control panel. If an Airesearch APU is installed, the 3 circuit breakers marked STA 1180 POWER OUTLET on the GENERATOR NO. 2 section of the MCBP should also be pulled. This will prevent damaging the battery.
- When using all 8 heaters, nuisance tripping of the heater circuit breakers may be experienced if the bus voltage is allowed to exceed 200 volts.

D. All Switches - OFF

E. Power Supply - As desired

ENGINE MALFUNCTION ANALYSIS



WHEN COMPARED WITH KNOWN VALUES OR WITH THE OTHER ENGINES, INSTRUMENT READING HIGHER THAN NORMAL FOR A PARTICULAR CONDITION

WHEN COMPARED WITH KNOWN VALUES OR WITH THE OTHER ENGINES, INSTRUMENT READING LOWER THAN NORMAL FOR A PARTICULAR CONDITION

INSTRUMENT READING ZERO

INSTRUMENT READING NORMAL FOR A PARTICULAR CONDITION

CAUTION

WHENEVER A STARTING ATTEMPT IS DISCONTINUED, THE ENTIRE STARTING SEQUENCE MUST BE REPEATED FROM THE BEGINNING AFTER ALLOWING THE PRESCRIBED FUEL DRAINING OR STARTER COOLING PERIOD, WHICHEVER IS LONGER.

ENGINE STARTING (GROUND)

F 384

CONDITION	PROBABLE CAUSE	ACTION
No start after engaging the starter. Compressors rotate but NO fuel flow observed. EPR: NO RISE TACH: NORMAL TO STARTER CUTOUT SPEED EGT: NO RISE FUEL FLOW: ZERO OR RISE TO NORMAL FOR STARTING, THEN DROP OIL PRESS.: NOT APPLICABLE	No fuel to engine	Discontinue the starting attempt and investigate. Check fuel boost pump switch ON. Check fuel in tank. Switch tanks, if necessary. Check engine fire switches pushed in. During cold weather, suspect possible ice in fuel lines or sumps. Suspect a fuel bypass or relief valve hung open, which might prevent the engine from starting by causing the engine pump stage of the fuel pump to bypass excessively. If fuel tank has been run dry or if maintenance has been performed on the fuel system, suspect an airlock in the fuel lines or system, which will require bleeding the system.

Figure 7-3 (Sheet 1 of 8)

ENGINE STARTING (GROUND) (CONT)

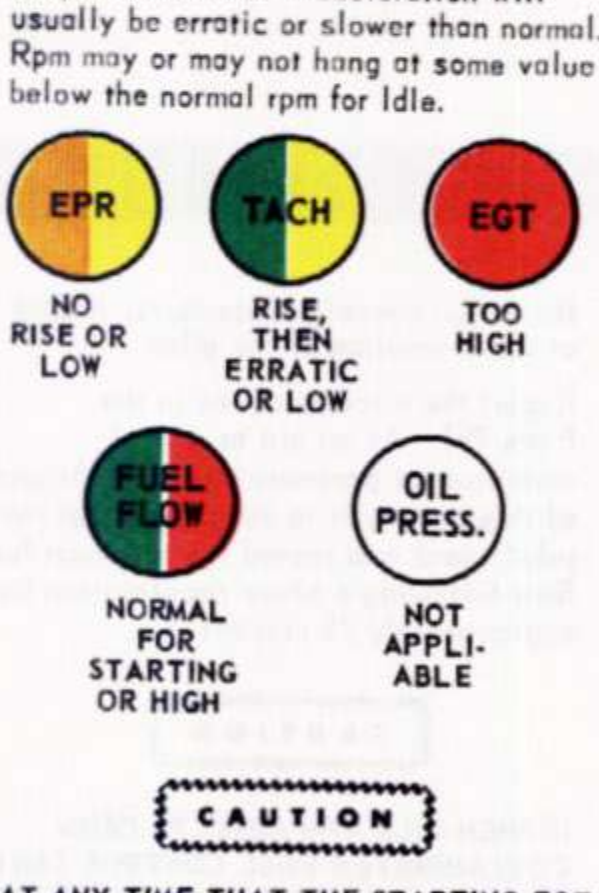
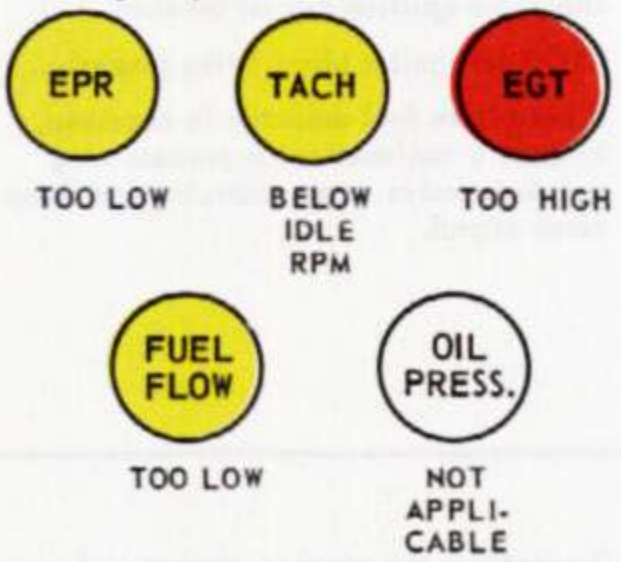
CONDITION	PROBABLE CAUSE	ACTION
No start after engaging the starter. Compressors rotate and normal fuel flow IS observed. 	Malfunctioning engine ignition or airplane relays Malfunctioning pressurizing and dump valve, or weak signal from fuel control to pressurizing and dump valve (unlikely but possible)	Discontinue the starting attempt and investigate. Check for low battery. Check for open circuit in electrical power leads from power source to ignition system. If a fuel puddle is observed in the engine tailpipe and no drainage is observed from the pressurizing and dump valve, suspect ignition system malfunction and check the ignition circuit breaker. Check for igniter plugs firing properly. If excessive fuel drainage is observed, suspect a malfunctioning pressurizing and dump valve or pressurizing and dump valve signal.
Hot start. Engine "lights up," but EGT goes overboard, exceeding the starting temperature limit. Acceleration will usually be erratic or slower than normal. Rpm may or may not hang at some value below the normal rpm for Idle. CAUTION AT ANY TIME THAT THE STARTING EGT REACHES 400°C AND IS STILL CLIMBING DURING THE GROUND STARTING CYCLE, A HOT START WILL ALMOST INVARIABLY RESULT.	Overrich fuel/air ratio in the combustion chamber. This condition might be the result of any one of the several possible causes indicated under ACTION.	Discontinue the starting attempt and investigate. Suspect possible malfunction of the starter or its fuel and/or air source. Suspect starter cutout rpm set too low. Suspect possible fuel control malfunction ONLY if the fuel flow gage indicates an abnormal reading. Inspect engine air inlet duct for obstruction. During cold weather, suspect possible ice in the fuel control, which will require the application of heat before a successful start can be made.

Figure 7-3 (Sheet 2 of 8)

ENGINE MALFUNCTION ANALYSIS (CONT)

ENGINE STARTING (GROUND) (CONT)

CONDITION	PROBABLE CAUSE	ACTION
Hung or false start. Engine "lights up," but does not accelerate to normal idle rpm, the rpm hanging at some lower value, instead. EGT will probably (but not necessarily always) be higher than normal and may, or may not, exceed the starting temperature limit. 	At low ambient temperaures, frozen burner pressure line to fuel control Insufficient air to the starter Binding rotor assemblies, damaged compressor or turbine blades, damaged accessory gearbox Starter improperly adjusted. Cuts out below engine self-accelerating speed. In a few cases, one malfunctioning igniter has resulted in almost identical conditions.	Discontinue start attempt and apply heat to fuel control. Discontinue the starting attempt and investigate. Suspect possible malfunction of the starter and/or air source. Check compressors for free rotation. Inspect compressor and turbine blades and the accessory gearbox for possible damage. Suspect starter cutout rpm set too low. Suspect possible fuel control or fuel pump malfunction.

ENGINE AT IDLE ON THE GROUND

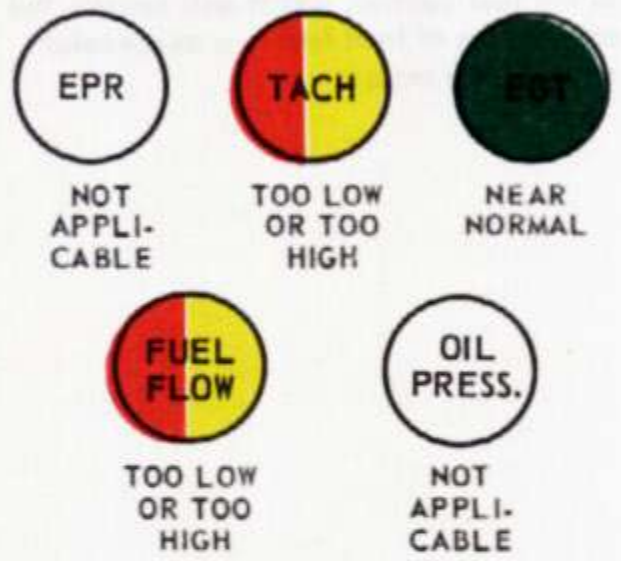
CONDITION	PROBABLE CAUSE	ACTION
Abnormal idle rpm. Rpm high or low when compared with the prescribed range for rpm at idle. 	Loose throttle rigging and/or linkage Incorrect fuel control idle rpm adjustment Possible tachometer system malfunction Fuel control servo bleeds possibly contaminated. A malfunction of this nature may be recognized by very high rpm at idle (in the vicinity of 85 percent) and failure of the engine to decelerate properly.	No action normally necessary, except at the discretion of the pilot. Report the circumstances in the Form 781. As an aid to ground maintenance personnel with conditions of this nature, it is suggested that the pilot check and record the minimum fuel flow following a sharp deceleration from approximately 75 percent rpm. **CAUTION** *IF HIGH IDLE RPM RESULTS FROM CONTAMINATED FUEL CONTROL SERVO BLEEDS, ENGINE MIGHT POSSIBLY NOT RESPOND TO THROTTLE MOVEMENT LATER IN FLIGHT, WHICH COULD BE SERIOUS. ALSO, HIGH IDLE RPM COULD RESULT IN ACCELERATED WEAR OF THE AIRPLANE BRAKES, WITH POSSIBLE SERIOUS CONSEQUENCES. IN CASE OF DOUBT, ABORT THE TAKEOFF.*

Figure 7-3 (Sheet 3 of 8)

TAKEOFF ENGINE CHECK

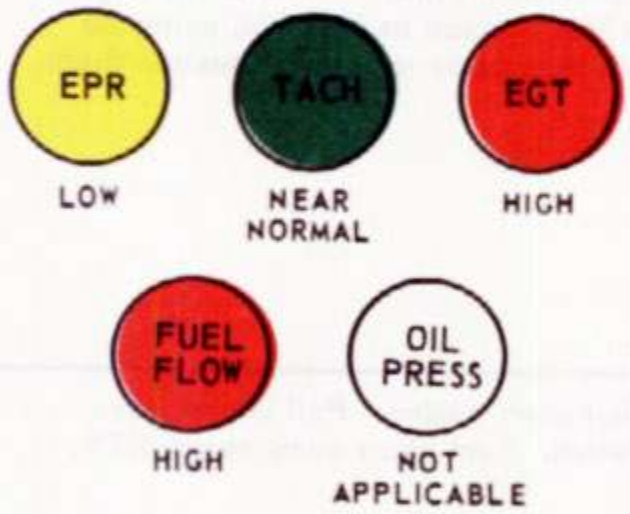
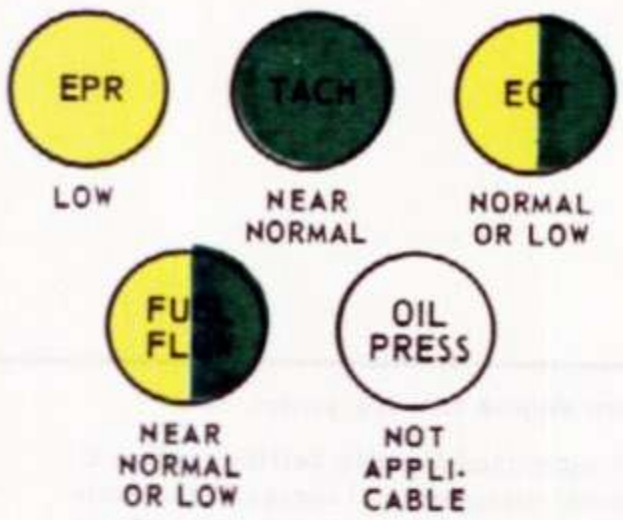
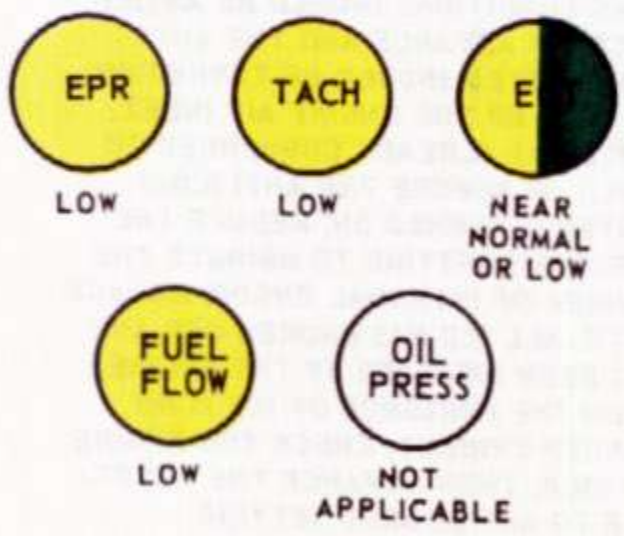
CONDITION	PROBABLE CAUSE	ACTION
EGT high, EPR low and fuel flow high when throttle is adjusted to match the N2 tachometer reading on the engine being checked with the N2 tachometer readings of the other engines. 	Damaged compressors or turbines, or other internal engine damage Possible instrumentation malfunction. In particular, the EPR indicating system may need calibration. Improperly trimmed engine	Abort the takeoff. Report the engine for inspection for possible internal damage and/or and instrument calibration check (of the EPR indicating system, in particular). **NOTE:** *IF NO OTHER MALFUNCTION IS EVIDENT, CHECK THE ENGINE TRIM. WHENEVER THE EPR INDICATING SYSTEM IS RECALIBRATED, THE ENGINE TRIM "MUST" BE RECHECKED.*
EPR obtained at full throttle is less than the computed EPR for takeoff under existing ambient conditions. (Inability to obtain takeoff EPR, even at full throttle.) 	Engine thrust deterioration due to deposits of foreign material on the compressor blades	Abort the takeoff. Report engine for up-trimming or field-cleaning by Carboblast (or other approved cleaning method).
EPR obtained at full throttle is less than the computed EPR for takeoff under existing ambient conditions. (Inability to obtain takeoff EPR, even at full throttle.) 	Possible miscalculation, or use of incorrect temperature when computing takeoff EPR Engine trimmed too low or shift in trim setting Improperly rigged throttle or loose throttle rigging Possible airlock in fuel control or fuel lines Partially closed emergency fuel shutoff valve Low fuel supply in fuel tank	Recheck takeoff EPR computation for prevailing ambient conditions. Abort the takeoff. If an airlock is suspected, accelerate the engine a few times to try to clear up the condition. Try changing fuel tanks. Check engine fire switch position Report engine for engine trim and throttle rigging check.

Figure 7-3 (Sheet 4 of 8)

ENGINE MALFUNCTION ANALYSIS (CONT)

INFLIGHT

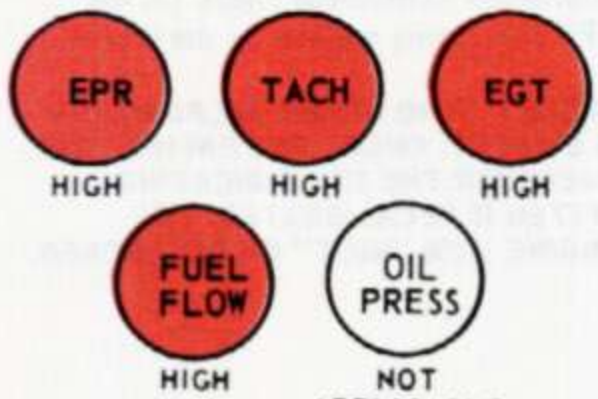
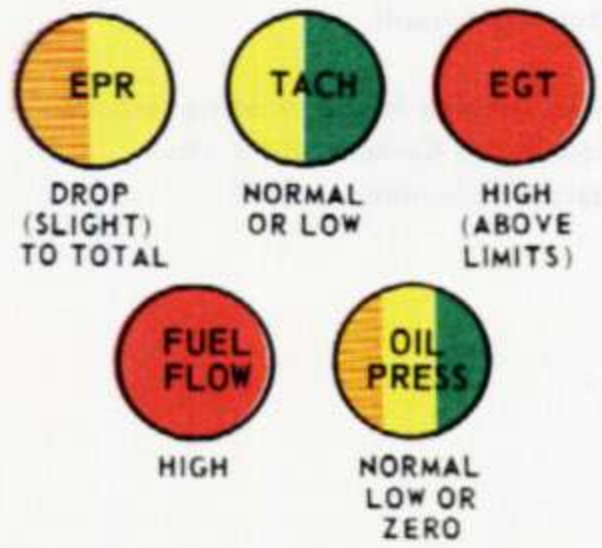
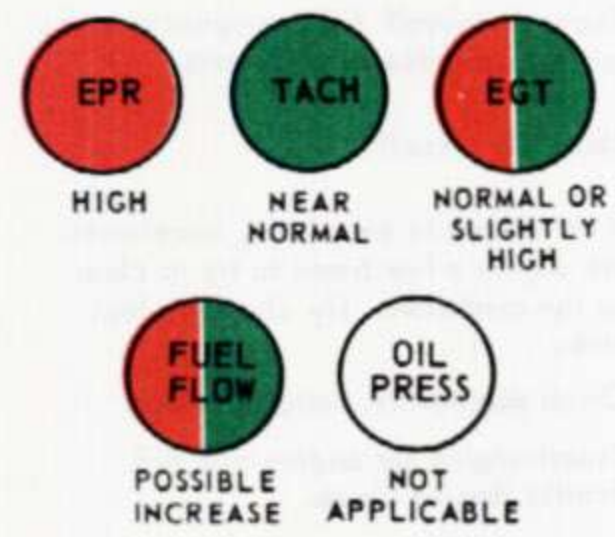
CONDITION	PROBABLE CAUSE	ACTION
Two or more of the four primary instruments indicate abnormally high readings 	Fuel control malfunction	Reduce throttle setting to maintain EGT within allowable limits. Continue engine operation at the pilot's discretion. If gage abnormalities are pronounced, either shut down the engine or land as soon as possible, using the minimum thrust required to sustain flight.
Rough engine with possible vibration. Possible compressor stall for no apparent reason. Possibly an audible explosion. Engine may seize. Possible fire warning light. 	Compressor, turbine or bearing damage or failure	Shut down engine. Pull engine fire switch. Fuel boost pump switch OFF.
Instrument readings indicated below occur during known or possible icing conditions. Compressor stall, either slight, "snorting" or very pronounced. high EGT decreases with throttle reduction. 	Ice forming in the engine air inlet **NOTE** *A RISE OR FLUCTUATION IN EPR WILL BE THE FIRST INDICATION THAT INLET ICING IS COMMENCING TO FORM. SHOULD THE CHANGE IN EPR NOT BE OBSERVED, THE NEXT NOTABLE INDICATION OF ICING COULD BE ENGINE SURGE OR COMPRESSOR STALL. A RISE IN EGT MAY BE A THIRD INDICATION BUT THIS ONLY RESULTS FROM ICE BREAKING OFF AND PASSING THROUGH THE ENGINE.*	Turn engine anti-ice switch ON. An increased throttle setting and/or a slower airspeed will increase the anti-icing heat and decrease the rate of ice formation. Observe EGT closely to avoid exceeding the prescribed limits. **CAUTION** *THE ENGINE ANTI-ICING SYSTEM PREVENTS THE FORMATION OF ICE AND IS NOT A DEICER. WHENEVER POSSIBLE, ICING CONDITIONS SHOULD BE ANTICIPATED IN ADVANCE AND THE ANTI-ICING SYSTEM SHOULD BE TURNED ON TO WARM UP THE ENGINE AIR INLET. IF ICE HAS ALREADY COMMENCED TO BUILD UP BEFORE THE ANTI-ICING SYSTEM IS TURNED ON, REDUCE THE THROTTLE SETTING TO MINIMIZE THE DANGER OF INTERNAL ENGINE DAMAGE UNTIL ALL ICE HAS BROKEN OFF AND HAS BEEN INGESTED BY THE ENGINE. WHEN THE PRESENCE OF ICE IS NO LONGER EVIDENT, CHECK THE ENGINE AT IDLE, THEN ADVANCE THE THROTTLE TO ANY DESIRED SETTING.*

Figure 7-3 (Sheet 5 of 8)

INFLIGHT (CONT)

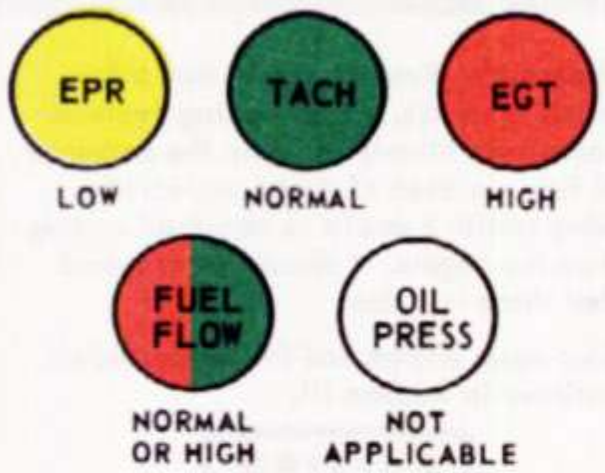
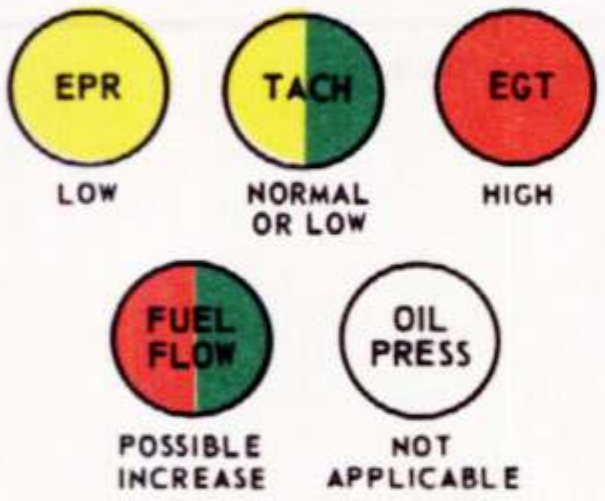
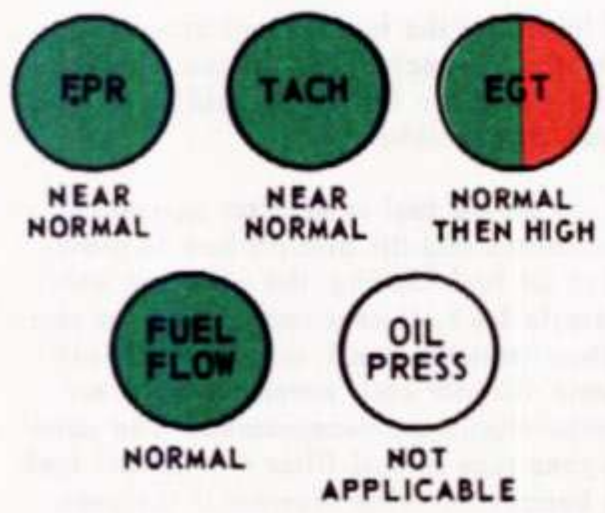
CONDITION	PROBABLE CAUSE	ACTION
EGT too high, EPR lower than normal, all other instruments approximately normal. 	Excessive airbleed from engine due to: (1) Overboard airbleed valve stuck open, or (2) Excessive leakage in the airplane airbleed system.	Anticipate a higher than normal fuel consumption for the thrust produced until the condition can be corrected. Reduce the throttle setting, if necessary, to avoid exceeding the allowable maximum EGT. If overtemperaturing cannot be controlled, either shut down the engine or land as soon as possible.
Either during normal flight or possible icing conditions, instruments suddenly read, as indicated. Instruments may or may not return to normal. Compressor stall may or may not occur. 	Engine ingestion of foreign object, such as a bird, with or without damage to the engine. If stall and/or high EGT continues, suspect compressor damage. If condition occurs during suspected inlet icing conditions, there is a possibility of accumulation of ice on the engine air inlet section. Particularly if accompanied by compressor stall, may indicate engine ingestion of ice, with or without damage to the engine. If during or following an acceleration, suspect possible airbleed valve malfunction, particularly if stall disappears after engine has stabilized and instruments return to normal. Possible excessive leakage in the airbleed system.	Reduce throttle setting to maintain EGT within allowable limits. If the condition occurs when ice might form in the engine inlet, turn engine anti-ice switch ON. If a persistent stall occurs during or following acceleration and a stuck airbleed valve is suspected, reduce throttle setting and accelerate slowly. This may or may not be effective. CAUTION ***IF INTERNAL ENGINE DAMAGE IS SUSPECTED OR IF EGT OR COMPRESSOR STALL CANNOT BE CONTROLLED, EITHER SHUT DOWN THE ENGINE OR LAND AS SOON AS POSSIBLE, USING THE MINIMUM THRUST REQUIRED TO SUSTAIN FLIGHT.***
Compressor stall during deceleration. Rise in EGT when condition persists. 	Overboard airbleed valve does not open during deceleration due to: (1) Bleed governor schedule set too low, or (2) Bleed governor or bleed valve malfunction.	Increase airspeed to correct stall condition. If overtemperaturing cannot be controlled, shut down the engine.

Figure 7-3 (Sheet 6 of 8)

ENGINE MALFUNCTION ANALYSIS (CONT)

INFLIGHT (CONT)

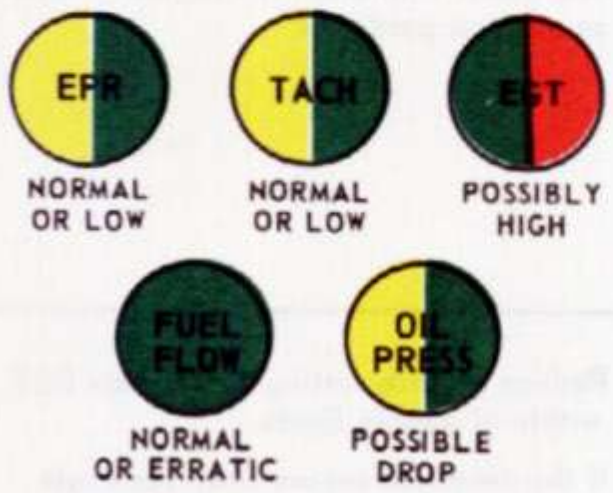
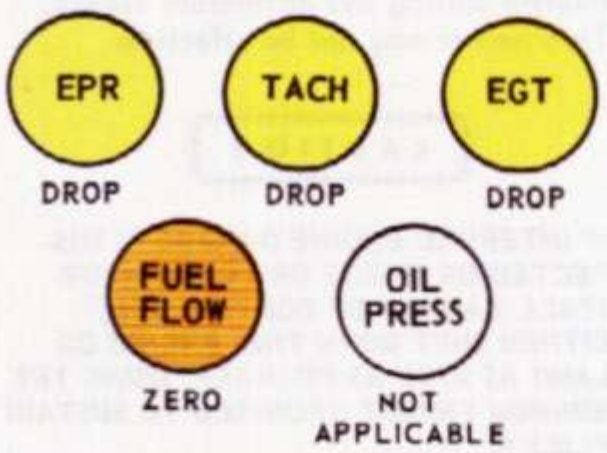
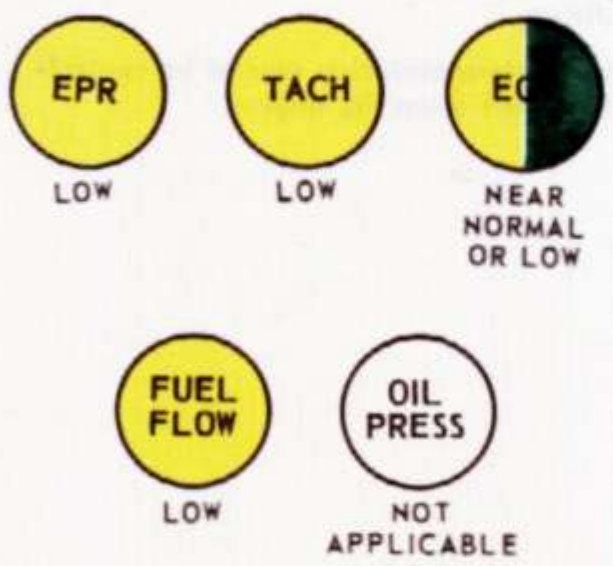
CONDITION	PROBABLE CAUSE	ACTION
Fire warning light illuminated. Engine probably trailing smoke. Possibly high EGT. Possible drop in rpm and/or fuel or oil pressure. 	Engine fire, either within the engine or in the engine nacelle. Such a fire might result from several possible causes, one of which might be a ruptured fuel or oil line.	If possible, first ascertain that a fire actually exists. Fire warning systems sometimes falsely indicate the presence of fire. In case of doubt, especially when trailing smoke is observed coming from the engine, it should be assumed that there is a fire. Shut down engine and follow procedure outlined in Section III. **CAUTION** *IN THE EVENT THAT SOMETHING DRASTIC HAS HAPPENED TO CAUSE THE FIRE, DO NOT ATTEMPT TO RESTART THE ENGINE FOR THE DURATION OF THE FLIGHT. BROKEN FUEL AND OIL LINES OR SHORTED ELECTRICAL WIRES DO NOT MEND THEMSELVES AFTER THE FIRE IS OUT.*
Sudden drop in EGT, rpm and EPR. Fuel flow drops to zero. Complete loss of thrust. 	Failure of engine-driven fuel pump or fuel pump drive shaft. Engine gearbox failure.	Shut down the engine.
EGT near normal or low. Rpm, EPR and fuel flow low. Engine continues to operate. 	Fuel control malfunction If engine remains "hung" at some intermediate operating condition and does not respond to throttle movement, the cause may be failure of the fuel control actuating shaft. Possible ice forming on the fuel inlet filter screen.	Unless the condition is serious, no action is necessary except at the pilot's discretion. Report circumstances in Form 781. If the condition cannot be controlled, shut down the engine. If failure of the fuel control actuating shaft is suspected, the engine should be shut down or a landing should be made as soon as possible. If ice on the fuel inlet filter screen is suspected and the aircraft has no provision for fuel heating, the pilot can only throttle back, if necessary, until the condition corrects itself, or reduce the airplane altitude until warmer outside air temperatures are encountered. The usual bypass type of fuel filter will permit fuel to bypass the filter element if the pressure drop increases above approximately 5.8 PSI.

Figure 7-3 (Sheet 7 of 8)

INFLIGHT (CONT)

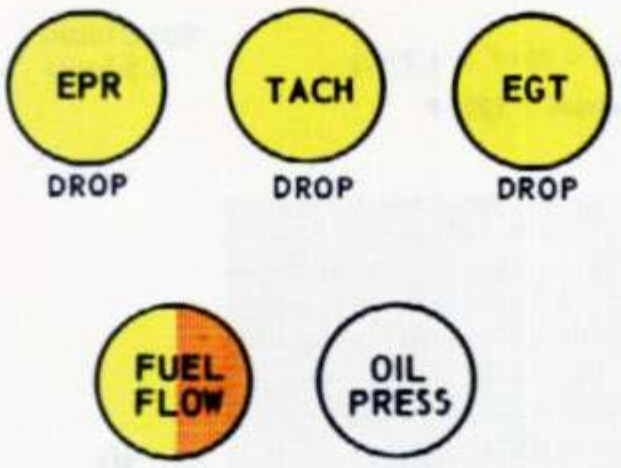
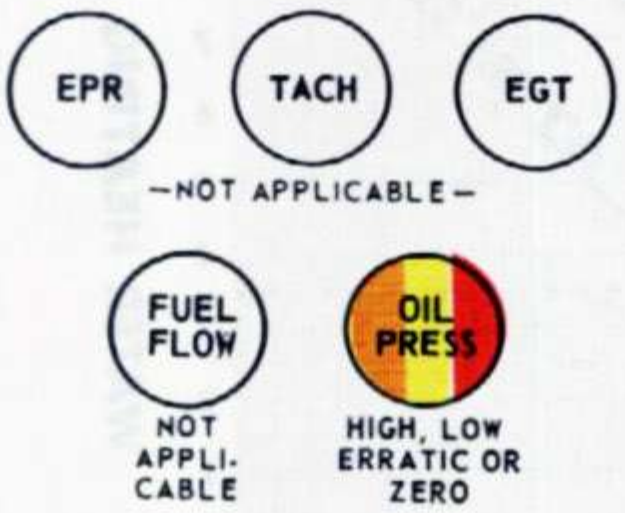
CONDITION	PROBABLE CAUSE	ACTION
Sudden drop in EGT, rpm, EPR and fuel flow. Complete loss of thrust. 	Engine Flameout	Check fuel in tanks. Switch tanks, if necessary. Check position of emergency fuel shut-off valve. Relight the engine. **CAUTION** ***UNLESS THE ENGINE IS URGENTLY NEEDED, DO NOT ATTEMPT AN AIR START UNTIL IT CAN BE POSITIVELY DETERMINED THAT THE FLAMEOUT WAS NOT CAUSED BY A RUPTURED FUEL LINE OR SIMILAR CIRCUMSTANCE WHICH MIGHT RESULT IN A FIRE.*** If cause was a simple flameout resulting from flying in turbulent air, try increasing the airspeed to prevent recurrence.
Abnormal oil pressure 	If oil pressure gage reading is too HIGH: Oil strainer is clogged Oil pressure relief valve is not bypassing If oil pressure gage reading is too LOW: Oil level in oil system is too low Oil line failure Bearing or oil seal failure Oil pump failure **NOTE** ● *A FLUCTUATING OIL PRESSURE MIGHT BE CAUSED BY ANY OF THE ABOVE.* ● *ALTHOUGH A HIGH, LOW OR ERRATIC OIL PRESSURE IS FREQUENTLY CAUSED BY A MALFUNCTION OF THE OIL PRESSURE TRANSMITTER OR THE OIL PRESSURE GAGE, IT WOULD NOT BE SAFE TO ASSUME POSITIVELY THAT THIS IS THE CASE.* ● *ENGINE OIL LOW PRESSURE WARNING LIGHTS WITH 1C10-738 WILL BE USED IN CONJUNCTION WITH LOW OIL PRESSURE GAGE READINGS TO VERIFY LOW OR ERRATIC OIL PRESSURE.*	Normal oil pressure is 40 to 50 PSI. Except at idle, oil pressures between 35 and 40 PSI are undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting. Oil pressures below normal should be reported as a flight discrepancy on the Form 781 and should be corrected before the next takeoff (i.e., do not practice touch-and-go landings). Oil pressures below 35 or above 50 PSI may be unsafe and require that either the engine be shut down or a landing be made as soon as possible, using the minimum thrust required to sustain flight. **CAUTION** ● *IF THE OIL PRESSURE DROPS TO ZERO AND REMAINS THERE FOR 15 SECONDS OR MORE AND THE ENGINE OIL LOW PRESSURE WARNING LIGHT WITH 1C10-738 ILLUMINATES:* **1 SHUT DOWN THE ENGINE IMMEDIATELY, OR** **2 REDUCE THE THROTTLE SETTING TO THE LOWEST POSITION REQUIRED TO SUSTAIN FLIGHT AND PREPARE FOR THE POSSIBILITY OF A SEIZED ENGINE WITHIN 2 TO 4 MINUTES.** ● **TAKEOFF SHOULD NOT BE ATTEMPTED IF THE OIL PRESSURE IS MORE THAN 50 PSI. (PRESSURE VARIATIONS OF 5 PSI ARE PERMISSIBLE PROVIDED THE AVERAGE OF THE FLUCTUATIONS IS NO GREATER THAN 50 PSI.) BLOWN OIL SYSTEM SEALS AND/OR LOSS OF LUBRICATION CAN RESULT. THE CONDITION SHOULD BE CORRECTED BEFORE FLIGHT.**

Figure 7-3 (Sheet 8 of 8)

WATER HEATING AND COOLING TIME

DATE: APRIL 1961

DATA BASIS: CALCULATED DATA

EXAMPLE OF COOLING TIME

GIVEN:
Initial water temperature = 110°F (43.3°C)
Ambient temperature = 20°F (−6.7°C)
Final water temperature = 60°F (15.6°C)

FIND:
Cooling time

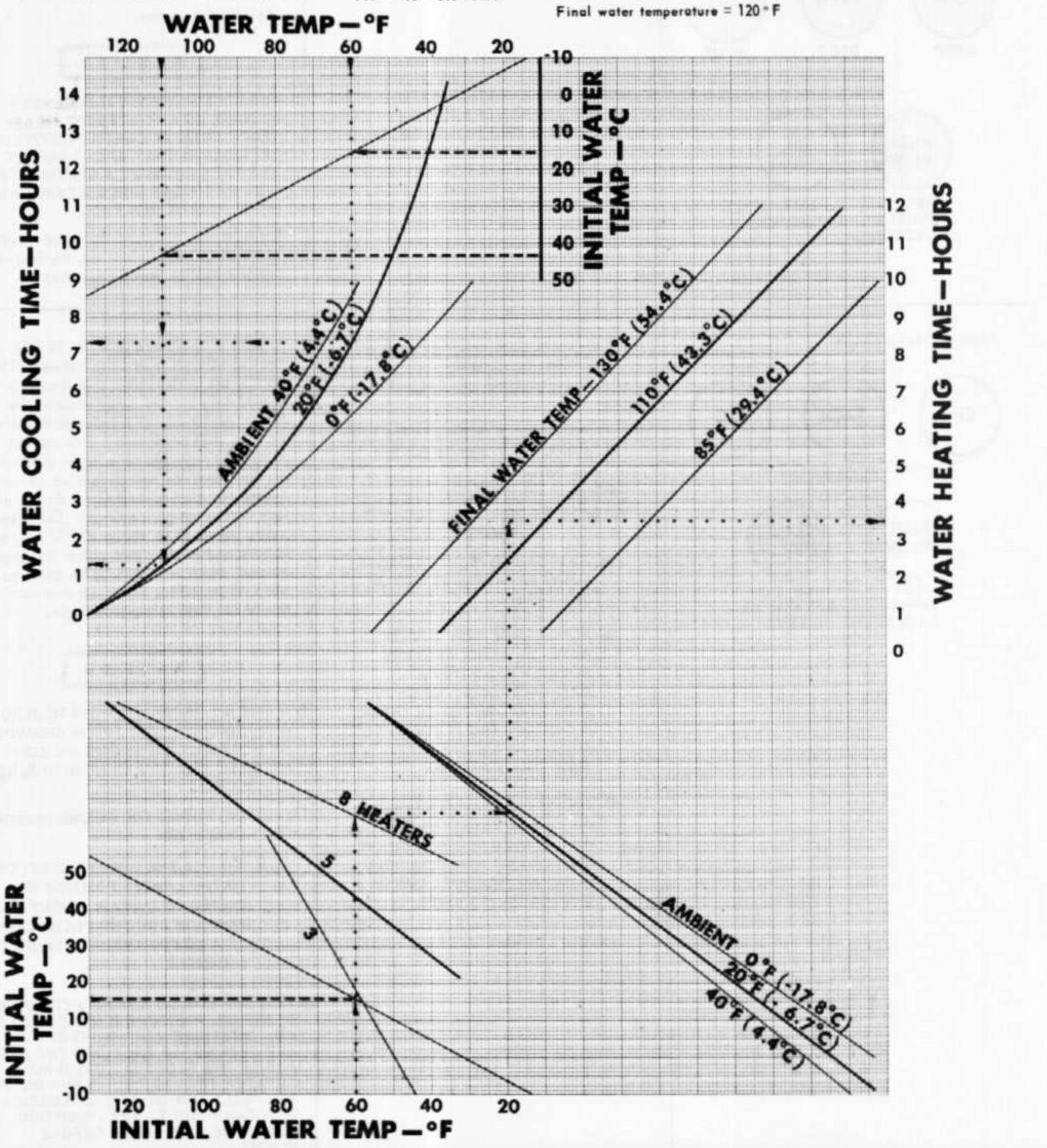
SOLUTION:
7.3 − 1.3 − 6.0 hours

EXAMPLE OF HEATING TIME:

GIVEN:
Initial water temperature = 60°F (15.6°C)
Heaters used = 8
Ambient temperature = 20°F (−6.7°C)
Final water temperature = 120°F

FIND:
Heating time

SOLUTION:
3.5 hours



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Figure 7-4

(WITH UPPER DECK TANK)

FUEL SYSTEM OPERATION

CENTER WING TANKS TO ENGINES

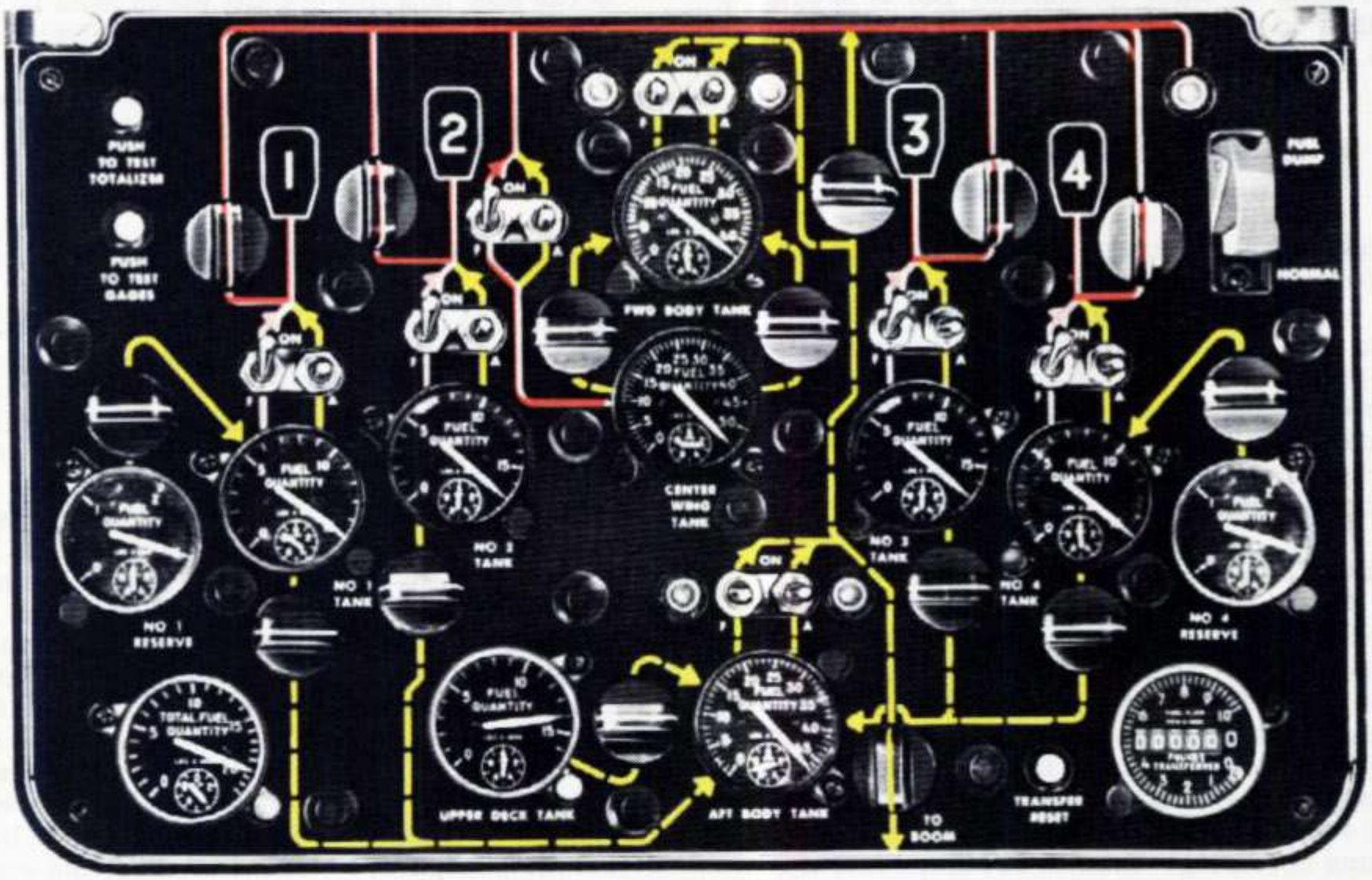


Figure 7-5

FUEL SYSTEM OPERATION AND MANAGEMENT

MAIN TANKS TO ENGINES

Normally each engine is fed directly from its respective main tank. Both boost pump switches for each main tank may be ON for this operation.

CAUTION

Boost pumps and air refueling pumps should not be operated dry for a period longer than two minutes. The override pumps should not be operated dry for a period longer than five minutes.

The airplane is capable of operating in the main tank to engine configuration, without the aid of fuel pressure boost, up to cruise altitude or higher, but this is only an emergency provision to be used with low power settings. However, to insure a positive head of fuel being delivered to the engine fuel feed system, both boost pump switches should be ON for takeoff and landing and other high power operations. Water settling out of the fuel collects in the sump of the forward boost pump and can freeze the impeller when the pump is not running. One boost pump is sufficient to feed one engine at any altitude, and two boost pumps will insure a positive feed in event of failure of one. At higher altitudes one boost pump can feed more than one engine, if necessary. Whenever a main tank fuel level falls below 20% of capacity, the engines should be fed from the tank to engine manifold configuration. For single boost

pump operation, in level flight and nose down attitudes, it is preferable to operate the forward pump in each main tank, as the possibility of it being uncovered and pumping air, is less than with the aft pump. One tank to engine manifold valve (preferably No. 2) should be open in this configuration to pressurize the engine manifold.

WARNING

For takeoffs and landings with fuel in any main tank below 9000 lb, fuel should be present in all main wing tanks. All tank to engine manifold valves will be opened and the boost pumps will be turned ON. The A/R pumps shall not be operated during takeoff or landing, except during an emergency, but may be used as necessary for other phases of operation, including the traffic pattern.

FUEL BALANCING

If the wings have an unbalanced fuel load, the tanks containing the most fuel can be used to feed two engines at a time. It may also be desirable to feed one engine on each side from a single tank, e.g. engine Nos. 1 and 4 from an outboard tank or engines Nos. 2 and 3 from an inboard tank. It should be noted that the tank from which fuel is to be used should have both the boost pumps operating. This is to insure fuel transfer and a positive head of fuel to the subordinate engine in case a malfunction exists in the primary tank system being used.

BODY TANK TO ENGINES

Only one A/R pump should be used for this operation and that should be a forward air refueling pump for either body tank. The higher pressure developed by the air refueling pump is reduced by the pressure regulator in the air refueling manifold to engine manifold line to a level compatible with normal engine fuel pressure. All eight boost pump switches in the main tanks may be left ON for this operation, or just one boost pump per main tank, as the air refueling pump pressure will override the boost pump pressure. The configuration for the aft body tank crossfeed operation is similar to the operation for the forward body tank.

NOTE

- On airplanes 1, 3 and 25▶ when feeding the engines from either the body tanks or center wing tank, a gradual buildup of main wing tank fuel quantity may be noted. This is normal and is due to the bleed back through the thermal relief bleeds in the dual check valves.
- Do not operate A/R pumps and override pumps simultaneously when feeding engines from body tanks.
- The body tank fuel quantity gages must be monitored to determine when the tank is empty, since the A/R pump fuel pressure low warning lights will not indicate tanks empty when the engines are being fed from either body tank.

CENTER WING TANK TO ENGINES

Above 35,000 feet, one override pump will override the main tank boost pumps (if both override pumps are used for altitude cruise one pump would tend to put out all the flow because of low fuel demand and pump tolerances). In addition, the main tank boost pumps may or may not be turned on for altitude cruise. However, in the event of an override pump failure when main tank boost pumps are not used (manifold low pressure light will illuminate) either the opposite override pump or the main tank boost pumps should be turned on. Although the engines would continue to operate at cruise power without boost or override pumps, the life of the engine driven fuel pump would be reduced. As the fuel level in the center wing tank falls below 20% of capacity, operate with both override pumps and either one or two boost pumps per main tank until transfer is completed. For cruise below 35,000 feet to sea level, both override pumps are needed to meet the engine fuel flow demands. For this condition operate with at least one boost pump per main tank. At sea level, the override pumps do not have sufficient output to meet engine fuel requirements for power settings higher than cruise power.

GRAVITY TRANSFER

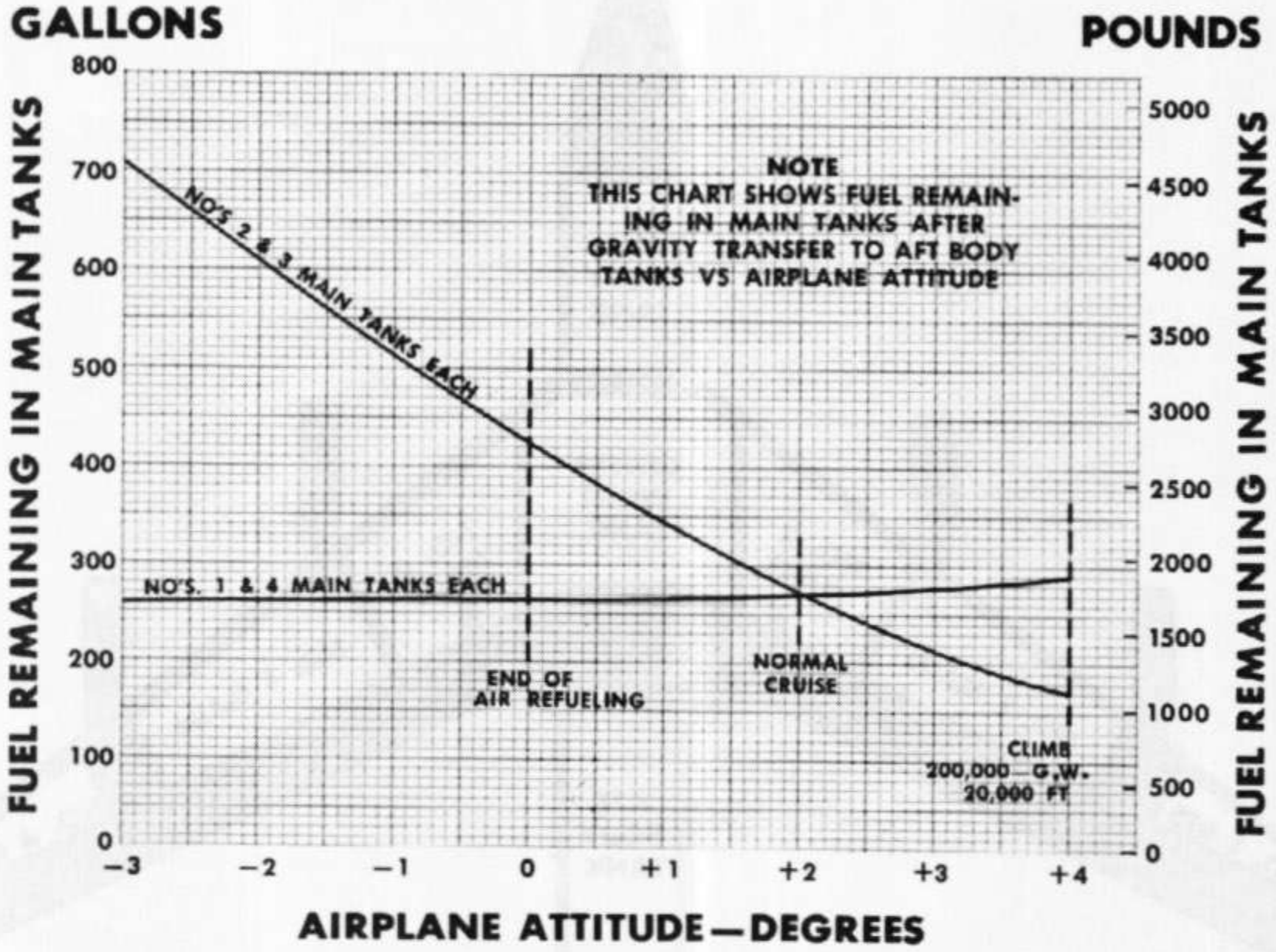
It is possible to gravity transfer fuel from the reserve tanks to the outboard main tanks, from the main tanks to the aft body tank, and from the center wing tank to the forward body tank. On those airplanes equipped with an upper deck tank, fuel may be transferred from the upper deck tank to the aft body tank.

Gravity transfer from the center wing tank to the forward body tank may be required:

A. During fuel dumping from center wing tank and forward body tanks.

FUEL REMAINING IN MAIN TANKS

DATE: AUGUST 1956
DATA BASIS: ESTIMATED



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Figure 7-6

B. In event of override pump failure in center wing tank.

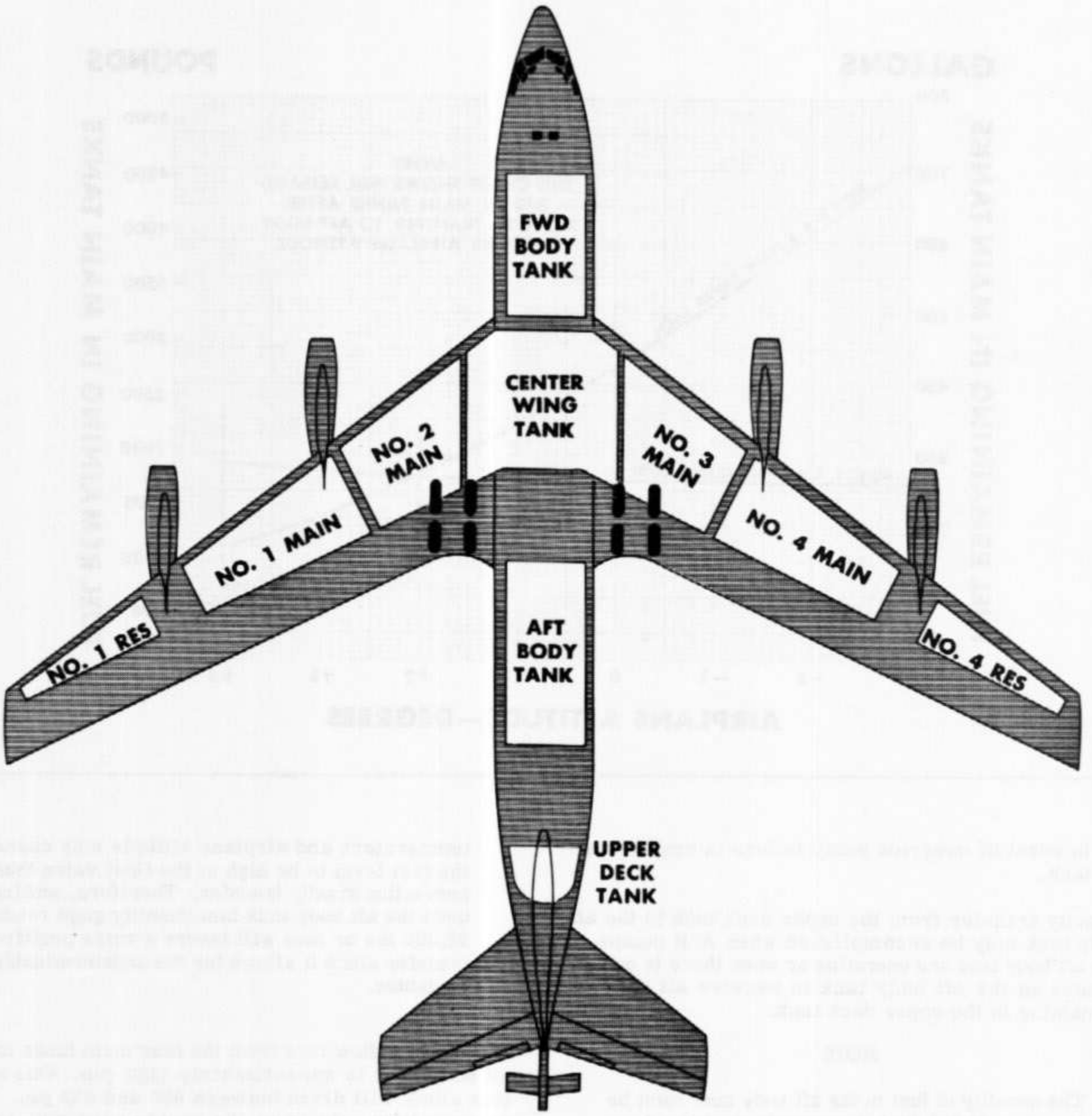
Gravity transfer from the upper deck tank to the aft body tank may be accomplished when A/R pumps in the aft body tank are operating or when there is enough volume in the aft body tank to receive all the fuel remaining in the upper deck tank.

NOTE

The quantity of fuel in the aft body tank must be less than 34,000 lbs before gravity transfer from the upper deck tank can be accomplished. Fuel quantity indication system tolerance, fuel temperature and airplane attitude may cause the fuel level to be high at the float valve thus preventing gravity transfer. Therefore, waiting until the aft body tank fuel quantity gage reads 28,000 lbs or less will insure a more positive transfer since it allows for the undeterminable variables.

The average flow rate from the four main tanks to the aft body tank is approximately 1300 pm. One main tank alone will drain between 650 and 975 pm. The average flow rate from the center wing tank to the forward body tank through both center wing to forward body tank valves is approximately 2270 pm. The

FUEL TANK LOCATION



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Figure 7-7

flow rate from the upper deck to aft body will average approximately 1400 pm. See figure 7-6 for fuel remaining in main tanks after gravity transfer to aft body tank.

NOTE

- The gravity flow rates quoted above are the average to be experienced during air refueling, when fuel is being off-loaded from the tank being gravity filled. These flow rates vary greatly depending on tank levels, altitude, airplane attitude, and whether or not fuel is being off-loaded.

- Before opening the reserve tank valves on tanker airplanes, it is necessary to reduce airplane gross weight to 268,000 lbs (cargo airplanes to 214,000 lbs) due to structural limitations. It is also necessary to lower the quantity of fuel in the No. 1 and No. 4 main tanks to 10,000 pounds each; otherwise unnecessary flooding of the wing tank vent system may occur. It is also necessary to lower the level of fuel in the aft body tank before opening the wing to aft tank valves or unnecessary flooding of the aft body tank vent system may occur. The fuel level in any tank to be filled should be monitored with the fuel quantity gage to prevent overfilling.

- Due to slow flow rates within the center wing tank (i.e. flow from the center bladder section to the structural root section of the center wing tank), the center wing tank may appear to be refilling after completion of gravity transfer to the forward body tank. After the center wing tank fuel quantity gage stabilizes, the remaining fuel may be gravity transferred to the forward body tank.

- At cruise speed it is possible that gravity transfer from the center wing tank to the forward body tank may cease if the fuel level in the center wing tank is less than 5000 pounds and the fuel level in the forward body tank is greater than 34,000 pounds.

FUEL MANAGEMENT PROCEDURES

Fuel Management procedures during normal operation will be in accordance with fuel management sequence, figure 7-7A.

NOTE

- The fuel panel must be monitored closely during an A/R operation.

- If unexpected changes in an A/R mission or training requirements dictate changes in prescribed fuel management procedures, any sequence of fuel usage or transfer can be accomplished so long as it does not violate the cg limitations of Section V.

- Slosh fuel carried in the upper deck tank should be drained each mission. This will reduce the possibility of contamination from fungus growth.

- Immediately following a fuel panel change, closely monitor the fuel panel to determine that no undesirable fuel transfer is taking place. If an undesirable fuel transfer is taking place, immediately take whatever fuel management action is necessary to re-establish a safe fuel configuration and a safe center of gravity location.

FUEL MANAGEMENT SEQUENCE

TOTAL RAMP FUEL – POUNDS			FLIGHT CONDITION	FUEL QUANTITY AND TANK USED
UP TO 90,000	90,000 TO 115,000	115,000 OR GREATER		
1	1	1	Start Engines Taxi Takeoff	Mains 1, 2, 3 & 4
	2	2	Enroute Climb & Cruise	Center Wing: Use down to 18,000 pounds
2			Enroute Climb & Cruise	Center Wing: Use until empty
		3	Cruise	Aft Body: Use 11,000 pounds (Transfer Upper Deck)
	3			Aft Body: Use until empty
3	4			Forward Body: Use until empty (A)
	5	4		Center Wing: Use until empty
		5		Aft Body & Fwd Body: Use in equal amounts not to exceed 6000 pounds until empty starting with the aft body tank. (A)
4	6	6		Mains 1, 2, 3 & 4: Use down to 9000 pounds each in Mains 1 & 4
5	7	7	Cruise	Drain Reserves 1 & 4
6	8	8	Landing	Mains 1, 2, 3 & 4: Use until mission completed.

(A) Retaining some forward body fuel may be required for cg control.

Figure 7-7A

FUEL TRANSFER FOR APU OPERATION

If operation of the APU is required and there is insufficient fuel in the aft body tank, the following procedures will be implemented. These procedures are applicable to those airplanes which do not require a minimum of 10,800 pounds of fuel in the aft body tank.

CAUTION

To avoid inadvertent tipping of the airplane on its tail, the cg location must be computed prior to start of transfer operations. At no time will fuel be transferred so as to exceed 35% MAC aft cg.

A. Condition I: Aft Body Tank Empty

Fuel available in center wing tank.

Require: 3000 lb in aft body tank.

Procedure:

(1) Park Airplane - Set parking brakes, check reserve brake pressure

(2) Engines Nos. 2, 3 and 4 - Shutdown

(3) Run No. 1 Engine Tank to Engine - No. 1 tank to No. 1 engine

(4) Manual Defueling Valve - OPEN

(5) Manual Refueling Valves Handle - Checked FLIGHT POSITION

(6) Center Wing Tank Override Switch - Actuate

Actuate one override pump switch for center wing tank

(7) Center Wing Tank Cverride Switch - OFF

Turn OFF after desired transfer has been obtained (3000 lb total)

(8) Manual Defueling Valve - CLOSED

(9) APU - Start

(10) No. 1 Generator - Trip

(11) External Power Switch - CLOSE

(12) APU Generator - Place on airplane bus

(13) No. 1 Engine - Shut down

B. Condition II: Aft Body Tank Empty

Fuel available in main wing tanks only, but insufficient amount to gravity feed to aft body tank.

Require: 3000 lb in aft body tank

Procedure:

(1) Park Airplane - Set parking brakes, check reserve brake pressure

(2) Engines Nos. 2, 3 and 4 - Shut down

(3) Run No. 1 Engine Tank to Engine - No. 1 tank to No. 1 engine

(4) Manual Defueling Valve - OPEN

(5) Manual Refueling Valves Handle - Checked FLIGHT POSITION

(6) Tank to Engine Manifold Valve - As desired

(7) Boost Pump Switches - Actuate

Actuate boost pumps in main wing tanks (Nos. 2, 3 and 4) as desired for fuel transfer

NOTE

If necessary, transfer from No. 1 tank last in order to avoid fuel starvation of No. 1 engine.

(8) Boost Pump Switches - OFF

Turn OFF boost pumps in operation after desired transfer has been obtained (3000 lb total)

(9) Tank to Engine Manifold Valves - Tank to Engine

(10) Manual Defueling Valve - CLOSED

(11) APU - Start

(12) No. 1 Generator - Trip

(13) External Power Switch - CLOSE

(14) APU Generator - Place on airplane bus

(15) No. 1 Engine - Shut down

C. Condition III: Aft Body Tank Empty

Sufficient amount of fuel in main wing tanks to gravity feed to aft body tank.

Require: 3000 lb in aft body tank.

Procedure:

(1) Park Airplane - Set parking brakes, check reserve brake pressure

(2) Wing to Aft Body Tank Valve Switches - Actuate

Actuate wing tank to aft body tank valve switches as necessary to gravity feed fuel from main wing tanks to aft body tank, turning switches off when desired transfer has been obtained (3000 lb total).

(3) APU - Start

(4) Nos. 1, 2 and 3 Generators - Trip

(5) External Power Switch - CLOSE

(6) APU Generator - Place on airplane bus

(7) Engines - Shut down

ELECTRICAL SYSTEM OPERATION

Major AC electrical loads are shown in figure 7-8. The DC electrical system is treated as a part of the AC system as it receives all its power from the AC system. Figure 7-8 also shows all DC electrical equipment loads that can be operated from the battery in event of complete AC power failure. Figure 7-8 can be used to determine what equipment to operate in the event of partial or complete electrical power failure.

Figure 7-9 shows electrical operation loads for different airplane operating conditions. Frequency oscillations of one cycle per second and load shift up to 6 KWS between generators in parallel are considered normal. It is possible when engines are operating at approximately 80% rpm that the drive will be in transition between underdrive and overdrive condition causing frequency and load division control to be less precise. Results of load swap between paralleled units may be indicated on the ammeters. Normally this condition will not affect the airplane or airplane electrical system but will decrease the mechanical life of the drive. An extended operation under the above condition should be avoided but never to the extent of jeopardizing flight safety.

NOTE

To prevent overcharging of the APU battery and the resulting loss of electrolyte, do not exceed 200 volts, as read on the airplane voltmeter, when charging the APU battery from the airplane electrical system, the APU, or ground power cart.

GENERATOR AUTOMATIC PARALLELING

The AC system is equipped with an auto parallel device to automatically parallel the generators when they are within 2 cycles of each other. Automatic paralleling of the generators can be accomplished as follows:

A. After an engine with a generator is started, check the generator failure light.

B. If illuminated, move generator control switch to the CLOSE position. The light will then be extinguished. (Generator relays normally will not go to the TRIP condition on shutdown.)

C. Check bus tie breaker circuit open light.

D. If illuminated, move the bus tie breaker switch to the CLOSE position; this will extinguish the light. (Bus tie breakers normally will not go to the TRIP condition on shutdown.)

E. Move the paralleling selector to the selected generator position, check frequency and voltage within limits.

F. Prior to closing the first generator breaker, place the applicable frequency and KWS control rheostat to the 6 o'clock position. The generator breaker switch can then be moved to the CLOSE position to connect power to the generator bus and thus extinguish the generator breaker circuit open light. Power will also be connected to all the generator busses. External power will be tripped out of the system.

G. Select the generator for the next engine started, check generator failure light and bus tie breaker circuit open light. Move paralleling selector to generator position and check frequency and voltage within limits. The generator circuit open light will be illuminated and the synchronizing lights will be flashing slowly.

CAUTION

If at any time the synchronizing lights illuminate alternately instead of together, trip the entire system out of operation as further operation will seriously damage the system.

ELECTRICAL EQUIPMENT LOADS

MAJOR AC ELECTRICAL LOADS

EQUIPMENT	NO. UNITS	WATTS PER UNIT	START TAXI	TAKEOFF CLIMB	CRUISE	LANDING
ANTI-ICING						
Windows P1, P2, CP1, CP2 Anti-ice	1	5700	5700	5700	5700	5700
Windows P3, P4, P5, CP3, CP4, CP5 Anti-ice	1	636	636	636	636	636
AUTOPILOT						
Autopilot	1	246			246	246
ELECTRICAL POWER					During Refueling	
A/R System	1	1586	300	300	1586	300
Copilot's Instrument Transformer	1	56		EMERGENCY USE ONLY		
Lighting Transformers 1 ▶ 249	3	550	1435	1333	1512	1507
Lighting Transformers 250 ▶	4	550	1962	1655	1876	1955
Pilot's Instrument Transformer	1	260	260	260	260	260
Transformer-Rectifier Unit (T-R No. 1 and 2)	2	3300	692	1376	1146	672
Transformer-Rectifier Unit 1 ▶ 371 less 26, 28 and 269	1	395	40	395	346	99
Transformer-Rectifier Unit 26, 28, 269, 372 ▶	1		300	1200	1200	300
ENGINES AND FUEL						
Boost Pump	8	440	2920	3520	3065	3065
Override Pump	2	1300			2600	
Water Injection Boost Pump	2	16,150		32,300		
Water Tank Drain Mast Heater	1	345	345	345	345	345
FLIGHT CONTROLS						
Stabilizer Trim	1	3290		MOMENTARY		
LIGHTING						
Retractable Terrain Light	1	600		600		600
Nose Landing Light	1	600	600	600		600
Taxi Lights	2	250	250			
Wing Landing Lights	2	600				1200
MISC. HEATING AND VENTILATING						
Beverage Jug	1	120	120	120	120	120
Blower - APN/82	1	225	225	225	225	225
Blower - Electrical Equipment Rack	1	1255	1255	1255	1255	1255
Hot Cup	2	600			1200	
Q-Inlet Heater	1	200	200	200	200	200

Figure 7-8 (Sheet 1 of 4)

MAJOR AC ELECTRICAL LOADS (Cont)

EQUIPMENT	NO. UNITS	WATTS PER UNIT	START TAXI	TAKEOFF CLIMB	CRUISE	LANDING
RADIO						
APN-59	1	1242			1242	
APN-69	1	570			570	
APN-82 1▶97	1	1525				
APN-99 98▶		2118	2118	2118	2118	
APN-134	1	556	556	556	556	556
APX-64	1	285	285	285	285	285
ARC-65 2▶185	1	54		54	54	54
ARC-58 1, 186▶	1					
Transmit		1715	345	345	345	345
Receive		1370	1370	1370	1370	1370
ASQ-15	1	424	424	424	424	424
SCR-718	1	133		133	133	133

NOTE

Equipment using less than 1% of system capacity is not listed

DC ELECTRICAL LOADS

This chart lists all equipment that can be operated from the battery in the event of complete electrical power failure. Other DC equipment will operate only under normal operation of one or both T-R units

EQUIPMENT	NO. UNITS	AMPS PER UNIT	START TAXI	TAKEOFF CLIMB	CRUISE	LANDING
A/R					During Refueling	
A/R Pump Control Valve	4	1.00			4.0	
A/R Valves and Control	1	5.00			5.0	
Boom Nozzle Lights	1	2.70			2.7	
Boom Operator Panel Lights	37	0.04			1.5	
Boom Operator's Spotlight	2	0.17			0.2	
Boom Operator's Window Deice Relay	1	0.35			0.4	
Boom Retract Valve	1	2.50			MOMENTARY OPERATION	
Fuel Transferred Indicator	1	0.45			0.5	
Fuel Transfer Valves A/R Manifold to Eng Manifold	1	2.00			MOMENTARY OPERATION	
A/R Manifold Line Valve	1	2.00			MOMENTARY OPERATION	
Signal Amplifier	1	2.00			2.0	
Underbody Illumination 1▶386	2	1.80			3.6	
Boom Position Indicator	3	0.06			0.2	
Underwing Illumination 387▶	2	1.80			3.6	

Figure 7-8 (Sheet 2 of 4)

ELECTRICAL EQUIPMENT LOADS (CONT)

DC ELECTRICAL LOADS (Cont)

EQUIPMENT	NO. UNITS	AMPS PER UNIT	START TAXI	TAKEOFF CLIMB	CRUISE	LANDING
ENGINES						
Engine Ignition	4	7.00	7.0			
Engine Start Valve and Relay	3	6.20	6.2			
Cartridge Starter	1	3.10	Neg			
FUEL AND OIL						
Fuel Dump Relays	3	0.81		MOMENTARY OPERATION		
Fuel Dump Valve	1	2.10		MOMENTARY OPERATION		
Fuel Firewall Valves	4	2.00		EMERGENCY OPERATION		
Fuel Pressure and Scavenge Light	2	0.04		MOMENTARY OPERATION		
Fuel Transfer Valves	6	2.00		MOMENTARY OPERATION		
Single Point Refueling Light and Control	1 ea	0.40				
Single Point Refueling Valves	10	2.00				
Upper Deck to Aft Tank Valve	1	5.00		MOMENTARY OPERATION		
HEATING, VENTILATING AND PRESSURIZATION						
A/C Crossover Valve	1	1.50		MOMENTARY OPERATION		
Air Conditioning Shutoff Valve	1	1.50		MOMENTARY OPERATION		
Emergency Pressurization and Air Heating Valve	1	2.00		EMERGENCY OPERATION		
Engine Air Bleed Valve	4	2.00		EMERGENCY OPERATION		
Ground Air Ejector Valve 98▶	1	2.00		MOMENTARY OPERATION		
Ram Air Valve 98▶	1	1.20		MOMENTARY OPERATION		
HYDRAULIC						
Engine Hydraulic Oil Shutoff Valve	4	1.90		MOMENTARY OPERATION		
Generator Hydraulic Valve	1	1.20		MOMENTARY OPERATION		
Hydraulic Pump	1	53.00		EMERGENCY OPERATION		
Hydraulic Pump Control	1	0.45		EMERGENCY OPERATION		
Hydraulic System Depressurization Valve	2	3.00		MOMENTARY OPERATION		
LIGHTS						
Alert Light, Cockpit	1	0.79				
Alert Light, APU	1	0.65				
Entry Light	1	0.17				
Magnetic Compass Light	1	0.04				
Pilot and Crew Instructor's Spotlight	2	0.17	0.3	0.3	0.3	0.3
MISC. EQUIPMENT						
Windshield Wiper	2	4.86		CLIMATIC OPERATION		

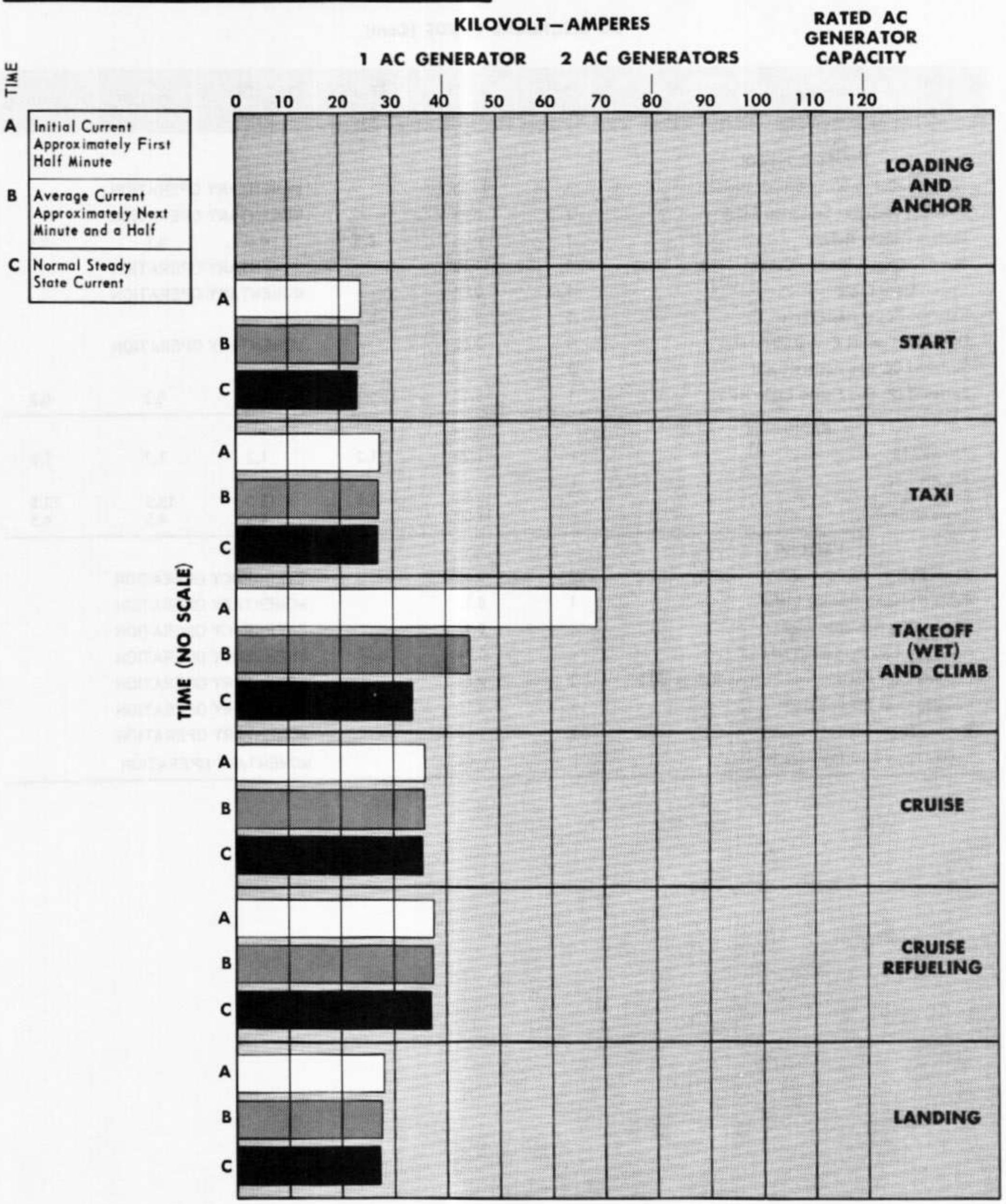
Figure 7-8 (Sheet 3 of 4)

DC ELECTRICAL LOADS (Cont)

EQUIPMENT	NO. UNITS	AMPS PER UNIT	START TAXI	TAKEOFF CLIMB	CRUISE	LANDING
POWER CONTROL						
Auto Parallel Unit and Circuit Breaker	1	24.00		MOMENTARY OPERATION		
Auxiliary Negative Sequence Relay	2	0.35		MOMENTARY OPERATION		
Battery Control Relay	1	0.45	0.5	0.5	0.5	0.5
Bus Tie Circuit Breaker Control	3	12.00		MOMENTARY OPERATION		
Circuit Open Light	9	0.04		MOMENTARY OPERATION		
External Power Receptacle	1	0.60	0.6			
Generator Control Circuit Breaker	3	7.00		MOMENTARY OPERATION		
Switched DC Bus Failure Light	1	0.04				
Switched DC Bus Failed Light Relay	1	0.23	0.2	0.2	0.2	0.2
RADIO						
AN/AIC-10	1	1.20	1.2	1.2	1.2	1.2
AN/ARC-34	1					
Receiving		13.50	13.5	13.5	13.5	13.5
Transmitting		18.00	4.5	4.5	4.5	4.5
WARNING						
Alarm Bell	3	0.60		EMERGENCY OPERATION		
Cabin Pressure Warning Light	1	0.17		MOMENTARY OPERATION		
Engine Fire Detection Lights	4	0.17		EMERGENCY OPERATION		
Hydraulic Low Pressure Light	4	0.04		EMERGENCY OPERATION		
Landing Gear Position and Warning Relays 15 ▶	3	0.27		MOMENTARY OPERATION		
Landing Gear Warning Light	1	0.17		MOMENTARY OPERATION		
Warning Horn	1	1.00		MOMENTARY OPERATION		
Engine No. 4 Low Pressure Warning	1	.04		MOMENTARY OPERATION		

Figure 7-8 (Sheet 4 of 4)

ELECTRICAL OPERATIONAL LOADS



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Figure 7-9 (Sheet 1 of 2)

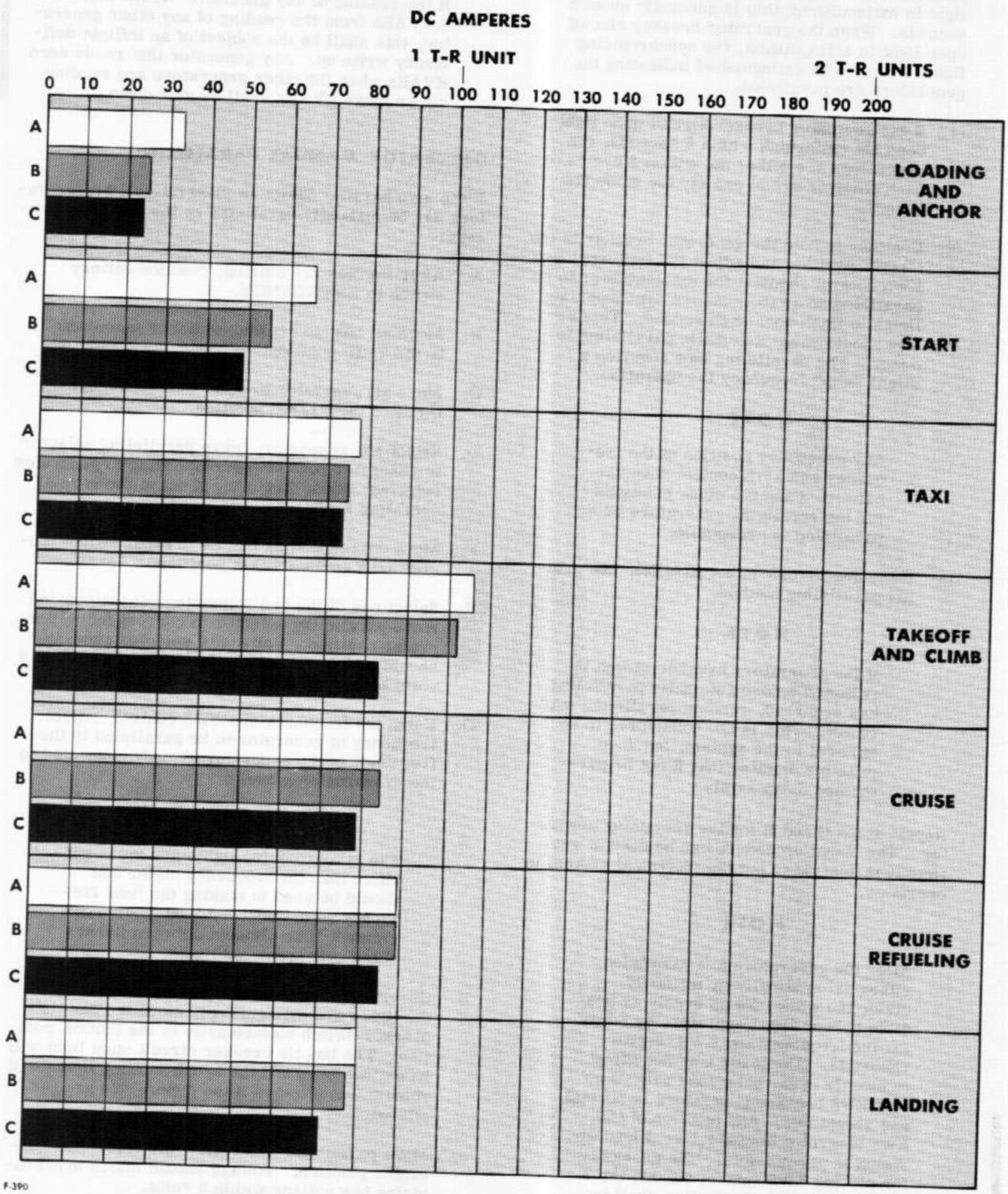


Figure 7-9 (Sheet 2 of 2)

H. Hold the generator breaker switch in the CLOSE position until the generator breaker circuit open light is extinguished; this is generally about 5 seconds. When the generator breaker circuit open light is extinguished, the synchronizing lights will also be extinguished indicating the generators are paralleled.

(1) If the generator breaker circuit open light does not extinguish within 5 seconds, the generators are either not within 2 cycles of each other or are at exactly the same frequency.

(2) Continue to hold the generator breaker in the CLOSE position and adjust the frequency and KWS control rheostat for the generator to be paralleled so as to cause the synchronizing lights to flash once each second. This action should cause automatic paralleling to occur. The paralleling unit requires a slight "slip" frequency for operation.

NOTE

Any necessary position of the frequency and KWS control rheostat between 3 and 9 o'clock positions for the remaining generators being paralleled is acceptable.

(3) If the generators do not parallel, use manual paralleling method.

NOTE

If the generators breaker switch is released before automatic paralleling has occurred, random paralleling may result. This is not considered to be harmful to the system, but good practice dictates that it not be performed deliberately.

J. Repeat steps G and H for the remaining generator. The above procedure can be used at any time it is desired to put the electrical system in operation.

NOTE

After the generators are paralleled, either automatically or manually, divide the work load as evenly as possible between the generators by adjusting the frequency and KWS control rheostats. The loads may not adjust to exactly even, but a load shift of up to 6 KWS between generators is normal and acceptable. Any position of the KWS control required for real load division is permissible. The necessity for placing KWS control outside the 3 o'clock to 9 o'clock position shall be the subject of a deficiency write up.

K. Using the KWATT-KVAR switch (item 15, figure 1-30) monitor the KVAR load of each generator. If the reading of any generator varies more than 6 KVARS from the reading of any other generator, this shall be the subject of an inflight deficiency write up. Any generator that reads zero KVARs when the other generators are reading six or more KVARs shall be shut down.

GENERATOR MANUAL PARALLELING

If the auto parallel device is inoperative, the generators can be manually paralleled by the following procedure:

A. After engines are started, position battery switch to EMERGENCY.

B. Move all bus tie breaker switches momentarily to the TRIP position.

C. Move all generator breaker switches momentarily to the CLOSE position.

D. Select any generator, move paralleling selector to generator position corresponding to generator selected; adjust frequency if out of the normal operating range.

E. Move corresponding bus tie breaker switch momentarily to the CLOSE position.

F. Select one of the two remaining generators and move paralleling selector to corresponding generator position. Voltage of selected generator should match synchronizing bus voltage within 5 volts before paralleling.

G. Using the frequency and KWS control, adjust frequency of generator to be paralleled to the frequency of the generator already connected to the synchronizing bus.

NOTE

The synchronizing lights are more sensitive than the frequency meter and should be used in making the final frequency adjustment. Adjust to give the greatest time element between flashes of the synchronizing lights.

H. Observe synchronizing lights carefully. While the lights are extinguished, move the bus tie breaker switch momentarily to the CLOSE position. The bus tie breaker circuit open light will be extinguished and the synchronizing lights will remain extinguished if the generators are paralleled.

J. Move paralleling selector to the remaining generator position. Voltage should match synchronizing bus voltage within 5 volts.

K. Repeat steps G and H. If unable to parallel generators either automatically or manually, see ELECTRICAL SYSTEM EMERGENCY OPERATION, Section III.

L. Move battery switch to NORMAL position.

EXTERNAL POWER

External or APU power may be used to operate the airplane electrical systems. The following procedure should be used when connecting external or APU power:

CAUTION

Prior to inserting the external power plug into the airplane receptacle, place the battery switch to EMERGENCY and TRIP the external power switch. This will trip the external power breaker and allow the airplane's phase sensing relay to function should reverse phase external power be subsequently applied.

NOTE

The APU generator is automatically tripped from the system when the external power receptacle cover is opened.

A. Move battery switch to the EMERGENCY position and check bus tie circuit open lights extinguished and generator breaker circuit open lights illuminated.

(1) If any bus tie circuit open light is illuminated, move its bus tie breaker switch momentarily to the CLOSE position and if any generator breaker circuit open light is extinguished, move its generator breaker switch to the TRIP position.

B. Check power source.

(1) If external power is used, insert power plug into the external power receptacle.

(2) If APU power is used, check external power receptacle door closed.

C. Turn paralleling selector on electrical control panel to EXTERNAL POWER and check voltage and frequency.

D. Move external power switch momentarily to CLOSE position.

E. Check for voltage on T-R No. 1 and T-R No. 2.

F. Move battery switch to NORMAL position.

G. Check battery charging ammeter for charge.

NOTE

- External or APU power will be tripped out of the system when the first generator is connected to the system.
- Shutting down the external power cart will not trip the external power breaker unless the battery switch is in EMERGENCY.

BATTERY CHARGE LEVEL (NICKEL-CADMIUM BATTERY)

Check BATTERY CHARGE circuit breakers set (three on main circuit breaker panel, one on battery circuit breaker panel and one on the battery charge control panel). Apply power to airplane electrical system, battery switch NORMAL. Allow one minute for battery charge ammeter reading to stabilize. The readings indicate as follows:

On airplanes 1▶371 less 26, 28 and 269:

A. 1 Amp or less - Battery fully charged.

B. 4 Amps or less - Desired reading, battery is 80% charged.

C. 7 Amps - Battery 50% charged, minimum charge for normal operations.

D. 10 Amps - Battery charge very low, charge battery before takeoff except for emergency conditions.

On Airplanes 26, 28, 269, and 372▶:

A. Less than 2 amps or ammeter pulsing – battery fully charged.

B. 5.5 Amps or more, constant - battery less than 75% charged.

The airplane nickel-cadmium battery can be charged continuously when the engines are operating or the APU is operating. To determine the battery state of charge, enter figure 7-10 with charging current, charging voltage, and approximate battery area average temperature for the preceding 5 to 6 hours. Then pick the point on the appropriate curve that fits these data. Proceed down to the "percent of full charge" line to determine the state of charge of the battery. Charging of the APU nickel-cadmium battery should be monitored to prevent overcharge and subsequent damage to the battery. When the battery charge ammeter for the APU battery indicates 4 amps or less, pull both (the 5 amp and 25 amp) circuit breakers on the Solar APU control panel marked BATTERY CHARGER or, if an AiResearch APU is installed, pull the 3 circuit breakers marked STA 1180 POWER OUTLET on the GENERATOR NO. 2 section of the MCBP. When the battery charging ammeter reading is 4 amps or less during ground operation of the AiResearch APU or whenever an energized external power plug is connected to the airplane, the BATTERY CHARGE circuit breakers on the APU panel should also be pulled to prevent overcharge. After the battery charging circuit has been deactivated in flight, it will not be necessary to reset the circuit breakers as there is no load on the APU battery to discharge it. See also OPERATION OF SOLAR (AIRESEARCH) APU in Section IV.

CAUTION

If the APU battery is left on trickle charge, it may be damaged.

COPILOT'S INSTRUMENT POWER SYSTEM

After hydraulic pressure and supply are normal, hold the copilot's instrument power switch in the START position until the copilot's instrument power off light is extinguished; then release to NORMAL.

BATTERY CHARGE STATUS

(NICKEL-CADMIUM BATTERY)

EXAMPLE:

GIVEN:
Charging current = 10 amps

Charging voltage = 31.5 volts

Battery area ave. ambient temp. for preceding 5 - 6 hours = 0°F (-18°C)

FIND:
Percent of full charge of battery

SOLUTION:
Enter chart with 10 amp charging current

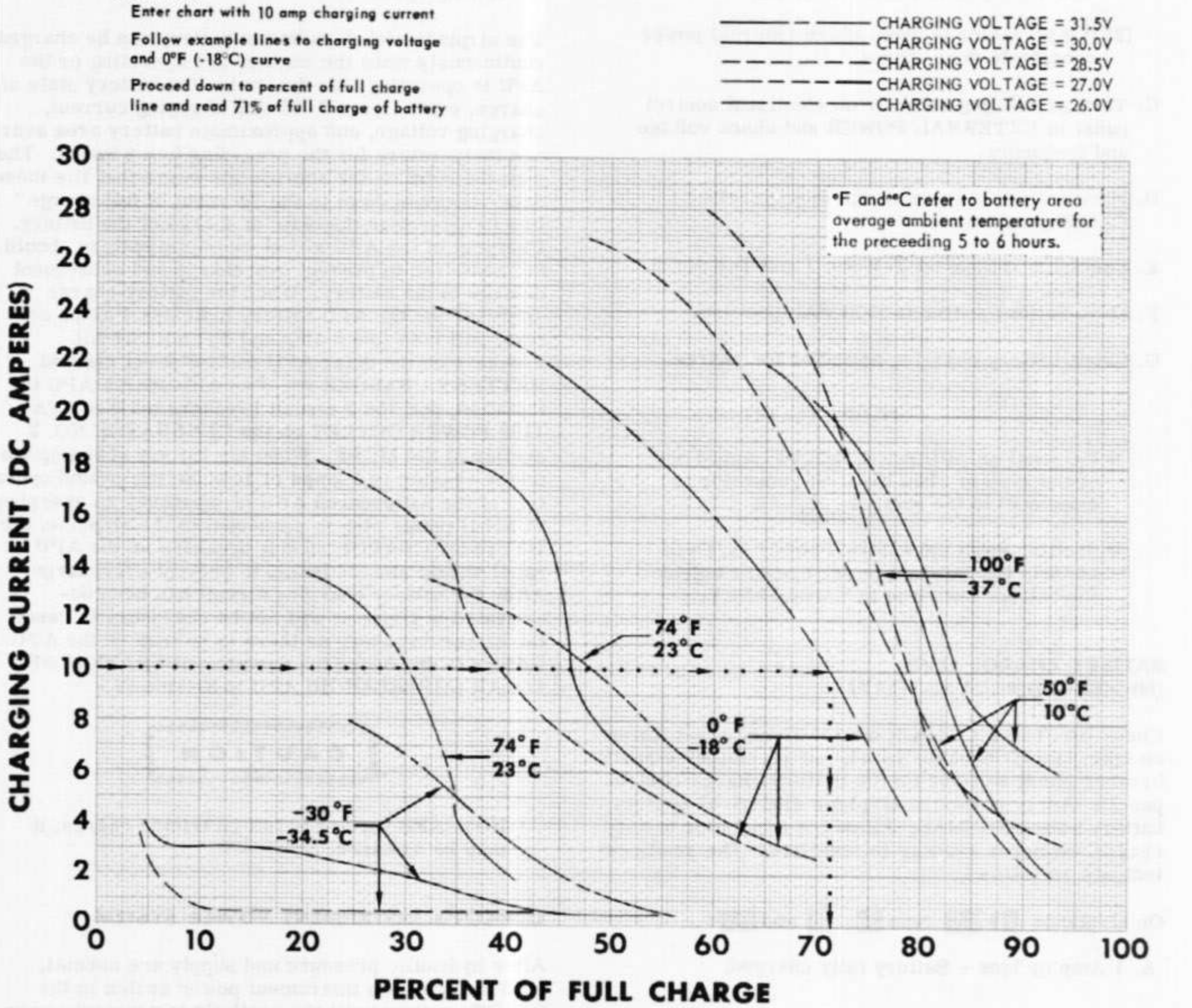
Follow example lines to charging voltage and 0°F (-18°C) curve

Proceed down to percent of full charge line and read 71% of full charge of battery

NOTE

Deviation from curves will indicate:

1. Battery electrolyte level is improper.
2. Battery previously completely discharged.



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Figure 7-10

BRAKE SYSTEM OPERATION

In order to slow or stop the airplane, the kinetic energy (energy of motion) of the airplane must be absorbed by rolling friction, aerodynamic drag, and braking action. The relative effect of these factors depends upon the length of the landing roll and the touchdown speed. If the runway length were sufficient, aerodynamic drag and rolling friction would slow the airplane to taxi speed; however, this would require approximately three to five miles. Braking action then, is the controlling factor in stopping the airplane.

Four factors limit the ability of the brakes to stop the airplane. These factors are: braking friction available between the tire and the runway, torque capability of the brake, kinetic energy limits of the brake, and pilot technique for brake usage.

A. Braking friction is primarily dependent upon type of runway surface and runway climatic conditions. This information is generally available to the pilot in the form of a runway condition reading (RCR). When not available, use average values found in Part 9 of the Appendix, T.O. 1C-135(K)A-1-1. These latter values are averages and should be used with caution.

B. Torque is the mechanical capability of the brakes to slow the wheel rotation and is limited by design. Maximum braking action occurs when the wheels are in a rolling skid and the wheel rpm is 80 to 85% of brakes off rpm. During light weight low energy stops, torque available is greater than torque required. Therefore, when full brakes are applied, the wheels will approach a skid condition and anti-skid cycling will occur. During heavy weight high energy stops, torque available for maximum braking is generally less than torque required. Under the latter condition, anti-skid cycling will seldom occur until the airplane has slowed to a very slow speed.

C. The energy absorption of the brake is measured in terms of kinetic energy and is limited by design. The energy appears in the form of heat, and the absorption capability of the brakes is a function of the brakes mass and materials. Brake energy is cumulative if heat is not dissipated by cooling between brake applications. Therefore, brake usage should be kept to a minimum to insure that the full energy capability of the brake is available for a maximum effort stop. Kinetic energy brake limits are shown in figure 5-14.

D. Pilot technique is very important if maximum braking capability of the brakes is to be obtained on airplanes without WSP 550. Although the pilot's brake system is equipped with an anti-skid system, it was not intended to be and is not an automatic braking system. The primary function of the anti-skid system is to prevent excessive wheel skidding. When rapid anti-skid cycling occurs, the brake pressures are too great for maximum braking performance. When this occurs, the pilot must rapidly reduce brake pressures to approximately half initial level, then slowly increase pressure until another anti-skid is detected. Continue this technique. Maximum braking performance occurs at a pressure slightly below the level that anti-skid cycling will occur. The ability of the pilot to maintain brake pressures at the proper braking level is an important factor in airplane stopping performance.

On airplanes with WSP 550, the pilot should apply full brake pedal to obtain minimum stopping distance under any runway condition.

NORMAL BRAKING

The brake is a rugged piece of equipment which can absorb a large amount of punishment when required to do so. However, the brakes should be treated with respect and not subjected to unnecessary wear and abuse. This will insure that maximum performance is available when required. During normal landings, full 60 degree speed brakes and all of the runway available should be used to slow the airplane to taxi speed or a full stop. The greatest amount of aerodynamic braking and rolling friction are realized during the initial part of the landing roll. Steady braking as required should be added during the latter part of the roll to further slow to taxi speed. If antiskid cycling occurs on airplanes without WSP 550, braking is too hard. This technique takes full advantage of the aerodynamic braking and rolling friction to reduce the kinetic energy the brakes must absorb. Refer to LANDING ROLLOUT STOP in Section V.

MAXIMUM EFFORT STOP

If maximum braking is required during an abort or after touchdown, lift should first be decreased as much as possible by rotating the nose wheel to the runway and applying full 60 degree speed brakes before applying wheel brakes. This procedure will improve braking action by increasing the frictional force between the tires and the runway. On airplanes without WSP 550, for minimum landing ground roll, apply brakes with increasing pressure until the anti-skid cycles once, release brake pressure slightly to allow anti-skid to cycle 2 to 3 times (maximum 5 times) during ground roll. On airplanes with WSP 550, the pilot should apply full brake pedal to obtain minimum stopping distance under any runway condition. The BRAKE LIMITS charts in figure 5-14, sheets 1 and 3, should be used for all maximum effort stops.

NOTE

If spoilers are not used, anti-skid cycling on airplanes without WSP 550 will increase and braking effectiveness will be reduced. At light weights and zero spoiler, it is possible to encounter rapid cycling of the anti-skid system. If this occurs, use braking technique outlined below for braking on wet, icy, or slush covered runways.

BRAKING ON WET, ICY OR SLUSH COVERED RUNWAYS

Braking friction will be greatly reduced on wet, slush covered or icy runways. On rain soaked or slush covered runways the wheels may hydroplane during the first part of the landing roll and rapid anti-skid cycling may occur on airplanes without 1C/D 550. On these airplanes maximum braking action is obtained by reducing brake pedal pressure to minimize the anti-skid cycling; very light pedal pressure will be sufficient. On airplanes with 1C/D 550, maximum braking action is obtained by application of full brake pedal. As the airplane slows, more weight will be placed on the wheels and braking action will become somewhat more effective. Two symmetrical engines should be shut down when practical to further reduce braking requirements. It is possible that during asymmetrical wheel loading (e.g., crosswind conditions) the lighter loaded wheels may remain in almost constant anti-skid release. This could result in a directional control problem if runway conditions are such that nose wheel steering is ineffective. If encountered, release all pressure on both brakes, level wings to equalize wheel loads, slowly reinitiate braking procedure.

The recommended procedure to be followed on airplanes without 1C/D 550 is:

A. Apply brakes slowly until first anti-skid cycling is noted.

B. Release pressure until cycling disappears.

C. Repeat above steps during remainder of stop.

D. If directional control becomes difficult, release pressure to both brakes, level wings and reinitiate braking cycle.

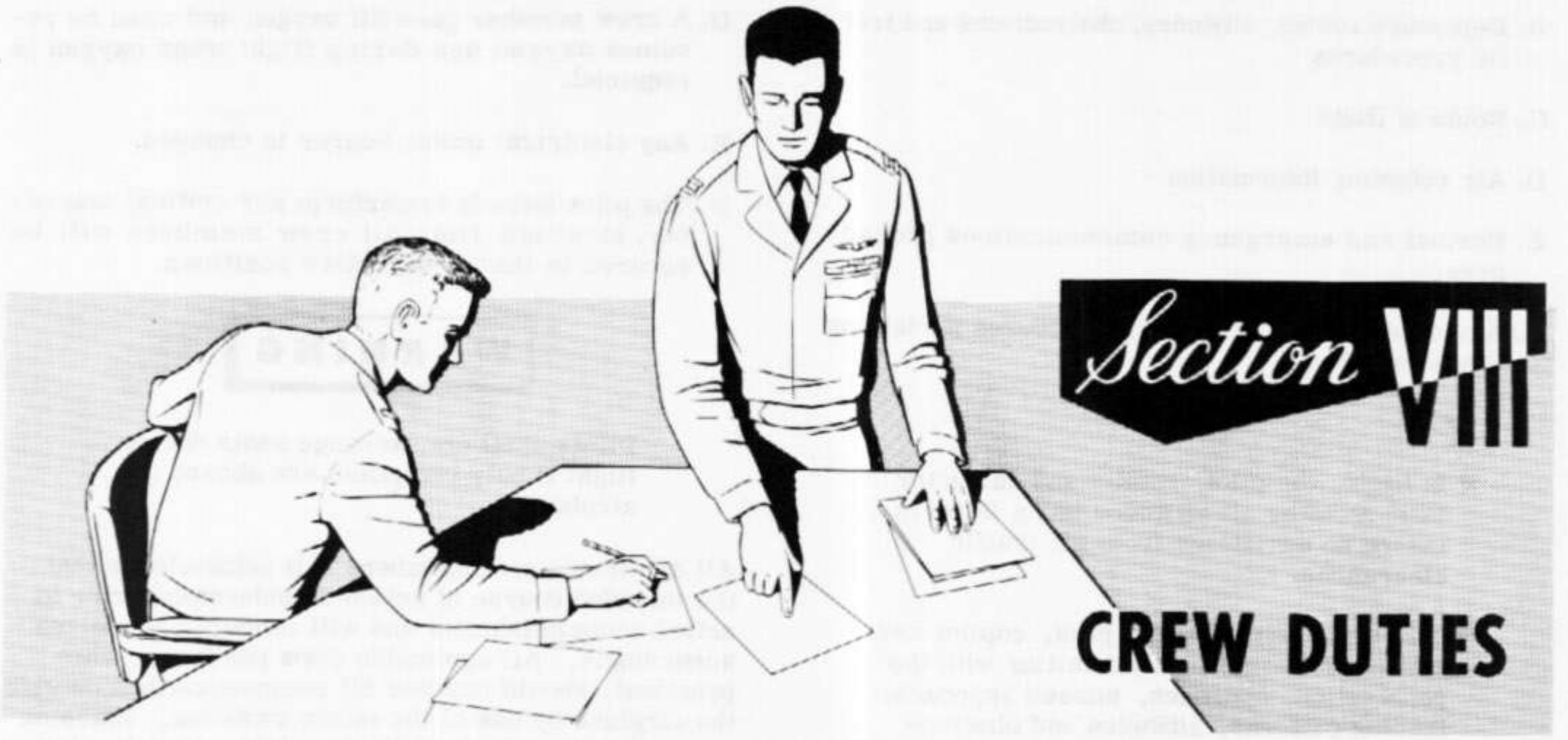
NOTE

Under the most severe runway conditions it may not be possible to reduce brake pressures to the level that anti-skid cycling will completely disappear. When this situation exists, maintain cycling at the minimum level without complete brake release. Cycling will gradually decrease as the airplane slows and braking action will improve.

On airplanes with 1C/D 550 the pilot should apply full brake pedal to obtain minimum stopping distance under any runway condition.

ANTI-SKID INOPERATIVE

The pilot must use more caution when stopping with antiskid system inoperative or when copilot's brakes (no antiskid) are used. The pilot must learn to judge braking action by sensing the deceleration of the airplane while applying brake pressure. Apply brakes until braking action is felt, then completely release brakes momentarily. Repeat this procedure until stopped. Brake pressures should be kept to the minimum required to slow the airplane to taxi speed or a full stop. Excess brake pressure will result in skidding tires and possible tire failure.



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INTRODUCTION

The purpose of this section is to provide a compact collection of material wherein each crew member can readily determine his duties in relation to the accomplishment of the over-all mission. Instructions relating to crew duties in this section do not include information which is already covered in other sections.

CREW COORDINATION

Coordination of actions within a crew is of prime importance to insure the optimum degree of mission success and safety during all phases of operation. This coordination is not necessarily limited to actions alone. Complete familiarity with one's crew position, the responsibilities thereof, and a working knowledge of the other crew members' duties will contribute immeasurably toward crew coordination. Each crew member must be constantly on the alert and will notify the responsible crewmember of any deviation or discrepancy which will affect successful accomplishment of the mission. Liaison between individuals concerned must be established prior to initiating any action or procedure which will alter airplane configuration or require correlation of activities between crewmembers. Prior to flight, the pilot must insure that all crewmembers are thoroughly familiar with all aspects of the assigned mission as pertains to their crew specialty to include:

A. Applicable instructions in the Flight Information Publications

B. Departure routes, altitudes, obstructions and traffic procedures

C. Route of flight

D. Air refueling information

E. Normal and emergency communications procedures.

F. Any special instructions or procedures pertaining to the mission

NOTE

- In flight, the pilot, copilot and navigator must monitor all altitudes being flown to insure no deviations from air traffic clearances.
- It is imperative that the pilot, copilot and navigator be thoroughly familiar with the penetration, approach, missed approach, landing patterns, altitudes and obstructions at both destination and alternate airfields. Available aids such as current FLIP Terminal and approach charts must be studied. A complete set of current approach charts must be available for inflight use by both pilots and the navigator. The navigator, as well as the pilot not actually flying the airplane, will closely monitor all departures, penetrations and approaches. The pilot at the controls will be notified immediately of any deviation from published procedures or air traffic clearances.
- During any critical phase of flight, especially under night or instrument conditions, the pilot not flying the airplane will closely monitor his flight instruments and cross-check them against the instruments of the other pilot. If an apparent error in airplane attitude is detected, the pilot flying the airplane will be advised immediately and appropriate corrective action will be initiated.

Positive measures must be taken to insure that safety of personnel and airplane are not jeopardized. Flight attitude of the airplane must be carefully monitored by either pilot or copilot at all times. Verbal coordination between applicable crewmembers will be required when:

A. Control of the airplane is transferred between pilot and copilot.

B. Repositioning fuel panel valves and switches.

C. A crew member leaves position or leaves interphone.

D. A crew member goes off oxygen and when he resumes oxygen use during flight when oxygen is required.

E. Any electrical power source is changed.

F. The pilot intends to perform any critical maneuver, at which time all crew members will be secured in their respective positions.

WARNING

Pilots shall not exchange seats during flight if only two pilots are aboard the airplane.

All applicable crewmembers will acknowledge that the intended course of action is understood prior to actual accomplishment and will conduct themselves accordingly. All applicable crew positions, when practical, should monitor all communications outside the airplane by use of the mixer switches. Extreme care must be exercised by the pilots, when leaving seats, to avoid inadvertent operation of switches or controls on the aisle stand or overhead panel. When a safety belt is unfastened inflight or on the ground, place the belt carefully so as not to inadvertently operate any switches or damage equipment.

PILOT

The pilot is the airplane commander and is responsible for the airplane and crew. For simplification, and to avoid any misunderstanding, the pilot and copilot will be referred to as such during interphone transmissions. The successful accomplishment of the mission is of prime importance; in no instance, however, will the safety of the airplane or crew be compromised. The pilot is responsible for the issuance of instructions governing all phases of flight operation. In addition to his regular function, the pilot will perform the following:

A. Mission Planning

(1) Coordinate with other crew members on exact mission requirements, including items pertinent to individual crew procedures. Supervise the preparation of all required forms, charts, logs, etc., in accordance with existing directives.

(2) Attend required briefings.

(3) Conduct specialized crew briefing. The pilot and crew shall review the mission profile. The briefing shall also include but not be limited to the following items: Special clothing requirements, a review of bailout, crash landing and ditching procedures and a discussion of departure and approach procedures which may be used. The pilot shall review normal and emergency takeoff and initial climb considerations with the copilot at this time and again just prior to takeoff.

(4) Before each overwater flight, the pilot shall check that the equipment listed under DITCHING EQUIPMENT in Section III is aboard and stowed in the proper places.

B. Upon arrival at the airplane, the pilot will complete required inspections as outlined in Section II. Discrepancies will be brought to the attention of the ground crew as quickly as possible. In the absence of the navigator or the boom operator, the pilot will insure that the applicable inspections are completed.

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.

Attend required briefings and aid the pilot as directed. See sample mission flight plan (figure 8- 1).

NAVIGATOR

The navigator will plan thoroughly each facet of the mission that pertains to navigation, supplying such related information to the pilots as may be necessary to complete their planning requirements. He will be responsible for the navigation of the airplane, using all means available to accomplish the mission successfully. He must be thoroughly familiar with emergency procedures as they pertain to his duties.

MISSION DATA RECORDING

Mission Preparation Data

SELECTION AND PREPARATION OF CHARTS

A. Select maps and charts which have scale and projection to suit the requirements of the mission and plot the required routes including departure route to be flown if SID is to be flown, or if the departure track is known. Additional maps should be procured to provide coverage for an emergency change in flight plan.

B. When using Lambert Conformal charts, the route should be divided into segments with the length of each leg short enough to prevent large departures of the rhumb line from the route drawn on the chart, except when flying a great circle course utilizing the N-1 compass in the unslaved mode.

C. Assure that all pertinent special use airspace and ADIZ boundaries within 50 nautical miles and in the altitude structure of the flight planned route are annotated. Include altitude and time of restriction when applicable. The current Flight Information Publication will be consulted for information on special use airspace and ADIZ's.

D. Coordinate with the pilots to select reporting points enroute, and for control area entry or departure.

PREPARATION OF THE MISSION FLIGHT PLAN

A. The form provided for mission flight planning is printed in such a manner that, by use of carbon paper, a duplicate copy is made. The original is the navigator's copy, and the duplicate, which includes the fuel flight plan, is the copilot's copy.

B. The navigator will prepare a complete mission flight plan with separate line entries for approximately each hour of cruise and each phase of the mission which would cause a change in fuel consumption, such as: climb, level-off, off-load fuel, descent, etc. If desired, accumulated air distance entries may be omitted. Mission flight plan preparation is optional for local area pilot training, such as transition, instruments, etc.

C. The duplicate copy of the mission flight plan must be completed with the metro data available at the time of mission planning so that fuel predictions can be computed. If an appreciable difference exists between the forecast and final metro winds, the pilots should be informed.

D. Enter the planned route in the ROUTE column.

(1) The first line is used to record the fuel required for SETTOAC, and the time and distance required for takeoff and acceleration to climb speed. The abbreviated entry "SETTOAC" indicates: Start Engines, Taxi, Takeoff and Accelerate.

(2) A single line entry may be used to indicate a published controlled departure plan.

(3) Subsequent lines, as required, are used to plan the initial climb to altitude, based on information supplied by the copilot. If a planned secondary climb of 10,000 feet or more is required after initial level off, it may be desirable to compute a secondary level off position. Since the computed level-off point will be clearly marked on the chart, coordinates need not be included in the flight plan.

E. Enter the flight condition for each leg in the FLT COND column, using the following abbreviations or symbols:

(1) Climb - CL, ↗

(2) Cruise - CR, →

(3) Cruise Climb - C/C

(4) Descent - DES, ↘

(5) Landing - LDG

F. The ETA, ATA, and REMARKS columns may be utilized as desired.

Planning for grid navigation and airborne radar approaches, as required, will be completed in accordance with instructions contained in this Section.

Other planning as may be required for the mission will be completed in accordance with current directives. See sample jet mission flight plan (figure 8-1).

Mission Inflight Data

Sufficient information will be recorded by the navigator to permit complete and accurate reconstruction of the mission.

Positions and fixes will be indicated on the plotting chart by proper symbols and time in GMT. Any position or fix marking an alteration of course or any other condition of importance to the mission will be recorded.

Altitudes normally will be flown as planned. If a change is necessary, the new altitude will be noted on the chart or log at the point where the change takes place.

Pertinent observations will be noted on the chart or log where they take place.

The mission planning form, all celestial computations, and other pertinent computations will be filed with the chart in accordance with current directives.

Grid Navigation Planning

Select a suitable chart of the area over which the grid navigation leg is to be flown. The chart may either incorporate a printed grid overlay, or an overlay may be constructed.

Label the grid meridians and grid parallels unless mission requirements prohibit use of the GPI. The grid parallel nearest the mid-grid latitude of the route may be designated the grid equator and other parallels labeled accordingly, increasing toward grid North and South in one degree increments. However, as long as the ten degree limit, both North and South, is not exceeded; the grid latitude may be constructed to reflect all North or all South latitudes. The grid meridians may be labeled without regard for actual geographic coordinates, but longitude must increase or decrease properly with relationship to grid direction. It is convenient to label the grid meridian nearest the entry the same as the nearest geographical longitude and label the others accordingly, so that the longitude counters will not have to be moved excessively when setting grid longitude in the GPI.

Some polar charts have an equatorial latitude and longitude overlay prelabeled with values of latitude, in place of the standard USAF grid overlay. This overlay is compatible with computer operation. Do not relabel latitude as this would upset the scale. The grid meridians may be labeled without regard for actual geographic coordinates, but longitude must increase or decrease properly with relationship to grid direction.

Prepare the grid navigation portion of the flight plan with all courses, headings, and winds measured with reference to grid North.

INTERIOR INSPECTION—POWER OFF

1. Celestial Tables and Air Almanac - Check

1A. IFF - Set

a. Master Switch - OFF

b. Mode Enabling Switches - OUT

c. Mode 4 ON/OUT Switch - ON

d. Mode 3/A Code Selectors - SET

Insure that all four Mode 3/A selectors are set to zero.

2. GPI - OFF

3. Auto-Nav System Power - OFF

4. System Monitor Switch - NORMAL

5. Search Radar Control Panel:

a. FTC - OFF (down)

b. IAGC - OFF (down)

c. PATT Switch - As desired

d. Bearing Switch - As desired

e. STC - CCW

f. Stab Switch - OFF (down)

CAUTION

The stab switch should be in the OFF position until the radar warms up. If the switch is in the STAB position, an approximate 40 volt drop will result when the set is switched to STDBY, and the fuse can be overloaded, particularly in cold weather.

g. GAIN - CCW

h. Heading Select - Set

-East Variation

Set heading select control to 360

West Variation

i. Scan - OFF

j. Test Meter Switch - MAG

k. Range - 3-30

l. Function - OFF

6. Radar Pressurization Control Switch - NORMAL ON

7. Radar/Rendezvous Beacon - OFF, code set

a. Pulse Width Switch - Set

Set code selector switches for briefed code and long or short position on pulse switch as required.

8. Electronic Cabinet Cooling Switch - ON

9. Search Radar Indicator:

a. Range Delay Switch - OFF (down)

b. Intensity - CCW

10. Interphone Selector - INTER

11. Liaison Radio - OFF

12. Radio Altimeter - OFF

13. Crew Assembly - Complete

The assembly is conducted as outlined in CREW ASSEMBLY, Section II.

14. Oxygen System - Check

See Section IV detailed oxygen check.

15. Crew Report - Report, "Navigator, Interphone and Oxygen Checked" (BO, N, CP, P)

When copilot announces, "Crew Report," switch to CALL, report following the boom operator. If desired, headset may be worn after this point.

INTERIOR INSPECTION—POWER ON

1. Liaison Radio Control Switch - ON

If necessary to obtain time hack or if mission requirements dictate a ground radio check.

2. IFF Master Switch - STBY

3. N-1 Compass:

a. Latitude Correction Pointer - OFF

b. Annunciator Pointer - Centered

4. NAV Computer

a. Function Switch - NORMAL

b. Departure Switch - STANDBY 1▶97

5. GPI - ON or STBY

6. ASN-6 Control Panel: 1▶97

a. Wind Force Knob - GND SPD

b. Variation Dial - Set as desired

Grivation would be used if grid coordinates are used and the Navigator desires to take off with the N-1 Compass in magnetic operation.

c. Ground Position Indicator - Set

Insert the coordinates of the runway. Optional-grid coordinates could be used if taking off in grid operation or if grivation is used and your map is grid-oriented for this portion of the mission.

d. GPI - OFF

7. ASN-7 Control Panel: 98▶

a. Wind Speed Slew Switch - GND SPD

The following method of setting present position and destination values is a suggested method only. Any method is acceptable that does not exceed design limits or damage the equipment.

b. Latitude and Longitude Values - Set

(1) Display Switch - PP

(2) Destination Switch - STORE

(3) Latitude and Longitude Slew Switches - Set

Insert the coordinates of the runway. Optional - grid coordinates could be used if taking off in grid operation or if grivation is used and your map is grid-oriented for this portion of the mission.

(4) Display Switch - DEST

(5) Latitude and Longitude Slew Switches - Primary destination coordinates

(6) Destination Switch - INS until LA and LO flags disappear, then return to STORE

(7) Latitude and Longitude Slew Switches - Secondary destination coordinates, if desired

(8) Display Switch - PP

c. Variation Slew Switch - Set as desired

Check for proper variation setting in the variation window. Grivation would be used if grid coordinates are used and the navigator desires to take off with the N-1 compass in magnetic operation.

d. GPI - OFF

8. IFF Mixer Switch - As required

Placing the IFF mixer switch on the interphone panel to ON allows the crewmember to monitor Mode 4 interrogations. Insure switch is ON for EWO and alert cocking.

9. IFF Control Panel - Checked

a. IFF Antenna Switch - BOTH

b. RAD-TEST/MON Switch - OUT

c. Master Switch - NORM

d. Modes 1, 2, 3/A, and C - Tested

Momentarily hold each mode enabling switch to TEST, then return to OUT. Illumination of TEST light for each mode indicates satisfactory operation. If TEST function is inoperative, determine status of IFF with approach control if possible.

e. Mode 4 Computer - Encode

f. Mode 4 Caution Light - OUT

g. Mode 4 Code Switch - HOLD (Momentarily), then A or B, as applicable

NOTE

The Mode 4 code switch must be activated to the HOLD position a minimum of 15 seconds prior to the removal of electrical power from the aircraft.

h. Master Switch - OFF

i. Mode Enabling Switches - ON, as briefed

j. Modes 1 and 3/A - Set codes, as briefed

Mode 1 code will be set. Mode 3/A code may be set upon receipt.

k. Audio/Light Switch - As desired

Insure switch is in AUDIO for EWO and alert cocking.

10. Altimeter - Set and checked

The copilot will obtain and relay the altimeter setting during his radio check. Insure that all three pointers are correctly positioned. See figure 1-60.

11. Liaison Radio:

a. Time Hack - Obtain (if necessary)

AN/ARC-65

NOTE

At extremely low operating temperatures (approximately -55° C) the liaison radio control switch may return to OFF in 40 seconds. If this happens, select another channel and return control switch to ON. Repeat this procedure until the control switch stays ON, then allow the equipment to warm up for 15 minutes. During the warmup period, do not change channel or transmit. After the warmup, proceed with normal operation.

AN/ARC-58

NOTE

It is possible for the radio frequency to be stabilized for operation prior to the recommended warmup times. Should the frequency not be stabilized, the following times should be observed prior to reporting a malfunction. Warmup time is 7 minutes for ambient temperature above +30°C (+86°F), 15 minutes for temperature between 0° to 29°C (+32° to 84°F), and 20 minutes for temperatures below 0°C (+32°F).

b. Mission Frequency - Set

c. Ground Operational Check - If required

WARNING

Coordinate with ground crew to insure that no personnel are working on the boom.

d. Control Switch - OFF

12. Navigator's Clock - Wind and set

13. Radio Altimeter 1▶547 - Checked (for ground operational check if mission dictates); 548▶ - Checked

a. Rec. Gain Knob - ON

b. Scale Switch - As desired

c. Rec. Gain and Circle Size - Adjust

A 3-minute warmup period is required.

d. Rec. Gain Knob - OFF

NOTE

- A ground operational preflight is authorized prior to an overwater flight if the mission dictates the use of the SCR-718 equipment.
- Sequence of steps 10, 11, 12, and 13 may be varied to best suit mission requirements.

14. Celestial Observation Windows Thermal Radiation Curtains - Checked and installed (if applicable)

See ALERT PROCEDURES, Section II.

STARTING ENGINES AND BEFORE TAXIING

1. Airplane Electrical Power - Check

Ascertain that a generator is on the line.

2. IFF Master Switch - STBY
3. GPI - ON or STDBY
4. Auto-Nav System Power Switch - ON
5. Search Radar Function Switch - STDBY
6. Radar/Rendezvous Beacon - STBY, if required
7. Liaison Radio Control Switch - ON
8. Radio Altimeter 548▶ - ON and set, if required

For missions that require the use of pressure pattern, it is permissible to delay turning the set ON until prior to coast out. It is not mandatory to turn the set to ON if the mission is flown entirely over land and the set is not to be used.

9. Warning and Indicator Lights - Press to test, if not illuminated
10. Taxi Report - Report "Navigator, alarm bell checked, ready to taxi" (BO, N, CP, P)

When copilot sounds alarm bell and announces, "Taxi Report," report following the boom operator or coordinate with the boom operator and report for him.

11. Command Radio - Monitor

TAXIING

1. Search Radar - Turn on

a. Function Switch - SEARCH

WARNING

Before placing the function switch in SEARCH, BEACON, or WARN, make sure that all personnel are clear of the antenna radiation pattern. Avoid directing the energy beam toward inhabited structures, personnel groupings, or areas where airplanes are being serviced with fuel. (See figure 4-21.)

NOTE

Before placing the function switch in SEARCH, ensure that three minutes have elapsed since placing the function switch in STDBY.

b. Intensity Control - Rotate CW for faint trace.

c. Scan Switch - As desired

d. Stab Switch - STAB (up)

e. Gain and Tilt Controls - Set for optimum picture

BEFORE TAKEOFF

1. Radio Call - Monitor

   Monitor and record flight plan clearance and takeoff instructions. Set mode 3/A code if not previously set.

2. Safety Belt and Shoulder Harness - Fastened

3. Oxygen - ON and 100%

4. Takeoff Report - Report, "Navigator ready for takeoff" (BO, N, CP, P)

   When copilot announces over interphone, "Takeoff Report," report following boom operator.

5. Radar/Rendezvous Beacon - As required

NOTE

Sequence of items may be varied to best suit mission requirements.

TAKEOFF

1. IFF - As required

2. Takeoff Time - Record

3. GPI - RUN

4. Radar Silence Switch - TRANSMIT

AFTER TAKEOFF — CLIMB

1. IFF Mode 4 Caution Light - Out

2. Altimeter - Set 29.92 (N, P, CP)

   Reset altimeter to 29.92 at transition altitude.

3. Level Off - Record time

4. Radio Altimeter 1▶547 - ON (over ocean)

NOTE

Except in emergency, the SCR-718 radio altimeter equipment will be used only over broad ocean areas starting not less than 50 miles off shore unless the restriction is specifically waived by Headquarters USAF. Check current FLIP documents for areas in which additional restrictions are placed on the use of the SCR-718.

GRID NAVIGATION

The USAF grid system will be used at all times when flying in areas where magnetic compass indications become unreliable, where course angles change rapidly because of meridian convergence and where large and rapidly changing values of magnetic variation exist.

The unslaved N-1 compass will be used as the primary steering instrument. The copilot's unslaved J-4 compass will be used as a secondary steering instrument.

The ground position indicator on airplanes 1▶97, or the values in the latitude and longitude display windows on the ASN-7 control panel on airplanes 98▶ will be set to grid coordinates while grid navigation is being performed unless mission requirements prohibit use of the GPI.

Celestial heading checks will be accomplished periodically and recorded along with the N-1 and J-4 readings. In no case will one compass be reset (corrected) to agree with the other compass without first obtaining a celestial heading check.

Cross check the headings of the N-1 and J-4 compasses after a turn of 20° or more.

Entry

1. Heading Select and VOR-LOC - OFF (N, P)
2. N-1 Compass - Unslaved and set to present grid heading

   Unslave the N-1 compass and set the latitude pointer on geographic or false latitude, and the heading pointer on present grid heading.
3. Grid Heading - Check (N, BO)

   Check grid heading by celestial means.
4. J-4 Compass - Set latitude, unslave and set the grid heading (N, CP)

   Advise the copilot to set the J-4 latitude dial on the geographic or false latitude and to unslave the J-4 compass and set the present grid heading under the lubber line.
5. Search Radar Heading Select Control - ZERO
6. GPI - PP RST or STANDBY
7. GPI Variation - As required
8. Latitude and Longitude - Set
9. GPI - RUN

NOTE

- Steps 6, 7, and 8 may be accomplished prior to entry.
- Sequence of steps 6, 7, 8, and 9 may be varied to best suit mission requirements.
- Omit steps 7, 8, and 9 when specific requirements prohibit using the GPI.

10. Latitude Pointer for N-1 and J-4 - Reset as applicable (N, CP)

    The latitude pointer of the N-1 and J-4 compasses must be reset periodically as the geographical latitude of the airplane changes. Ordinarily, resetting within 4° of airplane latitude will give acceptable accuracy.

Exit

1. N-1 Compass - Reset to magnetic heading and slave

   Reset the N-1 compass to the approximate magnetic heading and reslave by turning the latitude pointer to the OFF position.
2. J-4 Compass - Set to magnetic heading and slave (N, CP)
3. Magnetic Heading - Check (N, CP)

   Cross-check the magnetic headings of the N-1 and J-4 compasses. Abnormal differences (5° or more) must be resolved by accomplishing a celestial heading check.
4. Search Radar Heading Select Control - Set to local variation
5. GPI Variation - As required
6. GPI - PP RST or STANDBY
7. Latitude and Longitude - Set
8. GPI - RUN

NOTE

- Steps 5, 6 and 7 may be accomplished prior to exit.
- Sequence of steps may be varied to best suit mission requirements.

DESCENT AND BEFORE LANDING

1. Latitude and Longitude - Corrected

2. GPI Variation - As required

3. Review Penetration and Approach - Accomplished (P, CP, N)

   Prior to starting penetration or letdown, the pilot will ensure that the copilot and navigator are informed as to the specific terminal chart and type of approach to be used. The pilot will review the approach with the copilot and navigator with particular emphasis on any intermediate altitude restrictions, minimum altitude and minimum visibility for the type of approach and missed approach. Subsequent approaches, if applicable, will be reviewed prior to accomplishing the approach.

4. Command Radio - Monitor

   The navigator will monitor COMMAND conversation at all times during the penetration and approach for changes in instructions to correlate radar approach information with airborne radar.

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

   Set altimeters to station pressure immediately prior to penetration or when passing transition altitude.

6. Descent Altitude Calls - Complete (N, P, CP)

   The navigator will report over interphone 2000 and 1000 feet prior to any assigned or published level-off altitude and alert the pilot approaching level-off. He need not interrupt radio transmissions for these calls but must ensure that the pilot is aware of the altitude restrictions. The navigator will alert the pilots approaching the applicable DH or MDA.

7. Search Radar Heading Select Control - Set

8. Safety Belt and Shoulder Harness - Fasten

NOTE

Sequence of items may be varied to best suit mission requirements.

AIRBORNE RADAR DIRECTED/MONITORED PENETRATION AND APPROACH

The navigator may practice, within restrictions set by directives, directing the penetration and approach using airborne search radar (AN/APN-59). The penetration and approach pattern will be established and directed by following a designated FLIP terminal pattern for the specific station.

Altitudes for an airborne radar directed penetration and approach will be those published in the FLIP terminal pattern for the penetration. Published minimums as contained in the FLIP Terminal Publication or 500 feet above field elevation, whichever is higher, will apply for the approach.

When the navigator is practicing an airborne radar directed penetration and approach, pilots will monitor all navigational aids (TACAN, VOR, ILS, ground radar, etc.) that may assist in cross-checking airplane position and altitude.

Penetration

The navigator will coordinate with the pilots in directing the airplane so as to arrive over the start penetration point at the specified altitude and on the desired heading for initiation of the descent. After the penetration is initiated, the navigator will call altitudes as directed in the DESCENT AND BEFORE LANDING CHECKLIST. Close attention must be paid to minimum and/or maximum crossing altitudes for the type of penetration being performed. The navigator will direct the descent, penetration, traffic pattern entry and final approach with search radar. Pilots will follow the navigators direction advisedly, breaking off the approach if the navigator directs the airplane toward a dangerous situation.

Approach

After directing the airplane to the start of the final approach, the navigator will set the etched cursor on the inbound magnetic course of the particular approach being performed. Using the drift angle indicator, direct the pilot to fly the magnetic heading that will make good the desired magnetic course.

Using the 3-30 range control, keep the airfield return on the outer two-thirds of the scope. At the desired distance from the runway, direct the pilots to descend to minimum descent altitude or 500 feet above field elevation, whichever is higher. Check that the course is correct and observe closely for changes in drift angle. Call off ranges to the pilots using the one mile range markers. Alert the pilots as minimums are approached.

The navigator will continue monitoring the search radar during the missed approach and advise the pilot of any hazard to flight.

NOTE

- Penetrations and approaches not directed by the navigator will be monitored utilizing the appropriate techniques and procedures required for Radar Directed Penetrations and Approaches.
- For multiple approaches, when radar monitoring is not productive, the navigator may be better utilized visually scanning for aircraft and other hazards. He must continue to monitor aircraft altitude, alert the pilots as minimums are approached, and be prepared to return to radar monitoring if the need arises.

AFTER LANDING

1. Mode 4 Code Switch - As required

NOTE

The mode 4 hold is good indefinitely. Aircraft power loss or IFF master switch OFF does not cause loss of the code. If the mode 4 hold switch has been activated, the code must be zeroized upon flight termination.

2. Mode 4 On/Out Switch - OUT
3. IFF Master Switch - OFF
4. GPI - OFF
5. Radar Silence Switch - SILENT
6. Search Radar - Turn off (CP, N)
   a. Gain Control - CCW
   b. Intensity Control - CCW
   c. Scan Switch - OFF
   d. Stab Switch - OFF (down)
   e. Function Switch - OFF

NOTE

Insure that pilot's indicator intensity control is turned full CCW before placing the function switch OFF.

7. Radar/Rendezvous Beacon - OFF, if not previously accomplished
8. Liaison Radio Control Switch - OFF
9. Radio Altimeter Receiver Gain Knob - OFF
10. Oxygen System
    a. Oxygen Supply Shutoff Lever - OFF
    b. Diluter Lever - 100% OXYGEN and bleed pressure
11. Auto-Nav System Power Switch - OFF, after airplane parked

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.

PREFLIGHT

Accomplish INTERIOR INSPECTION - POWER OFF, and INTERIOR INSPECTION - POWER ON as set forth in the normal checklist prior to airplane being placed on alert status.

COCKING

No items are required for the navigator.

SCRAMBLE

Complete normal STARTING ENGINES AND BEFORE TAXIING, TAXIING and BEFORE TAKEOFF checklists.

TAKEOFF AND CLIMB

Accomplish normal TAKEOFF and AFTER TAKEOFF-CLIMB checklists.

DAILY PREFLIGHT

The navigator will assist with the preflight as required.

UNCOCKING

1. Mode 4 Code Switch - Zeroized

NOTE

The mode 4 hold is good indefinitely. Aircraft power loss or IFF master switch OFF does not cause loss of the code. If the mode 4 hold switch has been activated, the code must be zeroized upon alert uncocking.

No additional items are required for the navigator.

TAXI BACK

Accomplish normal AFTER LANDING checklist.

NAVIGATOR'S POSTURE 3/4 AND POSTURE 5

COCKING (POSTURE 3/4 AND POSTURE 5)

If launch progression occurs, crew initiates STARTING ENGINES AND BEFORE TAXIING checklist and continues normal "Scramble" procedures. If STARTING ENGINES AND BEFORE TAXIING checklist has been completed, accomplish the following checklist to assume posture 3/4 and posture 5.

1. Radio Altimeter Receiver Gain Control - OFF
2. Liaison Radio Control Switch - OFF
3. Search Radar - Turn off (N, CP)
   a. Gain Control - Rotate CCW
   b. Intensity Control - Rotate CCW
   c. Scan Switch - OFF
   d. Stab Switch - OFF (down)
   e. Function Switch - OFF

NOTE

Insure that pilot's indicator intensity control is turned full CCW before placing the function switch OFF.

4. GPI - OFF
5. Auto Nav System Power Switch - OFF, after airplane parked

SCRAMBLE (POSTURE 5)

This checklist will be used only when launch is required subsequent to accomplishment of the COCKING checklist.

1. Airplane Electrical Power - Check

   Ascertain that a generator is on the line.

2. Search Radar Function Switch - STDBY
3. Auto-Nav System Power Switch - ON
4. GPI - ON or STDBY
5. Radar/Rendezvous Beacon - As required
6. Liaison Radio Control Switch - ON
7. Radio Altimeter - ON and set
8. N-1 Compass Annunciator - Synchronized
9. Search Radar - Turn on
   a. Function Switch - SEARCH
   b. Intensity Control - Rotate CW for faint trace
   c. Scan Switch - As desired
   d. Gain and Tilt Controls - Set for optimum picture
   e. Stab Switch - STAB (up)
10. Safety Belt and Shoulder Harness - Fastened

During takeoff, perform normal TAKEOFF checklist.

NOTE

The navigator's normal procedures also appear in T.O. 1C-135(K)A-1CL-2 which is an abbreviated checklist. The abbreviated checklist has each numbered step of the normal, alert, and emergency procedures in shortened form.

NAVIGATOR'S EMERGENCY PROCEDURES

Refer to NAVIGATOR'S EMERGENCY PROCEDURES in Section III.

JUMPMASTER

The boom operator will act as the jumpmaster. In his absence, or if his duties require otherwise, the navigator will assume this duty. The jumpmaster will be responsible for the preparation and execution of bailout procedures as dictated by the inflight emergency, and will be on interphone during bailout alert. Prior to bailing out, the jumpmaster will notify the pilot and copilot that all other occupants have departed and that he is leaving the airplane. The jumpmaster will normally be designated to conduct the passenger briefing covered in this section.

BOOM OPERATOR

The boom operator will be familiar with the mission/sortie requirements. He will provide weight and balance data, as required, and will be responsible for the safe operation of the air refueling equipment as pertains to his duties. He must be thoroughly familiar with emergency procedures as they pertain to his duties.

MISSION PLANNING

A. Complete Form 365F, using airplane basic weight and index, fuel loading as specified in this manual on T.O. 1C-135(K)A-2-2, and cargo and passenger data. Refer to T.O. 1-1B-40, T.O. 1-1B-50, and this manual for weight and balance information. (See figure 8-4 for sample Form 365F).

B. Obtain receiver call sign(s), receiver type, type of refueling (boom/drogue), fuel off-load, and refueling control time.

INTERIOR INSPECTION

The Thru-Flight Checklist is integrated into the boom operator's normal checklist. Thru-flight items to be accomplished are preceded by an asterisk (*). When a different crew is to be utilized for the succeeding flight, the present crew will brief them on the status of the airplane.

* 1. Equipment - Stow

Stow all professional, personal, and survival equipment aboard the airplane.

NOTE

Equipment that could obstruct the main AC power panel will not be placed on the floor behind the boom operator's seat.

* 2. Ground Safety Locks - Stow

* 3. Crew Assembly - Complete (P, BO)

Report to pilot, "Six ground safety locks stowed." Brief location of spare parachute(s). Extra crewmembers will be briefed commensurate with their experience on safety procedures and responsibilities.

* 4. Boom Operator's Forward Station:

a. Interphone - Connect

Check selector switch to INTER and the NORMAL-AUX LISTEN switch to NORMAL.

b. Oxygen System - Check

Check oxygen equipment as outlined in Section IV.

* 5. Crew Report - Complete (BO, N, CP, P)

When copilot announces, "Crew report," switch to CALL and report, "Boom operator's interphone and oxygen checked." Headset may be worn after this point.

Cargo Compartment

1. Cargo Compartment A/C Master Switch - OFF

2. Passenger Stations Oxygen Panels - OFF, 100% OXYGEN

* 3. Overwing Emergency Exit Hatches - Check

With the hatch properly placed in the hatch opening, check latching mechanism for proper latching and unlatching operation. After check is performed, hatches may be left open until MISCELLANEOUS DUTIES Checklist is completed.

4. Emergency Interphone Panel - Check operation

* 5. Aft Emergency Exit Hatch - Check

With the hatch properly placed in the hatch opening, check latching mechanism for proper latching and unlatching operation. After check is performed, hatch may be left open until MISCELLANEOUS DUTIES Checklist is completed.

6. Aft Compartment Interphone Panel - Check operation

Boom Operator's Compartment

1. Boom Operator's Compartment Air Outlet Doors - As desired

   Check emergency defrost slide closed.

2. Sighting Door Lever - Open

3. Boom Operator's Interphone Panel - Check operation

* 4. Oxygen Regulator - Check

   Check oxygen pressure, regulator OFF, 100% and bleed to zero.

* 5. IBO Oxygen Regulator - OFF, 100%

6. Emergency Override Switch - NORMAL

* 7. A/R Master Switch - ON

   The master switch will remain ON throughout the flight and until the airplane is parked.

* 8. Boom - Fully retracted

   Manually retract boom and check that telescope indicator reads zero.

9. Signal Coil - Test (if applicable)

10. Underbody and Underwing Lights - ON

11. Sighting Door Compartment - Check

    Visually check general condition of the sighting door compartment.

CAUTION

If the sighting door has failed to open, leave the sighting door lever in the OPEN position and notify maintenance. Placing the lever in the CLOSE position could result in damage to equipment.

12. Sighting Door Lever - CLOSE

WARNING

Insure the sighting door compartment area is clear, prior to closing the door.

13. Boom Compartment - Check

    Check applicable switches OFF, circuit breakers closed, and controls as required.

MISCELLANEOUS DUTIES

1. Navigator's Sighting Stool - Install

WARNING

Failure to insure that stool is properly locked in position, or failure to utilize the stool when checking the sextant could result in serious injury.

2. Periscopic Sextant and Mount - Check

NOTE

On passenger/cargo missions, it may be necessary for the navigator to accomplish this check. Steps may be accomplished in varying sequence or in conjunction, as appropriate.

a. Sextant Desiccant - Check

   The desiccator crystals should be replaced when the crystals are pink.

b. Sextant - Install

   Insert sextant in the mount, connect electrical cable and turn illumination switch ON.

c. Averager Check - Complete

   (1) Depress winding lever, the half-time and averager indicators should align.

   (2) Rotate altitude knob slowly, ascertain that knob turns freely and altitude counters follow its movement. Rotation of the altitude knob should not cause averager indices to move more than twice the width of the index line.

   (3) Depress the averager actuating lever and time the averager through its full time period, at which time the shutter should fall.

d. Alignment - Check

Set azimuth counter to 0 degrees, collimate on the center line of the vertical stabilizer, 180 degrees should be read under the crosshair. Small errors may be removed by adjustment of the projection lens.

NOTE

On some airplanes, it is possible to mistakenly align the sextant on an antenna rather than the vertical stabilizer. Insure that sufficient light is available to positively identify the vertical stabilizer before attempting to perform the alignment. (Up to 4° azimuth error can result if aligned on an antenna.)

3. Sextant and Navigator's Sighting Stool - Remove and stow

NOTE

Rotate bubble adjustment knob to the full increase position and depress the averager actuating lever when stowing sextant.

* 4. Form 365F - Check

Cross-check planned basic weight and index against the last entry of Chart C of T.O. 1-1B-40. Compare planned against actual fuel distribution and quantity, and other airplane loading. Make required corrections and inform pilot of the actual takeoff weight and percent of MAC.

* 5. Cargo and Loose Equipment - Secure

Cargo and loose equipment will be secured in accordance with T.O. 1C-135(K)A-9. Securing the flight crew's equipment may be delayed until the ladder is stowed.

6. Cargo Compartment and Boom Pod Thermal Radiation Curtains and Eye Protective Devices - Checked and installed, sealed (if applicable)

Refer to ALERT PROCEDURES, Section II.

* 7. Cargo Door - Close and lock

Using procedures outlined in Section IV of this manual, check for proper closing and locking of the cargo door.

* 8. Passengers - Brief (as applicable)

Accomplish PASSENGER BRIEFING Checklist.

STARTING ENGINES AND BEFORE TAXIING

1. Water Heater Power Panel - All switches OFF
2. APU - Start (if applicable)
3. Water Temperature - Check (if applicable)

   When ambient temperature is between 20°F (-6.7°C) and 40°F (4.4°C), note water temperature and inform pilot prior to takeoff.

4. Entrance Ladder - Remove

NOTE

In the event the ground crew is not available to assist in closing the door or on a scramble, the boom operator must close outer door latch handle cover, release and stow the door support structure before removing the ladder.

5. Entry Door - Close and latch

   Check indicating rod extended, pressure plate closed and door warning light extinguished.

6. Entrance Ladder - Stow

   Secure flight crew equipment and ground interphone cord if not previously accomplished.

7. Emergency Exit Hatches - Check security

   Insure that the latch pin and striker plate are properly engaged, that the lock handle roller is engaged in the actuator arm, check over center lock mechanism, and pivot hook and pivot stop for proper engagement.

8. APU - Check

   If APU is to be shut down, accomplish STOPPING APU Checklist. If previously shut down, open battery charging circuit breakers on the APU.

9. Passengers - Check ready for takeoff (if applicable)
10. Cargo Door - Check closed and locked

    Visually check that the four latch handles and the eight latch cams are in the locked position.

11. STA 1180 POWER OUTLET Circuit Breakers - Open (as applicable)

    AiResearch: Open the three circuit breakers marked STA 1180 POWER OUTLET on the GENERATOR NO. 2 section of the MCBP.

12. Taxi Report - Complete (BO, N, CP, P)

    Copilot will ring the alarm bell and announce "Taxi report." Report "Boom operator, alarm bell checked, ready to taxi." Coordinate with the navigator if still performing checklist, the navigator will then report for the boom operator.

13. Electrical Control Panel - Monitor

    Boom operator will monitor the electrical control panel during taxi and takeoff.

BEFORE TAKEOFF

1. Boom Operator's Compartment Window Heat Switch - ON

2. APU Inlet and Exhaust Valves (3) - Closed

   To insure that the valves are closing properly, actuate the valve handles and check for a positive spring action, then place the handles in the closed position.

WARNING

Failure to completely close the cabin air inlet valve before takeoff can result in reverse rotation, overspeed, and subsequent disintegration of the APU cabin air fan, endangering personnel in the area of the APU.

If APU was not previously shut down, accomplish the STOPPING APU checklist.

3. Flow Divider Valve - NORMAL

4. Fuel Distribution - Check

   Check fuel distribution for any unscheduled changes in fuel tank readings from actual fuel loading previously recorded. Report any changes to the pilot.

5. Chinning Bar Pin - Remove and stow (if applicable)

   The chinning bar pin will be removed on all flights where bailout is possible and stowed in the end of crew entry door crank handle opening. On passenger carrying flights, when parachutes are not available, the chinning bar pin will not be removed.

6. Circuit Breakers - Check

   Check the SBCBP, CIPP, MCBP (including STA 1180 POWER OUTLET CB's opened, if applicable), main AC power panel, and battery CB panel to insure that all circuit breakers are set.

7. Oxygen - ON and 100%

8. Safety Belt and Shoulder Harness - Fasten and lock

9. Takeoff Report - Complete (BO, N, CP, P)

   Boom operator reports, "Boom operator ready for takeoff."

AFTER TAKEOFF-CLIMB

NOTE

If a generator light illuminates prior to S_1, notify pilot by announcing, "Generator light." After flaps up, report any malfunctions such as generator light, circuit breakers, etc, that occurred after S_1.

1. Wheel Well Lights - OFF

2. Sextant - Install (if applicable)

   If additional height is needed to install the sextant, the navigator's sighting stool will be properly installed and utilized.

3. Cargo Compartment A/C Master Switch - ON; Temperature Control - AUTOMATIC (set to desired temperature)

4. Cargo Compartment - Check

   Check cargo compartment for fuel fumes and general condition. Check APU inlet and exhaust valves closed.

5. Boom - Check (drogue installed)

   Check that boom is fully retracted (possibility that boom will extend when towing the drogue adapter).

6. Nacelle Illumination Lights - ON (if applicable)

   Turn lights on for night flights.

7. Boom Nozzle Light - ON (night A/R operations)

   Turn boom nozzle light on low just after takeoff gradually increasing brilliance at time of use. After transfer is complete, leave nozzle light on low until after landing.

8. Boom Marker Lights - ON (if applicable)

9. Inform Pilot - "Walkaround complete"

DESCENT AND BEFORE LANDING

NOTE

This checklist must be accomplished for each penetration.

1. Landing CG - Compute prior to descent, report to pilot (P, BO)

NOTE

- In addition, compute a CG using basic airplane weight plus final landing fuel. If an undesirable CG results, notify pilot immediately and notify applicable ground personnel after landing as to actions required prior to offloading the airplane.
- Sequence of the following items may be varied but all items must be accomplished prior to the first approach.

2. Navigator's Stool and Sextant - Remove and stow, (if not previously accomplished)

Rotate bubble adjustment knob to the full increase position and depress the averager actuating lever when stowing the sextant.

3. Circuit Breakers - Check

   Check the SBCBP, CIPP, MCBP, main AC power panel and battery CB panel to insure that all circuit breakers are set.

4. Cargo Compartment Temperature - As desired

5. Passengers and Extra Crewmembers - Notify to prepare for landing (if applicable)

6. Boom - Check boom latched

   a. Sighting Door - OPEN

   b. Elevation Gage - +12.5 degrees

   c. Azimuth Gage - 0 degrees

   d. Boom Latching Lever - LATCHED detent

   e. Boom Hoist Lever - LOWER

      Hold in LOWER position for a minimum of 10 seconds. Watch for any movement of the boom or elevation gage.

   f. Boom Hoist Lever - HOLD

   g. Sighting Door - CLOSE

7. Safety Belt and Shoulder Harness - Fasten and lock

8. Inform Pilot - "Descent and Before Landing Checklist complete"

TOUCH AND GO LANDING

1. Circuit Breakers - Set

   Check circuit breakers on MCBP and SBCBP when airplane turns downwind.

2. Electrical Control Panel - Monitor

AFTER LANDING

1. Oxygen - OFF and 100%

2. Chinning Bar Pin - Install (if applicable)

3. Nose Gear Ground Downlock and Release Handle - LOCK

4. Cargo Compartment A/C Master Switch - OFF

POSTFLIGHT (accomplish after parking)

1. Interphone Selector Switch (BO Forward Station) - INTER

2. Entry Door - Open

3. Entrance Ladder - Install

4. Boom Compartment - All switches OFF

5. Form 781 - Complete

   Enter all applicable discrepancies in Form 781.

APU

During preflight if the APU is to be used for power and the alarm bell rings, the boom operator will start the APU using the following checklist.

Starting APU

1. Inlet and Exhaust Valves (3) - OPEN

2. Circuit Breakers - Set

3. Master/Power Switch - ON

4. AiResearch Primer Switch - ON

5. Start/Stop Switch - START (momentarily)

6. Tachometer - Check

   AiResearch - 100 plus or minus 0.5%
   Solar - 102 plus or minus 0.5%

7. AiResearch Primer Switch - OFF

8. AC Power Control/Generator Switch - RESET

   AiResearch - Momentarily then ON
   Solar - Hold until generator voltmeter reaches approximately 200 VAC then ON

Heating the Living Quarters

1. Cargo Compartment A/C Master Switch - OFF
2. Air Conditioning Master Switch (Control Cabin) - OFF
3. Flow Divider Valve - APU
4. Boom Operator's Compartment Air Outlet Doors - Close

   Close emergency defrost slide prior to closing doors.
5. All Diffusers Aft of the Sound Curtain - As desired
6. Cabin Air/Blower Switch - ON
7. APU Temperature Control - As desired

Stopping APU

After an airplane generator is on the line, the APU may be shut down or, if necessary, left running for heating purposes, but will be shut down prior to takeoff.

1. Cabin Air/Blower Switch - OFF
2. AC Power Control/Generator Switch - OFF
3. Start/Stop Switch - STOP (momentarily)
4. Master/Power Switch - OFF
5. Inlet and Exhaust Valves (3) - CLOSED

   Close exhaust duct, cabin air inlet, and compressor inlet valves when tachometer reads zero; however, during an alert the valves may be closed immediately if necessary. To insure that the valves are closing properly, actuate the valve handles and check for a positive spring action, then place handles in the closed position.

WARNING

Failure to completely close the cabin air inlet valve before takeoff can result in reverse rotation, overspeed, and subsequent disintegration of the APU cabin air fan, endangering personnel in the area of the APU.

6. APU Circuit Breakers - Open (if applicable)

   Open the battery charging circuit breakers on the APU.

PASSENGER BRIEFING

Briefing will be completed prior to engine start if conducted inside the airplane.

1. Flight Information

   Brief destination, altitude, and time enroute.
2. Life Support Equipment (as applicable)

   Brief location and proper use of

   a. Oxygen equipment

   b. Overwater equipment

   c. Parachutes and spares
3. Alarm Bell Signals (as applicable)

   Brief alarm bell signals and preparation required by passengers for

   a. Ground

   b. Inflight/bailout

   c. Inflight/crash landing or ditching

   d. Immediately after takeoff
4. Emergency Exits (as applicable)

   Brief location, how to open, egress technique, and escape ropes

   a. Ground emergencies

   b. Inflight emergencies

NOTE

Passengers occupying seats near an egress exit will be individually briefed as to the exit opening and survival equipment operation.

5. Passenger Information Cards

   Brief information not previously covered and location of passenger information cards in the airplane. Instruct each passenger to review the card prior to takeoff.
6. Flashlight (if applicable)

   Insure a flashlight is available in passenger compartment for night flights.

7. Interphone

   Designated individual to be on interphone in passenger compartment.

8. Relief Facilities

   Explain location

9. Ear Plugs

   Brief that disposable ear plugs are available for those desiring to use them.

BOOM OPERATOR'S ALERT PROCEDURES

For the scope of the alert procedure, refer to Section II.

PREFLIGHT

The alert preflight is integrated into the normal checklist. The boom operator performs his preflight up to STARTING ENGINES AND BEFORE TAXIING checklist. When an alert signal is sounded, the boom operator begins with the STARTING ENGINES AND BEFORE TAXIING checklist. Should the airplane require maintenance during the time it is in the "cocked" configuration, it will be "uncocked" prior to maintenance being performed. Upon completion of maintenance, it will be returned to the "cocked" configuration by accomplishing the normal preflight checklists.

DAILY PREFLIGHT

1. Water Heater Switches - OFF (before applying power)

2. APU - START (if applicable)

3. Gaseous Oxygen Pressure - Check

4. Preflight - Assist as required

5. APU - STOP (if applicable) (BO, CP)

   Insure that CP has tripped external power switch prior to placing the AC Power Control Switch (Airesearch) or the Generator Switch (Solar) to the OFF position.

6. Battery Charge Circuit Breakers - Open (prior to departing the airplane)

   AiResearch - Open the BATTERY CHARGE circuit breakers on the APU, and the three circuit breakers marked STA 1180 POWER OUTLET on the MCBP.

   Solar - Open both (the 5 amp and 25 amp) circuit breakers marked BATTERY CHARGER on the APU.

7. Entry Door Light - OFF

UNCOCKING

1. Nose Gear Ground Down Lock and Release Handle - Lock

If airplane is to be "uncocked" for maintenance after taxiing back to parking area, the normal AFTER LANDING checklist will be accomplished in normal sequence, instead of the TAXI BACK checklist.

TAXI BACK

1. Oxygen Levers - OFF and 100% OXYGEN

2. Chinning Bar Pin - Install

3. APU - START (if applicable)

4. BO Window Heat Switch - OFF

5. APU - STOP (after igniters checked)

6. Water Heater Switches - ON (if applicable)

7. Entry Door Light - OFF

BOOM OPERATOR'S POSTURE 3/4 AND POSTURE 5

COCKING (POSTURE 3/4 AND POSTURE 5)

1. APU - START (prior to engine shutdown)

2. Water Heater Power Panel - Water heater switches ON (if applicable) (CP, BO)

   All checklists through the BEFORE TAKEOFF checklist must have been completed prior to starting the Posture 5 checklists.

3. Oxygen Regulator - OFF, 100%

4. No. 4 (No. 1, 3, and 4 with 1510/920) Engine Starter Circuit Breaker(s) - Open, Close (P, CP, BO)

   The No. 4 (No. 1, 3, and 4 with 1510/920) starter circuit breakers will be opened prior to cartridge insertion. The circuit breaker(s) will be closed after cartridge insertion is complete.

5. No. 2 (with 1510/920) Engine Starter Circuit Breaker - Open, Close (P, BO)

   The No. 2 starter circuit breaker will be opened prior to cartridge insertion. The circuit breaker will be closed after cartridge insertion is complete.

SCRAMBLE (Posture 5)

1. Water Heater Power Panel - Water heater switches OFF (if applicable)
2. APU - OFF (after one generator is on the line)
3. APU Inlet and Exhaust Valves (3) - Closed

   Close cabin air inlet, compressor inlet, and turbine exhaust valves.
4. Flow Divider Valve - NORMAL

NOTE

The boom operator's normal procedures appear in T.O. 1C-135(K)A-1CL-3 which is an abbreviated checklist. The abbreviated checklist has each numbered step of the normal, alert, and emergency procedures in shortened form.

BOOM OPERATOR'S EMERGENCY PROCEDURES

Refer to BOOM OPERATOR'S EMERGENCY PROCEDURES in Section III.

GROUND CREW

GROUND CREW CHECKLIST

NOTE

The abbreviated ground crew checklist is contained in T.O. 1C-135(K)A-1CL-4.

1. When the airplane is moved into the alert line, the ground crew accomplishes the ALERT LINE PREPARATION checklist.
2. After the airplane is cocked, the ground crew will clean up the alert parking area in the vicinity of the airplane.
3. When the execution order to scramble is received, the ground crew will accomplish the GROUND CREW SCRAMBLE checklist without delay.
4. When practice alerts are terminated the ALERT LINE PREPARATION checklist will be completed in conjunction with the flight crew recocking the airplane.

ALERT LINE PREPARATION

1. Airplane - Position in designated parking position
2. Wheel Chocks - Position
3. Static Ground Wire - Install
4. AGE - Position (if applicable)
5. AGE Fuel and Oil - Check (if applicable)
6. Fire Extinguishers - Position
7. Interphone Cord and Headset - Connect
8. Cold Weather Operation - Position ground heaters as required
9. Engine Inlet and Tailcone Plugs - Install (if necessary)
10. Pitot Covers - Install
11. Ram Air Inlet Plug - Install (if necessary)
12. Unnecessary Stands and Equipment - Remove and secure

GROUND CREW SCRAMBLE

NOTE

This checklist will be accomplished by the ground crewmember when the order to scramble is given.

1. **PITOT COVERS—REMOVED**
2. **RAM AIR INLET PLUG AND GROUND WIRE—REMOVED**
3. **ENGINE INLET AND TAILCONE PLUGS FROM ENGINES 1, 2, 3, 4—REMOVED**
4. **GROUND HEATERS AND DUCTING—DISCONNECTED AND REMOVED**
5. **ENGINES—CLEARED**

   Report to pilot "Chocks in place, engines clear, fire guards standing by."
6. **EXTERNAL POWER, CHOCKS AND INTERPHONE—REMOVED WHEN DIRECTED**

   Report to pilot - "Overwing and aft hatches checked closed; ground wires, chocks, pitot covers, and external power removed; disconnecting interphone cord and (if applicable) coming aboard."
7. **CREW ENTRY DOOR—CLOSED**
8. Practice Alert Terminated - Accomplish ALERT LINE PREPARATION checklist (if applicable)

RULES TO BE ENFORCED

USE OF OXYGEN AND PRESSURIZATION

A. Oxygen masks will be carried by crew members on all flights regardless of altitude or duration of flight.

B. The copilot will initiate oxygen checks at appropriate time intervals when cabin altitudes are as shown in the table below:

10,000 to 25,000 feet - every 15 minutes
25,000 feet and above - every 5 minutes

When copilot calls for an oxygen check, the crew member will note normal oxygen pressure, flow indicators operating and regulator diluter lever in proper position.

NOTE

Above 25,000 feet cabin altitude, crew members will make continuous visual checks of personnel in their compartment to augment the above checks by the copilot.

C. The following general rules will apply:

(1) Copilot will make periodic checks of the oxygen quantity whenever airplane altitude is above 25,000 feet.

(2) Passengers normally will not be carried during training flights.

(3) The general rules on use of helmets and oxygen masks as prescribed by current directives will apply. Crew members will notify pilot when going ON or OFF oxygen.

USE OF INTERPHONE

A. All crew members will be on interphone during the following conditions:

(1) All ground operation (including engine starts) except when accomplishing crew duties that preclude use of interphone.

(2) During rendezvous and air refueling

(3) During flight under weather conditions

(4) Formation flying

(5) During all takeoffs and landings

B. Whenever personnel are occupying cargo compartment it will be necessary for a crew member or non-crew member (thoroughly briefed) to be on interphone at all times during flight.

C. All crew members will inform pilot when checking off and/or on interphone.

INTERPHONE PROCEDURES

Effective use of the interphone by each crewmember is essential for good crew coordination. Its use will be held to the minimum required for safe and effective conduct of the mission. When establishing contact, the crew position being called will be identified in the initial call to avoid confusion or the possibility of the call being missed. Unless an immediate call is mandatory, crewmembers will insure that other crewmembers are not transmitting or receiving on either the interphone or the command sets. Normally coordinated checklist items will be accomplished by use of interphone unless its use will interfere with other activities; however, during the accomplishment of certain checklist items, pilots can effectively communicate across the cockpit without using interphone. Interphone will be used by the pilots at any time coordinated actions are required with other crewmembers and when requesting initiation of/announcing completion of all checklists.

FLOOR HATCH PRECAUTIONS

During flight the emergency gear and flap access covers and receptacle areas should be kept clear and the covers closed. Both of the entry panels for covering the boom operator's compartment should be open and properly stowed, except on a passenger flight during which time they should be installed.

USE OF CIRCUIT BREAKERS

A. With properly operating equipment, circuit breakers will not be opened or used as a switch.

B. If a circuit breaker pops three times, do not attempt any further use of the affected equipment.

JET MISSION FLIGHT PLANNING

SAMPLE MISSION CALCULATION FORMS

Forms 200 and 365F are used for mission planning. Samples of these forms with applicable instructions

and explanations for the completion of the forms are presented in this Section (figures 8-1, 8-2, 8-3, and 8-4).

NOTE

The entries left blank on sample Forms 200 and 365F were intentional and need not be filled in. They may be used at the individual's discretion.

USE OF FORM 200

Form 200 is folded for planning so that the sheet with the fuel flight plan (pilot's copy) is on the bottom. Carbon paper is used by the navigator to duplicate the columns from the left of the form to the ETA column on the right. The pilot can use the information from the finished flight plan to complete the flight progress chart (figure 8-3).

Four categories of flights are considered to exist and the following specific procedures shall apply to each. If a particular sortie cannot be clearly categorized, the procedures to be used shall be determined prior to flight and shall include any necessary combination of procedures directed below:

A. Category I - Local area pilot training such as transition, instruments, etc. No inflight fuel record is required, but pilots shall monitor fuel remaining to insure adequate termination reserve as affected by weather or runway conditions. If this type of mission is combined with any other category, fuel recording shall be accomplished as specified for the non-transition portion.

B. Category II - Routine navigation and air refueling missions. Either the predicted fuel remaining column of the mission flight plan or the flight progress chart may be used. Fuel remaining shall be checked and recorded over planned geographic positions representing approximately one hour of planned cruise. Fuel in tanks from which offload is planned shall be recorded just prior to and after air refueling. The difference shall be computed to check totalizer accuracy and insure proper receiver onload. In addition, total fuel remaining shall be recorded at the end air refueling point.

C. Category III - Extended flights over water or over desolate areas. The flight progress chart should be used. Fuel remaining shall be flight planned to correspond to each position reporting point or positions representing approximately one hour of cruise. Inflight readings shall be recorded and checked at these geographic points.

D. Category IV - Multiple refuelings. In addition to log entries required by Category II and III mission, fuel remaining shall be computed for each end air refueling point, and inflight fuel readings shall be recorded at these geographic positions.

Mission Flight Plan-Form 200 (Pilot's Copy)

NOTE

On special missions where master preflight plans are available, individual crews need not reaccomplish this form.

PREDICTED FUEL REMAINING. First entry in this column will be total fuel on board as shown on the Form 365F.

Item A. SETTOAC. Start engine and taxi fuel is normally a standard planning factor. 2000 pounds of fuel was used in this case. Takeoff Fuel Allowance was determined from the Takeoff Fuel Allowance chart in Part 2 of the Appendix T.O. 1C-135(K)A-1-1.

Item B. CLIMB. Information is taken from the NRT or MRT Climb charts in Part 4 of the Appendix, T.O. 1C-135(K)A-1-1. For the sample, an MRT climb with a +10° temperature deviation was computed. Local instrument departures with a number of turns and low altitude level-off points can cause a considerable increase in climb fuel and may be planned for through the use of experience factors.

Item C. CRUISE. The fuel used during a cruise leg is found by entering the appropriate chart in Part 5 of the Appendix, T.O. 1C-135(K)A-1-1. During cruise, a fuel remaining entry is needed at approximately one hour intervals or prior to mission profile changes (such as air refueling, changes in mission altitude, etc.) to allow for a continuous cross check of fuel consumption during flight. When the drogue is installed, fuel consumption is increased by 3%.

Item D. ORBIT. The amount of fuel used during orbit is found by using figure 1A7-3, T.O. 1C-135(K)A-1-1. Sufficient fuel should be on board to allow for 15 minutes additional orbit time to accommodate late receivers.

Item E. REFUELING. Fuel consumption during air refueling is found by entering the applicable charts in Part 5 of the Appendix, T.O. 1C-135(K)A-1-1. An additional 25 pounds of fuel for each minute the boom is down can be used as a standard planning factor.

Item F. AIRWORK, PENETRATION AND LANDINGS. The fuel used during this portion of a mission will vary greatly depending upon the maneuvers performed and the altitude at which they were accomplished. Accurate fuel predictions can be made if pilots will make a breakdown of maneuvers to be performed as to altitude, gross weight and thrust required. For example, one hour of instrument prac-

tice at FL 250 can be computed by using the range charts in Part 5 or the endurance charts in Part 6 of the Appendix, T.O. 1C-135(K)A-1-1. Multiple departures can be computed from Part 5 of the Appendix, T. O. 1C-135(K)A-1-1. Low approaches and go-arounds or touch and go landings require fuel at an approximate rate of 10% of the airplane gross weight, e.g., airplane gross weight - 150,000 pounds, fuel consumption - 15,000 pph.

GROSS WEIGHT - The initial entry in this column will be total airplane weight as shown on Form 365F. Succeeding entries will be made opposite each entry in the predicted fuel remaining column. When water is used for takeoff, 5.6 thousand pounds is added to the start, taxi and takeoff fuel to arrive at a start climb gross weight.

Flight Progress Chart -Form 200

NOTE

Use of this form is optional.

TAKEOFF DATA. Entries in the REMARKS column can be obtained from Form 365F and applicable parts of the Appendix, T.O. 1C-135(K)A-1-1.

FLIGHT PROGRESS. This portion of the form is used during the conduct of the mission except for the first entry under "PLAN." The fuel quantity for each tank, as shown on Form 365F, is entered here during the mission planning phase. For purposes of illustration only, both individual gage readings and totalizer readings have been entered on the sample. Totalizer entries may be used for all entries subsequent to the BSE (Before Starting Engines) readings if the totalizer is accurate. The totalizer may be used for fuel on board readings provided it indicates within ± 1% of the sum of the individual tank gage readings. If it does not, then fuel on board readings must be determined from the individual tank gages. Individual quantities should be recorded for all tanks from which the air refueling offload is to be obtained.

NOTE

The allowable instrument error in the totalizer gage is ± 1% of its full scale reading. For example, on those totalizer gages which have a full scale reading of 230,000 pounds, the instrument error can be ± 2300 pounds.

Periodic fuel readings with their accompanying flight conditions have been entered on the sample to show only one method of maintaining the log during the progress of the flight. Other kinds of entries may be desirable depending upon the type mission flown or information required.

Alternate Flight Progress Monitoring

If the pilot elects not to use the flight progress chart, the following method of monitoring fuel usage and flight progress may be used. During mission planning, the predicted fuel remaining column on the Form 200 (Pilot's copy) may be divided into two columns by drawing a vertical line. The planned fuel figures may be entered in the left column, leaving the right column for periodic inflight fuel totalizer readings, with time of reading reflected immediately above each reading. In this manner, a comparison of planned versus actual fuel remaining can be obtained. It is important, however, that the totalizer be accurate within ± 1.0% of the sum of the individual tank gage readings. Just prior to conducting air refueling, individual quantities should be recorded for all tanks from which the offload is to be obtained. Inflight log entries shall include notation of actual flight conditions which differ from flight plan entries.

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. Two copies are normally completed, one of which is retained by the clearing authority and the other carried on the mission by the flight crew. Normally the load adjuster will be used to complete the individual indexes and takeoff center of gravity; however, for training purposes or when load adjuster is not available the form may be completed using moments. There are two versions of this form, Transport and Tactical, designed for Transport and Tactical loading arrangements respectively. A sample of each form is presented in figure 8-4. Applicable instructions and explanations for the completion of the form are presented in the following paragraphs.

The Tactical version of the Form 365F will be used for all missions except when the space in reference 3, Distribution of Load, is insufficient to list all weights by compartment.

Planning Factors

The information presented is to be used as a guide in accomplishing Form 365F. The fuel readings have been rounded off to the nearest hundred for ease of reading and computing. This procedure may be used locally. For weights of various items consult local operating procedures. The E-1111 computer plate, applicable to full gross weight airplanes, was used to complete figure 8-4. The E-1096 computer plate is applicable to limited gross weight airplanes.

The following list of mission planning factors will be used for all missions, when actual weights are not available.

20 man life raft	-- 155 pounds each
1 man life raft	-- 20 pounds each
Life vest or R1 suit	-- 5 pounds each
Individual survival kit	-- 40 pounds each
Crew survival kit	-- 360 pounds each
Spare parachute	-- 30 pounds each
URC-4 radio	-- 6 pounds each
Passenger seats	-- 70 pounds pair
Air Refueling Drogue	-- 120 pounds each (Index change +0.6 installed)
Passenger	-- 200 pounds each
Crewmember with professional equipment	-- 250 pounds each
Water Injection Fluid	--5581 pounds

SAMPLE MISSION FLIGHT PLAN

MISSION FLIGHT PLAN | SQ: 69 AREFS | WING: 8 BW | CREW NO: S-101 | ACFT TYPE: KC-135A | ACFT SERIAL NO: 57-1461

PILOT (Name & Grade): DROVER, LT COL | CO-PILOT (Name & Grade): EAGER, CAPT | NAVIGATOR (Name & Grade): BRIGHT, CAPT | RADAR NAVIGATOR (Name & Grade): | EW OFFICER (Name & Grade): | ~~GUNNER (S)~~ BOOM OPR (Name & Grade): AUFLODER, MSG | DATE OF TAKEOFF: 10 JAN 73 | ENGINE START | TAKEOFF TIME | LANDING TIME | DURATION OF FLT

FROM / ROUTE	FLT COND	T.C.	W/V / DC	T.H.	VAR	M.H.	TEMP / ALT	IAS / MACH	TAS / T.W.C.	GS	GRD DIS / ACC. GRD DIS	TIME / ACC. TIME	AIR DIS / ACC. AIR DIS	ETA	ATA	REMARKS
BARKSDALE AFB / LA							DEV°				10	:03	10	0100		
SETTOAC							0° M				10	:03	10	0103		
TEXARKANA #2	↗		180/30				°		374		78	:12	75			
TXK	↗	302	-4	298	-7	291	° M		374	390	88	:15	85	0115		
LEVEL OFF	↗	316	✓ -3	313	-7	306	° M		374	395	33 / 121	:05 / :20	31 / 116	0120		
ARCP	→		270/50				-36°		420		129	:20	140			
TUL 204/51	→	316	-5	311	-8	303	26.0 M	.70		383	250	:40		0140		
		251	✓	253		245	°		397			:20		ARCT		
ORBIT		071	+2/-2	069	-8	061	° M	275				1:00		0200		
AR EXIT PT							°		372		200	:29	180			
ARG 282/74	↓	073	-2	071	-7	064	° M	255		418	450	1:29		0229		
OFFLOAD				10,000		#	° M									
GRID ENTRY-ST NAV	→	G148	270/50	146	-77		-50°		440		80	:10	74			
ARG 005/41	→	076	-2	074	-5	069	33.0 M	.755		490	530	1:39		0239		
			340/50				°				138	:17	125			
EVV 194/40		148	-1	147			° M				668	1:56		0256		
T.P.			✓				°				192	:24	176			
LOU 103/74		148	-1	147			° M				860	2:20		0320		
			✓				-54°				168	:26	191			
EVV 137/36		327	+1	328			35.0 M	.764		391	1028	2:46		0346		
END NAV LEG			✓				°				168	:26	191			
ARG 010/47		327	+1	328			° M			391	1196	3:12		0412		
GRID EXIT		G284	270/50	290	-77		°				82	:12	88			
LIT 017/64		212	+6	218	-5	213	° M			410	1278	3:24		0424		
			✓				°				205	:30	220			
SHV	↓	211	+6	217	-6	211	° M			410	1483	3:54		0454		
AIRWORK, PENETRATION,							°				*	2:06				
AND LANDINGS							° M					6:00		0700		
							° M									
							° M									

* This entry may be broken down into separate time elements for each type of activity at the convenience of the crew.

SAC FORM MAR 66 200 REPLACES PREVIOUS EDITION AND SAC FORMS 1, 1A & 201, WHICH ARE OBSOLETE.

Navigator's Copy

SAC STANDARD PRINTING CO., OMAHA, NEBRASKA PAGE 1 OF 4 PAGES

Figure 8-1 (Sheet 1 of 2)

MISSION FLIGHT PLAN

SQ	WING	CREW NO	ACFT TYPE	ACFT SERIAL NO
69 AREFS	8 BW	S-101	KC-135A	57-1461

PILOT (Name & Grade)	CO-PILOT (Name & Grade)	NAVIGATOR (Name & Grade)	RADAR NAVIGATOR (Name & Grade)	EW OFFICER (Name & Grade)	~~GUNNER~~ BOOM OPR (Name & Grade)	NOTES
DROVER, LT COL	EAGER, CAPT	BRIGHT, CAPT			AUFLODER, MSG	

FROM / ROUTE	FLT COND	T.C.	W/V DC	T.H.	VAR	M.H.	TEMP ALT	IAS MACH	TAS T.W.C.	GS	GRD DIS ACC. GRD DIS	TIME ACC. TIME	AIR DIS ACC. AIR DIS	ETA	FUEL FLIGHT PLAN: PREDICTED FUEL REMAINING	FUEL FLIGHT PLAN: GROSS WEIGHT
BARKSDALE AFB / LA							DEV				10	:03	10	0100	120.0	227.0
SETTOAC							0 M				10	:03	10	0103	3.6	3.6
TEXARKANA #2	↗		180/30						374		78	:12	75		116.4	223.4
TXK	↗	302	-4	298	-7	291				390	88	:15	85	0115	↓	↓
LEVEL OFF	↗	316	✓ -3	313	-7	306	↓ M		374	395	33 / 121	:05 / :20	31 / 116	0120	6.4 / 110.0	6.4 / 217.0
ARCP			270/50				-36		420		129	:20	140		4.1	4.1
TUL 204/51	→	316	-5	311	-8	303	26.0 M	.70		383	250	:40		0140	105.9	212.9
		251	✓	253		245			397			:20		ARCT	4.1	4.1
ORBIT		071	+2/-2	069	-8	061	M	275				1:00		0200	101.8	208.8
AR EXIT PT									372		200	:29	180		5.8	5.8
ARG 282/74	↓	073	-2	071	-7	064	↓ M	255		418	450	1:29		0229	96.0	203.0
OFFLOAD				10,000		#									10.0	10.0
															86.0	193.0
GRID ENTRY-ST NAV		6148	270/50	146	-77		-50		440		80	:10	74		↓	↓
ARG 005/41	→	076	-2	074	-5	069	33.0 M	.755		490	530	1:39		0239		
			340/50								138	:17	125			
EVV 194/40		148	-1	147			M				668	1:56		0256	↓	
T.P.			✓								192	:24	176		8.6	8.6
LOU 103/74		148	-1	147			↓ M	↓		↓	860	2:20		0320	77.4	184.4
			✓				-54				168	:26	191		4.2	4.2
EVV 137/36		327	+1	328			35.0 M	.764		391	1028	2:46		0346	73.2	180.2
END NAV LEG			✓								168	:26	191		4.1	4.1
ARG 010/47		327	+1	328			M			391	1196	3:12		0412	69.1	176.1
GRID EXIT		6284	270/50	290	-77						82	:12	88		1.9	1.9
LIT 017/64		212	+6	218	-5	213	M			410	1278	3:24		0424	67.2	174.2
			✓								205	:30	220		4.8	4.8
SHV	↓	211	+6	217	-6	211	↓ M	↓	↓	410	1483	3:54		0454	62.4	169.4
AIRWORK, PENETRATION, AND LANDINGS											*	2:06			30.9	30.9
												6:00		0700	31.5	138.5
							M									
							M									
							M								

SAMPLE FLIGHT PROGRESS CHART

FLIGHT PROGRESS

REMARKS (*Abnormal Readings, etc; Takeoff Data, if Other Than Planned, Will be Entered Here.*)

CONDITION	PLAN	BSE	BTO	L/O	CR 1	CR 2	BAR	EAR	B/OSC	RAMP				
TIME				1630	1714	1820	1910	1956	2100	2300				
ALTITUDE				310	310	330	300	300	310					
IAS				287	287	277	275	255	255					
OAT (Gage)				-27	-27	-28	-24	-27	-29					
MACH				.78	.78	.78	.73	.68	.685					
FUEL														
NO 1 RES	2.8	2.8		2.8	2.8		2.8	2.8	-					
NO 1	13.5	13.5		9.8	9.8		9.8	8.1	10.9					
NO 2	14.7	14.7		11.1	11.1		11.1	9.4	9.4					
FWD BODY	26.3	26.3		26.3	26.3		26.3	5.0	5.0					
CTR WG	39.0	39.0		39.0	29.4		16.4	14.4	3.4					
AFT BODY	39.6	39.6		39.6	39.6		28.7	-	-					
LI DECK	.3	.3		.3	.3		.3	-	-					
NO 3	14.7	14.7		11.0	11.0		11.0	9.4	9.4					
NO 4	13.5	13.5		9.8	9.8		9.8	8.1	10.9					
NO 4 RES	2.8	2.8		2.8	2.8		2.8	2.8	-					
TOTAL	167.2	167.2		152.5	142.9		119.0	60.0	49.0					
TOTALIZER		167.2	165.2	152.5	142.9	129.3	119.0	60.0	49.0	224				
CONDITION														
TIME														
ALTITUDE														
IAS														
OAT (Gage)														
MACH														
FUEL														
TOTAL														
TOTALIZER														

F-395

Figure 8-2

SAMPLE PILOT FLIGHT PROGRESS CHART

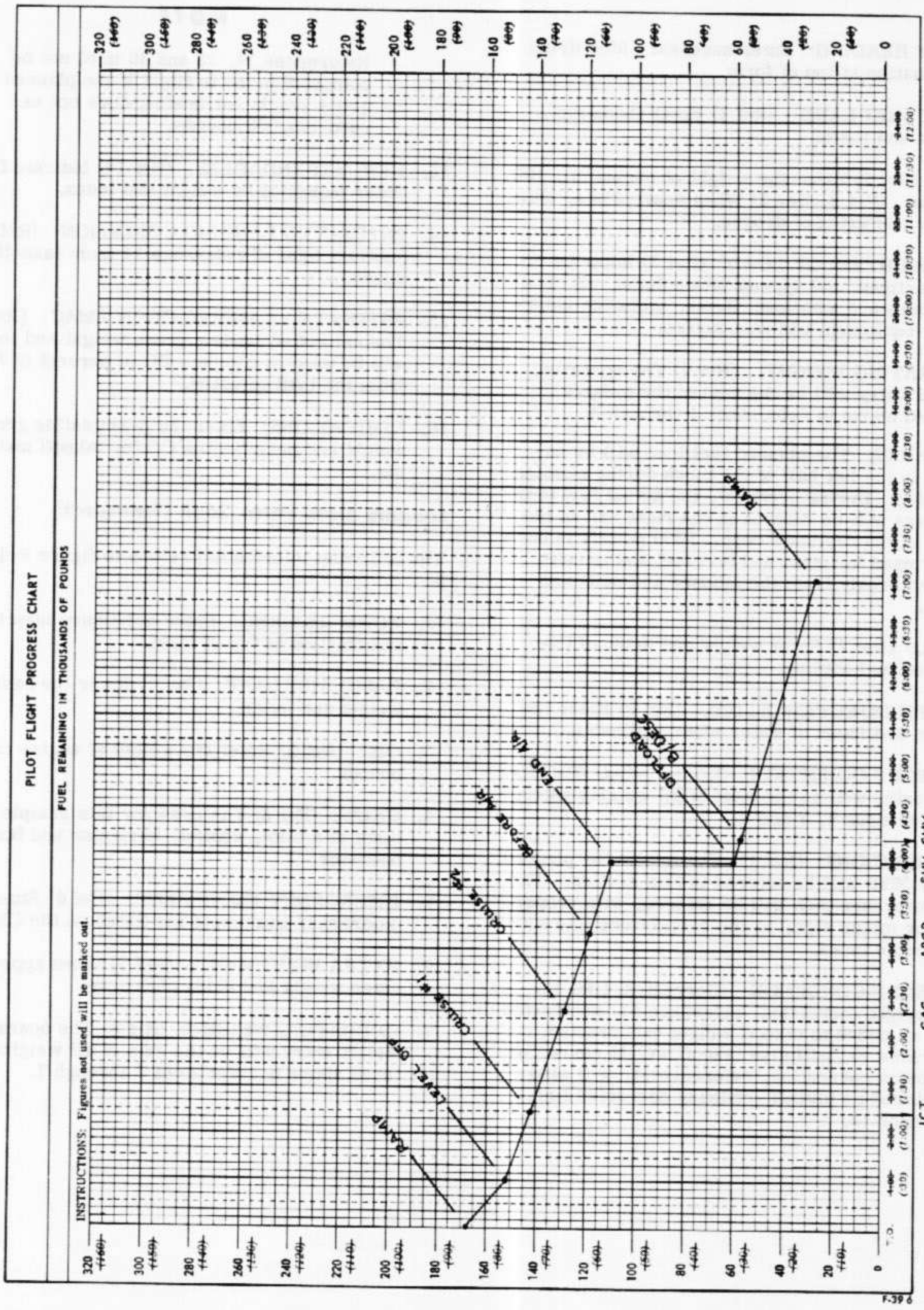


Figure 8-3

Loading Data Form 365F (Tactical)

The following information refers to figure 8-4, sheet 1.

1. FORM HEADING: Enter necessary identifying information at top of form.
2. BASIC AIRPLANE: (Ref 1) Enter the basic weight and index.
3. OIL: (Ref 2) Enter the weight of engine oil, 169 pounds. (Ref 2, line 2) When appropriate, enter weight and index of drogue.
4. DISTRIBUTION OF LOAD: (Ref 3) Enter by compartment and appropriate column, all crewmembers and additional items, including emergency equipment and passengers.
5. OPERATING WEIGHT. (Ref 4) The operating weight entry will be the sum of the weights entered above in references 1 through 3.
6. REMARKS: The planned fuel load will be entered in the left half of the block during mission planning. During preflight, the actual fuel tank readings will be entered in the right half of the block of the duplicate copy. 2000 pounds is normally used for start and taxi fuel and is subtracted evenly from the inboard and outboard tanks.
7. FUEL: (Ref 7) Enter weight and index of the planned fuel loading.
8. WATER INJECTION FLUID. (Ref 8) Enter the weight and index of water when applicable.
9. TAKEOFF CONDITION: (Uncorrected) (Ref 10) This entry will be the total of all weights entered in references 4, 7 and 8.
10. CORRECTIONS: (Ref 11) Changes to the planned Form 365F will be entered in this section. The net difference then will be entered, with proper plus or minus sign, on the corrections line with applicable index.
11. TAKEOFF CONDITION: (Corrected) (Ref 12) The weight correction, reference 11, subtracted from or added to takeoff weight uncorrected, reference 10, will give takeoff weight corrected. The index correction, reference 11, will also be entered on takeoff condition corrected line, reference 12.
12. TAKEOFF CG IN %MAC: (Ref 13) The takeoff gross weight and index will be used to compute cg in %MAC from the load adjuster.

NOTE

References 14, 15 and 16 need not be computed prior to flight if the planned gross weight for landing does not exceed 185,000 pounds.

13. LESS EXPENDABLES: (Ref 14) Indicate fuel and water expended by weight and index.
14. ESTIMATED LANDING CONDITION: (Ref 15) Subtract total of reference 14 from takeoff condition.
15. ESTIMATED LANDING CG IN %MAC: (Ref 16) The estimated landing gross weight and index will be used to compute CG in percent of MAC from the load adjuster.
16. LIMITATIONS: Enter the permissible gross weight and permissible CG for takeoff and landing.

Loading Data Form 365F (Transport)

The following information refers to figure 8-4, sheet 2.

1. FORM HEADING: Enter necessary identifying information at top of form.
2. BASIC AIRPLANE: (Ref 1) Enter the basic weight and index.
3. OIL: (Ref 2) Enter the weight of engine oil, 169 pounds.
4. CREW: (Ref 3) The crew for this sample consists of a pilot, copilot, navigator and boom operator.
5. EMERGENCY EQUIPMENT: (Ref 6) Enter all emergency equipment not listed on the Chart C.
6. EXTRA EQUIPMENT: (Ref 7) When appropriate, enter weight and index of drogue.
7. OPERATING WEIGHT: (Ref 8) The operating weight entry will be the sum of all weights entered above in references 1 through 7.

8. REMARKS: The planned fuel load will be entered in the left half of the block during mission planning. During preflight, the actual tank readings will be entered in the right half of the block of the duplicate copy. 2000 pounds is normally used for start and taxi fuel and is subtracted evenly from the inboard and outboard tanks.

9. TAKEOFF FUEL: (Ref 9) Enter weight and index of the planned fuel loading.

10. WATER INJECTION FLUID: (Ref 10) Enter the weight and index of water when applicable.

11. TOTAL AIRPLANE WEIGHT: (Ref 11) The total airplane weight will be the sum of all weights entered in references 1 through 10.

12. DISTRIBUTION OF ALLOWABLE LOAD: (Ref 12) Enter all passengers, cargo and additional items in appropriate column by compartment.

13. TAKEOFF CONDITION: (Uncorrected) (Ref 13) This entry will be the total of all weights entered in references 1 through 12.

14. CORRECTIONS: (Ref 14) Changes to the planned Form 365F will be entered in this section. The net difference then will be entered, with the proper plus or minus sign, on the corrections line with applicable index.

15. TAKEOFF CONDITION: (Corrected) (Ref 15) The weight correction, reference 14, subtracted from or added to takeoff weight uncorrected, reference 13, will give takeoff weight corrected. The index correction, reference 14, will also be entered on takeoff condition corrected line, reference 15.

16. TAKEOFF CG IN %MAC: (Ref 16) Takeoff gross weight and index will be used to compute cg in %MAC from the load adjuster.

NOTE

References 17, 18, 19 and 20 need not be computed prior to flight if the planned gross weight for landing does not exceed 185,000 pounds.

17. LESS FUEL: (Ref 17) Indicate fuel expended by weight and index.

18. MISCELLANEOUS VARIABLES: (Ref 19) Indicate water expended by weight and index.

19. ESTIMATED LANDING CONDITION: (Ref 20) Subtract total of references 17 and 19 from takeoff condition.

20. ESTIMATED LANDING CG IN %MAC: (Ref 21) The estimated landing gross weight and index will be used to compute CG in percent of MAC from the load adjuster.

21. LIMITATIONS: Enter the allowable gross weight and permissible CG for takeoff and landing.

USE OF AFTO FORM 7

AFTO Form 7 is the aircraft refueling, defueling and fuel distribution log. There are 2 sides to AFTO Form 7; a REFUELING RECORD to be used when refueling to a higher fuel load, and a DEFUELING AND FUEL DISTRIBUTION RECORD to be used when defueling from a higher to a lower fuel load. During the interior inspection prior to flight, the pilot and copilot will record actual fuel gage readings and enter them in Bock I, line 3. The form remains with Form 781 until signed by the aircraft commander and is returned to the maintenance office prior to flight. It will then be retained for a period of 72 hours. Refer to T.O. 1C-135(K)A-2-2 for additional instructions and an example problem concerning the use of AFTO Form 7.

SAMPLE WEIGHT AND BALANCE CLEARANCE FORM F (TACTICAL)

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	AIRCRAFT TYPE	FROM	HOME STATION
30 SEPT 65	KC-135A	BARKSDALE AFB, LA.	BARKSDALE AFB, LA
MISSION/TRIP/FLIGHT/NO.	SERIAL NO.	TO	PILOT
AR/NAV	57-1234A	BARKSDALE AFB, LA.	BANKS, R. K.

REMARKS FUEL

	PLANNED	ACTUAL
R	6.6	5.6
O	26.0	25.5
I	29.0	28.5
C	41.5	41.0
A	41.4	41.0
F	28.0	28.5
U	.3	.5
Tot	171.8	170.6
Tx	-2.0	-2.0
Tot	169.8	168.6

COMPUTER PLATE NO. (If used) E-1111

REF	ITEM	WEIGHT	INDEX OR ~~MOMT~~
1	BASIC AIRCRAFT (From Chart C)	101240	520
2	OIL (Qts.)	169	520
3	DISTRIBUTION OF LOAD		

COMPT.	CREW NO.	CREW WEIGHT	BAGGAGE	CARGO AND MISC.	WEIGHT	INDEX OR
B	4	1000			1000	491
F	2	500			500	483
J	1	250			250	483
H				475	475	481

4	OPERATING WEIGHT	103634	481
5	AMMUNITION — COMPT. / ROUNDS / CALIBER		
6	BOMBS, ROCKETS, ETC. — FORWARD / AFT / EXTERNAL / ROCKETS		
7	FUEL — BUILT IN (Gal.)	169800	320
	FUEL — BOMB BAY (Gal.)		
	FUEL — EXTERNAL (Gal.)		
8	WATER INJ. FLUID (Gal.)	5581	342
9	JATO OR RATO		
10	TAKEOFF CONDITION (Uncorrected)	279015	342
11	CORRECTIONS (If required)	-700	338
12	TAKEOFF CONDITION (Corrected)	278315	338
13	TAKEOFF C. G. IN % M. A. C.	~~23.2~~ 23.1	
14	LESS EXPENDABLES — JATO OR RATO / BOMBS / AMMUNITION / FUEL		
15	ESTIMATED LANDING CONDITION		
16	ESTIMATED LANDING C. G. IN % M. A. C.		

Pertinent instructions to the pilot for shifting load and crew during takeoff and landing should be noted above.

CORRECTIONS (Ref. 11)

COMPT.	ITEM	CHANGES (+ or -) WEIGHT	CHANGES (+ or -) INDEX OR ~~MOMT~~
	FUEL	-1200	33.9
I	EMER EQUIP	+500	33.8
	TOTAL WEIGHT REMOVED	-1200	-
	TOTAL WEIGHT ADDED	+500	+
	NET DIFFERENCE (Ref. 11)	-700	33.8

LIMITATIONS

[1] GROSS WT. TAKEOFF (lb.)	[1] GROSS WT. LANDING (lb.)
297,000	297,000

	FROM	TO (% M. A. C.)
[2] PERMISSIBLE C. G. TAKEOFF	18.5	~~33.5~~
[2] PERMISSIBLE C. G. LANDING	18.0	~~35.0~~

[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/ JOE G. ROSS, SMSGT.
WEIGHT AND BALANCE AUTHORITY (Signature)
PILOT (Signature) /S/ ROBERT K. BANKS, MAJ, USAF

SAMPLE

DD FORM 1 SEPT 54 365F

1-297

Figure 8-4 (Sheet 1 of 2)

SAMPLE WEIGHT AND BALANCE CLEARANCE FORM F (TRANSPORT)

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 (6276)

FOR USE IN T.O. 1-1B-40 & AN 01-1B-40

DATE	AIRCRAFT TYPE	FROM	HOME STATION
15 SEP 72	KC-135A	BARKSDALE AFB LA	MARCH AFB CA
MISSION/TRIP/FLIGHT/NO.	**SERIAL NO.**	**TO**	**PILOT**
HHQ	63-7992A	MARCH AFB CA	BROWN C.M.

LIMITATIONS			
CONDITION	TAKEOFF	LANDING	LIMITING WING FUEL
[1] ALLOWABLE GROSS WEIGHT	297000	297000	—
TOTAL AIRCRAFT WEIGHT (*Ref. 11*)	—		
OPERATING WEIGHT PLUS ESTIMATED LANDING FUEL WEIGHT		—	
OPERATING WEIGHT (*Ref. 8*)			—
ALLOWABLE LOAD (*Ref. 18*) (use *SMALLEST* figure)	—	—	—
[2] PERMISSIBLE C. G. TAKEOFF	FROM 16.0	TO (% M.A.C. ~~inches~~) 35.0	
[3] PERMISSIBLE C. G. LANDING	FROM 18.0	TO (% M.A.C. ~~inches~~) 35.0	
[4] LANDING FUEL WEIGHT			

REMARKS FUEL

PLANNED		ACTUAL
R	5.6	5.6
O	26.4	26.0
I	29.1	29.0
C	46.8	45.0
A	.0	.0
F	.0	.0
U	.2	.2
Tot	108.1	105.8
Tx	-2.0	-2.0
Tot	106.1	103.8

TOTAL FREIGHT	—
TOTAL MAIL	—

COMPUTER PLATE NUMBER (*If used*) E-1111

[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.*

REF	ITEM	WEIGHT	INDEX ~~(00)~~
1	BASIC AIRCRAFT (*From Chart C*)	106000	553
2	OIL (Gal.)	169	553
3	CREW (No.) 4B	1000	523
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT H	310	522
7	EXTRA EQUIPMENT		
8	OPERATING WEIGHT	107479	522
9	TAKEOFF FUEL (Gal.)	106100	317
10	WATER INJ. FLUID (Gal.)	5581	339
11	TOTAL AIRCRAFT WEIGHT	219160	339

12 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

COMPT	UPPER COMPARTMENTS PASSENGERS NO.	PASSENGERS WEIGHT	CARGO	COMPT	LOWER COMPARTMENTS PASSENGERS NO.	PASSENGERS WEIGHT	CARGO	WEIGHT	INDEX
A									
B									
C									
D									
E	2	400						400	332
F	6	1200	1500					2700	297
G	6	1200	1500					2700	270
H	1	200	500					700	266
I	7	1400	3000					4400	251
J	8	1600	3540					5140	255
K	6	1200	2500					3700	270
L	6	1200	2000					3200	293
M	6	1200	500					1700	310
N	5	1000						1000	323
O	1	200						200	327
P									
FWD	BELLY								
AFT	BELLY								

SAMPLE

NOTE

This sample was computed using data that would insure a 2.5 G load factor. Using certain other data, (i.e. fuel in the forward and aft body tanks, increased payload, etc.) will result in a 2.0 G load factor.

CORRECTIONS (*Ref. 14*)

COMPT	ITEM	CHANGES (+ or -) WEIGHT	INDEX ~~(00)~~
	FUEL	-2300	33.8
M	PASSENGER (2)	- 400	33.5
	TOTAL WEIGHT REMOVED	-2700	-
	TOTAL WEIGHT ADDED	+	+
	NET DIFFERENCE (*Ref. 14*)	-2700	33.5

13	TAKEOFF CONDITION (*Uncorrected*)	245000	327
14	CORRECTIONS (*If required*)	-2700	335
15	TAKEOFF CONDITION (*Corrected*)	242300	335
16	TAKEOFF C. G. IN % M. A. C. ~~inches~~	~~22.6~~ 22.9	
17	LESS FUEL		
18	LESS AIR SUPPLY LOAD DROPPED		
19	MISC. VARIABLES		
20	ESTIMATED LANDING CONDITION		
21	ESTIMATED LANDING C. G. IN % M. A. C. ~~inches~~		

COMPUTED BY Norman S. Jones SMSgt /s/ (SIGNATURE)

WEIGHT AND BALANCE AUTHORITY (SIGNATURE)

PILOT Charles M. Brown, Maj USAF /s/ (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

GPO: 1955 O - 315288

Figure 8-4 (Sheet 2 of 2)

Figure 8-5 (Deleted)

FUEL LOADS

STANDARD FUEL LOADS

FUEL DENSITY 6.3 POUNDS PER GALLON											
LOAD NO.	TOTAL USABLE FUEL (LBS)	NO. 1 RESERVE	NO. 1 MAIN	NO. 2 MAIN	NO. 3 MAIN	NO. 4 MAIN	NO. 4 RESERVE	FORWARD BODY	CENTER WING	AFT BODY	UPPER DECK
1	50000	2734	8000	8000	8000	8000	2734	9000	3332		200
2	55000	↓	9000	9000	9000	9000	↓	9000	4332		200
3	60000	↓	10000	10000	10000	10000	↓	9500	4832		200
4	65000	↓	11250	11250	11250	11250	↓	9500	4832		200
5	70000	↓	12500	12500	12500	12500	↓	9500	4832		200
6	75000	↓	12991	14333	14333	12991	↓	9500	5184		200
7	80000	↓	↓	↓	↓	↓	↓	9500	10184		200
8	85000	↓	↓	↓	↓	↓	↓	9500	15184		200
9	90000	↓	↓	↓	↓	↓	↓	9500	20184		200
10	95000	↓	↓	↓	↓	↓	↓	9500	22684	2500	200
11	100000	↓	↓	↓	↓	↓	↓	9500	25184	5000	200
12	105000	↓	↓	↓	↓	↓	↓	10000	27184	7500	200
13	110000	↓	↓	↓	↓	↓	↓	10000	29684	10000	200
14	115000	↓	↓	↓	↓	↓	↓	11000	31184	12500	200
15	120000	↓	↓	↓	↓	↓	↓	11000	33684	15000	200
16	125000	FULL	FULL	FULL	FULL	FULL	FULL	12000	35184	17500	200
17	130000	↓	↓	↓	↓	↓	↓	12000	38684	19000	200
18	135000	↓	↓	↓	↓	↓	↓	13000	40184	21500	200
19	140000	↓	↓	↓	↓	↓	↓	14000	41684	24000	200
20	145000	↓	↓	↓	↓	↓	↓	15000	43684	26000	200
21	150000	↓	↓	↓	↓	↓	↓	16000	45684	28000	200
22	155000	↓	↓	↓	↓	↓	↓	18000	46028	30656	200
23	160000	↓	↓	↓	↓	↓	↓	19000	↓	34656	200
24	165000	↓	↓	↓	↓	↓	↓	21000	↓	37656	200
25	170000	↓	↓	↓	↓	↓	↓	23475	↓	40181	200
26	175000	↓	↓	↓	↓	↓	↓	26675	FULL	↓	2000
27	180000	↓	↓	↓	↓	↓	↓	29675	↓	FULL	4000
28	185000	↓	↓	↓	↓	↓	↓	32675	↓	↓	6000
29	190000	↓	↓	↓	↓	↓	↓	35675	↓	↓	8000
30	195000	2734	12991	14333	14333	12991	2734	36540	46028	40181	12135

NOTE

If a mission requires in-between loads, use the closest loading below desired weight as a base and add fuel as required. Fuel should be added in a sequence similar to that indicated in the table.

Figure 8-6 (Sheet 1 of 3)

STANDARD FUEL LOADS

FUEL DENSITY 6.4 POUNDS PER GALLON											
LOAD NO.	TOTAL USABLE FUEL (LBS)	NO. 1 RESERVE	NO. 1 MAIN	NO. 2 MAIN	NO. 3 MAIN	NO. 4 MAIN	NO. 4 RESERVE	FORWARD BODY	CENTER WING	AFT BODY	UPPER DECK
1	50000	2778	8000	8000	8000	8000	2778	10000	2244		200
2	55000	↓	9000	9000	9000	9000	↓	10000	3244		200
3	60000	↓	10150	10150	10150	10150	↓	10000	3644		200
4	65000	↓	11400	11400	11400	11400	↓	10000	3644		200
5	70000	↓	12650	12650	12650	12650	↓	10000	3644		200
6	75000	↓	13197	14560	14560	13197	↓	10000	3730		200
7	80000	↓	↓	↓	↓	↓	↓	10000	8730		200
8	85000	↓	↓	↓	↓	↓	↓	10000	13730		200
9	90000	↓	↓	↓	↓	↓	↓	10000	18730		200
10	95000	↓	↓	↓	↓	↓	↓	10000	21230	2500	200
11	100000	↓	↓	↓	↓	↓	↓	10000	23730	5000	200
12	105000	↓	↓	↓	↓	↓	↓	10000	26230	7500	200
13	110000	↓	↓	↓	↓	↓	↓	10000	28730	10000	200
14	115000	↓	↓	↓	↓	↓	↓	11000	30230	12500	200
15	120000	↓	↓	↓	↓	↓	↓	11000	32730	15000	200
16	125000	↓	↓	↓	↓	↓	↓	12000	34230	17500	200
17	130000	FULL	FULL	FULL	FULL	FULL	FULL	12000	37730	19000	200
18	135000	↓	↓	↓	↓	↓	↓	13000	39230	21500	200
19	140000	↓	↓	↓	↓	↓	↓	14000	40730	24000	200
20	145000	↓	↓	↓	↓	↓	↓	15000	42730	26000	200
21	150000	↓	↓	↓	↓	↓	↓	16000	44730	28000	200
22	155000	↓	↓	↓	↓	↓	↓	17000	46758	29972	200
23	160000	↓	↓	↓	↓	↓	↓	18500		33472	200
24	165000	↓	↓	↓	↓	↓	↓	20500		36472	200
25	170000	↓	↓	↓	↓	↓	↓	22500		39472	200
26	175000	↓	↓	↓	↓	↓	↓	25353	FULL	40819	1000
27	180000	↓	↓	↓	↓	↓	↓	28353			3000
28	185000	↓	↓	↓	↓	↓	↓	31353		FULL	5000
29	190000	↓	↓	↓	↓	↓	↓	34353			7000
30	195000	2778	13197	14560	14560	13197	2778	37120	46758	40819	9233

NOTE

If a mission requires in-between loads, use the closest loading below desired weight as a base and add fuel as required. Fuel should be added in a sequence similar to that indicated in the table.

Figure 8-6 (Sheet 2 of 3)

STANDARD FUEL LOADS

FUEL DENSITY 6.5 POUNDS PER GALLON											
LOAD NO.	TOTAL USABLE FUEL (LBS)	NO. 1 RESERVE	NO. 1 MAIN	NO. 2 MAIN	NO. 3 MAIN	NO. 4 MAIN	NO. 4 RESERVE	FORWARD BODY	CENTER WING	AFT BODY	UPPER DECK
1	50000	2821	8000	8000	8000	8000	2821	9000	3158		200
2	55000	↓	9000	9000	9000	9000	↓	9500	3658		200
3	60000	↓	10000	10000	10000	10000	↓	10000	4158		200
4	65000	↓	11250	11250	11250	11250	↓	10000	4158		200
5	70000	↓	12500	12500	12500	12500	↓	10000	4158		200
6	75000	↓	13403	14097	14097	13403	↓	10000	4158		200
7	80000	↓	↓	14788	14788	↓	↓	10000	7776		200
8	85000	↓	↓	↓	↓	↓	↓	10000	12776		200
9	90000	↓	↓	↓	↓	↓	↓	10000	17776		200
10	95000	↓	↓	↓	↓	↓	↓	10000	20276	2500	200
11	100000	↓	↓	↓	↓	↓	↓	10000	22776	5000	200
12	105000	↓	↓	↓	↓	↓	↓	11000	24276	7500	200
13	110000	↓	↓	↓	↓	↓	↓	11000	26776	10000	200
14	115000	↓	↓	↓	↓	↓	↓	12000	28276	12500	200
15	120000	↓	↓	↓	↓	↓	↓	12000	30776	15000	200
16	125000	FULL	FULL	FULL	FULL	FULL	FULL	13000	32276	17500	200
17	130000	↓	↓	↓	↓	↓	↓	13000	35776	19000	200
18	135000	↓	↓	↓	↓	↓	↓	14000	37276	21500	200
19	140000	↓	↓	↓	↓	↓	↓	15000	38776	24000	200
20	145000	↓	↓	↓	↓	↓	↓	16000	40776	26000	200
21	150000	↓	↓	↓	↓	↓	↓	17000	42776	28000	200
22	155000	↓	↓	↓	↓	↓	↓	18000	44776	30000	200
23	160000	↓	↓	↓	↓	↓	↓	19000	45776	33000	200
24	165000	↓	↓	↓	↓	↓	↓	20000	47489	35287	200
25	170000	↓	↓	↓	↓	↓	↓	22000		38287	200
26	175000	↓	↓	↓	↓	↓	↓	24000		41287	200
27	180000	↓	↓	↓	↓	↓	↓	27000	FULL	41457	2030
28	185000	↓	↓	↓	↓	↓	↓	30030		FULL	4000
29	190000	↓	↓	↓	↓	↓	↓	33030			6000
30	195000	2821	13403	14788	14788	13403	2821	36030	47489	41457	8000

NOTE

If a mission requires in-between loads, use the closest loading below desired weight as a base and add fuel as required. Fuel should be added in a sequence similar to that indicated in the table.

Figure 8-6 (Sheet 3 of 3)



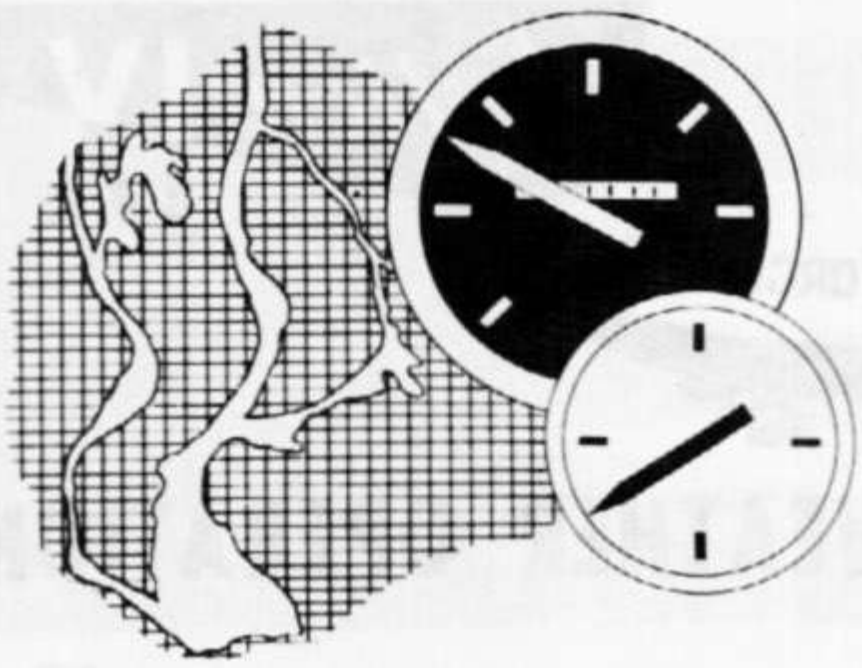
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INTRODUCTION

Except for some repetition necessary for emphasis, clarity, or continuity of thought, this Section contains only those procedures that differ or are in addition to the normal operating instructions covered in Section II. Any discussions relative to operation are covered in Sections IV and VII.



INSTRUMENT FLIGHT PROCEDURES

Flying the airplane in all weather conditions requires instrument proficiency and conscientious preflight planning on the part of all crewmembers. A standard operating procedure should be used by the pilot and copilot during all phases of instrument flight. Performance data, techniques, and procedures recommended are based on a standard airplane. All airspeeds recommended should be adhered to during instrument flight, especially during the final part of any instrument procedure or approach. During landing approaches, the airplane is being operated in the sensitive portion of the power curve and an approach at speeds below those recommended will result in poor response to power corrections. A bank angle of 30 degrees or less is recommended for all turns.

PREFLIGHT

Complete the normal preflight inspection of the airplane utilizing the checklist contained in Section II. Particular attention should be paid to those items required for instrument flight.

TAXIING

Complete the TAXIING checklist outlined in Section II.

BEFORE TAKEOFF

Accomplish the BEFORE TAKEOFF and TAKEOFF checklists and align the airplane visually with the runway. Pilot and copilot will review the takeoff procedure. Complete instrument takeoffs are not recommended due to the long takeoff run required prior to takeoff speed. Sufficient forward visibility should be available to maintain direction on the runway. Forward visibility in precipitation can be improved by using windshield wipers.

INSTRUMENT TAKEOFF AND INITIAL CLIMB

Follow normal takeoff technique and procedures.

NOTE

- The rotating beacon lights may be turned OFF during flight through conditions of reduced visibility where the pilot could experience spatial disorientation as a result of the rotating reflections of the light against the clouds. In addition, the light would be ineffective as an anti-collision light during these conditions since it could not be observed by pilots of other airplanes.
- Since the stabilizer trim affects the angle of the stabilizer and not the elevator, no immediate increase in control column force is felt by the pilot as a result of trimming the stabilizer. Considering instrument error, a lag of up to 9 seconds is possible between start of trim change and movement of the vertical velocity indicator pointer.

INSTRUMENT CLIMB

Climb in accordance with AFTER TAKEOFF-CLIMB checklist, Section II.

INSTRUMENT CRUISING FLIGHT

Handling characteristics under instrument cruise conditions are no different than VFR cruise. The airplane can be safely operated at all normal cruising speeds and altitudes. For cruise operation, use the recommended procedures given in Part 5 of the Appendix, T.O. 1C-135(K)A-1-1.

NOTE

Frequently check the attitude warning lights and comparator warning monitor panel during flight to quickly determine any discrepancies in the attitude director indicator and compass systems. The COMPAR WARNING lights on each pilot's instrument panel will attract attention to discrepancies between the compass subsystems.

Gyro Compass Malfunction

When a discrepancy occurs between the N-1 and J-4 gyro compass systems, the correct system can be readily identified. The effects of this discrepancy or malfunction on the radio navigation instruments are not readily identified and are complicated by the fact that the heading references for the bearing pointers do not necessarily come from the same compass system as the compass card reference. See figure 9-1. The navigation instrument selections and compass card control information is shown in figure 4-18A. Heading reference signals for VOR 1 and TACAN come from the N-1 compass, and for VOR 2 from the J-4 compass.

HOLDING

Unless fuel consumption is a factor, a holding airspeed of 220 KIAS may be used for all gross weights up to 170,000 pounds. Normal holding speed is obtained from the HOLDING SPEED chart in T.O. 1C-135(K)A-1CL-1.

NOTE

Holding speed is approximately 10 knots greater than best endurance speed; therefore add 3% to the fuel consumption values derived from Part 6 of the Appendix, T.O. 1C-135(K)A-1-1.

If descent is required while in the holding pattern, descend at holding airspeed.

DESCENT

NOTE

If window anti-icing is on NORMAL it may be desirable to increase window heat to HIGH 20 minutes prior to starting the descent to help prevent window fogging. If descent is made through icing conditions it will be necessary to maintain a high enough engine rpm to provide adequate hot air for the anti-icing systems. See ICE AND RAIN, this Section.

Descent to cruise or holding altitude and enroute descent will be performed in same manner as described in Section II. See Part 8 of the Appendix, T.O. 1C-135(K)A-1-1 for enroute descent rates and speeds. Penetration procedures will be performed in same manner as outlined in Section II and Figure 9-1A.

INSTRUMENT APPROACHES

NOTE

The approach category for the KC-135A airplane and all modified versions thereof, is as stated in the DOD FLIGHT INFORMATION PUBLICATION PLANNING.

Flight characteristics of the airplane during VOR, ILS, TACAN, and radar approaches are satisfactory under four, three and two-engine operation. Make normal turns during approaches except during two-engine operation when minimum bank angles should be used. With two-engine operation on one side, control will be difficult. Adhere to minimum control speeds as shown in Part 9 of the Appendix, T.O. 1C-135(K)A-1-1, and delay gear extension until reaching final approach. Allow 10 seconds for gear extension.

WARNING

Do not attempt an instrument approach with two-engine operation on one side if the ceiling is less than 1500 feet or 1000 feet above published minimums, whichever is higher, unless insufficient fuel is available or circumstances do not permit proceeding to a suitable alternate.

GYRO COMPASS INDICATOR ERRORS

N-1 COMPASS MALFUNCTION

NAV RADIO SELECTED	INSTRUMENT INDICATION				
	HSI INDICATION		RMI INDICATION		
	PILOT	COPILOT	PILOT	COPILOT	NAVIGATOR
TACAN	AZIMUTH CARD INCORRECT ❶ CDI SHOWS MAG BEARING TO STATION NO. 1 POINTER SHOWS MAG BEARING TO STATION	AZIMUTH CARD CORRECT ❶ CDI SHOWS MAG BEARING TO STATION NO. 1 POINTER INCORRECT	COMPASS CARD CORRECT NO. 1 POINTER INCORRECT	COMPASS CARD INCORRECT NO. 1 POINTER SHOWS MAG BEARING TO STATION	SAME AS COPILOT
VOR 1	AZIMUTH CARD INCORRECT ❶ CDI SHOWS MAG BEARING TO STATION NO. 2 POINTER SHOWS MAG BEARING TO STATION	AZIMUTH CARD CORRECT NO. 1 POINTER INCORRECT	--	--	--
VOR 2	AZIMUTH CARD INCORRECT NO. 1 POINTER POINTS TO STATION (RELATIVE BEARING)	INDICATION CORRECT	--	--	COMPASS CARD INCORRECT NO. 2 POINTER POINTS TO STATION

J-4 COMPASS MALFUNCTION

NAV RADIO SELECTED	INSTRUMENT INDICATION				
	HSI INDICATION		RMI INDICATION		
	PILOT	COPILOT	PILOT	COPILOT	NAVIGATOR
TACAN	INDICATION CORRECT	AZIMUTH CARD INCORRECT ❶ CDI SHOWS MAG BEARING TO STATION NO. 1 POINTER POINTS TO STATION (RELATIVE BEARING)	COMPASS CARD INCORRECT NO. 1 POINTER POINTS TO STATION (RELATIVE BEARING)	INDICATION CORRECT	INDICATION CORRECT
VOR 1	INDICATION CORRECT	AZIMUTH CARD INCORRECT NO. 1 POINTER POINTS TO STATION (RELATIVE BEARING)	--	--	--
VOR 2	AZIMUTH CARD CORRECT NO. 1 POINTER INCORRECT	AZIMUTH CARD INCORRECT ❶ CDI SHOWS MAG BEARING TO STATION NO. 2 POINTER SHOWS MAG BEARING TO STATION	--	--	COMPASS CARD CORRECT NO. 2 POINTER INCORRECT

❶ Manually rotate course set knob to center course deviation indicator when TO indication is received.

Figure 9-1

Initiate the BEFORE LANDING or the TRAFFIC PATTERN checklist as applicable on downwind leg (radar vectors) or during the intermediate segment (published approach). Lower the flaps to 30 degrees and allow the airspeed to bleed off, but not lower than 30 degree flap pattern speed. Just prior to reaching the final approach fix or beginning descent, lower flaps to 40 degrees and allow airspeed to decrease to the 40 degree flap pattern speed. Upon intercepting the glide slope during a precision approach, with four engines operating, flaps should be set to the landing flap setting and airspeed adjusted to the approach speed for the flap setting being used. See LANDING EMERGENCIES, Section III for procedures with one or two engines inoperative. Do not lower flaps to 50 degrees during a nonprecision approach until departing the MDA on final approach.

NOTE

Approaches with less than 50 degrees flaps will be flown at the appropriate approach speed.

WARNING

Speed brakes will not be used during the approach below 1000 feet AGL.

CIRCLING APPROACH

Circling approaches can be made using the standard techniques and procedures. Fly the entire procedure with the landing gear extended. Maintain 30 degrees of flaps and 30 degree flap pattern speed until turn on final.

TYPICAL JET PENETRATION

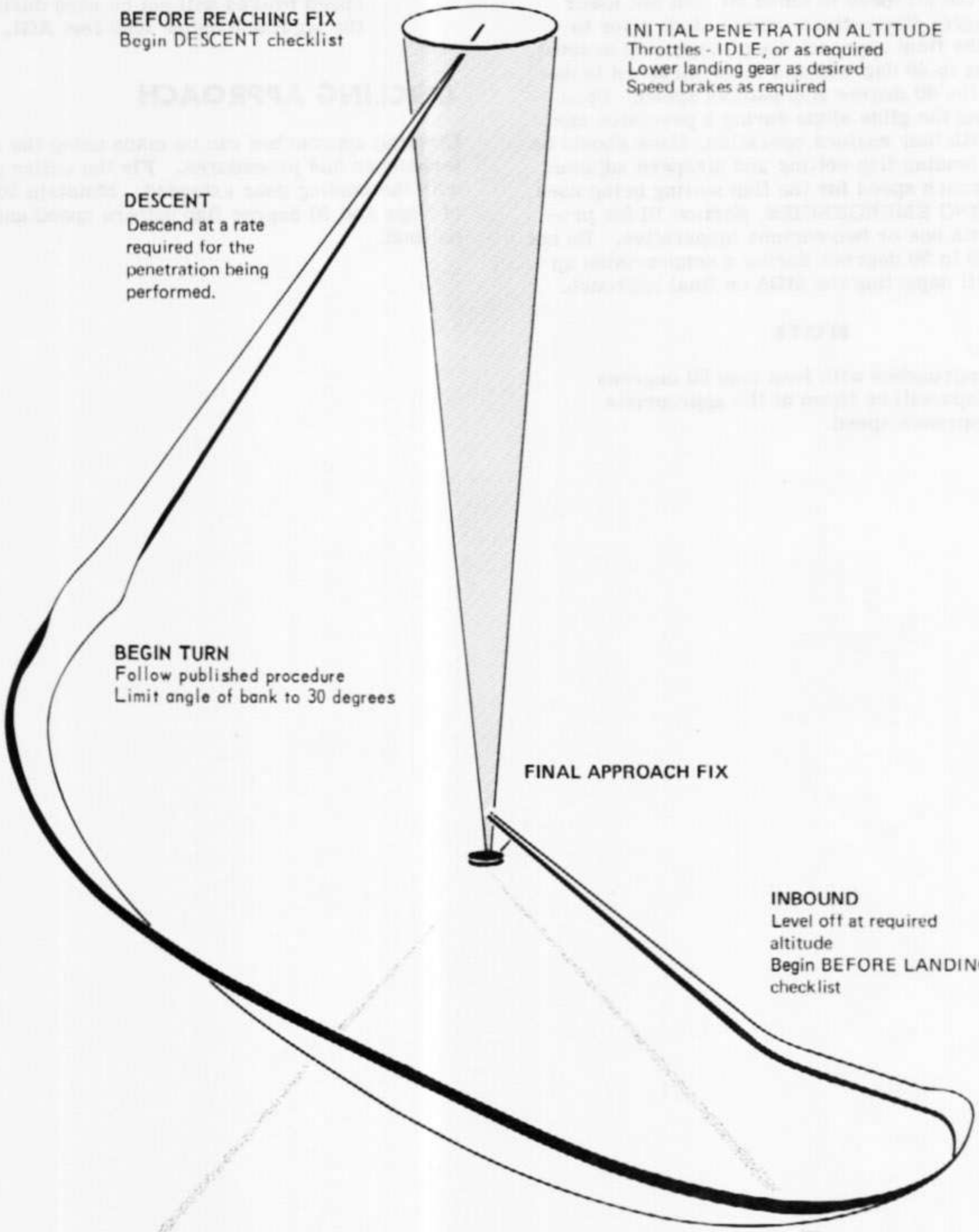


Figure 9-1A

All data on page 9-4A (Deleted)

INSTRUMENT LANDING SYSTEM (ILS)

Either manual or automatic ILS approaches can be made with this airplane. ILS equipment provided is described in Section IV. Automatic and manual ILS approach and subsequent landing under instrument conditions are outlined in figure 9-2.

AUTOPILOT APPROACH

Automatic approach equipment directs ILS received signals through the autopilot to guide the airplane along an approach path which is established by directional localizer and glide slope transmitters. Recommended using boundaries extend from the interception of the localizer course to the decision height. The pilot must be familiar with the ILS and automatic approach equipment in Section IV to achieve desired results. The autopilot approach is accomplished as follows. See also figure 9-2.

Transition

Accomplish normal transition as specified in the appropriate FLIP terminal chart. Set the VOR/ILS frequency selector switch to the frequency of the ILS localizer.

NOTE

After approximately 2 minutes warmup, observe that the navigation warning flags and glide slope warning flags disappear from view, especially if the airplane is within range of the localizer or glide slope. Failure of either to do so indicates no signal is received and is cause to discontinue the automatic approach until a check can be made on the system.

Extend wing flaps as required and lower the landing gear. Trim for straight and level flight; then engage the autopilot engaging switches. Turn on the altitude hold switch after speed and altitude are stabilized.

CAUTION

Turn off the altitude control switch prior to varying airspeed more than 50 knots when the flaps are down, as the autopilot may not be able to handle the trim changes occurring during these operations.

Intercepting Localizer

Intercept the inbound localizer course at any angle from 1 degree to 90 degrees and far enough from the outer marker to stabilize the flight path prior to intercepting the glide slope. The larger angles are not recommended, particularly close in. Set the course arrow to the inbound course. When the CDI makes a positive departure from full scale deflection, the airplane is intercepting the localizer. Engage the VOR-LOC engage switch and glide slope auto engage switch. The airplane automatically brackets the inbound localizer course. Observe the initial automatic turn to insure an inbound localizer course.

Intercepting Glide Slope

Just prior to beginning descent, lower flaps to 40 degrees and allow airspeed to decrease to 40 degree pattern speed. When the GSI reaches the center position, the glide slope mode indicator will go from ARM to ENG indicating the autopilot is locked on the glide slope. Select autopilot glide slope manual engage switch if auto engage switch has not been previously engaged, or did not engage. The altitude control unit is automatically disengaged and the airplane will be guided by the course indicator along the glide slope. Upon intercepting glide slope, set flaps to the landing flap setting and adjust airspeed to the approach speed for the flap setting being used. Power must be adjusted to maintain desired speed on the glide slope. After the airspeed and a steady rate of descent on the glide slope are reasonably established, check the autopilot trim indicator needles alignment prior to autopilot disconnect.

CAUTION

If a large out-of-center alignment occurs on the automatic trim indicator, discontinue the automatic approach and disconnect the autopilot maintaining firm manual control of the airplane.

Disconnecting The Autopilot

Continue the approach until visual contact is made with the runway or until reaching decision height (specified on the respective ILS procedure chart); then disconnect the autopilot by pressing the autopilot disconnect button on the control wheel and complete the landing with manual control of the airplane.

NOTE

It is recommended that the pilot not flying the approach disconnect the autopilot. When the autopilot is disconnected using the RGA/AP pushbutton switch, and the RGA power switch is ON, the command bars will display go-around command. See GO-AROUND, figure 4-30X.

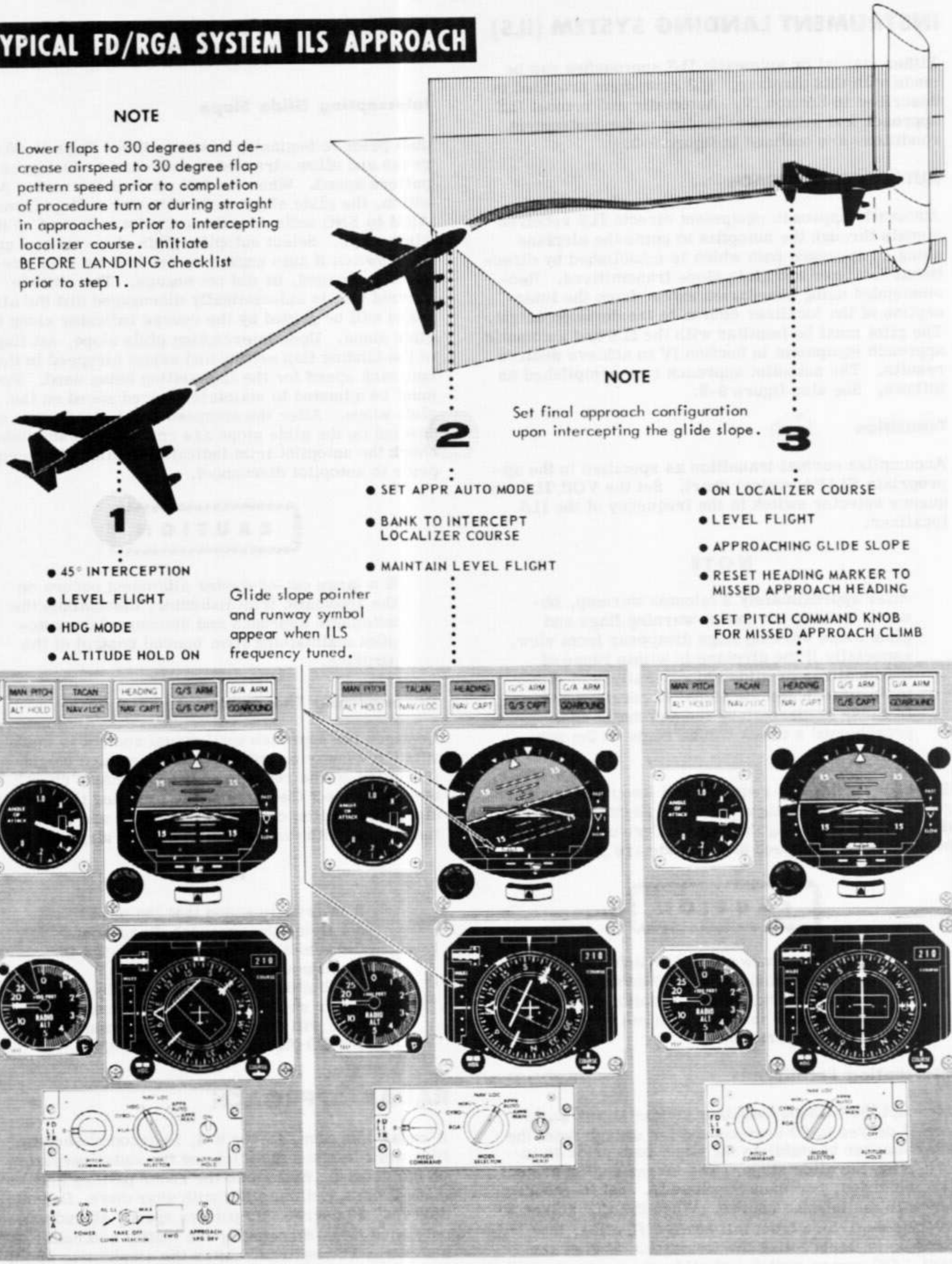
RADAR APPROACH

A radar approach, figure 9-3, is accomplished by teamwork between the pilot and the radar operator on the ground. Entry into the radar pattern may be made from a radio facility with gear down, flaps 30 degrees, 30 degree flap pattern speed, altitude as published or as directed by the traffic controller, and power as required. After the airplane is stabilized, the autopilot can be very helpful. If a constant altitude is to be maintained up to the final approach,

TYPICAL FD/RGA SYSTEM ILS APPROACH

NOTE

Lower flaps to 30 degrees and decrease airspeed to 30 degree flap pattern speed prior to completion of procedure turn or during straight in approaches, prior to intercepting localizer course. Initiate BEFORE LANDING checklist prior to step 1.



1

- 45° INTERCEPTION
- LEVEL FLIGHT
- HDG MODE
- ALTITUDE HOLD ON

2

- SET APPR AUTO MODE
- BANK TO INTERCEPT LOCALIZER COURSE
- MAINTAIN LEVEL FLIGHT

Glide slope pointer and runway symbol appear when ILS frequency tuned.

NOTE

Set final approach configuration upon intercepting the glide slope.

3

- ON LOCALIZER COURSE
- LEVEL FLIGHT
- APPROACHING GLIDE SLOPE
- RESET HEADING MARKER TO MISSED APPROACH HEADING
- SET PITCH COMMAND KNOB FOR MISSED APPROACH CLIMB

Figure 9-2 (Sheet 1 of 2)

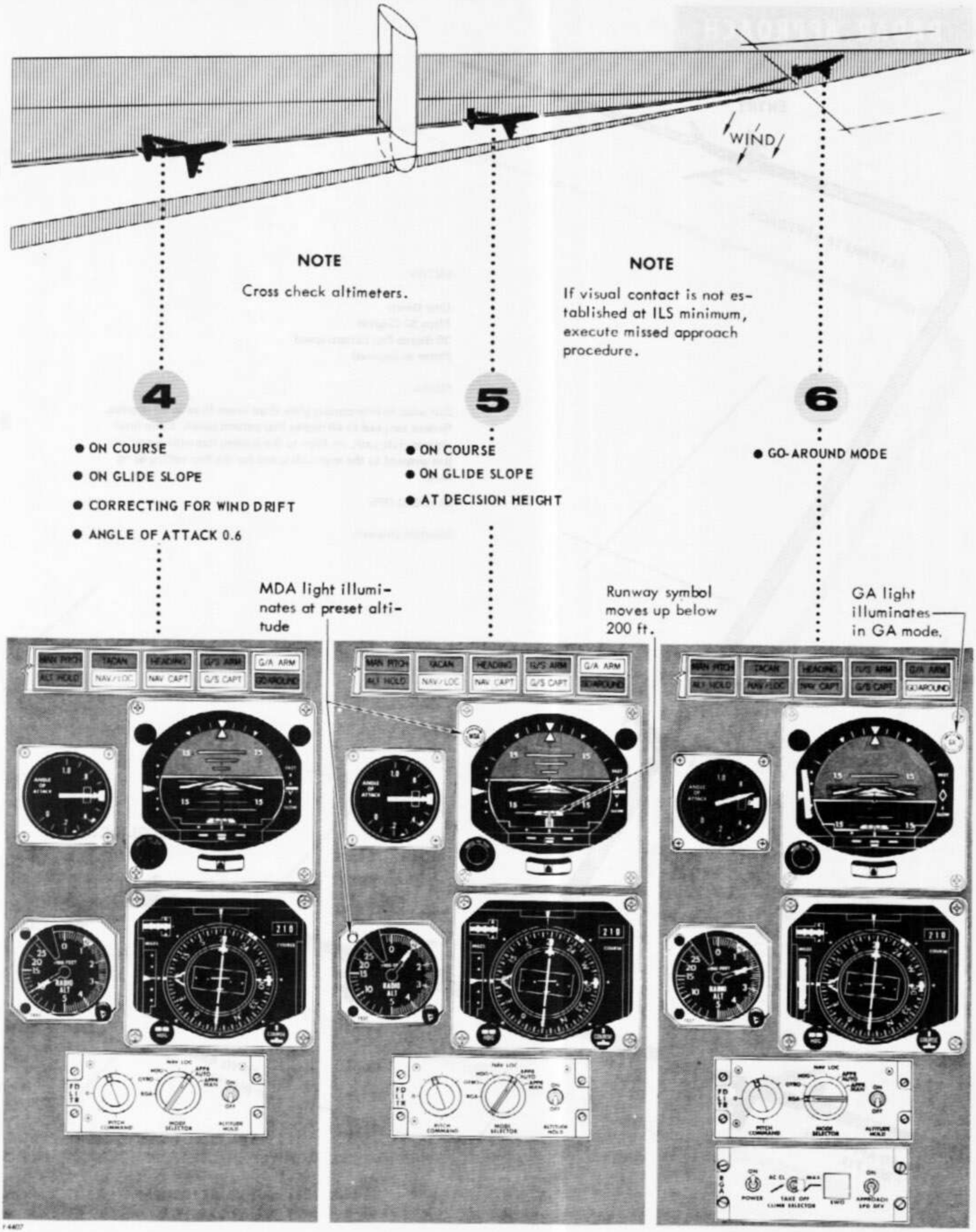


Figure 9-2 (Sheet 2 of 2)

RADAR APPROACH

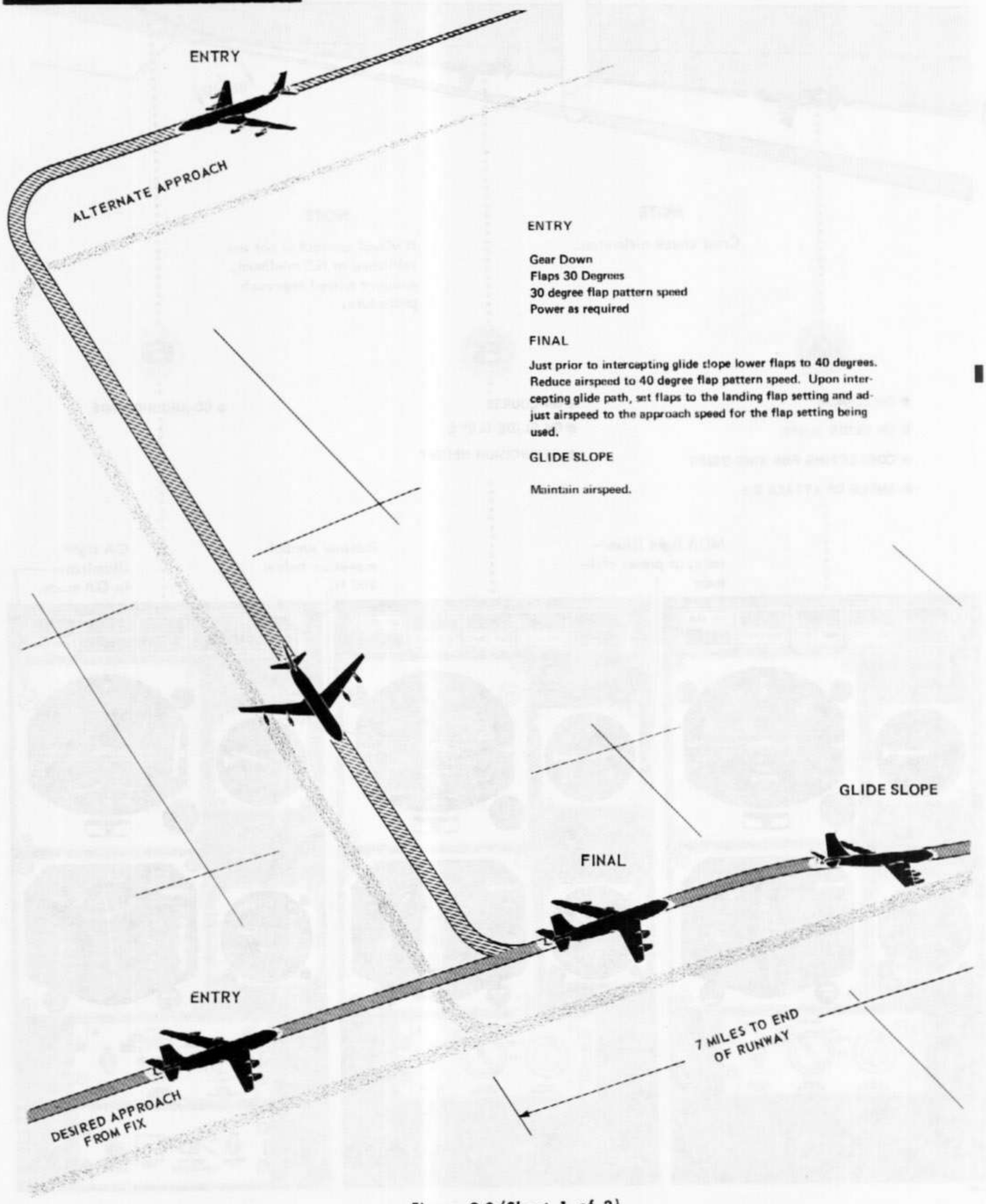
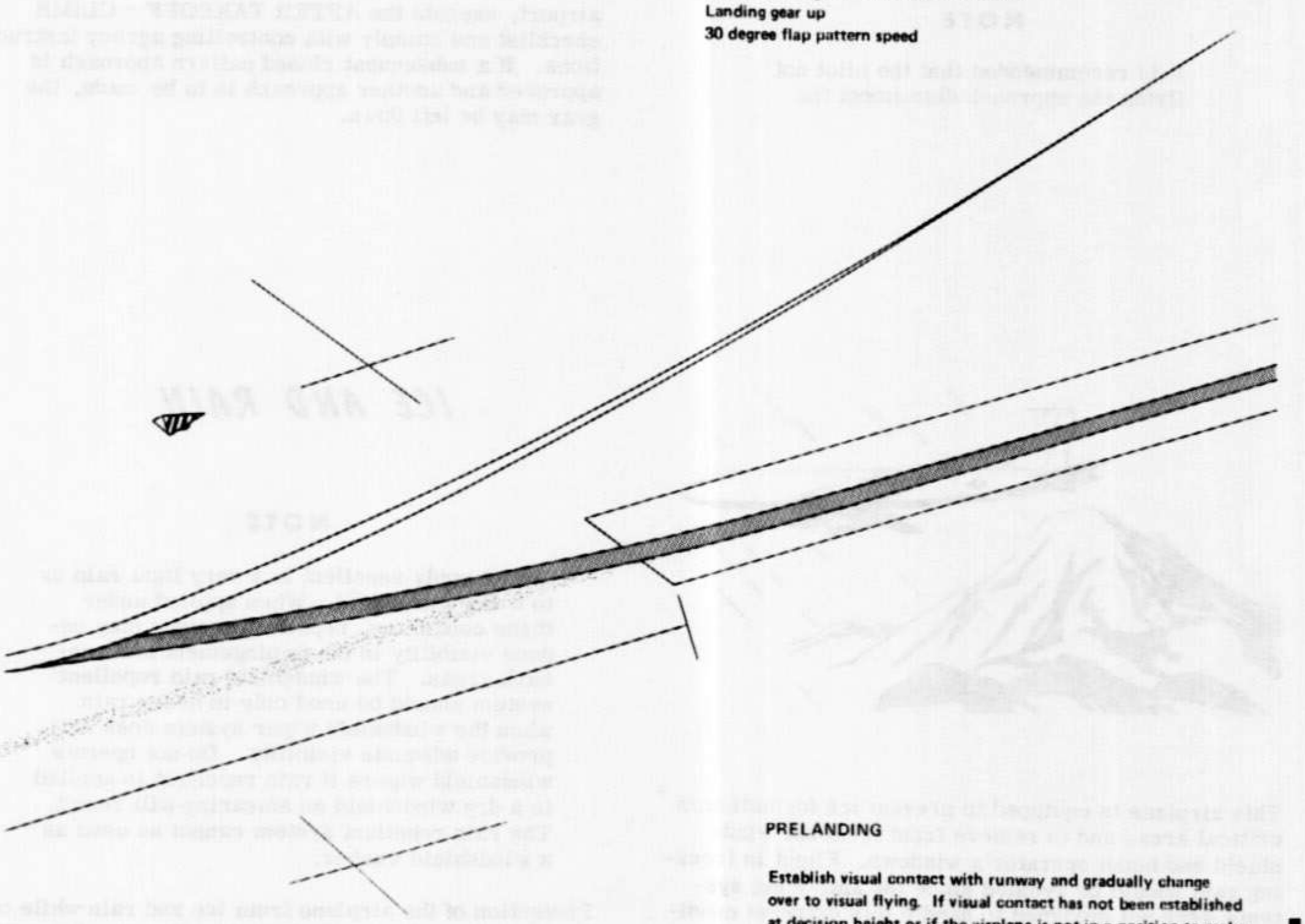


Figure 9-3 (Sheet 1 of 2)

MISSED APPROACH

Actuate RGA switch
Throttles – as required (not to exceed MRT)
Speed brakes retracted
Establish climb attitude
Flaps to 30 degrees on retraction schedule
Landing gear up
30 degree flap pattern speed



DESIRED APPROACH FROM FIX
ALTERNATE APPROACH
MISSED APPROACH

PRELANDING

Establish visual contact with runway and gradually change over to visual flying. If visual contact has not been established at decision height or if the airplane is not in a position to make a normal landing, execute the missed approach procedure as previously instructed by the controller or as published. After you have the airplane established in a climb, contact the controlling agency and state your intentions.

Figure 9-3 (Sheet 2 of 2)

the altitude hold function of the autopilot may be used. Just prior to intercepting the glide path, lower flaps to 40 degrees and reduce airspeed to 40 degree flap pattern speed. Upon intercepting glide path, set flaps to the landing flap setting and adjust airspeed to the approach speed for the flap setting being used. If the autopilot is used, release the altitude hold function and set the inbound heading of the final approach on the pilot's HSI. On the glide path, maintain approach speed and adjust altitude as directed by the ground controller. Approaches with less than 50 degrees flaps will be flown at the appropriate approach speed. If the autopilot is used, the heading select function may be engaged and the course set knob on the pilot's HSI can be used to make heading corrections as directed by the ground controller. Establish visual contact with the runway and disconnect the autopilot if it is being used. When it is certain visual contact will not be lost, change over to visual flying and make a normal landing.

NOTE

It is recommended that the pilot not flying the approach disconnect the autopilot. When the autopilot is disconnected using the RGA/AP push-button switch, and the RGA power switch is ON, the command bars will display go-around command. See GO-AROUND, figure 4-30X.

MISSED APPROACH, RADAR/ILS/VOR/TACAN

If visual contact is not established by the time the approach minimum altitude is reached and/or time completed, a safe landing is not possible, or the controlling agency directs a missed approach, execute missed approach as published or directed utilizing the normal go-around procedure. This configuration will be maintained for initial part of missed approach execution and subsequent approaches. If it is becomes necessary to proceed to an alternate airport, execute the AFTER TAKEOFF - CLIMB checklist and comply with controlling agency instructions. If a subsequent closed pattern approach is approved and another approach is to be made, the gear may be left down.



ICE AND RAIN

This airplane is equipped to prevent ice formation in critical areas and to remove frost from the windshield and boom operator's windows. Flight in freezing rain should be avoided since the anti-icing systems were not designed to handle this extreme condition. The windshield wiper system and the windshield rain repellent system are provided to maintain visibility during precipitation conditions.

NOTE

Do not apply repellent in a very light rain or to a dry windshield. When applied under these conditions, repellent residue may reduce visibility in the impingement and run-back areas. The windshield rain repellent system should be used only in heavy rain when the windshield wiper system does not provide adequate visibility. Do not operate windshield wipers if rain repellent is applied to a dry windshield as smearing will result. The rain repellent system cannot be used as a windshield washer.

Protection of the airplane from ice and rain while on the ground can be accomplished by the use of covers designed for that purpose. Their use is covered under COLD WEATHER PROCEDURES, this Section.

ICING

If penetrations through icing conditions are necessary, the engine anti-icing system, pitot anti-icing system and Q-inlet anti-icing system, if installed, should be turned on before entering the condition. The anti-icing systems are designed as anti-icing systems rather than deicing systems; therefore during potential icing conditions the anti-icing systems must be utilized before ice buildups can occur.

NOTE

The ram air temperature rise at the higher airplane speeds will reduce the outside air temperature at which ice will form; for example, at 375 knots ice does not form above 20° F OAT (True). The engine and nacelle anti-icing system will be more effective in most encounters at the lower speeds and higher engine powers. Operation below approximately 90% rpm may not supply sufficient heat to keep the engine inlet clear of ice under moderate to severe icing conditions. At the relatively high thrust settings used during climb or cruise, ample heat will be provided to assure protection. However, during descent at high airspeeds and low thrust settings, the heat supplied may be inadequate if the ice formation is moderate to severe. Under such circumstances, increased thrust should be applied in order to provide more heat. If ice is still accumulating in the compressor inlet, surge may occur when the throttle is advanced, indicating that a slower airspeed is necessary until the icing region has been penetrated. Descent through light to severe icing conditions should be made as quickly as possible. Refer also to SUSPECTED FUEL ICING in Section II.

ENGINE ICING

Axial-flow jet engines are seriously affected by icing. Ice forms on compressor guide vanes and restricts the flow of inlet air with a resultant loss in thrust. The initial symptom of engine inlet icing will probably be an increase in EPR indications. The construction of the EPR (P_{t2}) probe in the engine inlet is such that the probe inlet facing upstream records impact pressure of the ram air in the engine inlet; a drain hole is on the downstream side of the probe. When icing conditions are encountered, the P_{t2} probe inlet will usually ice over before a noticeable amount of ice accumulates on the engine cowl; however, the drain hole is not likely to ice over. When the P_{t2} probe inlet becomes iced over, the probe will sense through the drain hole, only static pressure in the engine inlet instead of impact pressure. This static pressure, when related to the pressure sensed by the P_{t7} probe in the tailpipe, will cause EPR indications to increase. If P_{t2} probe icing occurs during climb, the EPR indications will probably go to their upper limit (EPR = 3.4). It should be noted, however, that any time the engine anti-icing system is operating normally, the P_{t2} probe will be protected from icing. If ice is allowed to continue to build up in the engine inlet, engine surge may be encountered followed by compressor stall. In moderate icing, a rise in EGT may occur as ice breaks off and is ingested by the engine with the possibility of turbine failure from overtemperature.

NOTE

Conditions exist under which jet engine icing can occur without wing icing. Icing occurs when the adiabatic expansion reduces the air temperature in the engine inlet and ingested water droplets which impinge on the engine inlet components will freeze. This phenomenon may occur during ground and takeoff operations, when the airplane velocity is low and engines are operated at high powers.

Visible moisture is defined as rain, wet snow, or fog with one mile visibility or less. Consequently, engine anti-icing should also be used when climbing in clouds at temperatures near freezing or less, particularly at altitudes below 20,000 ft.

CAUTION

Prior to activating the anti-icing system, set throttles to NRT or below and place the ignition and start switches to FLIGHT START. This will preclude the possibility of an engine flameout due to inlet ice ingestion. As soon as the engines stabilize, turn ignition off.

If icing conditions cannot be avoided, turn the engine anti-icing system on prior to entering the expected icing area. Operate the engines at as high a power setting as practical to obtain the most effective anti-icing protection. Ice buildup on the nose cowl leading edge or nose cone will have a small effect on engine performance unless large amounts of ice (greater than 1 inch) are allowed to accumulate. These ice buildups present a potential hazard as compressor damage or engine surge may occur when the ice is released into the engine. If ice accumulates on the nose cowl leading edge or nose cone through system malfunction or exceeding the system anti-ice capability, the engine should be operated at the minimum power practical until the ice accumulation is ingested. This procedure will minimize the possibility of compressor damage. After leaving icing conditions, the anti-icing systems should be turned off to allow the ice to sublime rather than break off and be ingested by the engine.

CAUTION

Indiscriminate or prolonged use of engine anti-icing may cause cracking of inlet guide vanes. Anti-icing should be used only as necessary in prevention of icing and not for prolonged periods in dry air. When the possibility of encountering icing conditions no longer exists, engine anti-icing should be turned off.

PITOT ICING

After approximately 15 minutes in moderate to severe icing conditions, pitot icing can cause a loss of airspeed indications on the airspeed indicators even when pitot heat is on. Similar loss of airspeed indications may occur in light or trace icing conditions of longer duration, depending on the rate of buildup of structural ice.

NOTE

Types of structural icing referred to here are trace, light, moderate and severe in order of increasing severity as defined by Air Weather Service regulations for weather forecasters.

The airplane should not be flown continuously in moderate icing conditions for longer than 10 minutes and should never be flown into known or suspected severe icing conditions. When it is necessary to enter areas of known or suspected icing, monitor the structural ice build-up on the nose of the airplane. Since complete loss of airspeed indications will generally occur by the time that approximately one inch of ice has accumulated on the nose of the fuselage, every effort should be made to change altitude or course to get out of the icing conditions before a layer of ice one inch thick has accumulated on the fuselage nose. In all cases immediate action should be taken to get out of icing conditions if an airspeed indicator should begin to fluctuate whenever any amount of structural ice is visible on the airplane. Loss of airspeed indication is generally preceded by large fluctuations of the airspeed indicator as fuselage ice joins with ice forming on the pitot tube mast and eventually blocks off the airstream to the pitot tube. When the pitot tube is inoperative due to ice it will usually not deice, even in clear air, until the airplane enters ambient air above freezing.

Static port icing will affect all pitot and static instruments, while pitot tube icing will affect only IAS, TAS, and Mach number. To isolate the causes of various instrument irregularities, the following chart is presented:

INSTRUMENT	INDICATION	
	STATIC PORT ICING	PITOT TUBE ICING
Altimeter	Lag and/or erratic	Not affected
Airspeed Indicator	Lag and/or erratic	Erratic or no indication
Mach Indicator	Lag and/or erratic	Erratic or no indication
Vertical Velocity Indicator	Excessive lag, erratic or no indication	Not affected

NOTE

The above instrument indications could also occur due to introduction of foreign matter into the systems or mechanical failure.

Q-INLET

The Q-inlet for the powered rudder system contains an electrically operated heater to prevent icing of the inlet. When Q-inlet icing occurs, the rudder pedal forces will be reduced. Directional control is not affected except there may be a tendency to overcontrol during either turbulent air conditions or yawed flight caused by engine failure or crosswind landing. Whenever icing conditions are anticipated or encountered, the Q-inlet heat switch should be turned on.

NOTE

If Q-inlet icing occurs during rudder power on operation, rudder pedal feel forces will be reduced for all pedal deflections and may result in a tendency to overcontrol.

OPERATIONS UNDER ICING CONDITIONS

The following general operating techniques are applicable to flights in icing conditions. All operable anti-icing systems should be used as necessary to keep the airplane free of ice. During weather conditions in which ice or snow is continually accumulating during ground operation just prior to takeoff, ice accretion may be kept to a minimum by the application of cold concentrated deicing fluid (preferably Military Specification MIL-A-8243A) to the previously deiced surfaces just prior to engine start. Takeoff should be made within thirty minutes of the application. The cold deicing fluid has greater viscosity and will tend to remain longer on the surfaces, affording a longer time period of protection from ice accumulation. Accumulations of ice fog, which usually forms at temperatures below -20° F, should be removed from the side of the fuselage in the vicinity of the pitot masts and static ports prior to engine start. If freezing precipitation is severe, a final physical check of the surfaces, pitot masts and static ports should be made just before takeoff to determine if they are still free of ice. From the control cabin, it is difficult to see coatings of as much as one-fourth inch of clear ice on the wings.

Takeoff

If icing conditions are anticipated at any time from engine start to the time that climb power is established, the engine anti-icing will be turned on during taxi. If icing conditions are not anticipated until after cleanup height is reached, use of engine anti-ice may be delayed until clean-up is accomplished. Use of engine anti-icing during the takeoff will increase the takeoff run and reduce the climbout capability. See Parts 2 and 3 of the Appendix, T.O. 1C-135(K)A-1-1.

WARNING

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

- Depending on the weight of snow and ice accumulated on the airplane, 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 a 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; however, it should be noted that this airplane can safely takeoff with frost buildup of one eighth inch or less on the lifting surfaces.

Climb

Ice collected during climb will reduce rate of climb and range and will sublime after reaching cruise altitudes.

Cruise

Icing conditions at cruise altitude will be rare occurrences and the area and vertical extent of these conditions will generally be small. Slight deviations from course or altitude will normally avoid these areas.

During Descent

Descent through icing conditions should be made as quickly as possible. If icing conditions are anticipated, adjust throttles to maintain 80% rpm and turn on engine anti-ice system at least 10,000 feet above the highest icing level in order to provide adequate warm up time. This power schedule will provide adequate protection through light icing conditions and will allow a descent rate of approximately 4,000 feet per minute with gear down and speed brakes extended. Additional heat may be obtained for anti-icing by increasing RPM.

NOTE

- Operation below approximately 90% RPM may not supply sufficient heat to keep the engine inlet clear of ice under moderate to severe icing conditions.

- If it is not practicable to maintain 80% RPM or higher, place the starter switches to FLIGHT START position prior to starting the penetration.

Landing

Landing procedures will be in accordance with Section II, LANDING ON SLIPPERY RUNWAYS. Establish a normal approach with strict adherence to the correct approach speeds. Ice formations on the airplane will increase the stalling speed and consequently, the pattern, approach, and touch down speeds should be increased above normal. The amount of increase required depends upon the thickness and shape of the ice formations on the wings and empennage of the airplane. For ice formations of less than 1 inch in thickness, increase pattern, approach, and touchdown speeds 5 knots. Increase speeds 10 knots for 1 to 2 inches and 15 knots for more than 2 inches.

CAUTION

- If runway is snow or slush covered, retract flaps after touchdown unless stopping distance is critical. This will prevent ice buildup on the leading edge of the flaps that may cause damage to the flaps when they are retracted.

- If penetration has been made through moderate icing conditions, do not retract flaps to less than 20 degrees unless absolutely necessary. Ice formation on the flap leading edge will cause flap damage when flaps are retracted.

Retard all throttles to IDLE on touchdown and cut inboard engines if computed stopping distance is critical; before cutting any engines, a failed engine or any inoperable system must be considered. Raise speed brakes to 60 degrees when nose wheel touches down and use wheel brakes as necessary for the conditions. Braking friction will be greatly reduced on wet, slush covered or icy runways. On rain soaked or slush covered runways the wheels may hydroplane during the first part of the landing roll and rapid antiskid cycling may occur. On airplanes without 1618-550, maximum braking action is obtained by reducing brake pedal pressure to minimize the antiskid cycling such that one cycle occurs approximately every two seconds. On airplanes with 1618-550, the pilot should apply full brake pedal to obtain minimum stopping distance under any runway condition. Anytime an RCR of 7 or less is used for landing, the aircraft must be brought to a full stop as soon as practicable. As the aircraft slows down, more weight will be placed on the wheels and the braking action will become somewhat more effective. If taxi is then initiated, extreme caution must be used to avoid a skid when exiting the runway and proceeding along the taxi route.

NOTE

- On runways where normal traction is reduced by moisture, ice, or snow, the airplane will not respond as readily to normal turning forces. Therefore if large steering corrections are attempted, a slower rate of turn should be made to produce the best results.
- On airplanes that do not have an operable antiskid, depress and release brakes intermittently to prevent as much skidding as possible.

TIRE HYDROPLANING

The possibility of partial or total hydroplaning, during airplane takeoff and landing, exists whenever water or slush stands on the runway. Depending upon runway and tire conditions, tire hydroplaning can probably occur in depths less than 0.1 inch of slush or water.

CONDITIONS FOR HYDROPLANING

Hydroplaning will occur whenever a rolling or skidding tire does not displace water or slush at a rate fast enough to permit the complete tire footprint area to contact the runway surface. As the airplane ground speed increases on takeoff, a wedge of water gradually extends into the tire footprint area, decreasing the contact area between the tire and ground. The portion of the tire footprint being kept off the runway surface by a film of fluid gradually increases as airplane speed increases. As the wedge of water penetrates the tire footprint area, hydrodynamic pressure is built up between the tire and pavement which lifts the tire from the runway surface. Hydroplaning is a gradual process, and partial hydroplaning exists long before total hydroplaning occurs. At total hydroplaning speed the airplane tires will ride entirely on the film, and tire contact with the runway will be lost.

EVIDENCE OF HYDROPLANING

During takeoff in water or slush, a bow wave forms in front of the nose gear and main gear wheels. The retarding effect of slush or water on the wheels and airplane structure increases as airplane ground speed increases until the airplane reaches hydroplaning speed. At hydroplaning speed the bow wave disappears because the wheels have risen on top of the fluid, and the retarding force of water or slush therefore decreases. Once total hydroplaning is initiated, it will tend to continue even when the airplane speed has fallen below the beginning speed for total hydroplaning.

FACTORS INFLUENCING HYDROPLANING

A number of factors influence the extent of airplane hydroplaning. These include tire tread design and depth, depth of water or slush on the runway, the roughness of the runway surface, the tire inflation pressure, and the airplane forward speed.

Indications are that hydroplaning will occur at lower speeds on dimpled or smooth tires than on ribbed tread tires. Grooves in the tire tread allow escape of water or slush from the tire footprint area. If no grooves exist in the tire tread, the water or slush will have less chance to squeeze out of the tire footprint area. Also, when the water or slush on the runway surface exceeds the depth of the tire grooves, the effect will be the same as for a smooth tire.

On dry runway surfaces the coefficient of friction is unaffected by tire wear. On wet runways, however, braking effectiveness is seriously degraded when the tire becomes badly worn. Use of ribbed tires with good tread depth is therefore recommended on wet or slush covered runways. Even during partial hydroplaning conditions, braking traction on rib tread tires may be expected to be better than for smooth tread tires.

The minimum depth of fluid on the runway required for hydroplaning depends upon the tire tread design and the roughness of the pavement surface. Hydroplaning with least fluid depth will occur with smooth tires on smooth pavement. Hydroplaning is less likely to occur with ribbed tread tires operating on grooved or textured pavement.

The possibility of hydroplaning conditions existing on a crowned runway will be less than on an uncrowned

one. The crown allows water to drain off rapidly and usually prevents a deep accumulation except during heavy downpours. Slush will not drain off as readily as water, and hydroplaning in slush can be expected even on crowned runways.

The minimum total hydroplaning speed is dependent upon tire inflation pressure. The higher the tire inflation pressure the less likely hydroplaning is to occur. Tires should be checked frequently during winter for correct tire inflation pressure. It has been determined that the minimum total hydroplaning speed in knots for smooth tires or ribbed tires operating in fluid deeper than their tread depth, is approximately equal to nine times the square root of the tire inflation pressure ($V_H = 9\sqrt{p}$).

Because of the lower inflation pressures specified for nose gear tires, they can be expected to hydroplane before the minimum total hydroplaning speed is reached on the main landing gear tires. Smooth nose gear tires at a tire inflation pressure of 90 psi totally hydroplane at a ground speed as low as 85 knots. Smooth main landing gear tires at a tire inflation pressure of 105 psi may totally hydroplane at a ground speed of about 90 knots. There is evidence that the forward main gear tires are more susceptible to hydroplaning than the aft main gear tires. This would be the result of the forward main landing gear wheels clearing a path through the fluid for the rear wheels.

EFFECTS OF HYDROPLANING

Hydroplaning results in a marked loss of coefficient of friction between the tire and runway surface. The loss in coefficient of friction also reduces the effectiveness of nose wheel steering, and consequently the ability of the pilot to cope with crosswinds.

Stopping distances increase considerably when braking traction is lost. Applying brakes to wheels which have already slowed down or nearly stopped due to hydroplaning will not improve the coefficient of friction between the tire and runway. Tests have indicated that at high ground speeds on a wet runway, braking effectiveness is only about one-third that on a dry runway. In slush, braking effectiveness drops to about one-fifth that which could be expected on a dry runway.

Steering and cornering of airplane tires is dependent upon tire contact with the runway surface. If tires lift completely off the pavement, ability to steer the airplane will be lost. Thus, the tires will be unable to develop resistance needed to counteract crosswinds. Unless aerodynamic controls are used and are effective, the pilot under these circumstances may be unable to keep the airplane from veering off the pavement.

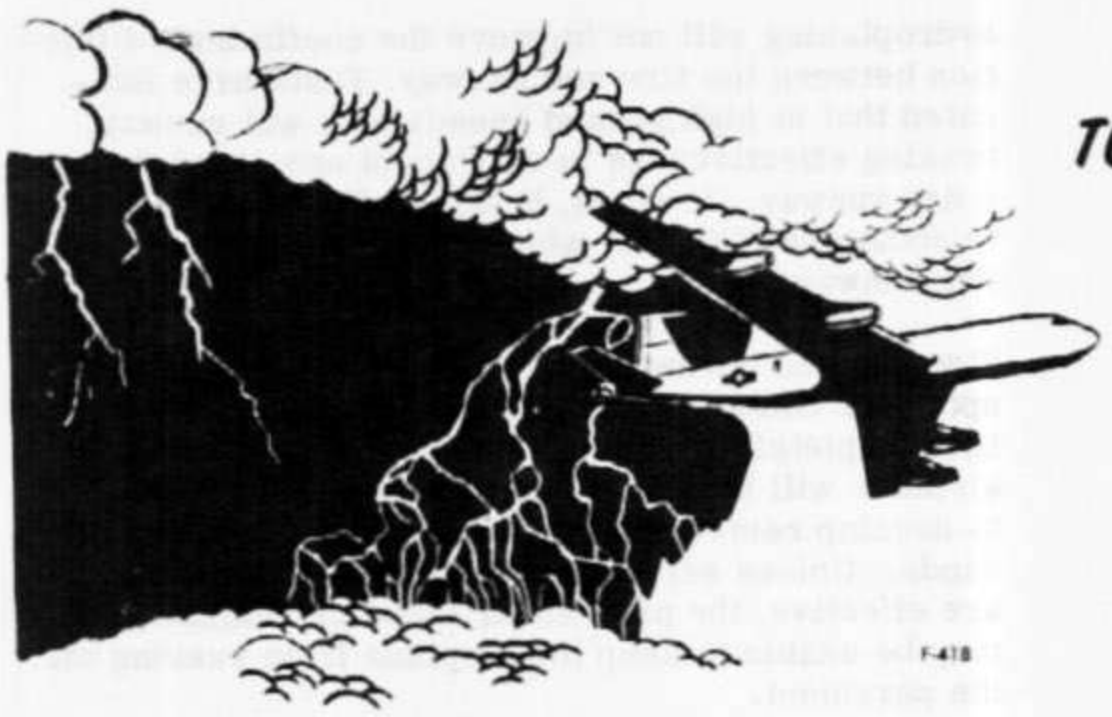
PILOT TECHNIQUE FOR HYDROPLANING

Takeoff Considerations

Takeoff in slush or on runways with standing water requires special care. Careful planning using flight manual procedures is mandatory. Refer to TAKEOFF in Section II, and to RUNWAY SURFACE in Part 2 of the Appendix, T.O. 1C-135(K)A-1-1.

Landing Technique

A check with the control tower will indicate braking and wind conditions which may affect ability of the airplane to stop on the runway after landing. In some instances it may be practical to fly over and inspect the surface before landing, particularly if existence of slush is suspected. The presence of water or slush on the runway makes it imperative that pilot technique be as recommended in LANDING ON SLIPPERY RUNWAYS, Section II; BRAKING ON WET, ICY OR SLUSH COVERED RUNWAYS, Section VII; OPERATIONS UNDER ICING CONDITIONS, this Section; and LANDING in Part 9 of the Appendix, T.O. 1C-135(K)A-1-1.



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TURBULENCE AND THUNDERSTORMS

CAUTION

Flight through thunderstorm activity, or known severe turbulence, is not recommended and should be avoided if at all possible. Careful judgment must be used by the pilot in determining capability to safely enter or circumnavigate areas of such weather activity. The appropriate corrective action to be taken if moderate or greater turbulence is forecast will be preplanned with assistance of the weather forecaster during the weather briefing for all flights.

Pilots are aware that it is possible, when flying in severe turbulence, to impose excessive structural loads on the airplane, and that airplane attitude may reach undesirable extremes. Turbulence penetration procedures have been established to minimize attitude excursions as much as possible and to maintain structural loads within acceptable limits. Recent evidence has borne out the validity of these procedures in that almost every structural breakup that has occurred in severe turbulence was preceded by a severe change in attitude with a subsequent combination of high stresses from both the recovery maneuver and the severe turbulence. The flexible swept back wing and high wing loading of the airplane make it highly possible that any structural damage which might occur in severe turbulence will be the result of airplane upset and recovery maneuvers in combination with turbulence, rather than the effects of turbulence alone. Retention of fuel in the reserve tanks until its use is required or until the last portion of the mission will improve the wing spanwise loading distribution.

Penetration of severe turbulence requires proper attention to airplane airspeed, attitude, thrust, altitude, and proper use of the autopilot.

AIRSPEED

While flight at low speeds is satisfactory in moderate turbulence, there are several disadvantages to flying at low speeds in severe turbulence. First, the airplane is closer to stall buffet and, since the angle of attack changes caused by severe turbulence can be high, there is a greater chance of encountering strong and alarming buffeting. This buffeting will be accompanied by high drag resulting in loss of altitude and will tempt the pilot to make undesirable thrust changes. Airplane trim changes due to thrust changes are greater at low speed compounding the difficulty of maintaining adequate attitude control. Second, it is easier for the airplane to be laterally and directionally upset at the lower speeds when turbulence is severe.

Because of the enumerated disadvantages of low speed flight, a penetration speed sufficiently high has been selected to provide adequate attitude control without subjecting the airplane to excessive structural loads. For simplicity it has been considered desirable to emphasize only one speed as target speed with the realization that sizable and rapid variations will likely occur depending on the severity of the turbulence.

It is considered highly undesirable to chase airspeed either with elevator or throttle manipulation since these efforts are usually ineffective. Moderate variations, either above or below the recommended penetration speed, are of minor consequence. Therefore, excessively abrupt or severe control or throttle movements should be avoided.

ATTITUDE

Flying under extremely turbulent conditions requires techniques which may be contrary to a pilot's natural reactions. Rapid and large aileron control inputs are permissible to hold the wings level, but in extreme turbulence, pitch attitude must be controlled using only small to moderate elevator control inputs to avoid over-controlling or over-stressing airplane structure. The natural stability of the airplane will work in a direction to minimize the loads imposed by turbulence.

The pilot should rely to a major extent on this natural stability and not become too greatly concerned about pitch attitude variations. Since there is always the uncertainty of the direction, timing, and size of the next gust, it is often better to do nothing at all than to attempt to control airplane pitch attitude too rigidly. The moderate control inputs that are considered desirable will not always allow very precise attitude control. Ideally, elevator control should be applied smoothly in a direction to resist motions away from the desired attitude, and the elevator should be returned to neutral when the airplane is progressing toward the desired attitude. The above described technique will help prevent over-controlling, will reduce the size of pitch attitude excursions, and will result in less g loads than a technique which very closely controls pitch attitude.

Pitch attitude should be controlled solely with the elevator; NEVER with stabilizer trim. Rapid changes in airspeed and attitude due to extreme gusts and drafts make stabilizer trim difficult to apply effectively. If trim has been applied to counter the first draft, the second draft, which will likely be in the opposite direction, will exaggerate the out-of-trim condition. It is therefore considered desirable to LEAVE THE STABILIZER TRIM ALONE in severe turbulence.

THRUST

Once the proper thrust setting for the speed recommended for penetration is achieved, it is undesirable to make thrust changes during severe turbulence. Large variations in airspeed and altitude are certain to occur in severe turbulence. The most desired thrust setting is one which will provide near level flight at the recommended penetration speeds in smooth air. In an emergency, however, when EPR gages fluctuate excessively, engine rpm can be used satisfactorily as an indication of thrust. Figure 9-4 provides rpm settings that will maintain near optimum penetration airspeed. The most important objective is to obtain an initial thrust setting reasonably close to the correct one.

Flying in turbulence or hail may cause engine inlet airflow distortion. This distortion, along with engine icing, angle of attack changes, and high altitude engine surge margins can result in engine surge and flameout. Therefore, the starter switches should be moved to FLIGHT START position as soon as turbulence is encountered.

ALTITUDE

Because of the high velocity updrafts and downdrafts in severe turbulence, large variations in altitude are certain to occur. Too much concern about these variations will merely lead to excessive control manipulations causing large structural load variations and unwanted airspeed excursions. Altitude should be allowed to vary within reasonable bounds.

At high altitudes or during high-speed cruise at intermediate altitudes, turbulence encounters may produce high speed buffeting. The airplane has been flown into the high-speed buffet region many times during flight tests. No unusual flight characteristics have been noted. However, the buffeting or shaking might be disconcerting, being somewhat similar in nature but more severe than the shaking that occurs when speed brakes are extended. When experienced in combination with severe turbulence, this buffeting might easily be incorrectly diagnosed as increased severity of the atmospheric disturbance. Even though prescribed procedures are used, an occasional encounter with high-speed buffeting in unexpected severe turbulence may be unavoidable above 35,000 feet. Such an occurrence should not be misinterpreted as a low speed stall with an accompanying rapid pushover for recovery. Any such action might aggravate the buffet situation by merely increasing the Mach number. This tendency to encounter high-speed buffeting in severe turbulence is increased with increasing altitude. It is therefore apparent that climbing in an attempt to avoid an area of expected severe turbulence could lead to this type of buffeting difficulty if the turbulent region could not be completely topped.

AUTOPILOT

It is recommended that, with the exception of the rudder axis, the autopilot be disengaged immediately upon encountering severe turbulence. The autopilot has only limited authority over the elevator control system and will call for stabilizer trim to augment this authority when necessary. Therefore, there is a good possibility that the airplane could be placed well out-of-trim by autopilot action. Also, an inadvertent disengagement at an inopportune time might initiate a maneuver from which it would be difficult for the pilot to recover. Thus, although the autopilot will do a reasonably good job of flying the airplane in light to moderate turbulence, it is not recommended for severe turbulence flight.

YAW DAMPING

Because of its swept wing, high weights, and the high altitude at which it flies, the airplane is more difficult to control in roll and sideslip than its straight wing predecessors. This type of motion is occasionally difficult to cope with from a piloting standpoint. Because the motion is easily initiated and poorly damped on swept wing configurations, the airplane autopilot rudder axis is designed to provide yaw damping to aid the pilot in flying the airplane. Flight test data substantiates that important benefits are obtained from the use of the yaw damping during turbulence penetration. Excursions in sideslip and roll are minimized and, even though the rudder control may be more active, the structural loads imposed on the vertical tail are considerably reduced. It is therefore recommended that the autopilot rudder axis always be engaged during penetration of severe turbulence.

PENETRATION PROCEDURES

The following procedures are to be used for flight in severe turbulence:

UNPLANNED PENETRATION

A. AIRSPEED - Approximately 280 KIAS or cruise Mach (.77 to .80) whichever is lower. Severe turbulence will cause large and often rapid variations in indicated airspeed. DO NOT CHASE AIRSPEED.

B. ATTITUDE - Maintain wings level and smoothly control pitch attitude. Use attitude director indicator as the primary instrument. In extreme drafts, large attitude changes may occur. DO NOT USE SUDDEN LARGE ELEVATOR CONTROL INPUTS.

C. STABILIZER - Maintain control of the airplane with the elevators.

CAUTION

After establishing the trim setting for penetration speed, disregard momentary airspeed changes and DO NOT CHANGE THE STABILIZER TRIM SETTING.

D. THRUST - Engine starter switches should be in FLIGHT START. Make an initial thrust setting for the target airspeed. CHANGE THRUST ONLY IN CASE OF EXTREME AIRSPEED VARIATION.

E. ALTITUDE - Do not deliberately change altitude; deliberate descent will require retarding of throttles and a change in pitch attitude, both of which are considered hazardous to accomplish in severe turbulence. Large inadvertent altitude variations can occur, however, but sacrifice altitude to maintain the desired attitude and airspeed. DO NOT CHASE ALTITUDE.

F. AUTOPILOT - Only autopilot power switch and rudder engage switch will be ON. It is desirable to engage the rudder axis when the rudder is centered.

G. DO NOT LOWER LANDING GEAR OR FLAPS.

H. Check that all passenger and crew safety belts are fastened. Passengers must be advised to fasten safety belts in sufficient time to firmly strap in prior to entering areas of forecast or suspected turbulence.

J. When penetrating thunderstorm turn on the pitot heat and window heat systems, the Q-inlet and engine anti-icing systems, and the thunderstorm lights. Move the window heat switches to HIGH position.

PLANNED PENETRATION

The recommended procedures for planned penetration are identical to those described above, with the following exceptions:

A. With fuel in the upper deck tank, penetration should be planned for an altitude of 10,000 feet below maximum range cruise altitude, at an airspeed of 280 KIAS.

B. Without fuel in the upper deck tank, penetration should be planned for an altitude of 10,000 feet OR MORE below maximum range cruise altitude at an airspeed of 280 KIAS.

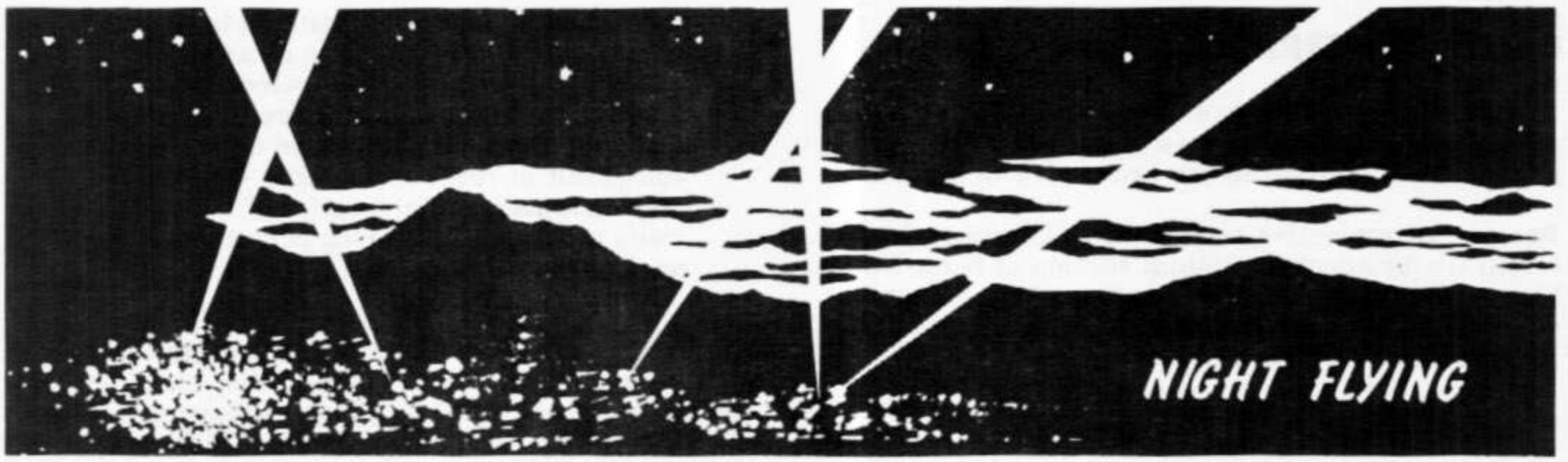
WARNING

In penetrating thunderstorms it is probable that load factors approaching zero g will be encountered. If this occurs, it can be expected that one or all generators will be lost due to an inability of the generator drive to function under zero g conditions. The resultant loss in electrical power, though temporary, will result in a loss of the APN-59 and the autopilot because of the recycling times required in this equipment after interruption of power. The APN-59 is necessary to assist in flying a path through a thunderstorm area. The autopilot rudder axis (yaw damper) is necessary for effective control of the airplane. The probability of loss of electrical power should be weighed carefully before deciding on a thunderstorm penetration.

TURBULENCE PENETRATION THRUST SETTINGS - PERCENT N_2 RPM

GROSS WEIGHT - 1000 POUNDS	ALTITUDE			
	15,000	25,000	35,000	45,000
120	82.3	82.8	83.0	86.0
160	83.1	83.9	84.7	-
200	84.1	34.6	86.8	-
240	85.2	86.1	90.0	-
280	86.5	87.9	-	-

Figure 9-4



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On entering airplane, turn on interior lighting and adjust light rheostats to provide illumination of all necessary controls and panels. Lights should be as dim as possible so the crewmembers' ability to see at night will not be greatly affected or limited. Before taxiing at night, turn taxi lights ON and retractable terrain light as required. Before takeoff, turn off all unnecessary interior lights and turn landing lights ON. After takeoff, landing lights and retractable terrain light will be turned off at 1000 feet above the ground, unless required to be turned off sooner because of smoke, haze, or clouds. Normally, the nacelle illumination lights will be turned ON by the boom operator after takeoff, and will be left on at all times during night flight, except at times when the glare would be objectionable.

The nacelle illumination lights may also be used to inspect wings and engine inlets for ice formation. If a night landing is to be made after flight in icing conditions, the landing lights may lose part or all of their effectiveness due to being covered with ice. The retractable terrain light, which will normally be used on all night landings, will assist in landing in these conditions.

For landing, unless a restriction to visibility exists, the landing lights will be turned ON at least 500 feet above the ground.



COLD WEATHER PROCEDURES

F-420

The majority of cold weather operating difficulties are encountered on the ground. The following instructions are intended to supplement the normal operating instructions in Section II, and should be followed where applicable as arctic-type weather is encountered. Extreme diligence on the part of both the ground and flight crews is the answer to successful arctic operation. Icing conditions during flight will not be considered here, as they have been covered under the heading of ICE AND RAIN this Section.

BEFORE ENTERING THE AIRPLANE

Even though preflight has been accomplished by the ground crew, the flight crew should make a number of checks in addition to the procedure in Section II.

Remove all protective covers. Check engines for internal ice by checking bottom section of front stator blades for evidence of ice, and see that all turbine wheels rotate freely. Check pitot tubes and static ports for ice; remove if present.

NOTE

Engine heat on shutdown melts ice accumulated during flight and the resulting moisture will refreeze in the lower sections of the front stator and rotor blades. An attempted engine start may result in starter failure. If engine is not free to rotate, external heat must be applied to forward engine sections to produce thawing. Start the engines as soon as possible after the application of heat in order to remove all moisture before refreezing can recur.

Although not required, it is desirable to preheat the crew compartment during cold weather operations.

CAUTION

Remove snow from top of fuselage as heating the pressurized compartment may result in melting of snow and ice on top of the fuselage. As a result, ice may form in the vicinity of the pitot heads and static ports which can deform the airflow and lead to inaccurate airspeed indications. Frost can form over the static ports as a result of temperature changes caused by cold fuel in the forward body tank.

WARNING

Clear areas of APU exhaust and intake ports of snow and ice. Failure to clear these ports can prevent closure of the valves, which will affect pressurization. Failure to completely close the cabin air inlet valve before takeoff can result in reverse rotation, overspeed, and subsequent disintegration of the APU cabin air fan, endangering personnel in the area of the APU.

Check that airplane exterior surface is free of ice and snow. Takeoff with light coatings of frost (approximately 1/8 inch) or powdery snow can be performed safely. Under conditions of blowing snow or where airplane has been exposed to unusual freezing conditions that require the use of deicing fluid (MIL-A-8243A or MIL-E-5559) or heat on the exposed surfaces, the control surface balance bays shall be visually inspected for evidence of snow or ice accumulations. When deicing with the MB-3 rig or by manually applying deicing fluid or by use of portable ground heaters, be sure that horizontal stabilizer is in "full up" (airplane nose down) position and that the elevator control surfaces are held in the "full down" position either by a bungee on the control column or by a crew member holding the control column full forward so that the runoff from the deicing operation does not seep into the balance bay areas and refreeze. (See figure 9-5.) Any ice or slush in the balance bay could possibly limit control surface movement and reduce airplane control. Deice from the leading edge to the trailing edge to prevent runback into the balance bays. All accumulation of snow, ice and heavy frost must be removed from the control surfaces to meet control surface balance requirements. When deicing is completed, move deicing rig in position in order to grasp the trailing edge of each control sur-

face and move by hand through the full travel to insure freedom of movement. Do not chip or scrape ice from the surfaces as this may damage the airplane.

WARNING

- Snow and ice accumulation in any significant degree must be removed from the upper aircraft control surfaces prior to flight. Snow or ice accumulation can increase takeoff distances and adversely affect climbout performance, stalling speed, and handling characteristics. Inflight structural damage can result from vibrations induced by unremoved accumulations.

- If snow is left on the radome it will tend to blow back on the windshield during takeoff and will restrict visibility during this critical period.

CAUTION

If deicing fluid is used, care should be taken to prevent it from coming in contact with plexiglas or plastic since it will tend to craze or soften these materials.

Check that all dirt or ice has been removed from landing gear shock struts, actuating cylinder pistons, and limit switches. Check that exposed parts of shock struts and pistons have been wiped with a rag soaked in hydraulic fluid.

ON ENTERING THE AIRPLANE

Check that anti-exposure suits are stowed. Check for stowage of seat-type survival kits. Survival kits should be type-designed for cold or very cold climates, depending on weather and terrain over which mission is to be flown.

Check control surfaces and trim tabs for proper operation. Operate all control surfaces several times to determine if operation is normal and not hampered by ice in hinge joints, which could not be seen during visual check of the airplane.

NOTE

Due to some loss of cable tension when operating at extreme low temperatures, it may be necessary to obtain assistance from a ground crew member who should push on the elevator

CONTROL SURFACE DEICING

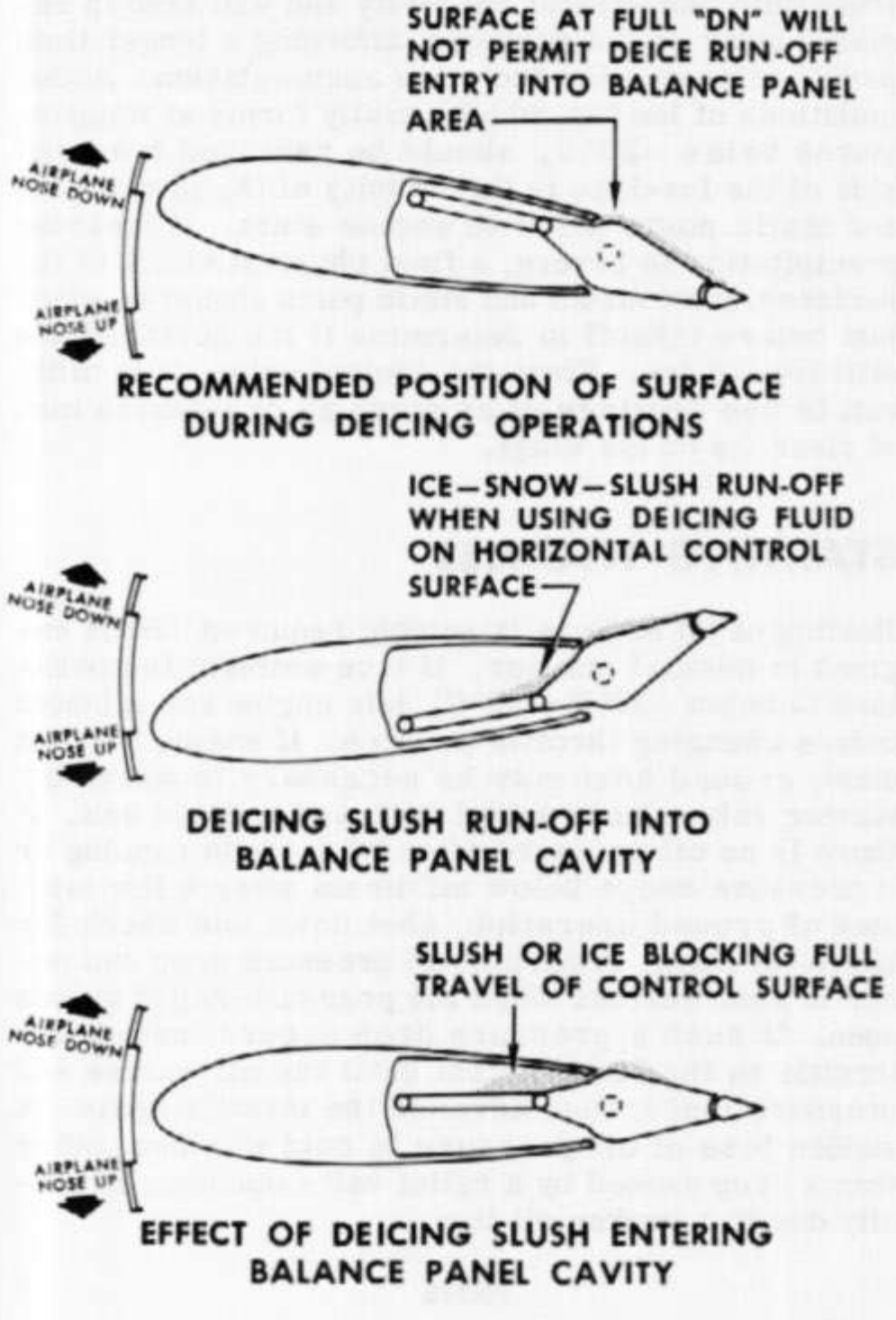


Figure 9-5

in order to reach the full up elevator position. Increase in control forces during low temperature ground checks can be expected due to low cable tension, cable seals, congealed oil in the snubbers and bearings.

BEFORE STARTING ENGINES

Connect external power and make sure that wheel chocks are placed securely so danger of slipping will be minimized during engine start and warmup. Operate brakes several times with increasing pressures before setting parking brakes. During weather conditions in which ice or snow is continually accumulating during ground operation just prior to takeoff, ice accretion may be kept to a minimum by the application of cold concentrated deicing fluid (preferably

MIL-A-8243A) to the previously deiced surfaces just prior to engine start. Takeoff should be made within thirty minutes of application. The cold deicing fluid has greater viscosity and will tend to remain longer on the surfaces, affording a longer time period of protection from ice accumulation. Accumulations of ice fog, which usually forms at temperatures below -20° F, should be removed from the side of the fuselage in the vicinity of the pitot masts and static ports prior to engine start. If freezing precipitation is severe, a final physical check of the surfaces, pitot masts and static ports should be made just before takeoff to determine if the surfaces are still free of ice. From the control cabin, it is difficult to see coatings of as much as one-fourth inch of clear ice on the wings.

STARTING ENGINES

Heating of jet engines is seldom required. Start engines in normal manner. If true ambient temperature is below -22° F (-30° C), idle engine two minutes before changing throttle position. If engine will not start, ground heat may be necessary to warm the starter valve, fuel control unit, and ignition unit. If there is no oil pressure after 30 seconds running or if pressure drops below minimum after a few minutes of ground operation, shut down and check for blown oil lines. A normal oil pressure drop can occur in cold weather when the pressure relief valves open. If such a pressure drop occurs, retard the throttle to the IDLE detent until the oil warms and pressure rises; then advance the throttle again. A sudden loss of oil pressure in cold weather, other than a drop caused by a relief valve opening, is usually due to a broken oil line.

NOTE

During cold weather starts, oil pressure might temporarily exceed maximum limits until oil temperature warms slightly.

To decrease the danger of slipping when the parking area is covered with ice or snow and no external air cart is available, sufficient air for starting the remaining engines individually can be obtained by advancing the number 4 throttle sufficiently to close the surge bleed valve, but not less than 1.85 EPR. The closing of the surge bleed valve must be determined by the ground crew and reported to the pilot.

WARMUP AND GROUND TESTS

Inspect instruments for normal operation and monitor wing flap operation.

WARNING

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

CAUTION

When operating the wing flaps at low temperatures, the flap position indicators should be closely observed for positive movement. If the flaps should stall, immediately place the flap lever in the same degree detent indicated by position indicators to prevent damage to linkage.

NOTE

- The indicated oil pressure may be slow to rise to the normal operating range after starting a cold soaked engine during very cold weather. If some indication of oil pressure is observed when the engine is first started, up to three and one half minutes may be allowed for the indicated oil pressure to reach the minimum limit.
- No warmup is required if the oil pressure remains below 50 psi at takeoff EPR. A temporary high pressure of above 50 psi at temperatures below 0° F (-18° C) is not dangerous, but takeoff should be delayed until the pressure drops below 50 psi.
- Do not turn on unnecessary electrical equipment until generators show output.

TAXIING INSTRUCTIONS

If snow or slush conditions exist on taxi strips, maintain inboard engine thrust at IDLE; thrust settings above idle on inboard engines may blow snow and slush back on aft fuselage and tail surfaces causing a hazardous flight condition. Outboard engines may be used for taxi or turning as necessary. Reduce speed and increase normal taxi interval time between airplanes on ice or snow covered area. Be especially careful in maneuvering near other airplanes as the downblast of the engines develops a great deal of ice on the ramp and takeoff area of the runway and blows snow and slush which freezes into ice on contact. Avoid taxiing in deep snow or slush as steering will

be more difficult and brakes, gear, and flaps may freeze after takeoff. Do not taxi with flaps down. Exercise the flight controls frequently to check for freedom of movement. During taxiing, exercise the nose wheel steering in both directions to permit the circulation of warm hydraulic fluid through the nose wheel steering cylinders. This will minimize the lag encountered in nose wheel steering at low temperatures.

CAUTION

On ice covered taxiways and runways, and on painted areas that are moisture covered, taxi with extreme caution. High crosswind or excessive speed during turns may start a skid. Also, be alert for extreme slipperiness at the approach end of snow covered runways. The intense heat produced by jet engine blasts may form ice due to melting and refreezing.

NOTE

Taxi time on snow and ice will be longer than under normal conditions, so plan the shortest possible route to takeoff point to conserve fuel and reduce the amount of ice fog generated by jet engines. This fog may delay takeoff by lowering the visibility below takeoff minimum.

BEFORE TAKEOFF

See ICE AND RAIN, this Section.

TAKEOFF

Preflight planning for takeoffs on icy or snow covered runways should include loading the airplane for a forward cg (approximately 23% MAC). Apply brakes and advance throttles to takeoff EPR. If airplane starts to slide on ice or snow before full power is reached, release brakes immediately and begin takeoff run. Continue engine check and runup during early part of takeoff run. If takeoff cannot be accomplished due to engine malfunction, retard throttles to idle and bring airplane to normal stop. Consult Part 2 of Appendix T.O. 1C-135(K)A-1-1 for the effect icy or snow covered runways have on takeoff performance. During takeoffs on icy or snow covered runways the lag in nose gear steering and the possibility of nose gear skidding must be realized by the pilot and corrections anticipated. Increased directional control may be obtained by the use of the ailerons (bicycling) between 60 and 100 knots.

Ice and light coverings of powdery snow have little effect on takeoff distance. Slush and water, on the other hand, can increase ground-run distances significantly due to the increased rolling resistance. Wet dense slush sometimes results when packed snow partially melts. This presents the worst takeoff condition, primarily because the water is prevented from draining off the runway surface. Water alone would present much the same problem of increased rolling resistance if it was retained on the surface. Normally, the crowned runway design allows water to drain away quickly. Slush, however, is a variable semiliquid that stays in place on the runway. Taking off in slush may produce two effects. First, and undoubtedly the most serious is the possibility of the airplane not attaining takeoff speed before running off the end of the available runway. Actual data on the specific increases in ground run distances are difficult to establish due to the differences in type, density, and depth of slush.

WARNING

It is recommended that takeoff not be attempted when slush and water puddles on the runway exceed 1/2 inch in depth. When slush or puddles are less than 1/2 inch in depth, takeoff distances may increase up to 25%. An instance has been recorded where puddles and running water ranging in depth from 1 to 4 inches resulted in an increased takeoff distance of 27%.

The second effect to be considered when considering a takeoff with slush on the runway is possible damage to the airplane from the impingement of slush.

CAUTION

Slush and water puddles on the runway can cause significant structural damage to the airplane, particularly at high speeds. If possible, known water puddles and slush should be avoided.

AFTER TAKEOFF

CAUTION

During operation at low gross weight and particularly at low ambient temperatures, the airplane accelerates very rapidly; therefore, care should be taken not to exceed the flap placard speeds during flap retraction.

If windshield anti-icing is not adequate with switch in NORMAL, place switch in HIGH. Watch closely for ice formation on critical areas; position engines anti-icing switch to ON as soon as detected and turn OFF as soon as conditions improve. For engine icing problems after takeoff, see ENGINE ICING in this Section.

CLIMB

Follow normal procedures for climb.

CAUTION

Since low OAT will cause a considerable increase in jet engine thrust, the airplane operating limitations may be reached with somewhat lower throttle settings.

DURING FLIGHT

NOTE

A gain in range may be obtained on a very cold day over normal temperature conditions. See Part 5 of the Appendix, T.O. 1C-135(K)A-1-1.

Adjust cabin temperature control to give required cabin heat. Under certain atmospheric conditions, it is possible for fog to accumulate in the cabin while pressurized and seriously restrict visibility. If this occurs, immediately turn cabin temperature control full WARMER (if operating under manual temperature control, hold cabin temperature control in WARMER). After cabin has cleared, reposition cabin temperature control (if operating under manual temperature control, move cabin temperature control to COOLER) to obtain cabin air temperature sufficiently higher than original to prevent recurrence of fog condition. If comfortable temperature cannot be maintained without fogging, reduce cabin pressure until an area with more favorable atmospheric conditions is entered.

DESCENT

See ICE AND RAIN, this Section.

LANDING

Landing procedures will be in accordance with Section II, LANDING ON SLIPPERY RUNWAYS.

STOPPING ENGINES

Use normal procedure to stop engines.

POSTFLIGHT

If it is anticipated that ice and snow will accumulate on the airplane after parking, set horizontal stabilizer to 2.5 units nose down. Have wheel chocks in place so parking brakes can be released; if moisture has entered brake assembly around brake shoes, leaving parking brakes released will forestall possibility of brakes freezing in position. Have airplane serviced with fuel and oil and drain all sumps before condensates reach freezing point. Check that all engine protective covers and intake and tailpipe plugs are installed. See that wing, empennage, and pitot tube covers are installed if there is the slightest possibility of blowing or drifting snow; have both main landing gear wheel well covers, air conditioning intake, and exhaust plugs installed. Remove ice and dirt from shock struts. If layover of several days is anticipated, the nicad battery for the airplane should be removed if the battery is expected to be subjected to temperatures of less than -20° F for 4 hours or more. If the APU is expected to be started, the APU nicad battery should be removed if battery ambient temperatures are expected to be less than 0° F for more than 4 hours. The APU battery need not be removed if the APU will not be started since cold soaking will not damage the battery. Cold soaking reduces battery output and prevents satisfactory charging until the battery is warmed. When removing batteries from the airplane due to cold temperatures always store them in a warm place.



HOT WEATHER AND DESERT OPERATION

F-422

High temperatures, alone or coupled with high humidity or blowing sand and dust, will complicate normal operations. Proper protection and inspection of the airplane while it is on the ground and observance of the precautions covered in this Section will assure you of the most successful operation. Examine the Appendix, T.O. 1C-135(K)A-1-1, critically to determine the adverse effects of high temperature on airplane performance.

BEFORE ENTERING THE AIRPLANE

Cool the pressurized compartment with a portable air conditioner if one is available. Inspect more closely tires and shock struts for proper inflation and accumulators for proper air charge. Be alert for hydraulic leaks. Clean dust and sand from struts and other hydraulic pistons and from limit switches. Inspect hatch and door seals for deformation and damage due to high temperatures. Remove all protective covers and dust plugs. Be sure that the airplane is positioned to avoid sand-blasting other equipment during start and run-up.

AFTER ENTERING THE AIRPLANE

Check instruments and electrical equipment for excessive moisture due to high humidity. If operating in a dusty location, check for accumulated dust at control, instrument, and electronic equipment areas inside the airplane. Check that survival kits appropriate to the climate are stowed aboard.

STARTING ENGINES

Complete as much of the preflight as possible before starting the engines to minimize the duration of engine ground operation. Use normal starting procedures. When using engine bleed air for the engine start, use a minimum of 90% rpm on the source engine to assure an adequate air supply to the engine being started. Expect the engines to accelerate to idle more slowly than on a normal or cold day because the air is less dense.

NOTE

Engine ground operation shall be limited to a maximum of five minutes at 90% rpm or above when the engine is fully cowled to prevent accessory overheat.

TAXIING

Use the brakes as little as possible during taxiing since brake cooling is retarded by high ambient temperatures. Keep sufficient distance between airplanes to prevent sand and dust from blowing into the engines.

TAKEOFF

Be prepared for sudden gusts of wind during takeoff. Strict adherence to recommended takeoff and climbing speeds is necessary during extreme high temperature operations because airplane performance decreases with temperature rise. Takeoff distances increase significantly as the temperature rises. See Part 2 of the Appendix, T.O. 1C-135(K)A-1-1.

CLIMB

Use the normal climb procedure.

NOTE

Temperatures above standard day conditions will decrease overall airplane performance. Rate of climb will decrease while climb time, climb fuel, and climb range increase. See Part 4 of the Appendix, T.O. 1C-135(K)A-1-1.

DURING FLIGHT

Avoid flying through dust or sand storms to prevent damage to the engines. To determine the effects of temperature on range and endurance, refer to Parts 5 and 6 of the Appendix, T.O. 1C-135(K)A-1-1.

NOTE

During prolonged flights at low altitude, high temperature conditions, use of the air refueling pumps in the forward and aft body fuel tanks should be alternated at frequent intervals to reduce probability of overheat of the hydraulic systems.

DESCENT

Use the normal descent procedure.

APPROACH AND LANDING

During extremely high temperatures, you must be very careful to adhere to the normal landing procedures. Since the air is less dense, true airspeeds are higher at the same indicated airspeeds and true stall and touchdown speeds will be higher. Do not attempt approaches at less than recommended touchdown speed plus 10 knots over the end of the runway. Anticipate longer ground rolls. Use care during brake operation to avoid overheating the brakes.

STOPPING ENGINES

Use the normal procedure for stopping the engines. Have the wheel chocks inserted as soon as the parking position has been reached and release the parking brakes to aid in brake cooling. After maximum performance landings or excessive braking, personnel should stay clear of the main landing gear areas as much as possible until the brakes have cooled.

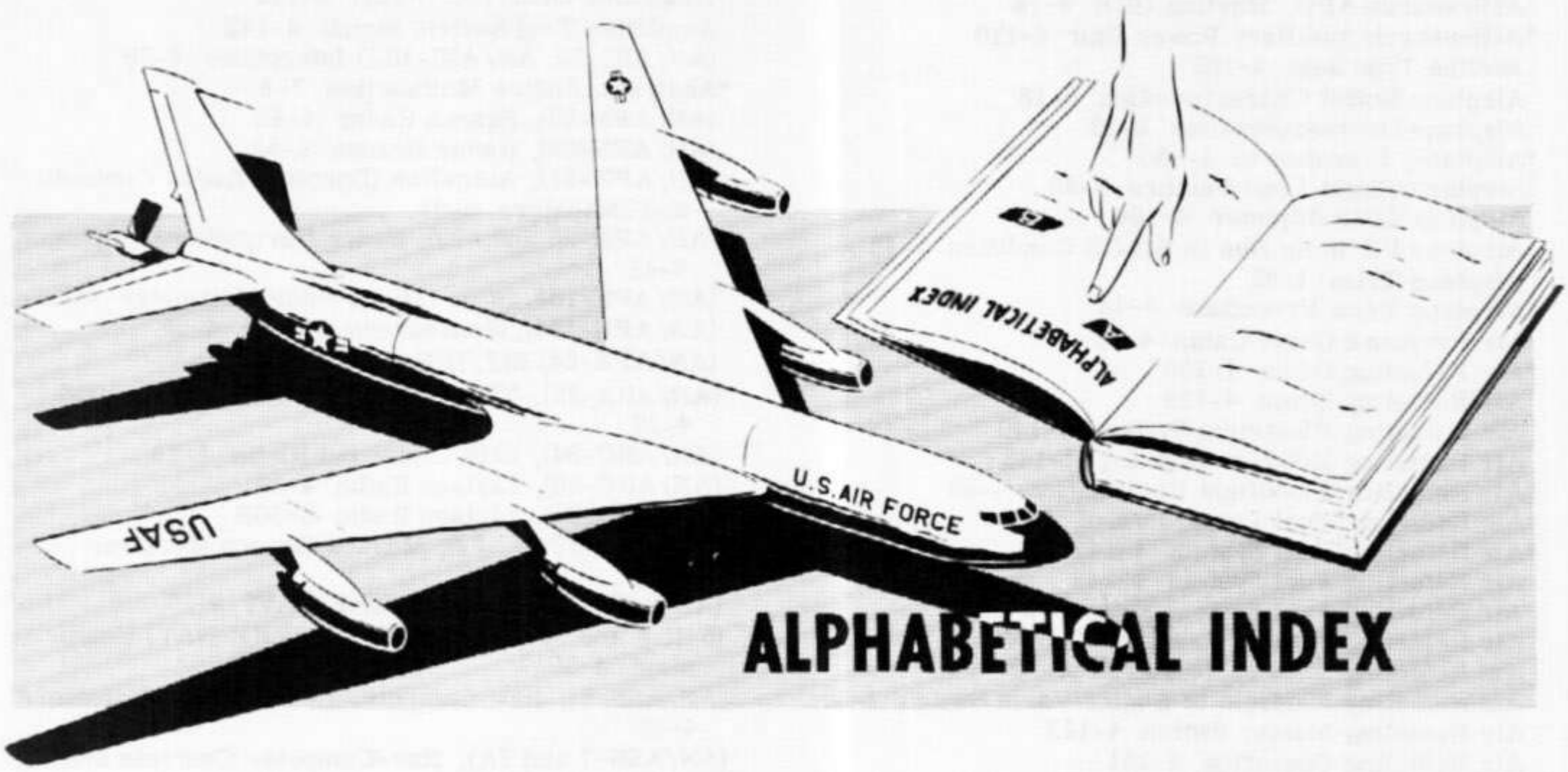
BEFORE LEAVING THE AIRPLANE

Have all protective plugs and covers installed. Except in dusty or rainy weather, leave the doors and hatches open for ventilation and open the nose and main landing gear wheel well doors.

NOTE

- In dusty locations, if it is necessary to leave hatches or doors opened, all equipment inside the airplane should be protected with dustproof covers where possible to keep out blowing dust and sand.

- In hot weather do not top off fuel tanks since expansion due to high temperature may cause considerable overflow thus presenting a fire hazard.



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28 APR 1976

T.O. 1C-135(K)A-1S-113

OPERATIONAL SUPPLEMENT

FLIGHT MANUAL

USAF SERIES

KC-135A

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1C-135(K)A-1.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AFFECTED AF PERSONNEL.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

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2 DECEMBER 1974

1. PURPOSE.

To provide flight crews with information on airplanes modified by T.O. 1C-135-763, LIFE HISTORY RECORDING SYSTEM installation (MX U-553/A).

2. GENERAL.

In recent years, the Air Force has experienced an increasing number of airplane structural failures which have resulted in catastrophic loss, unforeseen priority modification programs and degradation of operational readiness. As a result of this trend, the Aircraft Structural Integrity Program (ASIP) was established. An important part of the ASIP is the determination and monitoring of airplane service life. The Life History Recorder System, installed on airplanes modified by T.O. 1C-135-763, will provide invaluable information for use in this effort. These modified airplanes will serve as a sample of fleet usage and fatigue damage accumulation.

3. INSTRUCTIONS.

NOTE

The following operational procedures will be utilized by the responsible technician/ air crew member as designated by each using command.

LIFE HISTORY RECORDING SYSTEM (AIRPLANES WITH TCTO-763)

A. DESCRIPTION.

A life history recorder (LHR) is installed which will obtain structural stress and airplane usage data for the purpose of more accurately predicting life expectancy of the airframe in support of the Aircraft Structural Integrity Program (ASIP). The recorder is located on the right side of the fuselage just aft of the electronic equipment cabinet.

The system consists of several airborne elements: A recorder, converter/multiplexer and various airplane sensors. Parameters monitored by these sensors are airspeed, altitude, "G" loads, wing flap positions, and strain at various locations. Operating power to the recorder is 115-volt AC through a circuit breaker marked ASIP/LHR on the GENERATOR No. 2 section of the MCBP. Twenty-eight-volt DC power is supplied to the recorder through a circuit breaker marked ASIP/LHR on the TR BUS No. 2 section of the MCBP.

B. DOCUMENTARY DATA SWITCHES.

Twenty-four documentary data thumbwheel type switches accessible through the lower hinged door, are provided to manually dial in pertinent documentary data (figure 1). Data is manually dialed in prior to taxiing for takeoff. These switches are grouped in sets to record data as follows:

(1) AIRPLANE SERIAL NUMBER: Dial in the last four digits of the airplane serial number.

(2) AIRPLANE GROSS WEIGHT: When gross weight is 100,000 pounds or greater, dial in the first four digits of gross weight (before flight).

(3) FUEL WEIGHT: Dial in fuel weight in the same manner as airplane gross weight (before flight).

NOTE

The first digit will always be zero when fuel weight is less than 100,000 pounds.

(4) BASE OF ASSIGNMENT: Dial in applicable base of assignment from Table 1. Base of assignment is defined as Home Base. This should not change unless the airplane is on extended temporary duty planned for 15 days or more at another base. If this occurs, dial in the new base.

(5) MISSION: Dial in applicable mission code from Table 2 (before flight).

(6) CONFIGURATION: Dial in applicable configuration code from Table 3.

(7) DATE; YR-MONTH-DAY: Dial in the zulu date on which the flight takes place. For single digits on month and day, precede the number with a zero (before flight).

C. RECORDER TAPE CARTRIDGE.

A removable recorder tape cartridge with a capacity to record 15 hours of data, is contained within the recorder. This tape cartridge is removed when full and shipped to the data processing facility, Oklahoma City ALC/AIO, Tinker AFE OK 73145. Installation/removal of the tape cartridge is accomplished by opening the upper hinge door of the recorder and depressing the center spring lock. If it is determined that inadequate tape remains for the flight, remove the existing cartridge and replace with a fresh one. Tape remaining may be read directly from the cartridge, in percent of usable hours, through a window located on the front of the recorder unit (figure 1).

D. RECORDER POWER CIRCUIT.

The crew entry/cargo door not latched warning circuit activates the recorder. Both doors must be closed and locked to activate the recorder.

E. BUILT-IN-TEST BUTTON.

A press-to-test button, located on lower front of the recorder, is used to allow the system to perform a self test (figure 1). When the button is pressed, the recorder will self-test.

F. INDICATOR LIGHTS.

There are four indicator lights on the lower front of the recorder (figure 1). These lights are decaled TEST, MUX, SUP DATA and REC. The function of the TEST light, while illuminated, is to indicate the recorder is performing a self-test. The function of the MUX, SUP DATA and REC lights, if illuminated,

is to indicate that the system has a malfunction.

G. OPERATIONAL CHECKOUT OF THE RECORDER SYSTEM.

The operational checkout of the recorder will be accomplished by the responsible technician/flight crew member after dialing in the pertinent data. Accomplish system check as follows:

(1) Ensure tape cartridge is installed properly by firmly pressing the left and right-hand corners of cartridge. Ensure remaining tape is adequate for flight.

(2) Ensure all pertinent data has been dialed into the recorder.

(3) Close both doors on the recorder and latch securely. The tape cartridge door must be closed as recorder will not operate unless a built-in switch is closed by the upper door.

NOTE

CAL/DEACTIVATE switch on the recorder should remain in DEACTIVATE (UP) position at all times.

(4) Ensure all circuit breakers are closed.

(5) Press TEST, MUX, SUP DATA, and REC lights for light bulb check. Approximately 30 seconds after Power Switch has been turned on, the red TEST light will illuminate. This light indicates that an automatic built-in-test (BIT) is being accomplished. This TEST light will last for approximately 10 seconds and will go out. If MUX, SUP DATA, and REC lights do not illuminate, recorder system is now in a "GO" condition.

NOTE

The system should be allowed to operate throughout the taxi, take-off, flight and landing regimes with no further attention.

(6) If the MUX, SUP DATA, and/or REC light should illuminate, a malfunction exists. Retest the system again by momentarily pressing the Built-In-Test button. The red TEST light will illuminate and remain on during the BIT for approximately 10 seconds. If any of the failure lights still illuminate, a malfunction condition exists. Maintenance will perform system checkout at the earliest possible time.

H. AFTO FORM 495.

The AFTO Form 495, as illustrated in figure 2, is a keypunch size card form and will be used in processing data at the Data Processing Facility, Oklahoma City ALC. The form will be shipped to the field with each fresh cartridge.

(1) At the time of regular cartridge replacement, only the following data elements on the AFTO Form 495 will be completed as shown in figure 2.

BLOCKS	ENTRIES
2-7	Aircraft type (e.g. WC-135B)
8-14	Aircraft Serial Number
15-18	ICAO Code of Home Base
19-22	Numerical Designation of Squadron
27-32	Date (year, month, day) Cartridge Instl.

BLOCKS	ENTRIES
33-37	Airframe hours at time of Cartridge Instl.
38-41	Cartridge serial number; if number is more than four digits, enter last four digits.

(2) The following additional data elements on AFTO Form 495 will be completed at periodic intervals upon special request from Oklahoma City ALC/AIA.

BLOCKS	ENTRIES
*42-45	Recorder Serial Number
*46-49	Converter/Multiplexer Serial Number
50-60	Blank
*61-64	Normal Accelerometer Serial Number
65-68	Blank
*69-72	Altitude/Airspeed pressure transducer Serial Number

*All serial numbers may be found in the airplane's AFTO Form 95, SIGNIFICANT HISTORICAL DATA.

I. During system checkout, the responsible technician will dial pertinent documentary data into the recorder (figure 1). The following data for take-off configuration are required.

(1) Aircraft Serial Number - Four digits are provided. Dial in the last four digits of the aircraft serial number. This data should not be changed.

(2) Aircraft Gross Weight - Four digits are provided. Dial in the first four digits of aircraft gross weight. This data is easily obtainable from the weight and balance clearance form (DD Form 365F).

(3) Fuel Weight - Four digits are provided. Dial in fuel weight in the same manner as gross weight. This data is also obtainable from the weight and balance clearance form.

J. After dialing in pertinent documentary data, the responsible technician/crew member will perform an operational system check as follows:

(1) Ensure tape cartridge is installed properly by firmly pressing the left and right-hand corners of cartridge.

(2) Close both doors on the recorder and latch securely. The tape cartridge door must be closed as recorder will not operate unless a built-in switch is closed by the upper door.

NOTE

CAL/DEACTIVATE switch on the recorder should remain in DEACTIVATE (UP) position at all times.

(3) Ensure all circuit breakers are closed.

(4) Press TEST, MUX, SUP DATA, and REC lights for light bulb check. Approximately 30 seconds after OFF/ON switch has been turned on, the red TEST light will illuminate. This light indicates that an automatic built-in-test (BIT) is being accomplished. This TEST light will last for approximately 10 seconds and will go out. If MUX, SUP DATA, and REC lights do not illuminate, recorder system

is now in a "GO" condition.

(5) If the MUX, SUP DATA, and/or REC light should illuminate, a malfunction exists. Retest the system by momentarily pressing the Built-In-Test button. The red TEST light will illuminate and remain on during the BIT for approximately 10 seconds. If any of the failure lights still illuminate, a malfunction condition exists. Perform system checkout and test.

(6) Allow system to remain on for at least 2 minutes. If, after being preflighted, the airplane will not be scheduled for flight within the next 10 days, remove the cartridge and ship to Oklahoma City ALC/AIO as per instructions reflected in paragraph 3.C.

LIFE HISTORY RECORDER

Figure 1.

TABLE 1

BASE OF ASSIGNMENT (HOME BASE)

CODE	AIR FORCE BASE
01	Altus
02	Andersen, Guam
03	Andrews
04	Barksdale
05	Beale
06	Blytheville
07	Chicago - O'Hare Intl
08	Carswell/Gen. Dyn.
09	Castle
10	Davis-Monthan
11	Dyess
12	Edwards
13	Eielson
14	Ellington
15	Ellsworth
16	Fairchild
17	Forbes
18	Goose AB
19	Grand Forks
20	Griffiss
21	Grissom
22	Hickam
23	Hill
24	K. I. Sawyer
25	Kadena AB
26	Kelly
27	Kincheloe
28	Kirtland
29	Hanscom
30	Langley
31	Loring
32	MacDill
33	Majors Fld., Greenville ("E" Sys)
34	March
35	Mather
36	McClellan
37	McConnell/Boeing, Wichita
38	McCoy
39	Mildenhall, RAF
40	Minot
41	Offutt
42	Ontario
43	Patrick
44	Pease
45	Plattsburg
46	Ramey
47	Rhein-Main/Ramstein
48	Rickenbacker
49	Robins
50	Seymour-Johnson
51	Shemya
52	Tinker
53	Torrejon AB
54	Travis
55	U-Tapao Afld
56	Westover
57	Will Rogers Muni.
58	Wright-Patterson
59	Wurtsmith
60	Yokota AB
61	Zaragoza AB

NOTE

Use Code 00 for bases not listed above.

TABLE 2

MISSION TYPE

CODE	TYPE
01	Training
02	Operational
03	Flight Test (-6)

TABLE 3

CONFIGURATION CODE

TMS	AIRCRAFT
001	KC-135A Tanker
002	C-135B AFSC-TRIA
003	EC-135C
004	RC-135C/V
005	WC-135B
006	NKC-135A AFSC Test (55-3128, Edwards $H2_o$ Spray)
007	EC-135L
008	EC-135N
009	EC-135A
010	RC-135M
011	RC-135U
012	EC-135G
013	RC-135A
014	RC-135D
015	C-135A AFSC-TEST (QRC)
016	EC-135H
017	EC-135J
018	NC-135A
019	EC-135K
020	KC-135A SAC RELAY (SEA)
021	EC-135P
022	KC-135R
023	KC-135Q
024	RC-135S
025	VC-135B
026	KC-135A FAA
027	KC-135A ZERO "G" (59-1481, NASA)
028	KC-135A CASTLE TRNG.
029	KC-135A A/R TRNG (58-124)
030	NKC-135A QRC (55-3119)
031	C-135C
032	NKC-135A TRAP MATS (55-3134, Patrick)
033	NKC-135A TEST & TRNG (55-3135, Edwards)
034	NKC-135A AFSC TEST (55-3131, Kirtland)
035	C-135A AFLC (60-376)

SAMPLE AFTO FORM 495

EXAMPLE: Aircraft WC-135B, S/N 61-2665, stationed with the 55th Squadron at McClellan AFB has a new cartridge installed on June 20, 1974. Airframe hours are 15000.

OKLAHOMA CITY ALC
TINKER AFB OK 73145

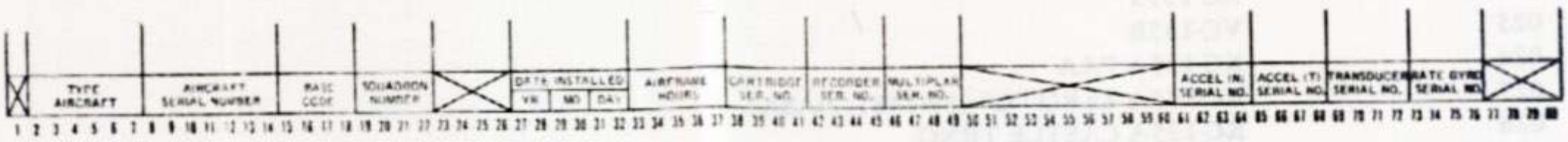
OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
DEPARTMENT OF THE AIR FORCE
DOD—318

U.S. MAIL

Oklahoma City ALC/AIA
Tinker AFB OK 73145

GLOBE 708806X-0



IMMEDIATE ATTENTION
(Complete and Return)

TYPE AIRCRAFT						AIRCRAFT SERIAL NUMBER						
1	2	3	4	5	6	7	8	9	10	11	12	13
W	C	1	3	5	B	6	1	0	2	6	6	5

CARTRIDGE SERIAL NO.				RECORDER SERIAL NO.				MULTIPLEX SERIAL NO.				BLANK									
38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
0	2	1	6																		

BASE CODE				SQUADRON NUMBER			
15	16	17	18	19	20	21	22
K	M	C	C	0	0	5	5

ACCEL (N) SERIAL NO.				ACCEL (T) SERIAL NO.				TRANSDUCER SERIAL NO.				RATE GYRO SERIAL NO.			
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76

DATE INSTALLED						AIRFRAME HOURS				
YR		MO		DAY						
27	28	29	30	31	32	33	34	35	36	37
7	4	0	6	2	0	1	5	0	0	0

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

GLOBE 708805-0

Figure 2.

THE END