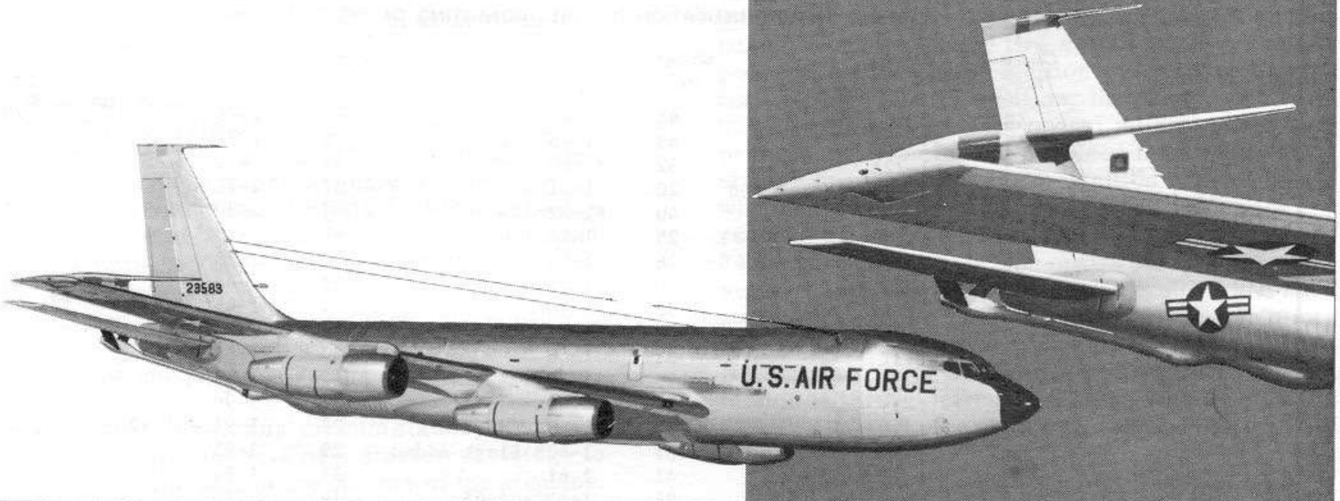
USAF SERIES AIRCRAFT

EC 135C FLIGHT MANUAL

CONTRACT NO. F04606-67-A-0519
CONTRACT NO. F34601-76-D-2380



CHANGE NOTICE

LATEST CHANGED PAGES SUPERSEDE THE SAME PAGES OF PREVIOUS DATE

Insert changed pages into basic publication. Destroy superseded pages.

F1683

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

THIS PUBLICATION INCOMPLETE WITHOUT T.O. 1C-135(E)C-1-1, T.O. 1C-135(E)C-1-2 AND T.O. 21M-LGM30F-1-7

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

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

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

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE.

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15 FEBRUARY 1966

CHANGE 43 - 10 JUNE 1977

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LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES. DESTROY SUPERSEDED PAGES.

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

Dates of issue of original and changed pages are:

Original 0	15 Feb 66	Change	11	20 Jan 69	Change	22	5 Feb 71	Change	33	10 Jun 74
Change 1	15 Jun 66	Change	12	25 Feb 69	Change	23	5 Jun 71	Change	34	10 Oct 74
Change 2	15 Oct 66	Change	13	25 Mar 69	Change	24	5 Oct 71	Change	35	10 Feb 75
Change 3	15 Dec 66	Change	14	25 Jun 69	Change	25	10 Feb 72	Change	36	10 Jun 75
Change 4	15 Feb 67	Change	15	30 Aug 69	Change	26	10 Jun 72	Change	37	10 Oct 75
Change 5	15 May 67	Change	16	25 Oct 69	Change	27	10 Oct 72	Change	38	10 Feb 76
Change 6	15 Jun 67	Change	17	15 Nov 69	Change	28	10 Feb 73	Change	39	10 Jun 76
Change 7	25 Oct 67	Change	18	5 May 70	Change	29	10 Jun 73	Change	40	10 Oct 76
Change 8	25 Feb 68	Change	19	15 Jun 70	Change	30	15 Jul 73	Change	41	10 Feb 77
Change 9	25 Jun 68	Change	20	5 Oct 70	Change	31	10 Oct 73	Change	42	10 Apr 77
Change 10	25 Oct 68	Change	21	30 Nov 70	Change	32	10 Feb 74	Change	43	10 Jun 77

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 788 CONSISTING OF THE FOLLOWING:

Page No.	Change No.	Page No.	Change No.	Page No.	Change No.	Page No.	Change No.
*Title	43	1-20 - 1-21	41	1-47	41	1-76	29
*A - C	43	*1-22	43	1-48 - 1-49	0	1-77	3
D - E Deleted	23	1-22A	32	*1-50	43	1-78	42
*Flyleaf 1	43	1-22B Blank Added	20	1-51	31	1-79	28
Flyleaf 2 Blank	25	1-23	40	*1-52	43	1-80 - 1-81	29
i	0	1-24	25	1-53	41	1-82	25
ii - iii	39	1-25	28	1-54	0	1-83	28
iv	19	1-26	0	1-55	29	1-84	25
*v	43	1-27	32	1-56	34	1-85	24
vi - viii	29	1-28 - 1-30	0	1-57	24	1-86 - 1-87	0
ix Blank Added	24	1-31	31	1-58	39	1-88	42
x	32	1-32	25	1-59	42	1-89	22
1-1	33	1-33	34	1-60	31	1-90	0
1-2	4	1-34	32	1-60A Added	29	1-91 - 1-92	24
1-3	28	1-35	31	1-60B Blank Added	29	1-93	0
1-4 - 1-5	42	1-36	41	1-61	31	1-94	8
1-6	31	1-37	24	1-62 - 1-65	19	1-95	2
1-7	0	1-38	41	1-66	42	1-96	8
1-8	41	1-39	0	1-67 - 1-68	19	1-97	0
1-9	31	1-40	41	1-68A	41	1-98	8
1-10	4	1-40A Added	19	1-68B Blank Added	19	1-99 - 1-101	0
1-11	0	1-40B Blank Added	19	1-69	41	1-102	38
1-12	9	1-41	0	1-70	31	1-103	28
1-13	34	1-42	40	1-70A	30	1-104	11
1-14 - 1-15	42	1-43	41	1-70B Blank Added	23	1-105	0
1-16	26	1-44	42	1-71	42	1-106	24
1-17	41	1-45	11	*1-72 - 1-73	43	1-107	22
1-18	25	1-46	41	1-74	41	1-108 - 1-109	0
1-19	32	1-46A - 1-46B Deleted	41	1-75	40	1-110	28

CURRENT FLIGHT CREW CHECKLISTS AND PERFORMANCE MANUAL

Pilots'	T.O. 1C-135(E)C-1CL-1	15 Feb 1966, Change 34 - 10 Jun 77
Navigator's	T.O. 1C-135(E)C-1CL-2	15 Feb 1966, Change 20 - 10 Feb 77
Boom Operator's	T.O. 1C-135(E)C-1CL-3	15 Feb 1966, Change 24 - 10 Jun 77
Ground Crewman's	T.O. 1C-135(E)C-1CL-4	10 Feb 1977
Radio Operators'	T.O. 1C-135(E)C-1-2CL-1	10 Jun 1973, Change 2 - 10 Oct 75
Crypto Operator's	T.O. 1C-135(E)C-1-2CL-2	10 Jun 1973, Change 2 - 10 Oct 75
Staff Personnel's	T.O. 1C-135(E)C-1-2CL-3	10 Jun 1973, Change 2 - 10 Oct 75
Flight Traffic Specialist's	T.O. 1C-135(E)C-1-2CL-4	1 Jun 1964, Change 6 - 10 Oct 75
Radio Maintenance Technician's	T.O. 1C-135(E)C-1-2CL-5	10 Jun 1973, Change 3 - 10 Feb 76
Trailing Wire Antenna Operator	T.O. 1C-135(E)C-1-2CL-6	10 Jun 1976, Change 1 - 10 Oct 76
Performance Data Flight Manual	T.O. 1C-135(E)C-1-1	15 Feb 1966, Change 23 - 10 Jun 77

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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USAF

LIST OF EFFECTIVE PAGES (continued)

Page No.	Change No.	Page No.	Change No.	Page No.	Change No.	Page No.	Change No.
1-111	0	2-26B	28	3-29	0	3-92B Blank Added	37
1-112	31	2-27	29	3-30 - 3-31	34	3-93	39
1-113	4	2-28	34	3-32	29	3-94	36
1-114 - 1-115	0	2-28A	40	3-33	12	3-94A Added	36
*1-116	43	2-28B Blank Added	24	3-34	36	3-94B Blank Added	36
1-117	6	2-29 - 2-30	40	3-35	28	3-95	39
1-118	12	2-30A	39	3-36	37	3-96	23
1-119	19	2-30B	40	3-37	22	4-1 - 4-2	31
1-120	0	2-31 - 2-32A	41	3-38	0	4-3	19
1-121	4	2-32B Blank Added	23	3-39	16	4-4 - 4-5	4
1-122	36	2-33	41	3-40 - 3-41	36	4-6	19
1-123	27	2-34	33	3-42 - 3-44	29	4-7	31
1-124	33	2-35	40	3-45	28	4-8	25
1-125 - 1-126	29	2-36	32	3-46	7	4-9	0
1-127 - 1-128		2-36A	38	3-47	31	4-10 - 4-10A	31
Deleted	24	2-36B Blank Added	22	3-48	28	4-10B Added	19
1-129	20	2-37	32	3-49 - 3-50		4-11 - 4-12	25
1-130	34	2-38	28	Deleted	27	4-13	28
1-130A	32	2-39	38	3-51	38	4-14	29
1-130B - 1-130D	33	2-40	35	3-52	34	4-15	0
1-131	31	2-41	41	3-53	38	4-16	29
1-132	24	2-42	38	3-54 - 3-54A	31	4-16A Added	29
1-133	42	*2-43	43	3-54B	40	4-16B Blank Added	29
1-134	0	2-44	41	*3-55 - 3-56	43	4-17	37
1-135	33	*2-44A	43	3-57	6	4-18	9
1-136	29	2-44B	38	3-58	34	4-19	31
*1-137 - 1-139	43	2-45	34	3-59	28	*4-20	43
1-140	0	2-46	36	3-60	34	4-20A Added	25
1-141	29	2-46A - 2-46B		3-61	6	4-20B Blank Added	25
1-142	9	Deleted	34	3-62	25	*4-21	43
1-143	19	2-47	37	3-62A Added	24	4-22	29
1-144	25	2-48	41	3-62B Blank Added	24	*4-23	43
2-1	25	2-49	40	3-63	24	4-24	24
2-2	28	2-50	36	3-64	0	4-25	29
2-2A	34	2-51	31	3-65	3	*4-26	43
2-2B Blank	11	2-52	40	*3-66	43	4-27	0
2-3	41	3-1 - 3-2	40	3-66A - 3-66B Added	41	4-28	24
*2-4 - 2-5	43	3-3 - 3-4	24	3-67 - 3-68	41	*4-29	43
2-6	41	3-5	29	3-68A	40	4-30	0
2-6A Added	41	3-6	0	3-68B	29	*4-31 - 4-32	43
2-6B Blank Added	41	3-7 - 3-8	29	3-69	36	*4-32A - 4-32B	43
2-7	39	3-8A	34	3-70	27	4-33	25
2-8	40	3-8B Blank Added	28	3-71	18	4-34	28
2-9	32	3-9	34	3-72	33	4-34A	24
2-10	29	3-10	32	3-73	0	*4-34B	43
2-10A	32	3-11	26	3-74	41	*4-35 - 4-36	43
2-10B	39	3-12	24	3-75 - 3-76	37	4-37	24
2-11	32	3-13	36	3-76A	29	4-38 - 4-38A	39
2-12	36	3-14	33	3-76B Blank Added	24	4-38B Added	24
2-13	31	3-14A	36	3-77	24	4-39	29
2-14	40	3-14B Blank Added	26	3-78	29	4-40	40
2-14A	41	3-15	34	3-79	0	4-41	0
2-14B Blank Added	19	3-16	35	3-80	20	4-42	32
2-15	41	3-17	25	3-80A Blank Added	28	4-43	40
2-16	35	3-18	34	3-80B Added	28	4-44	39
2-17 - 2-18	0	3-19	32	3-81	28	4-45	29
2-19	34	3-20 - 3-20A	31	3-82	20	4-46	25
2-20	40	3-20B Added	29	3-83	24	4-47	40
2-20A - 2-20B	41	3-21 - 3-22	31	3-84	18	4-48	24
2-20C	37	3-22A Added	28	3-85	26	4-49 - 4-51	6
2-20D Blank Added	34	3-22B Blank Added	28	3-86 - 3-87	35	4-52	40
2-21	31	3-23	29	3-88	37	4-52A	6
2-22	25	3-24	38	3-89	35	4-52B	37
2-23	29	3-25	28	3-90	37	4-52C	14
2-24	38	3-26	29	3-91	35	*4-52D	43
2-25 - 2-26	40	3-27	37	3-92	37	4-52E	40
2-26A	29	*3-28	43	3-92A Added	37	4-52F	12

LIST OF EFFECTIVE PAGES (continued)

Page No.	Change No.	Page No.	Change No.	Page No.	Change No.	Page No.	Change No.
4-53	28	*4-89	43	5-3	37	7-35	41
4-54	37	4-90	25	5-4	0	7-36	0
4-55 - 4-56 Deleted	29	4-91	24	5-5	10	7-37	12
4-56A	37	4-92	28	5-6	0	7-38	29
*4-56B	43	4-93	8	5-7	24	8-1	31
4-56C	40	4-94	24	5-8	29	8-2	41
4-56D	29	4-95	29	5-9	22	8-3	29
4-56E	38	4-96	24	5-10	37	8-4	40
4-56F Blank Added	24	4-96A Added	33	5-10A	14	8-5	41
4-57	41	4-96B Blank Added	33	5-10B Blank	4	*8-6	43
4-58 - 4-59	26	4-97 - 4-98	33	5-11	38	8-6A - 8-6B	41
4-60 - 4-61	0	4-99 - 4-103	29	5-12	10	8-7 - 8-8	41
*4-62 - 4-63	43	*4-104	43	5-13	38	8-9 - 8-10	40
4-64	26	4-104A - 4-104B		5-14	41	8-11 - 8-12	41
4-64A - 4-64C	41	Deleted	29	5-15 - 5-19	0	*8-12A	43
4-64D - 4-64E Added	24	4-105	0	5-20	31	8-12B	41
4-64F	29	4-106	24	5-21 - 5-25	0	8-13 - 8-14	40
4-64G - 4-64H Added	24	4-107	10	5-26	41	8-15	34
4-64-I	28	4-108 - 4-111	0	5-27	16	*8-16	43
4-64J - 4-64K		4-112	29	5-28 - 5-30	0	8-16A	31
Added	24	4-113	0	5-31 - 5-32	39	8-16B Blank	7
4-64L	35	4-114	38	5-33	0	8-17	39
4-64M Added	24	4-115	9	5-34 Blank	0	8-18	41
4-64N	28	4-116	7	6-1	14	*8-19	43
4-64-O Added	24	4-117	0	6-2	28	8-20 - 8-21	33
*4-64P - 4-64S	43	4-118	33	6-2A	29	8-22 - 8-23	2
4-64T	28	4-119	0	6-2B Blank	12	*8-24 - 8-25	43
4-64U - 4-64Z Added	24	4-120	6	6-3	29	8-26 - 8-28	36
*4-64AA	43	4-121	38	6-4 - 6-8	0	9-1	9
4-64AB Added	24	4-122	28	6-9	1	9-2	31
*4-64AC	43	4-123 - 4-125	0	6-10	0	9-2A Added	24
4-64AD Added	24	4-126	26	6-11	27	9-2B Blank Added	24
4-64AE	29	4-127	28	6-12	24	9-3	32
4-64AF	28	4-128	0	6-13	40	9-4	36
4-64AG - 4-64AH		4-129	25	6-14	29	*9-5 - 9-7	43
Added	24	4-130	28	6-15	14	9-8	31
*4-64AI - 4-64AJ	43	4-131 - 4-132	0	6-16	24	9-9	29
4-64AK	29	4-133	38	6-17 - 6-18	14	9-10 - 9-11	32
*4-64AL - 4-64AM	43	4-134	1	7-1 - 7-2	0	9-12	24
4-64AN	29	4-135 - 4-137	0	7-3	29	9-12A	29
4-65	34	4-138	28	7-4 - 7-4A	35	9-12B	9
4-66	0	4-139	2	7-4B Blank	2	9-13	9
4-67	29	4-140 - 4-141	31	7-5 - 7-7	29	9-14	41
4-68	0	4-142	10	7-8 - 7-10	0	9-15 - 9-16	29
4-69	25	4-143	0	7-11	20	9-17	38
4-70	41	4-144	31	7-12	40	9-18 - 9-19	29
4-70A	38	4-144A - 4-144B		7-13	29	9-20	37
4-70B Blank Added	25	Deleted	28	7-14 - 7-15	40	9-21	24
4-71	31	4-145	28	7-16 - 7-18	0	9-22	4
4-72	29	4-146 - 4-147	42	7-19 - 7-20	36	9-23	0
4-73	27	4-148	24	7-20A Added	36	9-24 Blank	0
4-74	32	4-148A	20	7-20B Blank Added	36	Index-1	39
4-75	0	4-148B Blank	5	7-21	0	*Index-2	43
4-76	40	4-149	10	7-22	19	Index-3	39
4-77	42	4-150 - 4-151	31	7-22A	41	*Index-4	43
4-78	33	4-152	21	7-22B Blank Added	19	Index-5	41
4-79	42	4-153	27	7-23	0	Index-6	35
*4-80	43	4-154	24	7-24	32	Index-7	41
4-80A	35	4-155	0	*7-25 - 7-26	43	Index-8	37
4-80B Added	28	4-156	7	7-27	31	Index-9	33
4-81	32	4-157	0	7-28	23	Index-10	42
4-82	35	4-158 - 4-159	31	7-28A	41	*Index-11	43
4-83 Added	35	4-160 - 4-162	0	7-28B Blank Added	23	Index-12	40
4-84 Blank Added	35	4-163	31	*7-29	43	*Index-13	43
4-85 - 4-86	37	4-164	41	7-30	31	Index-14	36
4-87	24	4-165	42	7-31	23	Index-15	37
4-88	29	4-166 Blank Added	27	7-32	0	Index-16	39
4-88A	37	5-1	34	7-33 - 7-34A	41	*Index-17	43
4-88B Blank Added	29	5-2	28	7-34B Blank Added	19	Index-18 Blank	0

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

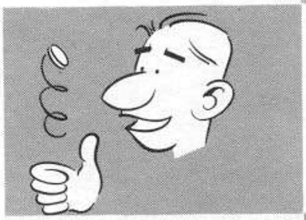
OUTSTANDING SUPPLEMENTS

Number	Date	Short Title	Section Affected

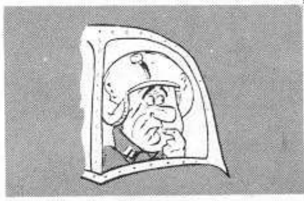
CONTENTS

SECTION

SCOPE. This manual must be used with T.O. 1C-135(E)C-1-1 and T.O. 1C-135(E)C-1-2 to obtain all the information necessary for safe and efficient operation of the EC-135C. T.O. 1C-135(E)C-1-1 is an Appendix containing the performance data. T.O. 1C-135(E)C-1-2 is a special supplemental manual containing descriptive information, theory of operation, operating procedures and malfunction analysis for the special Communciations Center Electronics equipment installed on the EC-135C. It is intended primarily for use of radio operators, crypto operators and special staff personnel concerned with this special communications equipment only. Information covering the flight crew communications and electronics equipment, however, is still contained in Section IV of this manual. All of 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.

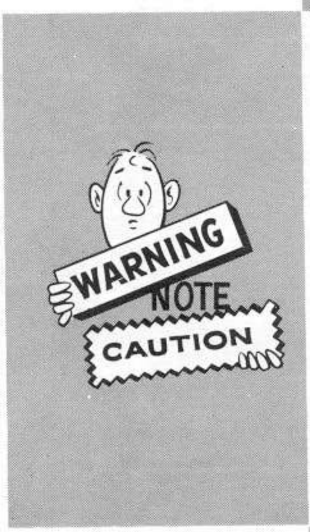


SOUND JUDGMENT. Instructions in this manual are for a crew inexperienced in the operation of this airplane. This manual provides the best possible operating instructions under most circumstances, but it is a poor substitute for sound judgment. Multiple emergencies, adverse weather, terrain, etc., may 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, Oklahoma City ALC/MMSRE, before any questionable operation is attempted which is not specifically permitted in this manual.

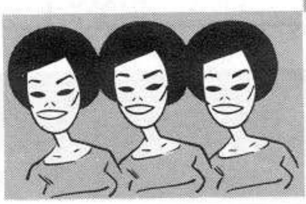


WARNINGS, CAUTIONS, AND NOTES. The following definitions apply to "Warnings," "Cautions," and "Notes" found throughout the manual.

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.

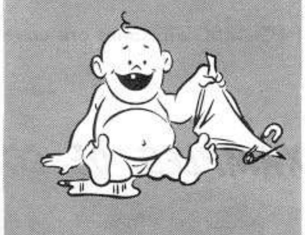
The following definitions apply to the words "shall," "will," "should," and "may."

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.

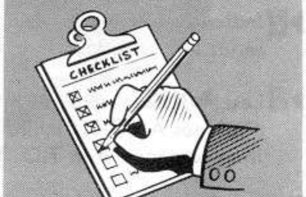


STANDARDIZATION AND ARRANGEMENT. Standardization assures that the scope and arrangement of all Flight Manuals are identical. This manual is divided into nine fairly independent sections to simplify reading it straight through or using it as a reference manual. All sections must be read thoroughly and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

SAFETY SUPPLEMENTS AND OPERATIONAL SUPPLEMENTS. Information involving safety will be promptly forwarded to you by Safety Supplements. Safety Supplements covering loss of life will get to you in 48 hours by TWX (called Interim Safety Supplements); those concerning serious damage to equipment within 10 days by mail (in a formal printed form). Operational information not involving safety but of an urgent nature will be forwarded to you by Operational Supplements. 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. 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.



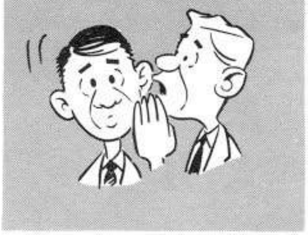
CHECKLISTS. The Flight Manual contains only amplified checklists. Abbreviated checklists have been issued as separate technical orders; see the back of the title page for T.O. number of your latest checklist. Line items in the Flight Manual and Checklists are identical with respect to arrangement and 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.



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.

HOW TO BE ASSURED OF HAVING LATEST DATA. Refer to T.O. 0-1-1-3 which is normally issued semi-annually and devoted solely to the 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.

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 routing channels established by Major Commands, as directed by AFR 60-9, to Oklahoma City ALC/MMSRE, Tinker AFB, Oklahoma 73145.



coding

All EC-135C airplanes are covered in this manual.

EXAMPLES OF CODES:

5 Indicates information is applicable only to airplane with serial No. AF62-3585

▶ Means "THRU or "AND ON"

5▶ Indicates information is applicable to all airplanes beginning with serial Nos. AF62-3585 and on

5▶7 Indicates information is applicable to airplanes with serial Nos. 62-3585 thru AF63-8047

1▶9 Less 590 indicates information is applicable to airplanes AF62-3581 thru AF63-8049 less those modified in accordance with T.O. 1C-135-590.

13▶ Plus E522 indicates information is applicable to all airplanes beginning with serial Nos. AF63-8053 and on plus those airplanes modified in accordance with T.O. 1C-135(E)-522.

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 EC-135C 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.

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

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.

A reverse number on an illustration such as 1 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

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.
1	62-3581	4	62-3584	7	63-8047	10	63-8050	13	63-8053
2	62-3582	5	62-3585	8	63-8048	11	63-8051	14	63-8054
3	62-3583	6	63-8046	9	63-8049	12	63-8052		

time compliance technical orders

NOTE

- The following time compliance technical orders (TCTO's) are those which are referred to in this publication. When TCTO modifications are completed on all airplanes, references are deleted from this manual.
- The letter "E" preceding a TCTO number indicates that TCTO is applicable to the EC-135 series only. The letters "EC" preceding a TCTO number indicate that TCTO is applicable to the EC-135C only. The TCTO numbers which do not have any letter preceding them also apply to other airplane series.

TCTO 763 — FLIGHT LOADS DATA RECORDER SYSTEM

TCTO 846 — LETDOWN CHART HOLDER

TCTO 1002 — COPILOT'S 1KVA GENERATOR MODIFICATION (ELECTRONIC)

TCTO 1016 — REWIRING OF AN/ASQ-141(V) POWER ON/OFF LIGHT PUSH-TO-TEST CIRCUIT

TCTO 1044 — INSTALLATION OF AN/ARC-164(V) UHF COMMAND RADIO

abbreviations and definitions

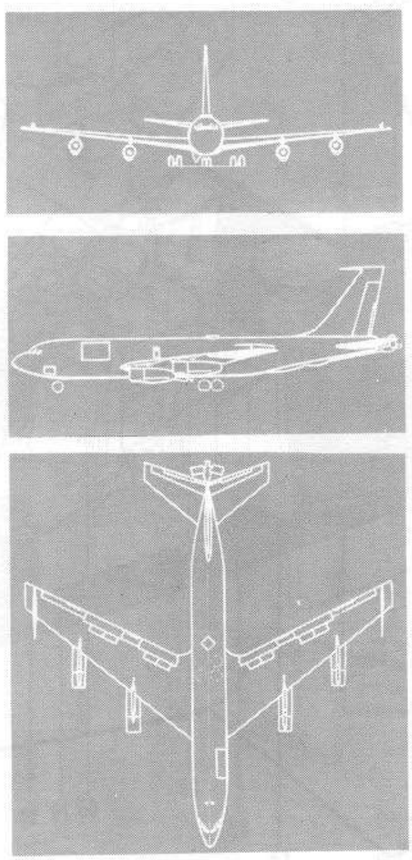
ABBREVIATION	DEFINITION
A/A	Air to Air (TACAN)
AC	Alternating Current
A/C	Air Conditioning
ACC	Accelerate
AC-CL	Accelerate-Climb
ACM	Air Cycle Machine (Air Conditioning)
ADF	Automatic Direction Finding
ADI	Attitude Director Indicator
ADIZ	Air Defense Identification Zone
ALCC	Airborne Launch Control Center
ALTM	Altimeter
AM	Amplitude Modulation (Communication radios)
AME	Equivalent AM
amp	Ampere
ANN	Annunciator
AOA	Angle of Attack
AP, A/P	Autopilot
APM	Airborne Performance Monitor
APPR	Approach
APU	Auxiliary Power Unit
A/R*	Air Refueling
ARR*	Air Refueling Receiver
ASR	Airport Surveillance Radar
ATA	Actual Time of Arrival
ATT	Attitude
(BO)	Boom Operator
BOCBP	Boom Operator's Circuit Breaker Panel
BRT	Bright
°C	Degrees Centigrade
CAPT	Capture
CAS	Calibrated Airspeed
CB	Circuit Breaker
CCBP	Communication Center Circuit Breaker Panel
CCABP	Communication Center Auxiliary 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
(CP)	Copilot
(CRYPTO)	Crypto Station Operator
(CW)	Continuous Wave
CW	Clockwise (Preceded by "turn" or "rotate")
C.W.	Center Wing
DC	Direct Current
DEV	Deviation
DF	Direction Finding
DN/R	Down/Right (ILS Test) (Inoperative)
DR	Dead Reckoning

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

ABBREVIATION	DEFINITION
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
FD/RGA	Flight Director/Rotation Go-Around
FLP	Flap
F/O	First Officer (Copilot) (on CBP), Fail Operative (on RGA interface unit)
fpm	Feet per Minute
FT, ft	Feet
(FTS)	Flight Traffic Specialist
FWD, fwd	Forward
g	Acceleration of Gravity
GA, G/A	Go-Around
(GC)	Ground Crew
GMT	Greenwich Mean Time
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
HDG	Heading
HF	High Frequency
Hg	Mercury
HSI	Horizontal Situation Indicator
HTR	Heater
IAS	Indicated Airspeed
IAW	In Accordance With
(IBO)	Instructor Boom Operator
ID	Indicator
IFF	Identification Friend or Foe
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
LB, lb	Pound, Pounds
LFA	Low Frequency Antenna
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.)
MACH NO.	Ratio of TAS to local speed of sound
MAN	Manual
MC	Megacycle
MCBP	Main Circuit Breaker Panel
(MCC-A)	Missile Combat Crew - Airborne
(MCCC)	Missile Combat Crew Commander
MCW	Modulated Continuous Wave
MDA	Minimum Descent Altitude
mHz	Megahertz

MPH, mph	Miles Per Hour
msl	Mean Sea Level
MSTR DISC	Master Disconnect
(N)	Navigator
NAM	Nautical Air Miles
NAV	Navigation
No.	Number
NRT	Normal Rated Thrust - Maximum allowable thrust for continuous operation determined by EPR setting.
ø	Phase
OAT	Outside Air Temperature (Synonymous with Free Air Temperature; See Section I)
(OPS)	Operations Officer
OWE	Operating Weight Empty
(P)	Pilot
PAR	Precision Approach Radar
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
RGA	Rotation Go-Around
RH	Right Hydraulic
(RM)	Radio Maintenance Technician
RMI	Radio Magnetic Indicator
RNWY	Runway
(RO-1)	Radio Operator No. 1
(RO-2)	Radio Operator No. 2
RPM, rpm	Revolutions Per Minute (For this airplane the revolutions per minute of the engine high pressure compressor rotor)
R/T	Receiver - Transmitter
SATCOM	Satellite Communications
SBCBP	Switched DC Bus Circuit Breaker Panel
SETTOAC	Start Engines, Taxi, Takeoff, and Accelerate
SIF	Selective Identification Feature
SPD DEV	Speed Deviation
SSB	Single Sideband (Communications Radios)
TACAN	Tactical Air Navigation
T/O	Takeoff
T-R	Transformer - Rectifier
TRT	Takeoff Rated Thrust - Maximum allowable thrust determined by EPR setting. Limited to 5 minutes.
TWA	Trailing Wire Antenna
(TWAO)	Trailing Wire Antenna Operator
UHF	Ultra High Frequency
UP/L	Up/Left (ILS Test) (Inoperative)
VHF	Very High Frequency
VLF	Very Low Frequency
VOR	VHF Omni Range (VHF Navigational Aid)
VROT	Rotation Speed
WOW	Weight On Wheels
X/MON	Cross Monitor

EC-135C



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section I

DESCRIPTION

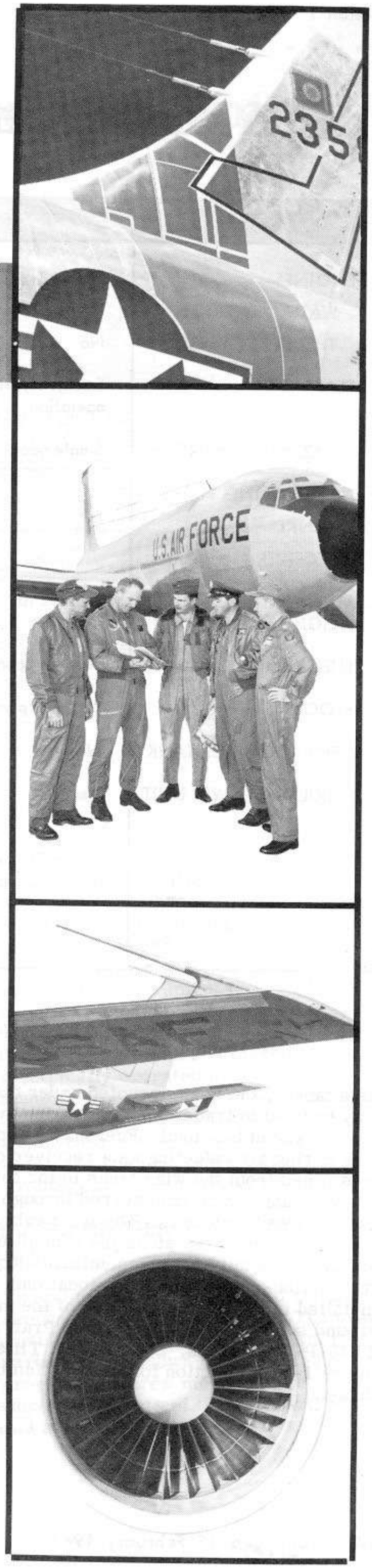

TABLE OF CONTENTS

THE AIRPLANE

The airplane, designed and manufactured by The Boeing Company, is a four engine, swept wing, long range, high altitude, high speed airplane that is primarily a flying command post but also may be used as a tanker. The normal crew consists of a pilot, copilot, navigator and boom operator; other crew members may be assigned as necessary to operate the communications equipment in the staff compartment. As a command post, or for other missions requiring extended range or airborne time, air refueling may be accomplished through the air refueling receptacle mounted above the control cabin.

main differences

ITEM	EC-135C	KC-135A	C-135A	C-135B
ENGINES	TF-33-P-9 (Turbofan)	J57-P-59W (Turbojet)	J57-P-59W (Turbojet)	TF33-P-5 (Turbofan)
WATER INJECTION	No	Yes	Yes	No
THRUST REVERSERS	No	No	No	Yes
FLAPS	Emergency electrical operation	Emergency manual operation	Emergency electrical operation	Emergency electrical operation
AIR CONDITIONING	Single pack	Single pack	Double pack	Double pack
AIR REFUELING				
TANKER	Yes	Yes	No	No
RECEIVER	Yes	Reverse refueling only	No	No
MAXIMUM FLIGHT WEIGHT (FLAPS UP)	299,000 lb	297,000 lb	270,000 lb	274,000 lb
FUEL DUMP	Through boom	Through boom	Fuel dump tube	Fuel dump tube
FLOOR	Rug over plywood	Wood	Metal	Metal
UPPER DECK FUEL TANK	No	Yes	No	No
AUXILIARY POWER UNIT	Yes	Yes	No	No

Figure 1-1

As a tanker, the boom mounted under the tail section may be used to transfer a major portion of the 175,000 pound fuel load. Fuel may be added to any tank during air refueling as a receiver or fuel may be drained from the wing tanks to the forward and aft body tanks to be transferred through the boom during tanker missions. The main cabin, which is the pressurized area aft of the control cabin, is furnished with additional communication equipment, control stations and staff accommodations. An APU is installed in the forward section of the main cabin for ground support. The engines are Pratt and Whitney TF33-P-9 turbofans. See ENGINE THRUST and figure 1-7 this Section for information on engine thrust.

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

compartments

PRESSURIZED AREA

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

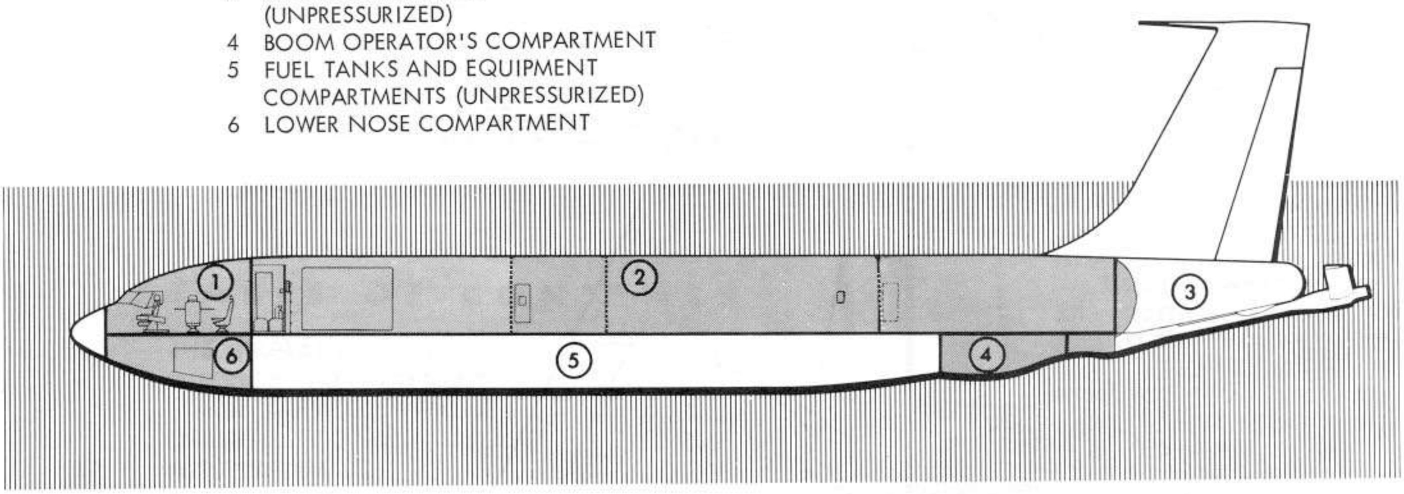

Figure 1-2

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 average size 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, air refueling receptacle slipway doors, powered rudder, and the trailing wire antenna system. The cargo door is opened and closed by means of a hand or electrically operated 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 the various subcompartments of the pressurized compartment as shown in figure 1-4.

general arrangement diagram

1 PROBE ANTENNA (3 PLACES)
2 APU
2A SATCOM EQUIPMENT RACK
3 ELECTRONICS CABINET NO. 2
3A AN/ARC-96 TWA FUSEHOLDER
4 AN/ARC-96 TRANSMITTER GROUP CABINET
4A AN/ARC-96 TRANSMITTER GROUP COOLING DUCTS
5 AN/ARC-96 TWA CONTROL PANEL
5A AN/ARC-96 RECEIVER GROUP
6 CRYPTO OPERATOR'S CONSOLE
7 SLIDING CURTAIN (3 PLACES)
8 CONTROLLERS' CONSOLE
8A LAUNCH CONTROL PANEL
8B 494L CONTROL PANEL
9 CLASSIFIED MATERIAL FILE
10 MAP FRAMES (2 PLACES)
11 AEAO CONSOLE
11A LAUNCH MONITOR PANEL
11B AN/ASQ-121 (HARDS) CONTROL INDICATOR AND TELEPRINTER
12 PROJECTION SCREEN (2 PLACES)
13 PARACHUTE STOWAGE
14 ESCAPE SLIDE STOWAGE
15 GALLEY
16 TRIPLE BUNKS (2 PLACES)
17 RIGHT AFT TOILET
18 WIRE ANTENNA
19 Q-INLET
20 LEFT AFT TOILET

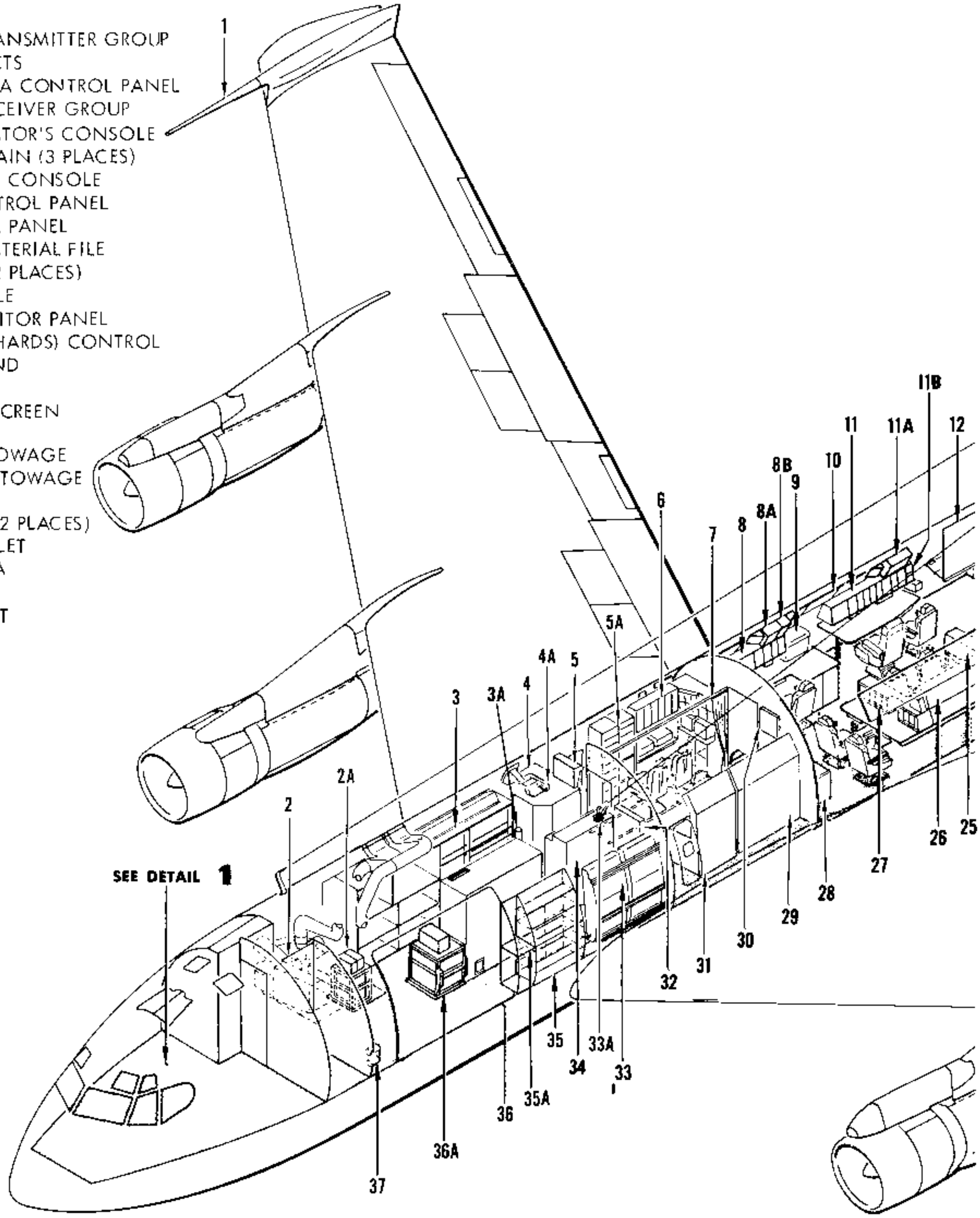

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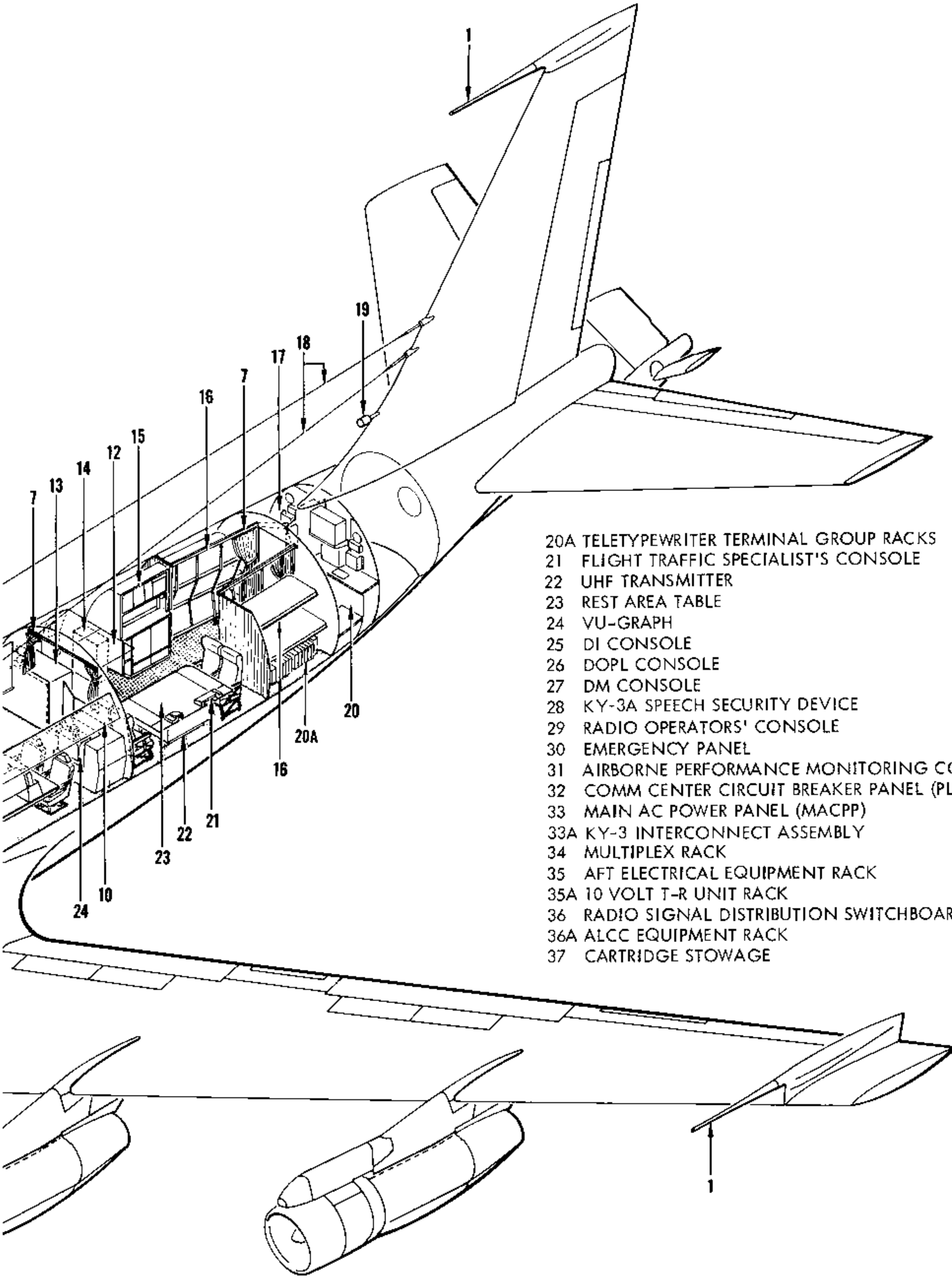
Figure 1-3 (Sheet 1 of 3)



20A TELETYPEWRITER TERMINAL GROUP RACKS
21 FLIGHT TRAFFIC SPECIALIST'S CONSOLE
22 UHF TRANSMITTER
23 REST AREA TABLE
24 VU-GRAPH
25 DI CONSOLE
26 DOPL CONSOLE
27 DM CONSOLE
28 KY-3A SPEECH SECURITY DEVICE
29 RADIO OPERATORS' CONSOLE
30 EMERGENCY PANEL
31 AIRBORNE PERFORMANCE MONITORING CONSOLE
32 COMM CENTER CIRCUIT BREAKER PANEL (PL-25)
33 MAIN AC POWER PANEL (MACPP)
33A KY-3 INTERCONNECT ASSEMBLY
34 MULTIPLEX RACK
35 AFT ELECTRICAL EQUIPMENT RACK
35A 10 VOLT T-R UNIT RACK
36 RADIO SIGNAL DISTRIBUTION SWITCHBOARD
36A ALCC EQUIPMENT RACK
37 CARTRIDGE STOWAGE

Figure 1-3 (Sheet 2 of 3)

general arrangement diagram (cont)

38 PILOTS' INSTRUMENT PANEL
39 COPILOT'S SIDE PANEL
40 COPILOT'S SEAT
41 OVERHEAD PANEL
42 NAVIGATOR'S STOWAGE CABINET
43 NAVIGATOR'S INSTRUMENT PANEL
44 SLIPWAY DOORS AND ARR RECEPTACLE
45 CELESTIAL OBSERVATION WINDOW (2 PLACES)
46 SEXTANT MOUNT
47 ELECTRONICS CABINET NO. 1
48 RADIATION CURTAIN STOWAGE
49 AUXILIARY ELECTRONICS COOLING SYSTEM CONDENSER FANS
49A AUXILIARY ELECTRONICS COOLING SYSTEM CONDENSER
49B AUXILIARY ELECTRONICS COOLING SYSTEM EVAPORATOR
50 BATTERY
50A PILOT'S ANGLE OF ATTACK TRANSMITTER (COPILOT'S OPPOSITE)
51 SWITCHED DC BUS CIRCUIT BREAKER PANEL (SBCBP)
52 SEXTANT AND SKY COMPASS STOWAGE
53 FWD ELECTRICAL EQUIPMENT RACK
54 BOOM OPERATOR'S RIDING STATION
55 CREW ENTRY CHUTE FLOOR GRILLE
56 LADDER
57 EMERGENCY EXIT SPOILER
58 FD-109/RGA EQUIPMENT RACK
59 CREW INSTRUCTOR'S CONSOLE
60 PILOT'S SEAT
61 PILOT'S SIDE PANEL
62 NOSE GEAR STEERING WHEEL
63 PILOT'S CONTROL COLUMN
64 CONTROL STAND

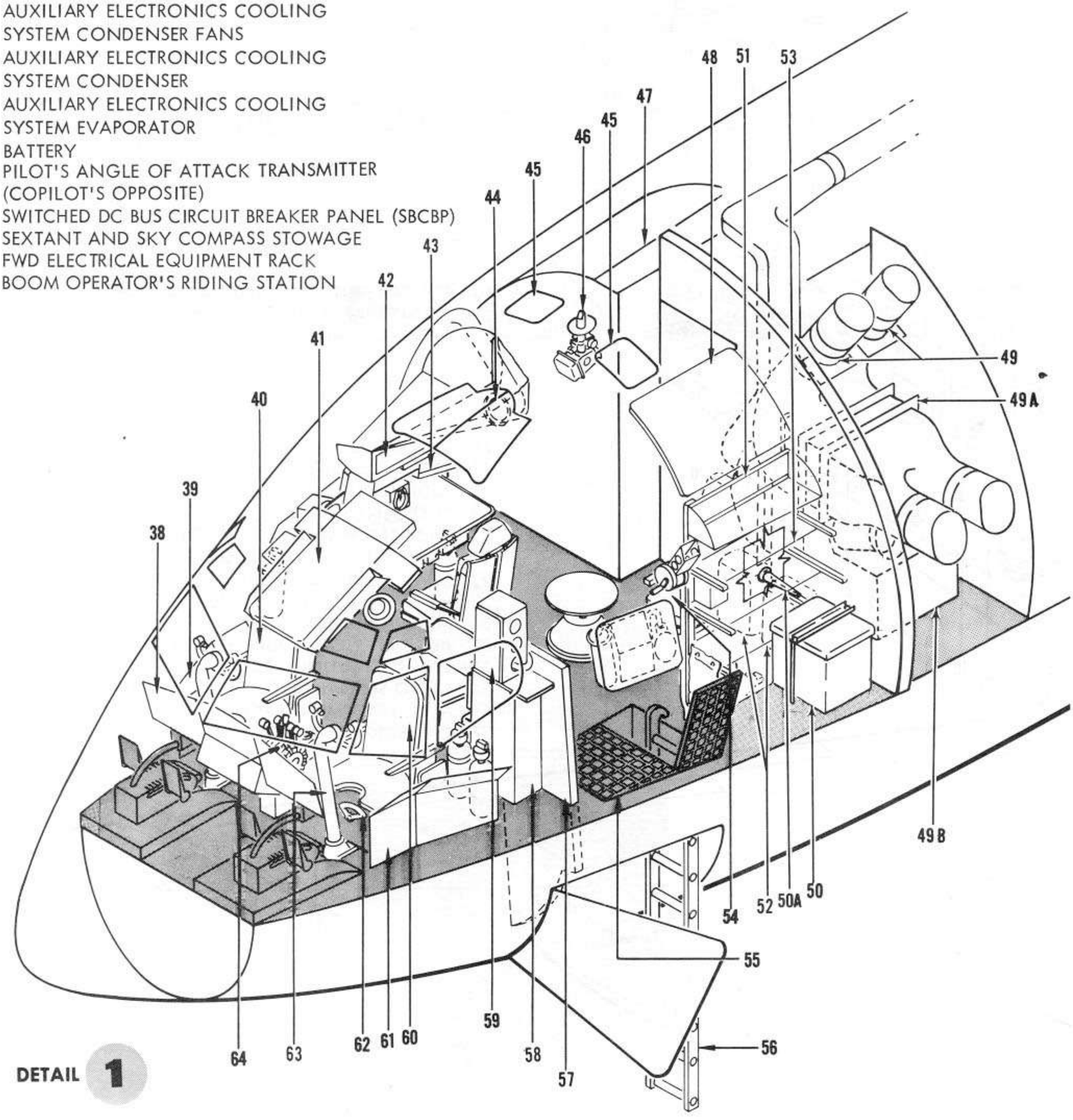


Figure 1-3 (Sheet 3 of 3)

crew movement diagram

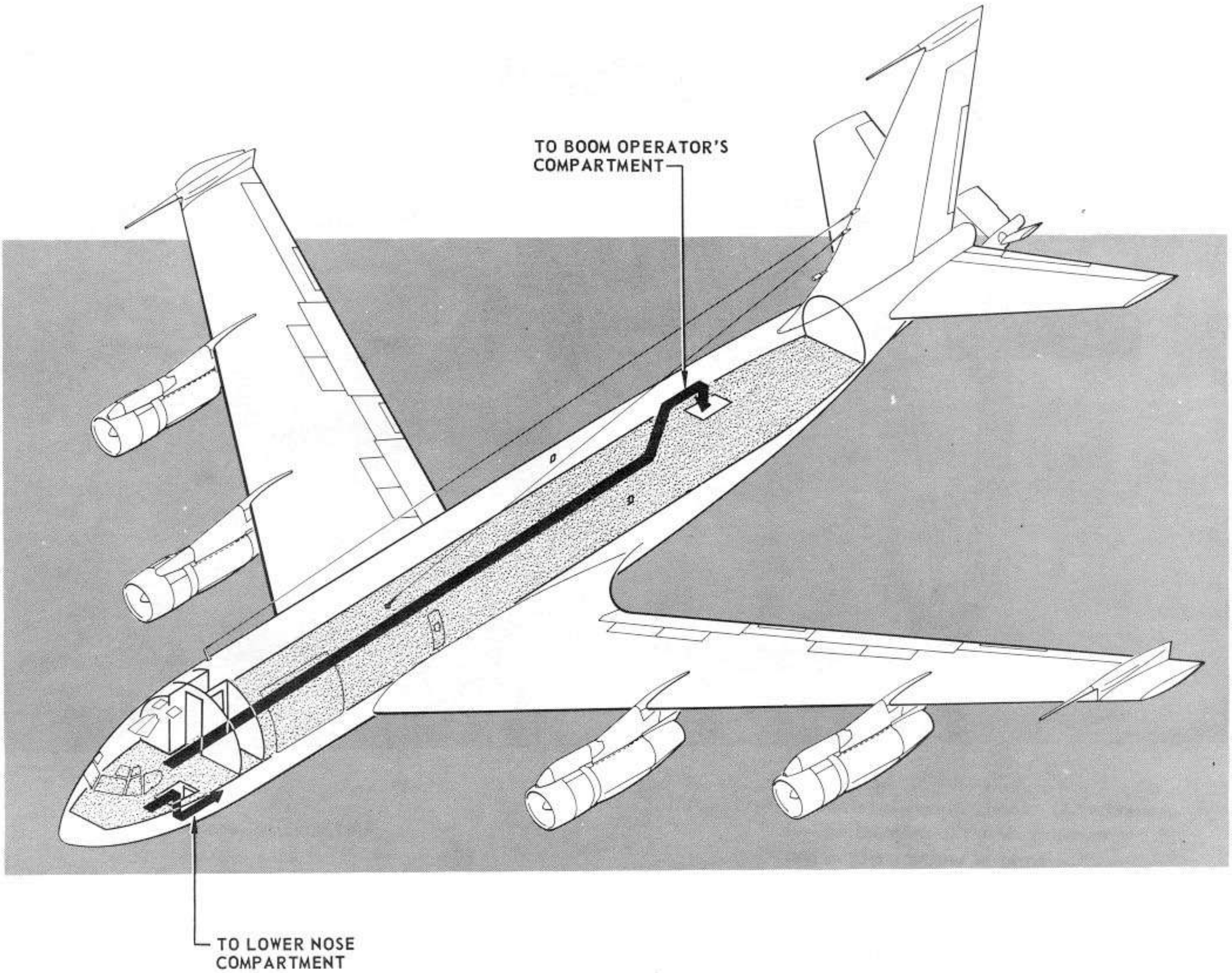
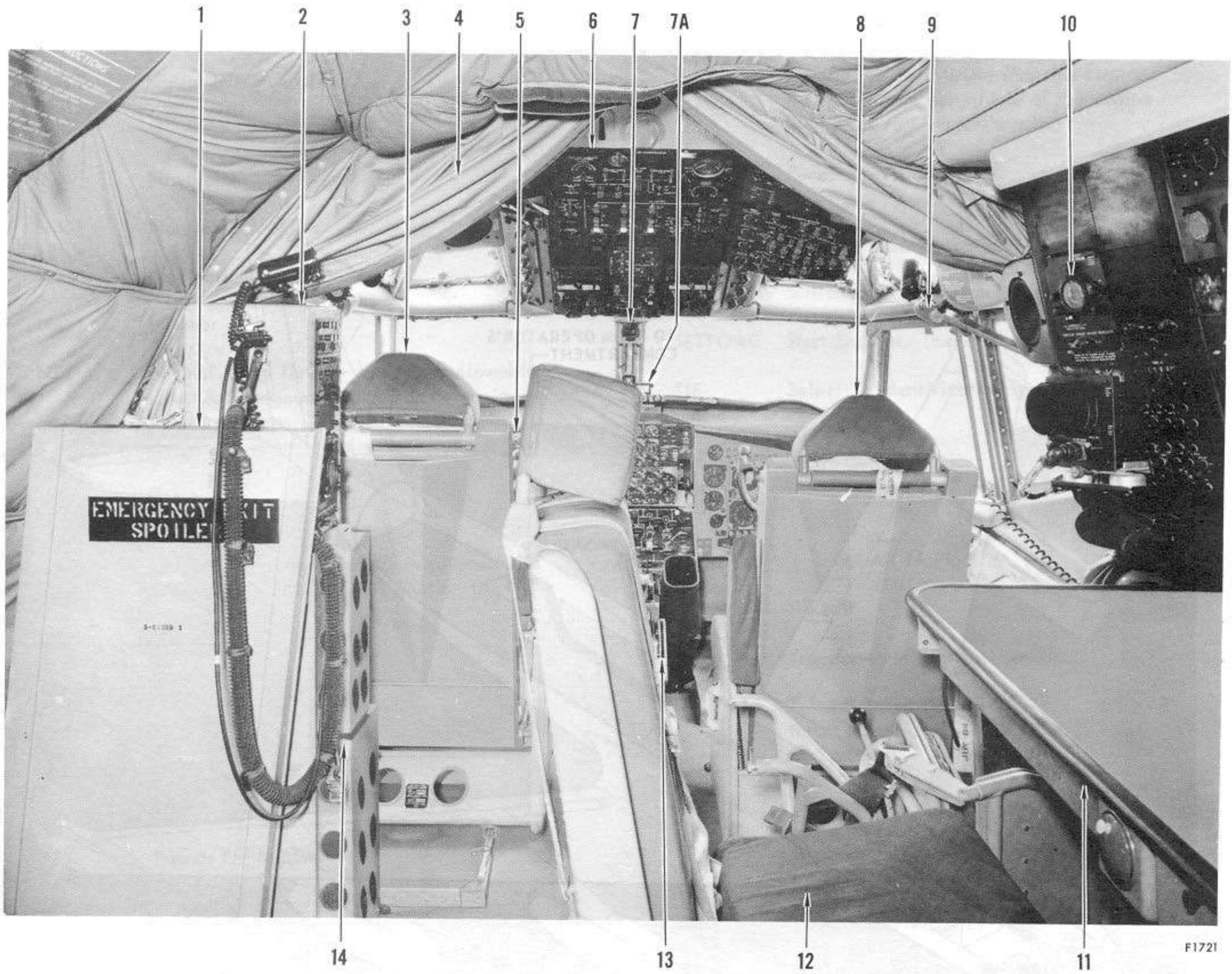


Figure 1-4

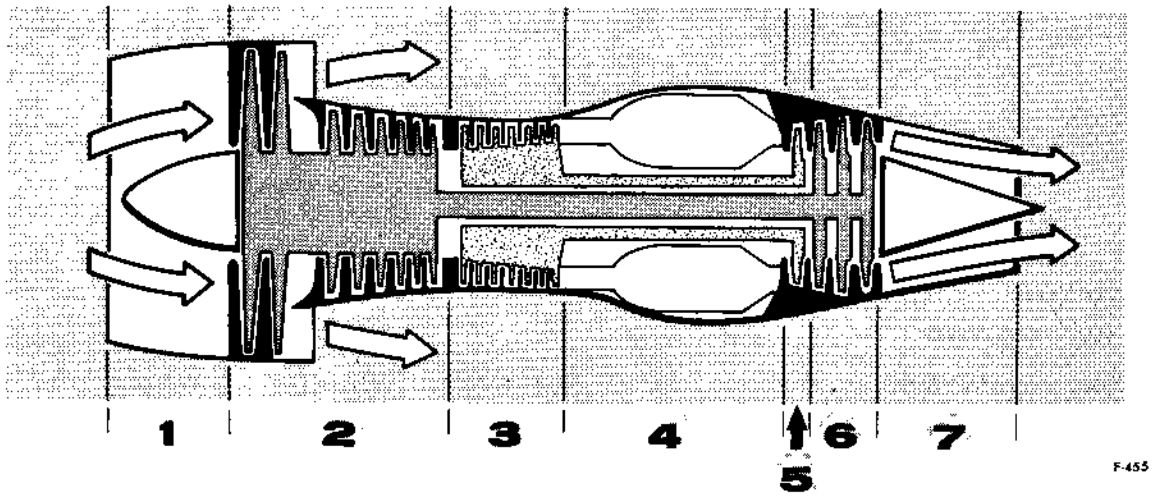
control cabin



1 EMERGENCY EXIT SPOILER
2 CREW INSTRUCTOR'S CONSOLE
3 PILOT'S STATION
4 BLACKOUT CURTAINS
5 PILOTS' INSTRUMENT PANEL
6 OVERHEAD PANEL
7 STANDBY MAGNETIC COMPASS
7A TAKEOFF AND LANDING DATA CARD HOLDER
8 COPILOT'S STATION
9 EMERGENCY HYDRAULIC CROSS-OVER VALVE LEVER
10 NAVIGATOR'S INSTRUMENT PANEL
11 NAVIGATOR'S STATION
12 NAVIGATOR'S SEAT
13 CONTROL STAND
14 FD-109/RGA EQUIPMENT RACK

Figure 1-5

engine diagram



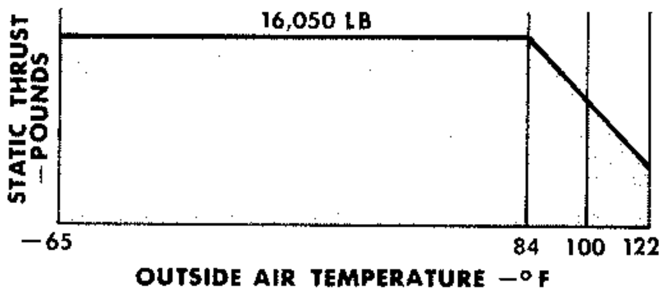
1 INLET
2 LOW PRESSURE COMPRESSOR WITH FAN SECTION
3 HIGH PRESSURE COMPRESSOR
4 COMBUSTION CHAMBER
5 HIGH PRESSURE TURBINE
6 LOW PRESSURE TURBINE
7 EXHAUST

Figure 1-6

ENGINES

The airplane is equipped with four Pratt and Whitney TF33-P-9 flat-rated, forward-fan-type engines which have twin spool, axial flow compressors. The engines are mounted individually in nacelles suspended below the wings and are numbered from left to right, one through four. On engines 1, 2 and 4 each nacelle includes an oil cooler inlet and forward nacelle fairing which houses an oil cooler and oil tank for the generator drive. Access doors are provided in the cowling for engine oil tank servicing and engine trimming. A fire extinguisher access door, located in the left side cowl panel, is held in place by spring clips and can be pushed out to allow insertion of a hand operated fire extinguisher. A spring-loaded door in the left side cowl panel is provided for engine surge bleed valve air exhaust. The bottom cowl panel has a cartridge starter exhaust door on engine 3 and a generator cooling outlet on engines 1, 2 and 4. A spring-loaded door is also provided in the bottom cowl panel to relieve excessive pressure within the cowling. The nose cowl, together with the nose dome, forms the engine air inlet. Eight auxiliary air inlet doors in the nose cowl provide an additional source of air for the engine during ground operation and takeoff. The doors, which are spring-loaded to the closed position, are opened by differential pressure. The TF33-P-9 engine has two compressors with their respective turbines which form the two rotor systems, mechanically independent but related by air flow. See figure 1-6. The low pressure compressor (N_1) consists of a two stage, large diameter fan plus six additional compression stages and is driven by a three stage turbine. The high pressure compressor (N_2) has seven stages and is driven by a single stage turbine. A hydromechanical fuel control establishes the engine thrust output in accordance with a predetermined schedule which is set by the throttle. Low pressure compressor bleed air is used for pneumatic starters, air conditioning, and window defrosting. 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, and generator drive system pressurization and cooling. See figure 1-8 for engine pod views.

engine thrust



F-32

SEA LEVEL

STATIC CONDITIONS

TAKEOFF RATED THRUST

ENGINE INSTALLED ON AIRPLANE

Engine on test stand develops 18,000 lb thrust -65°F to +80°F

Figure 1-7

ENGINE THRUST

The primary purpose of the flat rated engine is to provide constant thrust over a wide ambient temperature range. At sea level the engine, as installed on the airplane, will develop approximately 16,050 pounds of thrust at all ambient temperatures from -65° F to +84° F. Above 84° F the thrust decreases with increasing ambient temperature. The TF33-P-9 engines do not use water injection. See figure 1-7. For all temperatures the throttles will be set to obtain a predetermined, static takeoff EPR. For takeoff procedures refer to Section II. Takeoff thrust in terms of engine pressure ratio (EPR) for various OAT and altitudes is shown in Part 2 of the Appendix, T.O. 1C-135(E)C-1-1. Engine operating and temperature limits are shown in Section V. Refer to ENGINE OPERATION, Section VII.

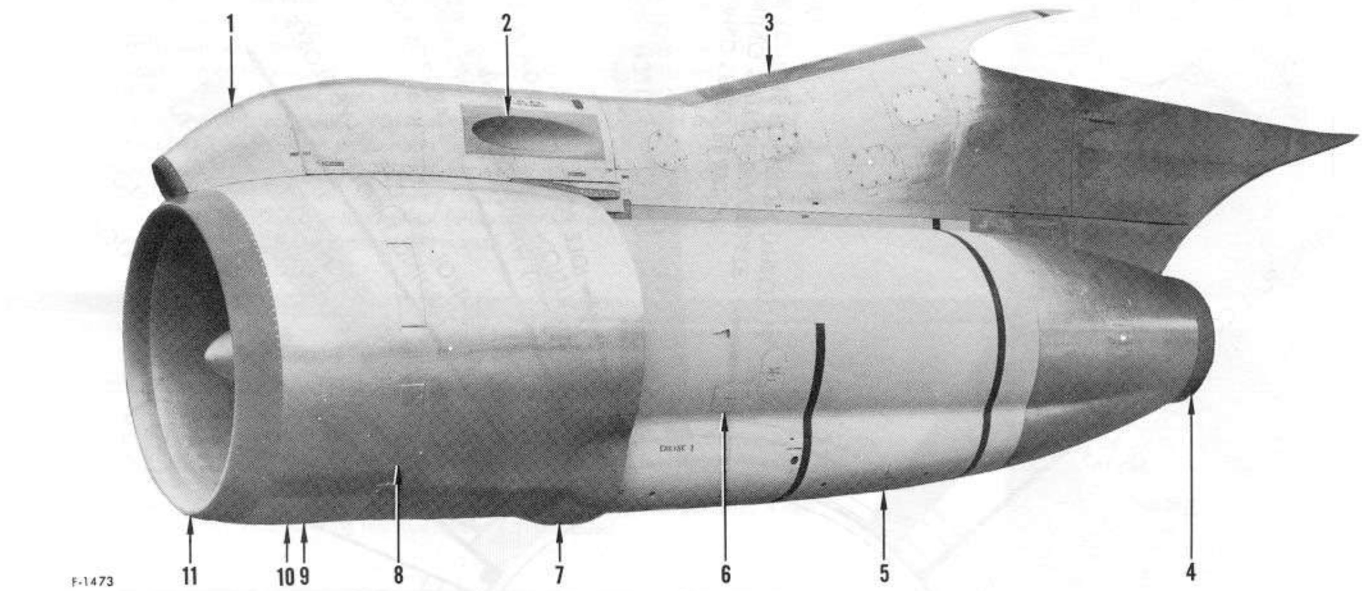
ENGINE FUEL CONTROL SYSTEM

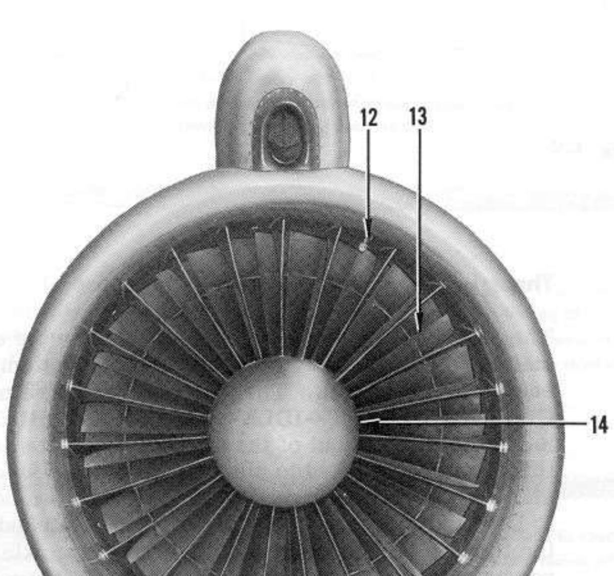
An engine fuel control system (figure 1-10) on each engine delivers fuel at pressures and flow rates as required to obtain the engine thrust output desired. Fuel from the tanks is routed through the system to a fuel control unit which meters fuel to the engine. The throttle provides basic engine thrust control and operates through the fuel control unit to position a throttle valve. Engine fuel is also controlled by an electrically operated fuel fire shutoff valve. From this valve, the fuel passes through a fuel flow transmitter to a fuel strainer. From the strainer the fuel flows through the fuel pump to a hydromechanical fuel control, a fuel-oil cooler and a fuel pressurizing and dump valve. The fuel pressurizing and dump valve functions as a flow divider, sending initial fuel flow to the pilot fuel manifold in the engine to achieve the desired fuel nozzle spray pattern. As the pressure increases, it also directs fuel flow to the main manifold for delivery through the main orifices of the fuel nozzles. The valve, which is held closed by fuel pressure, is opened by return spring pressure as fuel is shut off by the fuel control sequencing valve when the throttle is moved toward the CUT-OFF position. This permits fuel to drain automatically from the manifolds into the fuel manifold drain tank when the engine is shut down. The drain tank is drained automatically during flight by ram air introduced through a scoop located on the left side of the nacelle strut.

Fuel Control Unit

The fuel control is a high capacity fuel flow metering unit designed to permit selection of a desired engine thrust level. It provides automatic compensation throughout the full range of thrust for the ambient conditions encountered within the airplane flight envelope. A power lever on the fuel control is actuated by the throttle for regulating engine thrust in the range from idle to takeoff and to regulate fuel for engine starting and shutdown. The variables sensed by the fuel control are throttle position, burner pressure and high pressure compressor (N_2) speed. By using these variables, the fuel control accurately governs the engine steady state selected speed and limits fuel flow for acceleration and deceleration through a speed governing system. The fuel control may be considered as consisting of a fuel metering system and a computing system. The metering system regulates the fuel supplied by the engine-driven fuel pumps to provide the engine thrust output demanded by the pilot but subject to engine operating limitations as sensed and scheduled by the computing system. From the engine driven fuel pump, high pressure fuel is supplied to the filtration system which consists of a coarse filter and a fine filter. Inlet fuel pressure is then sensed by a pressure regulating valve which maintains a constant pressure differential across the throttle (metering) valve. All fuel in excess of that required to maintain this pressure differential is bypassed to the fuel pump interstage. The computing system of the fuel control unit positions the throttle valve to control the steady state engine speed, acceleration and deceleration. Positioning of the throttle valve is accomplished by using the ratio of metered fuel flow to engine burner pressure. Engine acceleration is controlled by placing a maximum stop on this same

engine pod views (typical)

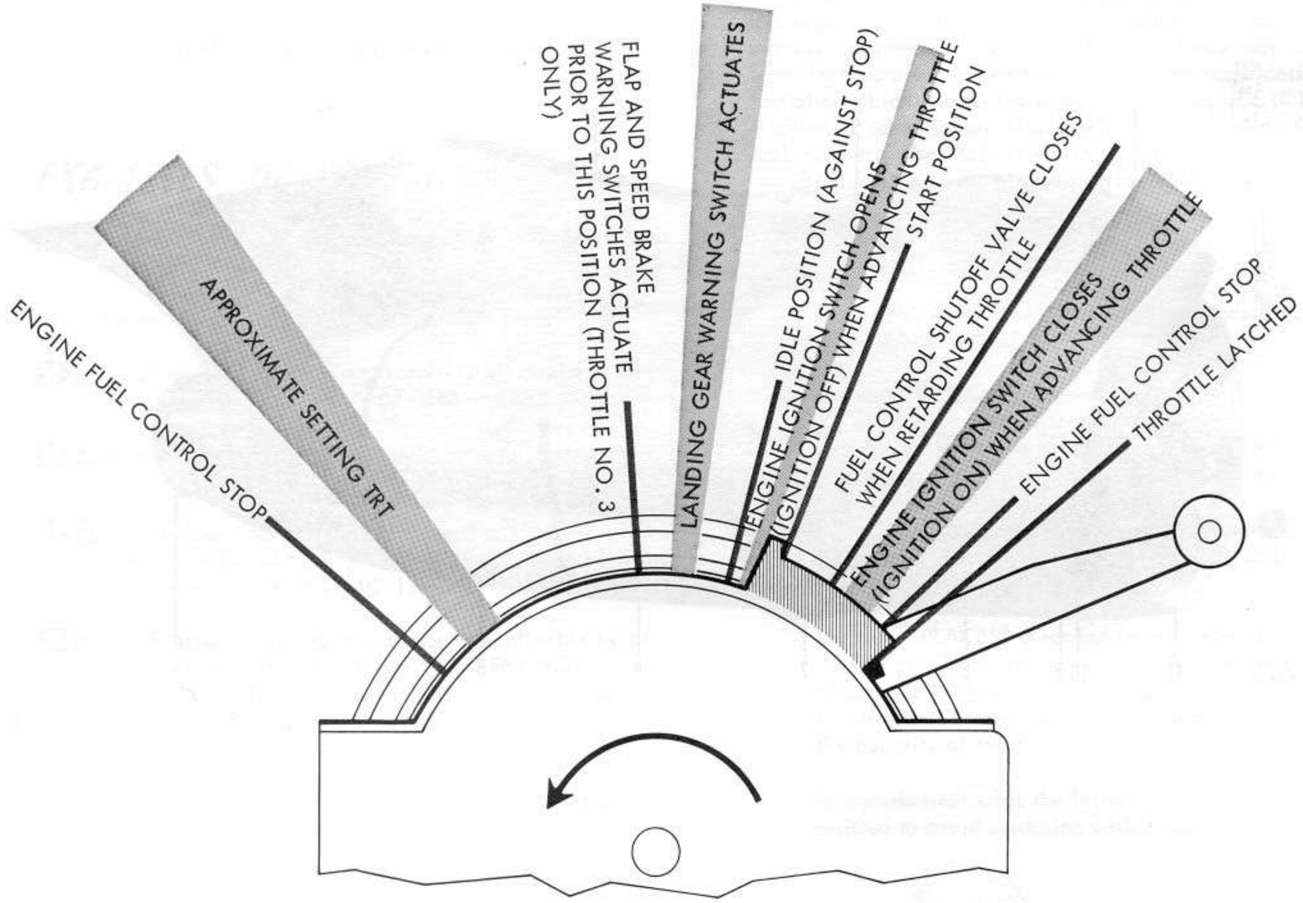




1. GENERATOR DRIVE OIL COOLER INLET FAIRING
2. GENERATOR DRIVE OIL COOLER EXHAUST
3. STRUT
4. AFT COWL SLEEVE
5. LEFT SIDE COWL PANEL
6. SURGE BLEED EXHAUST DOOR
7. FAN COWL PANEL
8. AUXILIARY AIR INLET DOORS
9. NACELLE ANTI-ICE EXHAUST
10. NACELLE ANTI-ICE COOLING AIR INLET
11. NOSE COWL
12. SURGE BLEED INLET PRESSURE PROBE
13. COMPRESSOR BLADES
14. NOSE DOME

Figure 1-8

throttle movement



F-436

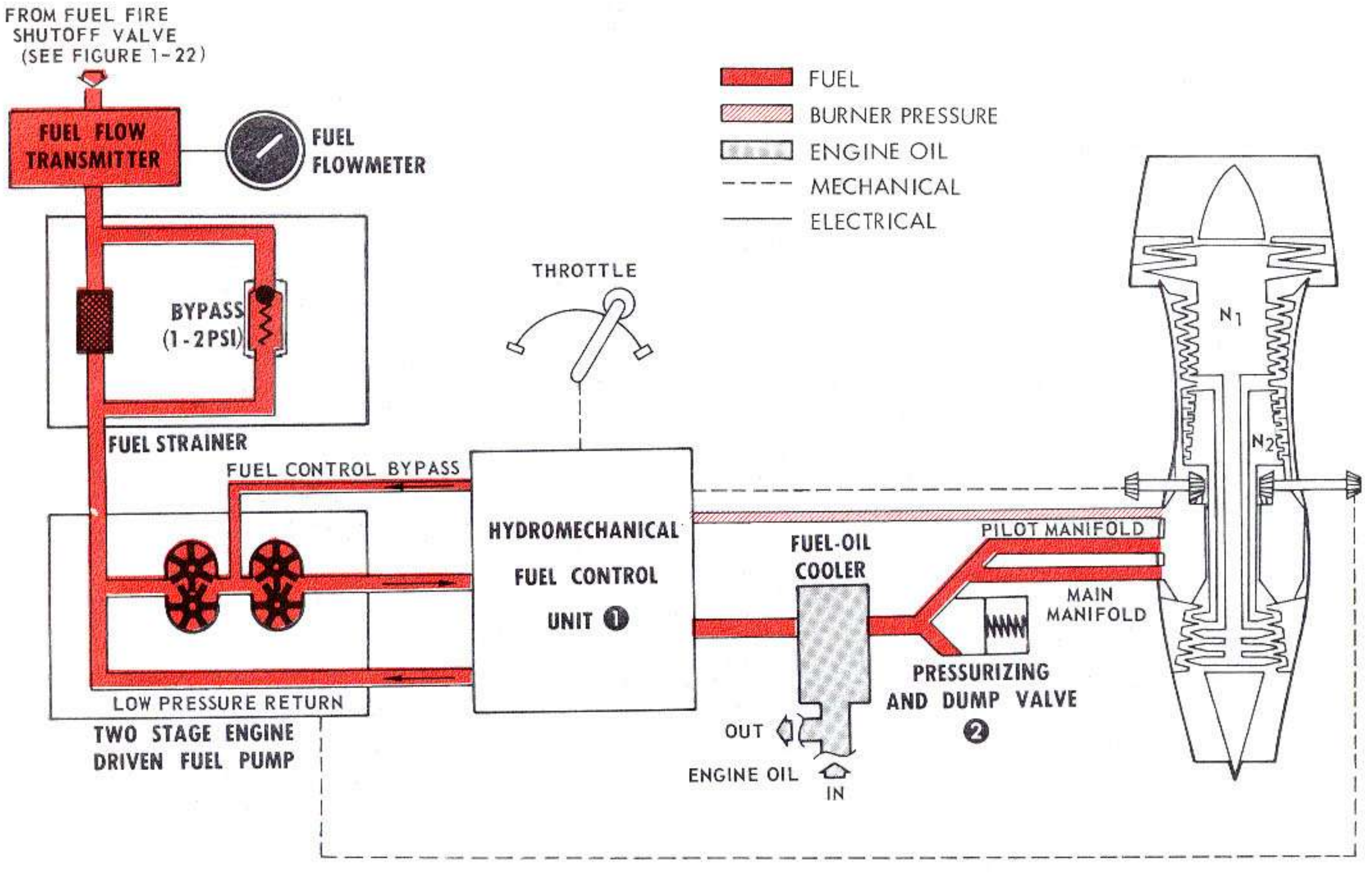
Figure 1-9

ratio. The resulting fuel schedule permits engine accelerations which avoid the over-temperature and surge limits of the engine without compromising engine acceleration time. Engine speed control is accomplished by comparing the actual speed with the desired speed through a speed-setting cam rotated by the power lever. A minimum pressure and shutoff valve, which is the final component to act upon the metered fuel flow, is opened by metered fuel pressure. This valve provides a minimum operating pressure within the fuel control, insuring that adequate pressure is always available for operation of the servos and valves at minimum flow conditions. When the throttle is moved toward the CUT-OFF positions, high pressure fuel is directed to the spring side of the shutoff valve which immediately closes and stops fuel flow to the engine.

Throttles

The engine throttles (8, figure 1-20) are on the control stand and are connected through a cable system to the engine fuel controls. Throttle positions are marked CUT-OFF--START--IDLE--INCREASE THRUST. 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

engine fuel feed system



NOTE

1 This unit senses high pressure compressor rpm and burner pressure to regulate fuel flow set by the throttles.

2 When fuel pressure is high enough, the pressurizing valve admits fuel to the main manifold. At shutdown the two manifolds are automatically drained

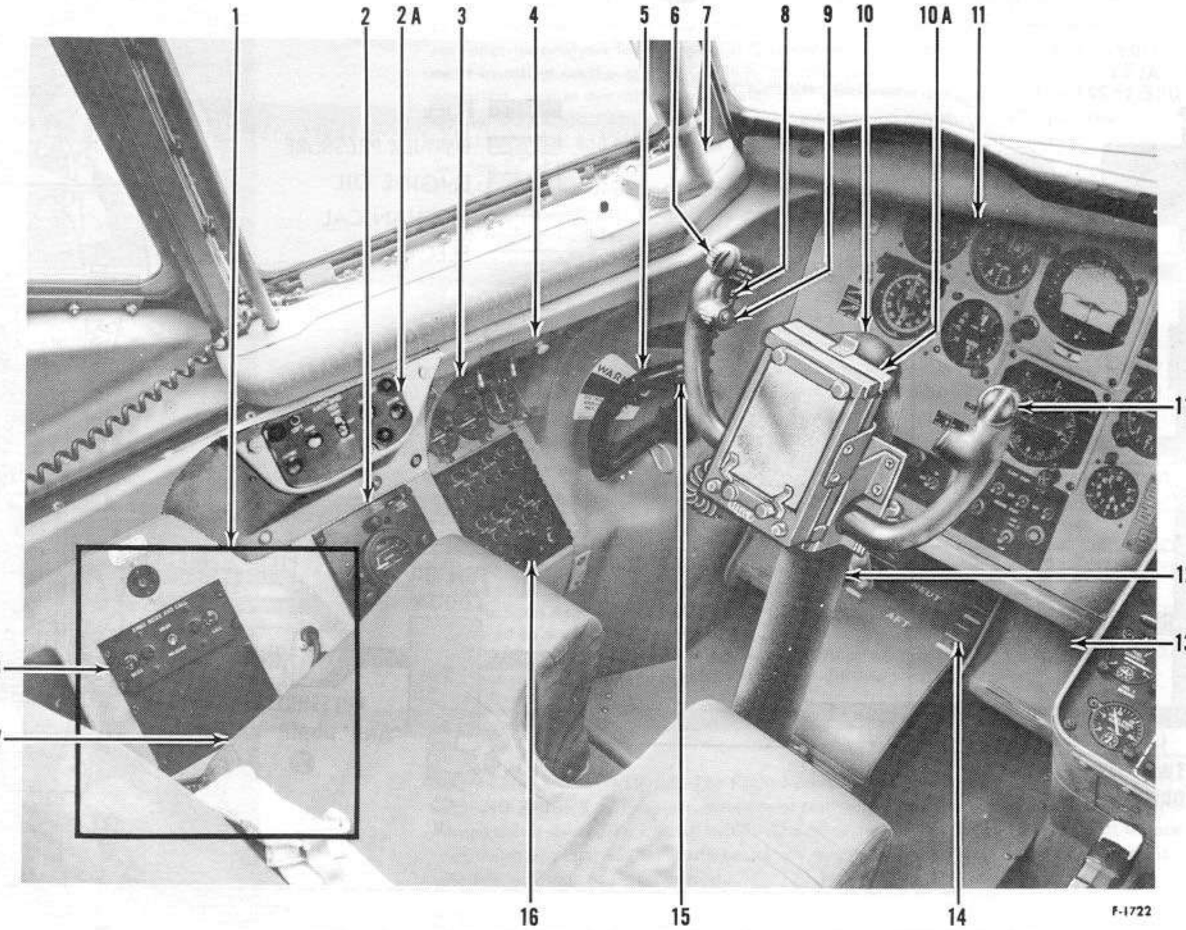
Figure 1-10

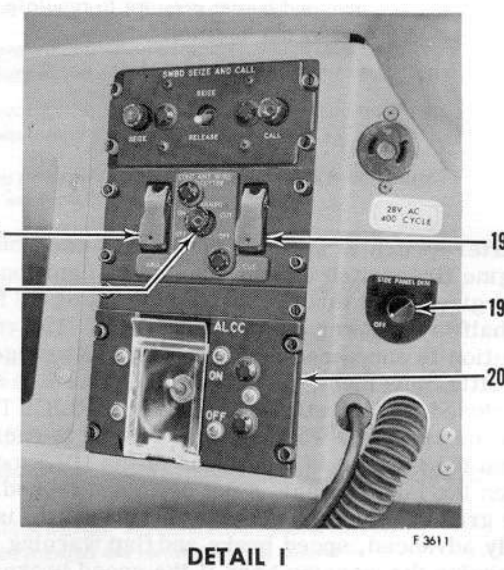
starter switch is in GROUND START position and the engine fire switch closed, the engine ignition will energize in the throttle range just out of CUT-OFF to halfway between START and IDLE. The engine ignition is energized throughout the full range of throttle movement, provided the engine fire switch 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, when the number three throttle is almost fully advanced, speed brake and flap warning switches energize the warning horn if the speed brakes or flaps are improperly set for takeoff. The warning horn will be energized if the No. 3 throttle is advanced 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. The full range of throttle movement is approximately 100 degrees.

Throttle Brake Lever

A throttle brake lever (3, figure 1-20) on the control stand (to the right of the throttle) adjusts the amount of resistance to throttle movement and holds 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.

pilot's station



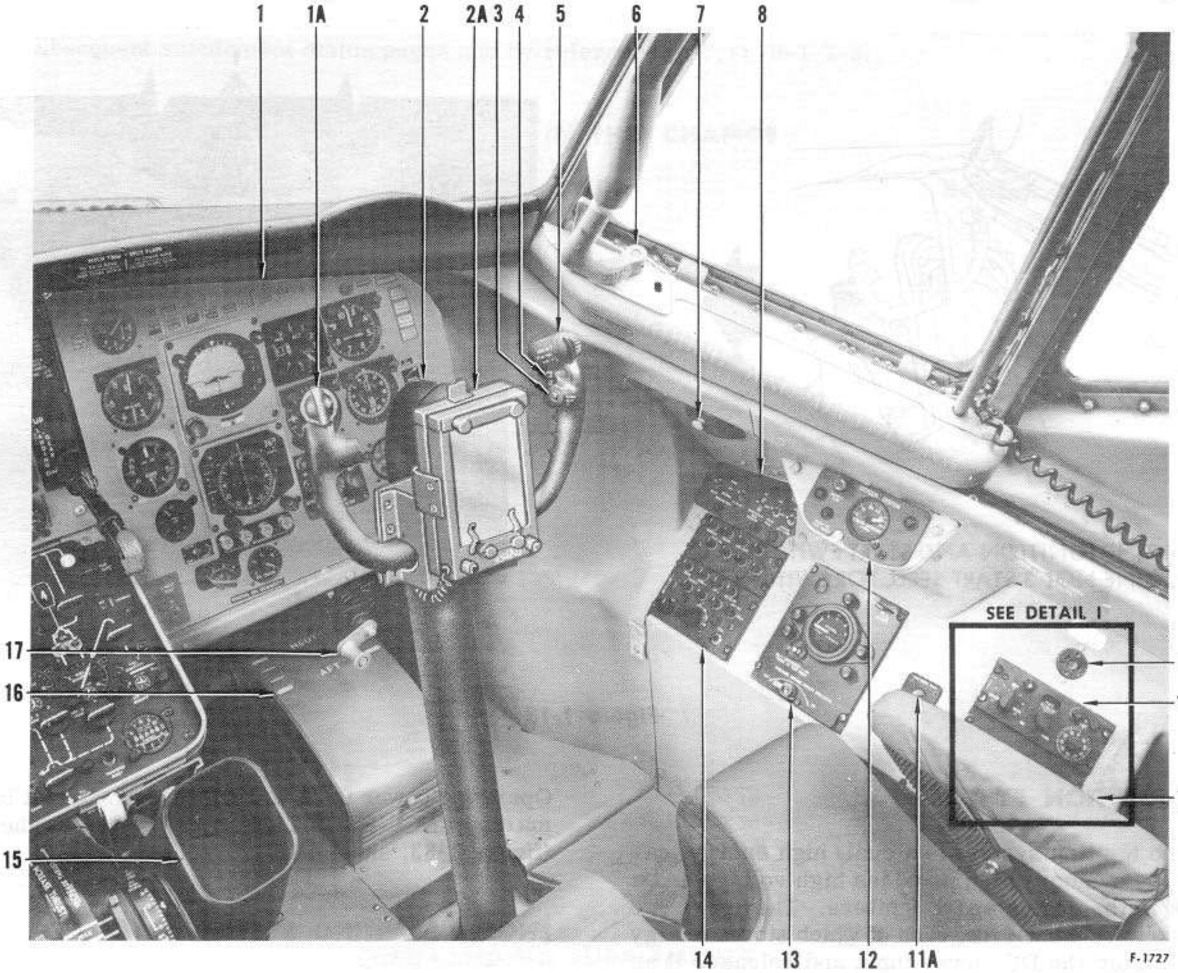


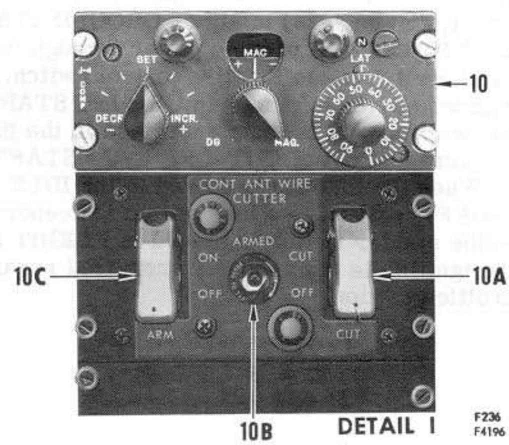
DETAIL I

1 PILOT'S SIDE PANEL
2 PILOT'S OXYGEN REGULATOR PANEL
2A ANTI-SKID PANEL (SEE FIGURE 1-53)
3 HYDRAULIC CONTROL PANEL (SEE FIGURE 1-36)
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 4-13)
9 AUTOPILOT AND ARR DISENGAGE AND RGA BUTTON
10 PILOT'S CONTROL COLUMN
10A LETDOWN CHART HOLDER (WITH TCTO 846)
11 PILOT'S FLIGHT INSTRUMENT PANEL (SEE FIGURE 1-16)
11A PILOT'S HEADING SLEW CONTROL
12 PILOT'S RUDDER PEDAL ADJUSTMENT HANDLE
13 PILOT'S RUDDER PEDALS
14 PILOT'S RUDDER PEDAL ADJUSTMENT INDICATOR
15 PILOT'S INTERPHONE SWITCH (SEE FIGURE 4-13)
16 PILOT'S INTERPHONE CONTROL PANELS (SEE FIGURE 4-13)
17 PILOT'S SEAT (SEE FIGURE 1-65)
18 SEIZE AND CALL PANEL (2 PLACES)
19 TWA CUTTER SWITCH
19A SIDE PANEL DIMMER RHEOSTAT
20 ALCC CLASSIFIED COMMAND CAPABILITY SWITCH
21 TWA CUTTER ARMED LIGHT
22 TWA CUTTER ARMED SWITCH

Figure 1-11

copilot's station

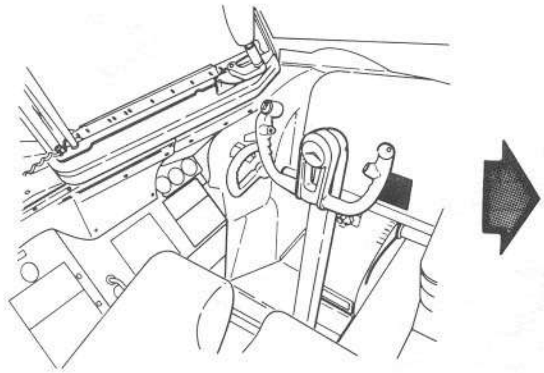


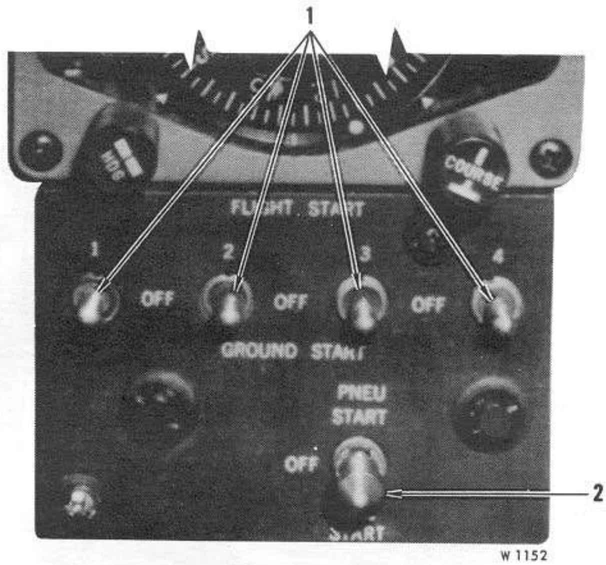


1 COPILOT'S FLIGHT INSTRUMENT PANEL (SEE FIGURE 1-17)
1A COPILOT'S HEADING SLEW CONTROL
2 COPILOT'S CONTROL COLUMN
2A LETDOWN CHARTHOLDER (WITH TCTO 846)
3 AUTOPILOT AND ARR DISENGAGE, AND RGA BUTTON
4 COPILOT'S INTERPHONE-MIKE SWITCH (SEE FIGURE 4-13)
5 STABILIZER TRIM CONTROL SWITCH
6 COPILOT'S SLIDING WINDOW HANDLE
7 COPILOT'S ASH TRAY
8 ANTI-ICING PANEL (SEE FIGURE 4-10)
9 PORTABLE SIGNAL LAMP RECEPTACLE (28 VOLT AC)
10 J-4 COMPASS PANEL (SEE FIGURE 4-43)
10A TWA CUTTER SWITCH
10B TWA CUTTER ARMED LIGHT
10C TWA CUTTER ARMED SWITCH
11 COPILOT'S SEAT (SEE FIGURE 1-65)
11A SIDE PANEL DIMMER RHEOSTAT
12 LIQUID OXYGEN QUANTITY GAGE
13 COPILOT'S OXYGEN REGULATOR PANEL
14 COPILOT'S INTERPHONE CONTROL PANELS
15 PILOT'S SEARCH RADAR INDICATOR (SEE FIGURE 4-19)
16 COPILOT'S RUDDER PEDAL ADJUSTMENT INDICATOR
17 COPILOT'S RUDDER PEDAL ADJUSTMENT HANDLE

Figure 1-12

engine ignition and start panel





1 ENGINE IGNITION AND START SWITCHES
2 ENGINE NO. 3 START SELECTOR SWITCH

Figure 1-13

ENGINE IGNITION SYSTEM

The engine ignition system is a dual, high energy, capacitor type system which provides high voltage and a hot spark to the engine spark igniters. There are two ignition exciters per engine, each of which stores energy converted from the DC power input and releases it as a fast, high voltage discharge to a spark igniter. Spark igniters are installed in No. 4 and No. 5 combustion chambers in the engine. Primary control of the system is through the engine ignition control and start panel (figure 1-13). Placing the engine ignition and start switch (1, figure 1-13) in either GROUND START or FLIGHT START will provide power through the engine fire switch to the throttle control switch. When the starter switch is placed in GROUND START, the engine ignition will become energized in the throttle range from just out of CUT-OFF to the START position. When the throttle is moved to the IDLE (or to CUT-OFF) position, engine ignition is deenergized. When the starter switch is placed in FLIGHT START, engine ignition is continuously energized regardless of throttle position.

CAUTION

Excessive use of continuous ignition may cause engine spark igniters to fail. If conditions permit, limit the use of continuous ignition to 5 minutes or less during ground operation and 10 minutes or less during flight.

Operating power is 28 volt DC through circuit breakers marked ENGINE IGNITION, 1, 2, 3 and 4 on the SBCBP (figure 1-33, sheet 4).

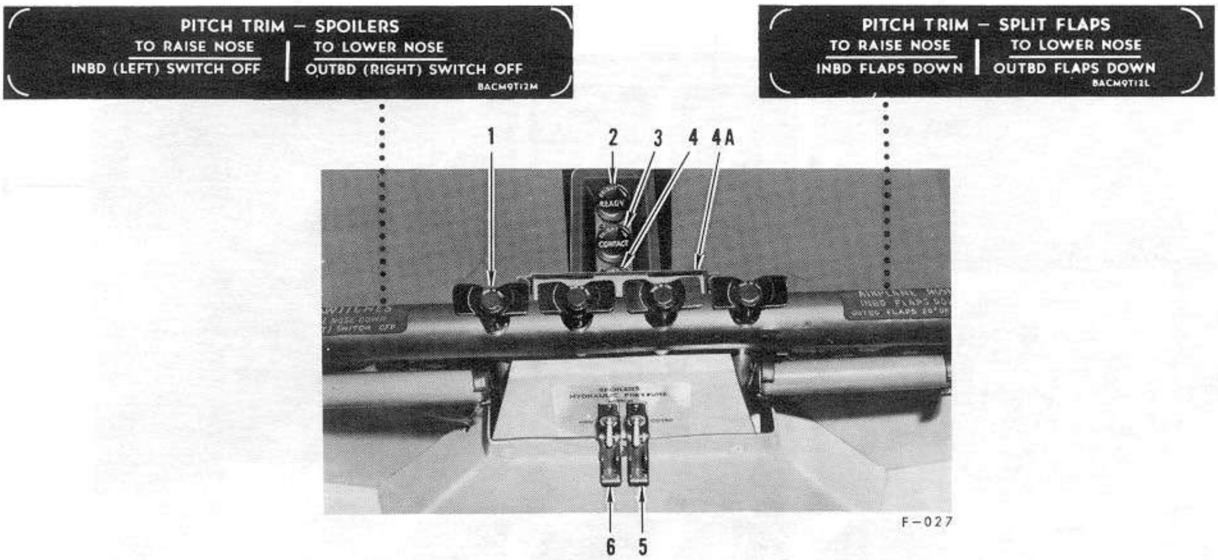
ENGINE STARTING SYSTEM

The engines are equipped with two types of starters. The No. 3 engine has a cartridge-pneumatic starter while the other engines are equipped with pneumatic starters. The cartridge-pneumatic starter, in the cartridge mode, permits engine starting without the aid of ground support equipment. Normally engine No. 3 is started first. Low pressure compressor air is then bled from engine No. 3 by the engine air bleed system (figure 4-1) to provide pressurized air for the pneumatic starters on the other engines. In the pneumatic mode the cartridge-pneumatic starter can be operated in the same manner as the other pneumatic starters, using a ground air compressor or engine cross bleed to pressurize the engine bleed manifold.

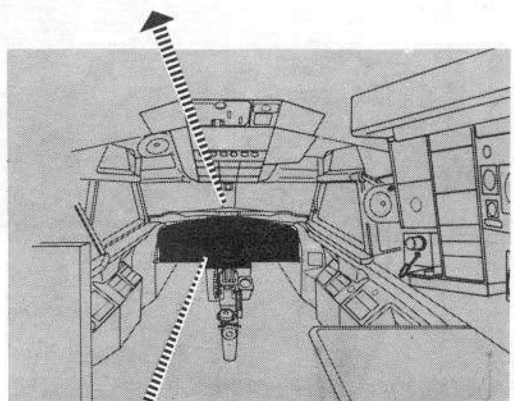
Cartridge-Pneumatic Starter System

The cartridge-pneumatic starter installed on engine No. 3 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. During a cartridge start, the solid-propellant cartridge is completely expended and must be replaced

pilots' instrument panel



1 ENGINE FIRE SWITCHES AND WARNING LIGHTS
2 ARR READY LIGHT
3 ARR CONTACT LIGHT
4 ARR DISCONNECT LIGHT
4A TAKEOFF AND LANDING DATA CARD HOLDER
5 OUTBOARD SPOILER SWITCH
6 INBOARD SPOILER SWITCH
7 PILOT'S FLIGHT INSTRUMENT PANEL (SEE FIGURE 1-16)
8 PILOTS' CENTER INSTRUMENT PANEL (SEE FIGURE 1-15)
9 COPILOT'S FLIGHT INSTRUMENT PANEL (SEE FIGURE 1-17)
10 FUEL PANEL (SEE FIGURE 1-23)



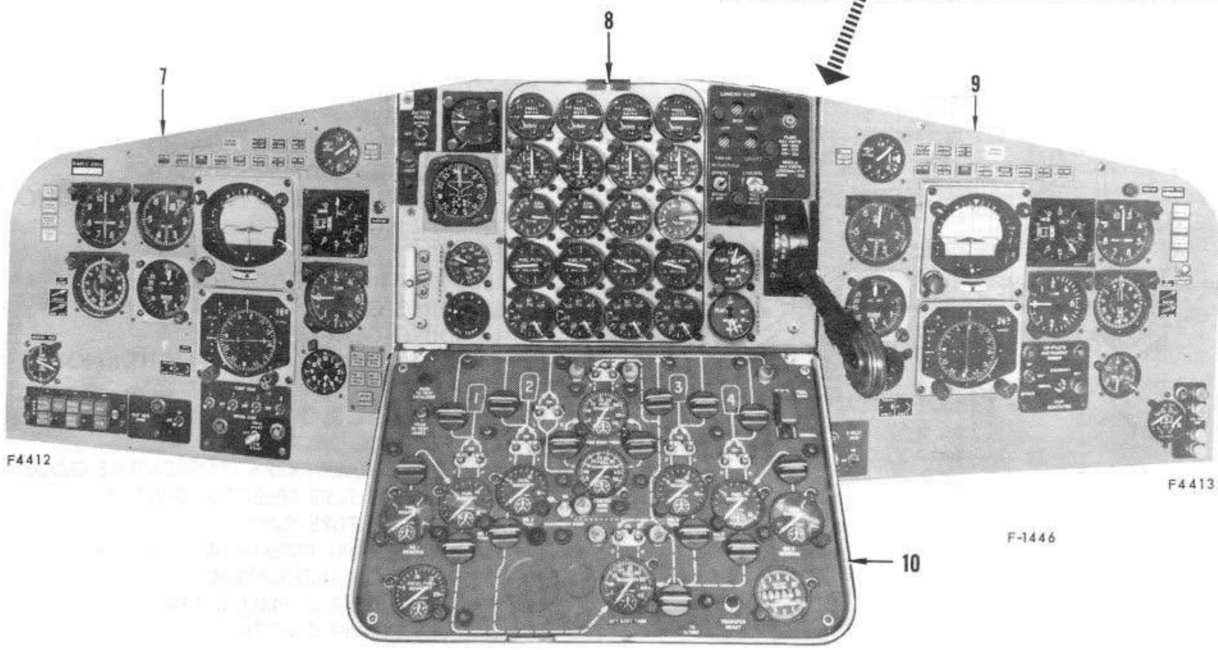
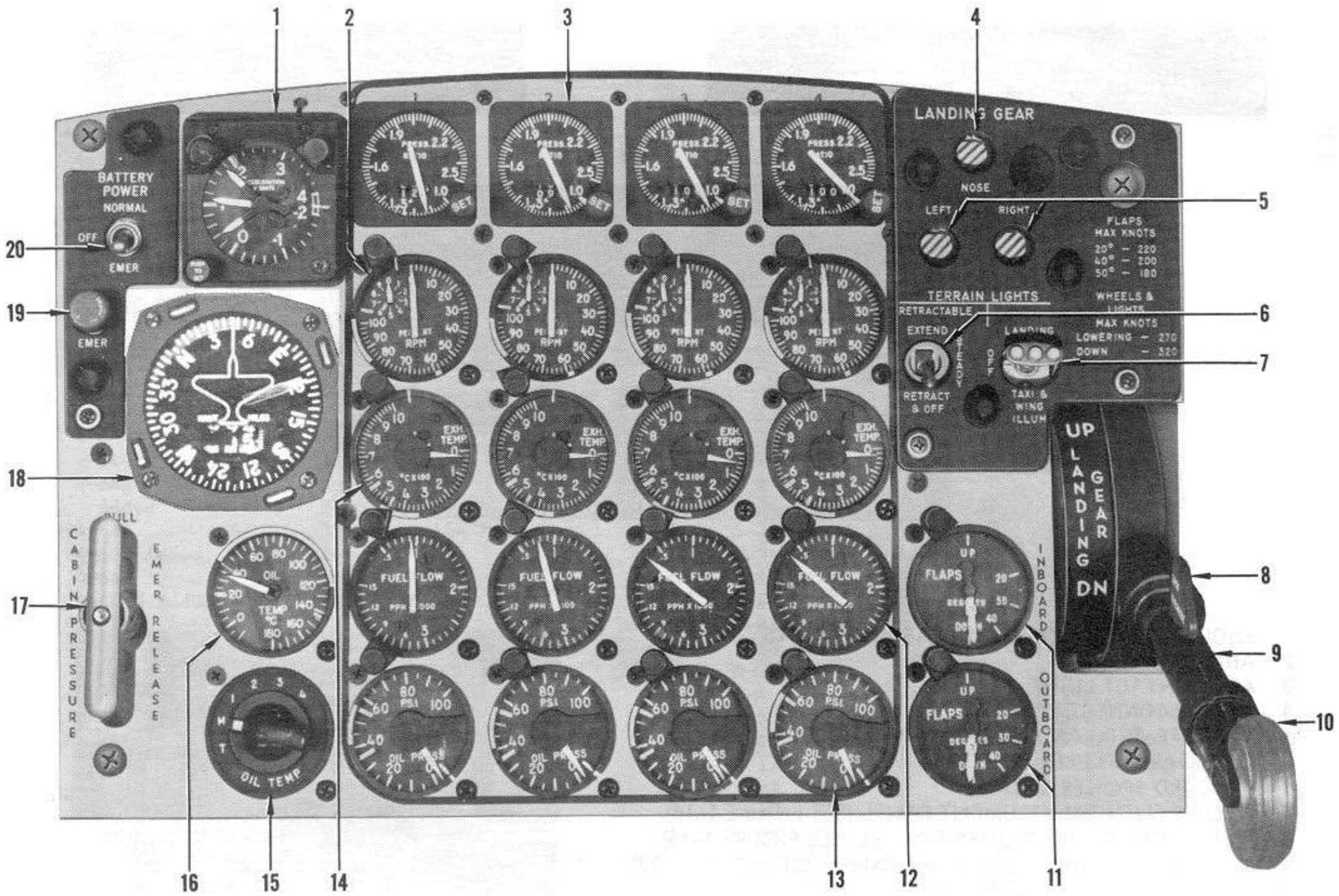
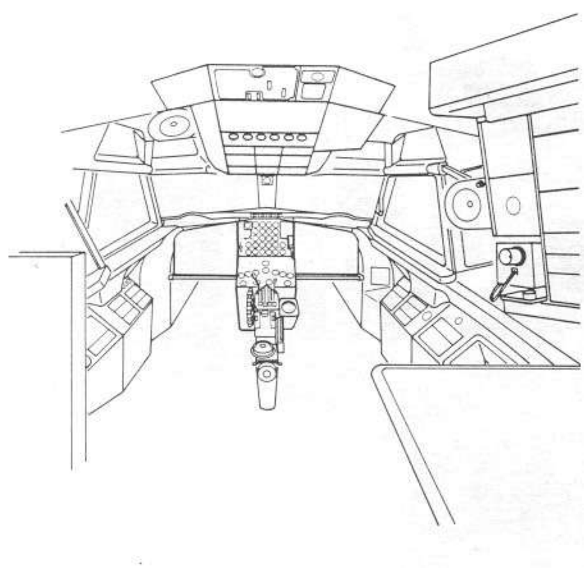


Figure 1-14

pilots' center instrument panel





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 OIL TEMPERATURE SELECTOR SWITCH
16 OIL TEMPERATURE GAGE
17 CABIN PRESSURE EMERGENCY RELEASE HANDLE
18 DESTINATION INDICATOR
19 SWITCHED DC BUS FAILURE LIGHT
20 BATTERY POWER SWITCH

Figure 1-15

before making another cartridge start. Refer to figure 1-66 and also to the applicable maintenance manual for cartridge replacement procedures. Starter exhaust gases are vented overboard through a spring-loaded door in the bottom cowl panel. Two spare cartridges (32, figure 1-66) are stowed on the left side of the main cabin, forward of the cargo door.

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 combinations of vibration and high temperature that can exist in the engine nacelle.
- Do not remove a cartridge that has fired normally, hang fired, or misfired until the exhaust smoke at the starter exhaust duct has completely cleared 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, under any circumstance, allow the electrical contacts of a starter cartridge to contact any part of the surface of the airplane.

Engine No. 3 Start Selector Switch

The start selector switch (2, figure 1-13) 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 engine ignition and start switch is in the GROUND START position provided the engine fire switch is in the normal position. With the engine No. 3 ignition and start switch in the GROUND START position and the start selector switch momentarily pressed to CTG START, the cartridge in the starter is ignited and the starter rotates the engine high pressure compressor for starting. For operation in the PNEU START position, 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 five minutes between starts. Operating power is 28 volt DC through a circuit breaker marked ENGINE STARTER, 3 on the SBCBP (figure 1-33, sheet 4).

Pneumatic Starter System

The pneumatic starter on each engine is controlled by a starter control valve mounted in the nacelle strut. The starter uses air from either a ground source or engine air bleed from another operating engine. Engines 1, 2 and 4 have pneumatic starters while engine 3 has a dual capability, cartridge-pneumatic starter. In the pneumatic mode, the cartridge-pneumatic starter operates in the same manner as the pneumatic starters. Refer to ENGINE AIR BLEED SYSTEM, Section IV.

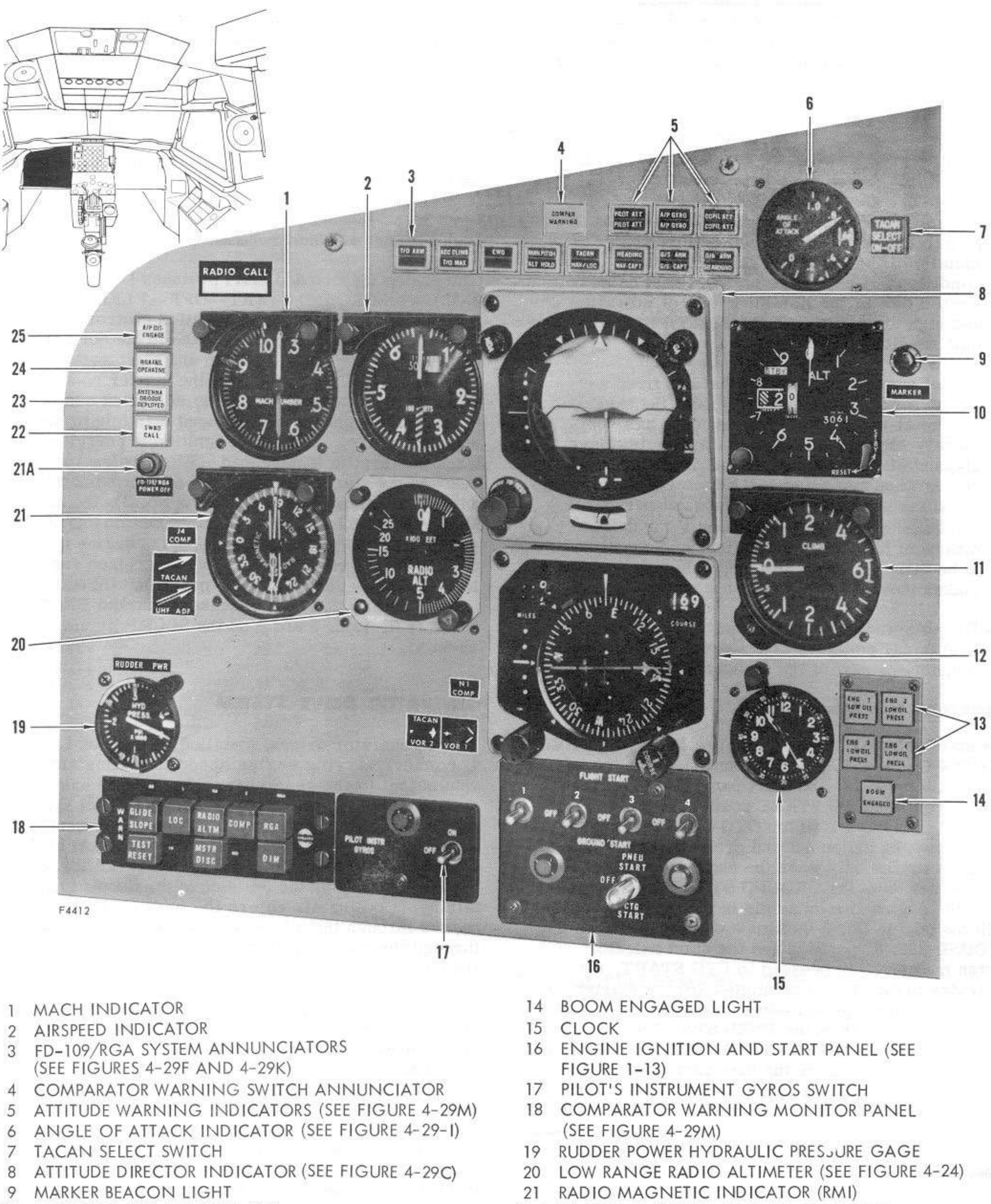
Engine Ignition and Start Switches

The engine ignition and start switches (1, figure 1-13), with GROUND START--OFF--FLIGHT START positions, are on the engine ignition control and start panel. With the engine fire switch in the normal position and the engine ignition and start switch in the GROUND START position, the starter control valve in the nacelle strut opens, admitting compressed air from the engine bleed manifold to the starter turbine. The engine ignition is energized when the throttle is advanced. When the engine reaches the starter cutout speed of approximately 34% (approximately 38% on engine No. 3), the air supply is cut off. With the engine ignition and start switch in FLIGHT START position the engine ignition only is energized and will remain energized regardless of start lever or throttle position. Circuit protection is through circuit breakers marked ENGINE STARTER, 1, 2, 3 and 4 on the SBCBP (figure 1-33, sheet 4).

GENERATOR DRIVE SYSTEM

Three generator drives, installed on engines 1, 2 and 4, convert varying engine speed to a constant 8000 rpm output to the generators. Each drive has an oil system which is separate from the engine oil system. An oil tank with a capacity of 6 quarts is mounted on top of the engine aft of the generator drive oil cooler. A sight gage on the tank can be observed through a window installed on the left side of the forward nacelle fairing. Cooling air enters the inlet (1, figure 1-8), passes through the oil cooler and exhausts overboard through the nacelle fairing. Oil temperature is controlled by a thermostatic valve which allows the oil to bypass the cooler at low oil temperatures. If oil temperature is too high during ground operation, an air ejector system uses high pressure compressor bleed air to induce a flow of cooling air through the oil cooler. No manual controls are provided. The generator drive and oil tank are pressurized by high pressure compressor bleed air through a regulator. A pressure fill valve in the oil-out line to the oil cooler is used to service the drive oil tank. The generator drive input shaft, which connects the drive to the engine, has a thermal disconnect. For servicing information, see figure 1-66.

pilot's flight instrument panel (TYPICAL)

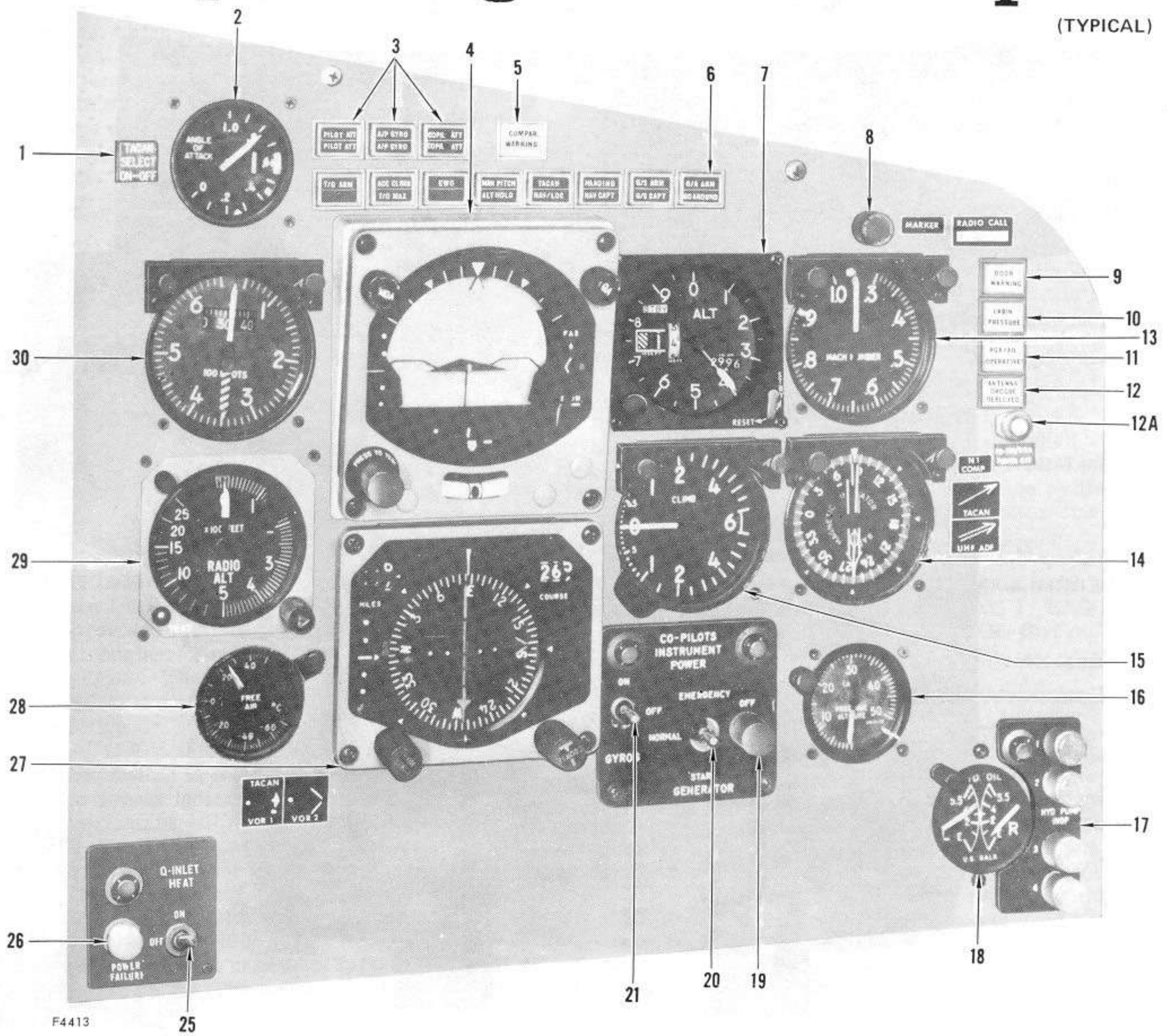


1 MACH INDICATOR
2 AIRSPEED INDICATOR
3 FD-109/RGA SYSTEM ANNUNCIATORS (SEE FIGURES 4-29F AND 4-29K)
4 COMPARATOR WARNING SWITCH ANNUNCIATOR
5 ATTITUDE WARNING INDICATORS (SEE FIGURE 4-29M)
6 ANGLE OF ATTACK INDICATOR (SEE FIGURE 4-29-I)
7 TACAN SELECT SWITCH
8 ATTITUDE DIRECTOR INDICATOR (SEE FIGURE 4-29C)
9 MARKER BEACON LIGHT
10 ALTIMETER (SEE FIGURE 1-59A)
11 VERTICAL VELOCITY INDICATOR
12 HORIZONTAL SITUATION INDICATOR (SEE FIGURE 4-29D)
13 ENGINE OIL LOW PRESSURE WARNING LIGHTS
14 BOOM ENGAGED LIGHT
15 CLOCK
16 ENGINE IGNITION AND START PANEL (SEE FIGURE 1-13)
17 PILOT'S INSTRUMENT GYROS SWITCH
18 COMPARATOR WARNING MONITOR PANEL (SEE FIGURE 4-29M)
19 RUDDER POWER HYDRAULIC PRESSURE GAGE
20 LOW RANGE RADIO ALTIMETER (SEE FIGURE 4-24)
21 RADIO MAGNETIC INDICATOR (RMI)
21A PILOT'S FD-109/RGA POWER OFF LIGHT
22 SWITCHBOARD CALL LIGHT
23 TWA DROGUE DEPLOYED LIGHT
24 RGA FAIL OPERATIVE LIGHT
25 AUTOPILOT DISENGAGED LIGHT

Figure 1-16

copilot's flight instrument panel

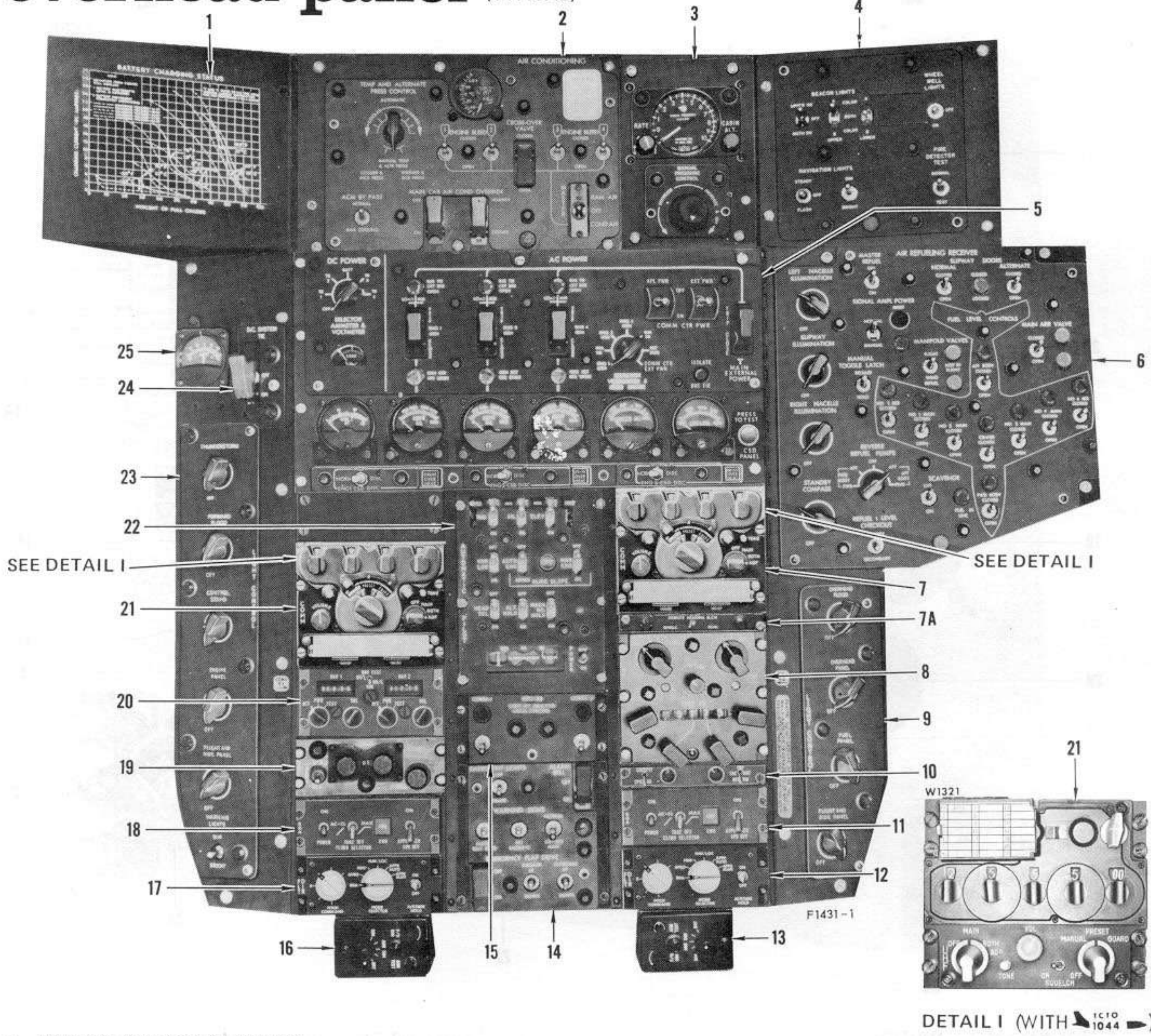
(TYPICAL)



1 TACAN SELECT SWITCH
2 ANGLE OF ATTACK INDICATOR
3 ATTITUDE WARNING INDICATORS
4 ATTITUDE DIRECTOR INDICATOR
5 COMPARATOR WARNING SWITCH ANNUNCIATOR
6 FD-109/RGA SYSTEM ANNUNCIATORS
7 ALTIMETER (SEE FIGURE 1-59A)
8 MARKER BEACON LIGHT
9 CARGO DOOR OR HATCH NOT LATCHED WARNING LIGHT
10 CABIN PRESSURE WARNING LIGHT
11 RGA FAIL OPERATIVE LIGHT
12 TWA DROGUE DEPLOYED LIGHT
12A COPILOT'S FD-109/RGA POWER OFF LIGHT
13 MACH INDICATOR
14 RADIO MAGNETIC INDICATOR (RMI)
15 VERTICAL VELOCITY INDICATOR
16 CABIN AIR PRESSURE GAGE (CABIN ALTIMETER)
17 HYDRAULIC PUMP INOPERATIVE LIGHTS
18 HYDRAULIC OIL QUANTITY GAGE
19 COPILOT'S INSTRUMENT POWER-OFF LIGHT
20 COPILOT'S INSTRUMENT POWER GENERATOR SWITCH
21 COPILOT'S INSTRUMENT GYROS SWITCH
22 (DELETED)
23 (DELETED)
24 (DELETED)
25 Q-INLET HEAT SWITCH
26 Q-INLET HEAT FAILURE WARNING LIGHT
27 HORIZONTAL SITUATION INDICATOR
28 FREE AIR TEMPERATURE GAGE (OAT)
29 LOW RANGE RADIO ALTIMETER
30 AIRSPEED INDICATOR

Figure 1-17

overhead panel (TYPICAL)



1 BATTERY CHARGING STATUS
2 AIR CONDITIONING PANEL (SEE FIGURE 4-5)
3 CABIN PRESSURE CONTROLLERS (SEE FIGURE 4-7)
4 PILOTS' LIGHTING CONTROL PANEL (SEE FIGURE 4-33)
5 ELECTRICAL CONTROL PANEL (SEE FIGURE 1-28)
6 ARR PANEL (SEE FIGURE 4-62)
7 UHF COMMAND NO. 2 CONTROL PANEL (SEE FIGURE 4-15)
7A DUAL REMOTE HEADING SLEW SWITCH PANEL
8 LIAISON RADIO CONTROL PANEL (SEE FIGURE 4-16)
9 COPILOT'S LIGHT CONTROL PANEL (SEE FIGURE 4-33)
10 LOUDSPEAKER AND TACAN ANTENNA CONTROL PANEL (SEE FIGURES 4-13 AND 4-17)
11 COPILOT'S RGA CONTROL PANEL (SEE FIGURE 4-29J)
12 COPILOT'S FLIGHT DIRECTOR CONTROL PANEL (SEE FIGURE 4-29E)
13 COPILOT'S FLIGHT DIRECTOR DIMMER CONTROL PANEL (SEE FIGURE 4-29L)
14 EMERGENCY PANEL (SEE FIGURE 1-63)
15 COMMAND RADIO SWITCHING PANEL (SEE FIGURE 4-15)
16 PILOT'S FLIGHT DIRECTOR DIMMER CONTROL PANEL (SEE FIGURE 4-29L)
17 PILOT'S FLIGHT DIRECTOR CONTROL PANEL (SEE FIGURE 4-29E)
18 PILOT'S RGA CONTROL PANEL (SEE FIGURE 4-29J)
19 UHF-NAV (TACAN) CONTROL PANEL (SEE FIGURE 4-17)
20 VHF NAVIGATION CONTROL PANEL (SEE FIGURE 4-17)
21 UHF COMMAND NO. 1 CONTROL PANEL (SEE FIGURE 4-15)
22 AUTOPILOT CONTROL PANEL (SEE FIGURE 4-38)
23 PILOT'S LIGHT CONTROL PANEL (SEE FIGURE 4-33)
24 DC SYSTEM TIE SWITCH (SEE FIGURE 1-28)
25 BATTERY CHARGING AMMETER (SEE FIGURE 1-28)

Figure 1-18

An electromechanical disconnect device is contained in the generator drive to provide a means of disconnecting the CSD from the engine in event of a drive malfunction which may result in destruction of drive components. A disconnect warning system utilizes drive oil temperature to warn of a malfunction and the need to disconnect the drive. The failure to disconnect the drive and impending drive destruction are also indicated by drive oil temperature. An overheat light connected to two thermal switches provides warning to disconnect and warning of failure to disconnect. When the overheat light first comes on at 350° (±15°) F, the drive should be disconnected. The overheat light will go out upon disconnect switch actuation. If the drive is not disconnected immediately, a rise in drive oil temperature actuates a second thermal switch at 460° (±25°) F causing the overheat light to illuminate regardless of disconnect switch position. After exceeding the 460°F thermal switch setting, the overheat light will remain on until the drive cools after disconnect or shutdown. Drive connection can only be determined by generator indications. The drive cannot be reconnected during flight.

CSD Disconnect Switches

Three disconnect switches, one for each generator, (20, figure 1-28) are on the electrical control panel and are provided to disconnect the generator drive from each engine. The switches have NORM--MON--DISC positions. The switches latch in NORM position. DISC is a momentary position springloaded to MON position.

Placing the switch in NORM position arms the 350° (±15°) F overheat indicating circuit. This position will be used during all normal generator operations. Placing the switch momentarily to DISC position will disconnect the generator drive from the engine. Placing the switch in either DISC or MON position will disarm the 350° (±15°) F overheat indicating circuit thus allowing the 460° (±25°) F overheat indicating circuit to function in case of further overheat of the generator drive. The drive cannot be disconnected on the ground since the disconnect circuit is wired through the landing gear safety switches. Operating power for the switches is 28 volts dc through a circuit breaker marked GEN DRIVE DECOUPLE on the MCBP (figure 1-33, sheet 1).

Generator Drive Overheat Lights

Three red, press-to-test generator drive overheat lights (12, figure 1-28), one for each generator, are located on the electrical control panel. Each light, when illuminated, indicates that its associated generator drive has reached an overheat condition. Each light will first illuminate when the associated generator drive temperature reaches a temperature of 350° (±15°) F provided the disconnect switch is in NORM position. This indicates that the drive is overheated and should be manually disconnected. Each light will also illuminate when the generator drive temperature reaches 460° (±25°) F regardless of the disconnect switch position. This is designed to indicate the drive has failed to manually disconnect and should be shut down.

NOTE

> If the overheat light does not go out when the disconnect switch is moved out of NORM position, it is an indication that initiation of disconnect was delayed and the generator drive temperature has exceeded 460° (±25°) F.

Operating power for the overheat lights is 28 volts dc through circuit breakers marked ENG 1, ENG 2, and ENG 4 on the GENERATOR CONTROL portion of the BCBP (figure 1-33, sheet 3).

CSD Panel Edge Lights

Six edge lights, two for each generator, are located on the electrical control panel, two each adjacent to the associated overheat light and disconnect switch. The lights can be used as an overheat indicator in the event of overheat light malfunction. The lights will illuminate simultaneously with the associated overheat light provided the disconnect switch is in NORM position. If the disconnect switch is moved out of NORM position, the overheat light will go out but the edge lights will remain on as long as the overheat condition exists. Operating power for the overheat lights is 28 volts dc through circuit breakers marked ENG 1, ENG 2, ENG 4 on the GENERATOR CONTROL portion of the BCBP (figure 1-33, sheet 3).

CSD Panel Press-to-Test Button

A press-to-test button (19, figure 1-28) on the electrical control panel is provided to test the CSD panel edge light bulbs and circuit. When the button is depressed, the lights will illuminate. When the button is released, the lights will go out.

ENGINE OIL SYSTEM

Each engine has an integral oil system which includes a dual oil tank with a total capacity of approximately 12.2 gallons (approximately 9.6 gallons useable). The tank supplies a gear type engine driven oil pressure pump. Oil is supplied by the pressure pump to the engine bearings and accessory drives in various engine compartments. Scavenge pumps remove oil from the engine compartments, route it through a fuel-oil cooler and return it to the tank. The fuel-oil cooler, which transfers heat from the oil to the fuel, is located on the right side of the engine. It consists of a cylindrical oil chamber surrounded by an external jacket through which the fuel passes without restriction of flow. Oil temperature is governed by a thermostatic control valve which is an integral part of the fuel oil cooler and permits bypassing of the oil at low oil temperatures. The fuel-oil cooler is located downstream of the fuel control unit and, as a result of metered fuel flow, better cooling is provided with increased fuel flow at advanced throttle settings than with reduced flow at lower settings. The selective type oil temperature indicating system consists of a temperature bulb on each engine, a temperature gage and a selector switch. With the exception of the oil temperature selector switch, no manual controls are provided for the engine oil system. For a description of the temperature gage and selector switch, refer to ENGINE INDICATORS in this Section. For oil servicing information, see figure 1-66.

ENGINE INDICATORS

Engine Pressure Ratio (EPR) Gages

Four engine pressure ratio gages (3, figure 1-15) are on the pilots' center instrument panel. Each gage indicates the ratio of engine exhaust pressure to engine inlet pressure as a measure of the thrust being developed by the engine. The engine inlet and exhaust pressures are compared by a transducer mounted in the nacelle strut. The transducer then transmits an electrical signal to the engine pressure ratio gage. The gage is calibrated from 1.0 to 2.5 units of engine pressure ratio. A triangular index and a drum-type counter (figure 7-1) can be adjusted to a selected value of EPR by a knob marked SET. The index and counter are normally used for reference to the takeoff thrust setting. Operating power is 115 volt AC through circuit breakers marked PRESSURE RATIO INDICATOR NO. 4 and NO. 1 on the ENG 1 GENERATOR section and PRESSURE RATIO INDICATOR NO. 3 and NO. 2 on the ENG 4 GENERATOR section of the MCBP (figure 1-33, sheet 2).

Tachometers

Engine high pressure compressor speed in % rpm is indicated by four tachometers (2, figure 1-15) on the pilots' center instrument panel. Power, independent of the airplane electrical system, is supplied by engine-driven tachometer generators. Each instrument has two pointers which allow readings between zero and 110%. The large 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

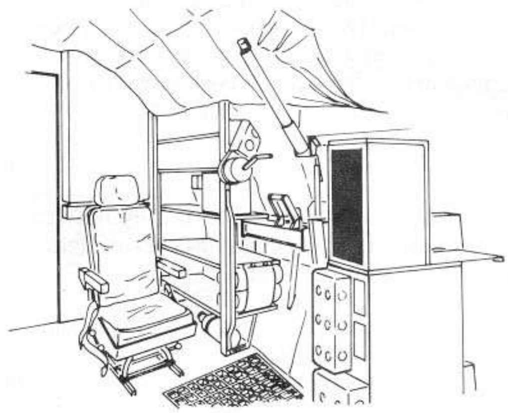
Exhaust gas temperature is indicated by four gages (14, figure 1-15) on the pilots' center instrument panel. These gages are calibrated in degrees centigrade. Power, independent of the airplane electrical system, is supplied by engine thermocouples to operate the gages.

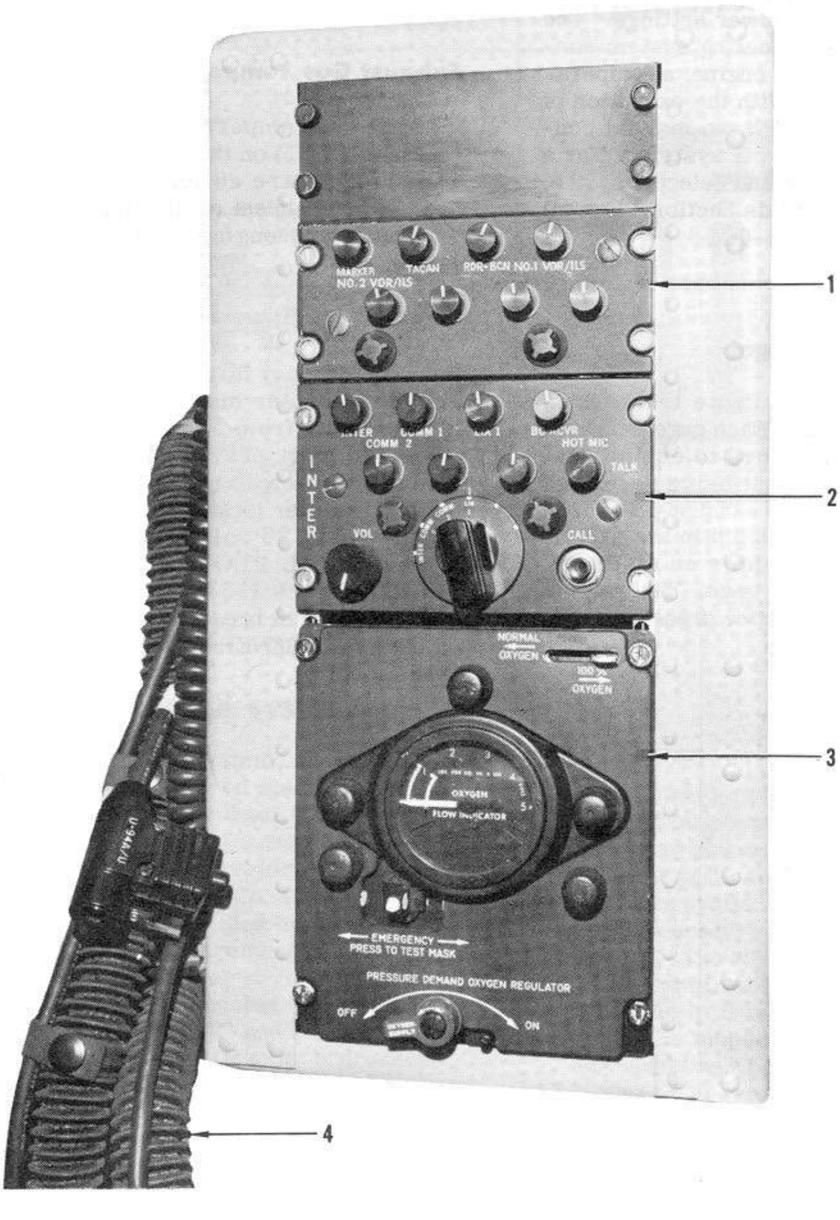
Engine Fuel Flowmeters

Four engine fuel flowmeters (12, figure 1-15) are on the pilots' center instrument panel. Each flowmeter is calibrated from 500 to 15,000 pph and has a zero reference mark prior to the 500 pph graduation. The rate of fuel flow to the engine is measured by a fuel flow transmitter located in each nacelle strut. Operating power is 28 volt DC through a circuit breaker marked FUEL FLOWMTR POWER SUPPLY on the SBCBP (figure 1-33, sheet 4) and 115/200 volt AC through a circuit breaker marked ENGINE FUEL FLOW on the ENG 2 GENERATOR section of the MCBP (figure 1-33, sheet 2).

crew instructor's console

1 INTERPHONE MIXER CONTROL PANEL (SEE FIGURE 4-13)
2 INTERPHONE CONTROL PANEL (SEE FIGURE 4-13)
3 OXYGEN REGULATOR PANEL (SEE FIGURE 4-35)
4 OXYGEN HOSE





F-1488

Figure 1-19

Oil Pressure Gages

Engine oil pressure is indicated by four oil pressure gages (13, figure 1-15) on the pilots' center instrument panel. These gages operate on 28 volt AC power supplied through pressure transmitters on each engine. 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 1-33, sheet 2).

Engine Oil Low Pressure Warning Lights

Oil low pressure warning lights for all engines are installed on the pilot's instrument panel (13, figure 1-16). These lights provide a backup system in case of failure of an oil pressure transmitter to an oil pressure gage. 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 the lights on engines 1, 2, and 4 is 28 V DC from a circuit breaker on T-R bus No. 1 and is labeled ENGINE 1, 2, 4 LOW OIL PRESS WARN (figure 1-33, sheet 1). Operating power for the light on engine 3 is 28 volt DC from a circuit breaker marked ENG NO. 3 OIL PRESS WARN on the SBCBP (figure 1-33, sheet 4).

Oil Temperature Gage

The engine oil temperature gage (16, figure 1-15) is on the pilots' center instrument panel and provides oil temperature readings for each engine selected by the temperature selector switch. It is also used to monitor the highest oil temperature and to provide a check of indicating system operation. Operating power is 115/200 volt AC through a circuit breaker marked ENG OIL TEMP IND on the ENG 4 GENERATOR section of the MCBP (figure 1-33, sheet 2).

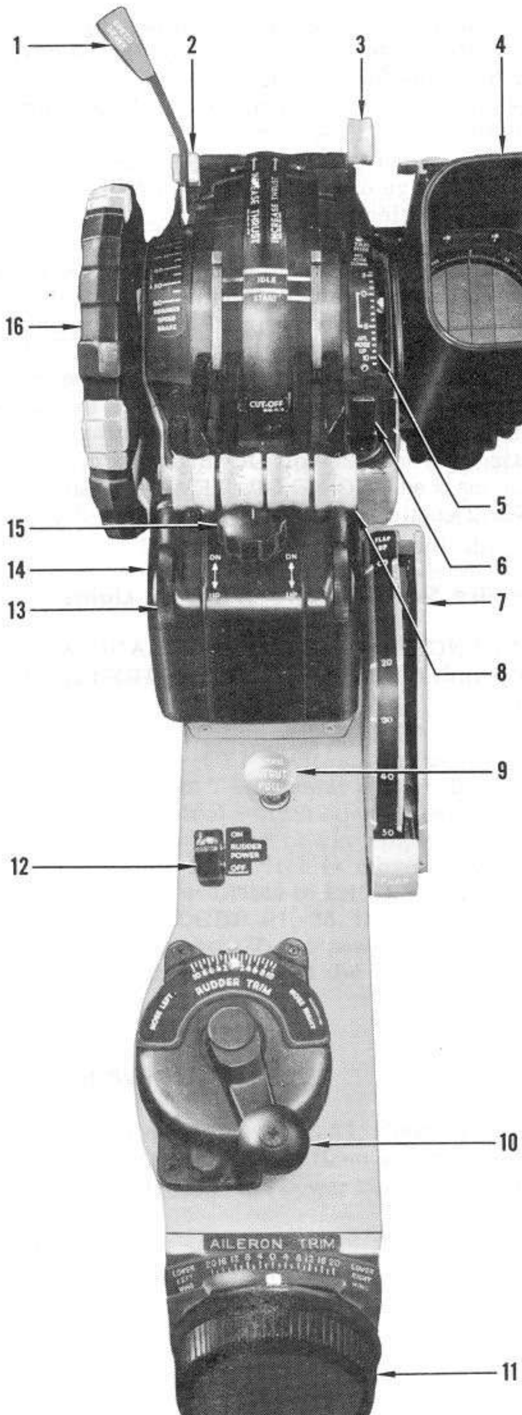
Oil Temperature Selector Switch

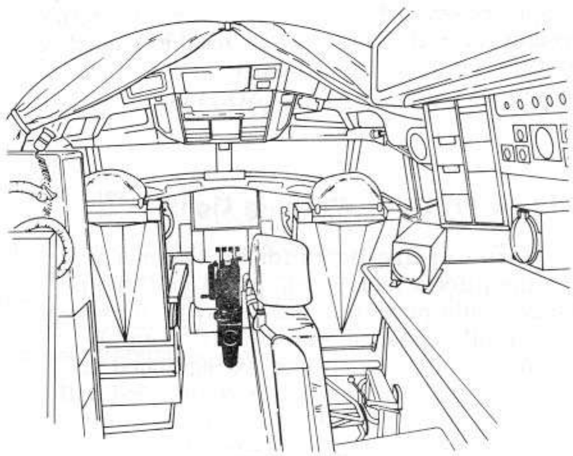
An oil temperature selector switch (15, figure 1-15) on the pilots' center instrument panel has 6 positions, one each for the four engine oil temperature probes (as designated by engine number), an M position and a T position which is spring-loaded to return to the M position. When the M position is selected, the temperature gage displays the temperature of the hottest of the 4 oil temperature probes but does not show which particular engine has the highest oil temperature. Due to quick indicating system response to changes in temperature, identification of the engine with high oil temperature is readily accomplished by selecting the engines separately. When the selector switch is held in T position, the indicator pointer moves toward the high end of the scale. This indicates that the system is operating normally. Operating power is 28 volt DC through a circuit breaker marked ENGINE OIL TEMP IND on the T-R BUS NO. 2 section of the MCBP (figure 1-33, sheet 1).

Engine Fire Switches and Warning Lights

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

control stand





1 SPEED BRAKE LEVER AND INDICATOR
2 PARKING BRAKE HANDLE
3 THROTTLE BRAKE LEVER
4 PILOT'S SEARCH RADAR INDICATOR (SEE FIGURE 4-19)
5 STABILIZER TRIM INDICATOR
6 STABILIZER TRIM CUT-OUT SWITCH
7 FLAP LEVER AND INDICATOR
8 THROTTLES
9 WARNING HORN CUT-OUT SWITCH
10 RUDDER TRIM CRANK AND INDICATOR
11 AILERON TRIM WHEEL AND INDICATOR
12 RUDDER POWER SWITCH
13 AUTOPILOT PITCH KNOB
14 AUTOPILOT FLIGHT CONTROLLER (SEE FIGURE 4-39)
15 AUTOPILOT TURN KNOB
16 STABILIZER TRIM WHEEL

F-1728

Figure 1-20

fuel quantity data

DATE: FEBRUARY 1964

DATA BASIS: FLIGHT TEST

TANKS	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	1	5800	37,700	5807	37,746
AFT BODY	1	6378	41,457	6415	41,698

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	19,484	126,646
FWD and AFT BODY	12,178	79,157
ALL	29,026	188,669

CONVERSION - Gallons to pounds
Gallons x 6.5 = pounds of fuel
The 6.5 fuel density factor is an average for std day temperatures and pressures for fuel specification MIL-J-5624, grade JP-4.

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.

Figure 1-21

FUEL SYSTEM

The airplane fuel system (figure 1-22) consists of six integral wing tanks, a combination bladder and integral center wing tank, and a forward and aft body tank with the necessary plumbing, valves and pumps. The integral tanks are formed by sealing structural areas of the wing while the bladder portion of the center wing tank has six conventional, nonself-sealing bladder cells. The forward body tank is forward of the front wing spar below the main deck floor beams and consists of four bladder cells. The aft body tank is aft of the main landing gear wheel wells and consists of five bladder cells. The outermost wing tanks are designated No. 1 reserve tank (left) and No. 4 reserve tank (right). The reserve tanks drain by gravity into main wing tanks 1 and 4 through interconnecting lines and valves. Main wing tanks 1 and 4 are inboard of the reserve tanks and between the dry bay areas. Main wing tanks 2 and 3 are inboard of and adjacent to main wing tanks 1 and 4 respectively, and also adjacent to the center wing tank. See figure 1-21 for fuel quantity data. There is no interconnection between the main tanks or between the main tanks and the center wing tank; however, the main tanks can be drained by gravity through the single point refueling manifold (into the aft body tank) down to amounts indicated in figure 7-6 for each main tank, and the center wing tank can be drained by gravity to the forward body tank. (See figure 1-22.) Valves are installed in the system to control the gravity flow. Primary control of the fuel system is from the fuel panel (figure 1-23) at the pilots' station. A manual defueling valve which is ground operated only, connects the engine manifold to the single point

fuel system

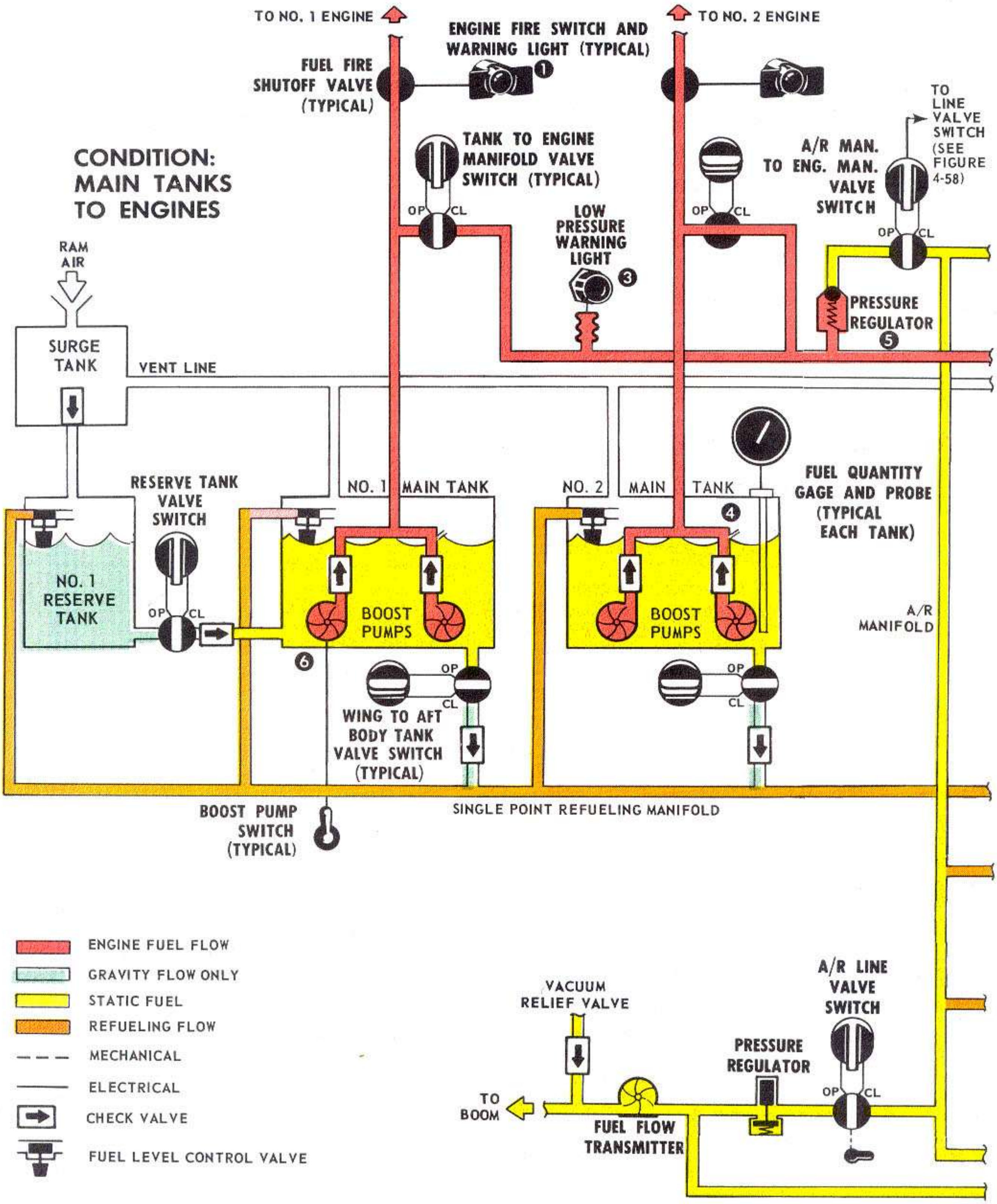
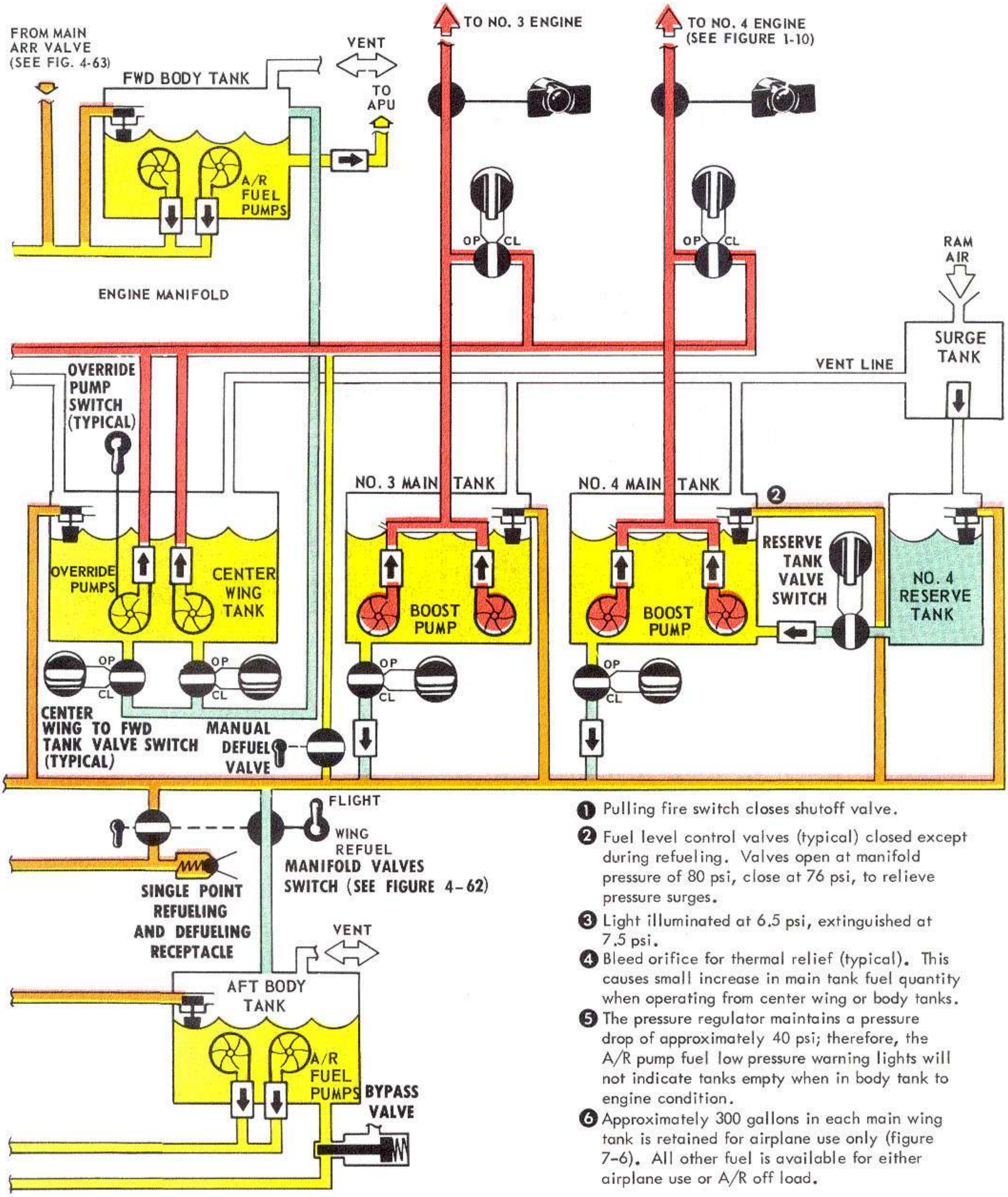


Figure 1-22 (Sheet 1 of 3)



1. Pulling fire switch closes shutoff valve.
2. Fuel level control valves (typical) closed except during refueling. Valves open at manifold pressure of 80 psi, close at 76 psi, to relieve pressure surges.
3. Light illuminated at 6.5 psi, extinguished at 7.5 psi.
4. Bleed orifice for thermal relief (typical). 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 low pressure warning lights will not indicate tanks empty when in body tank to engine condition.
6. Approximately 300 gallons in each main wing 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 1-22 (Sheet 2 of 3)

fuel system (cont)

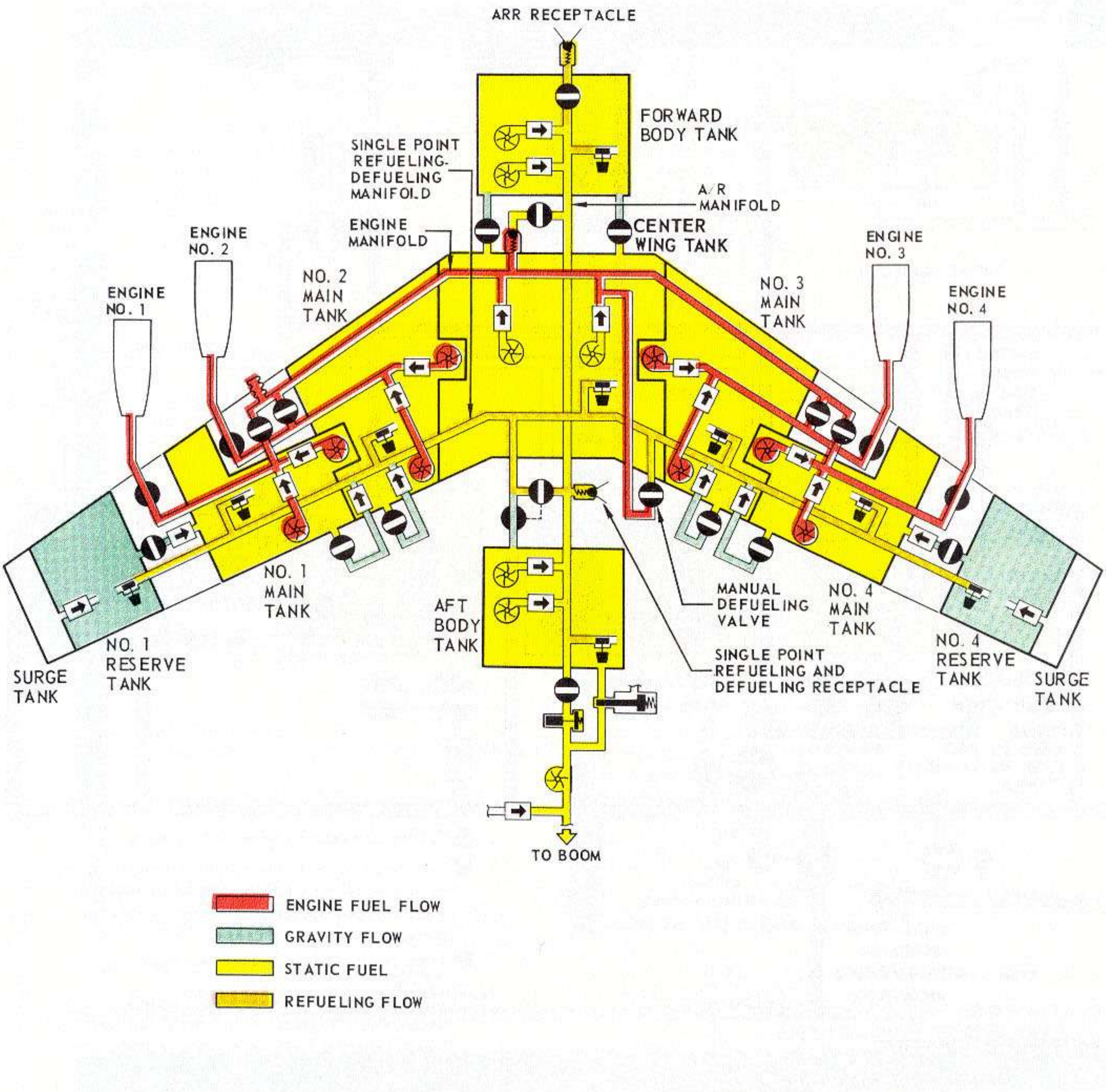


Figure 1-22 (Sheet 3 of 3)

refueling manifold. Refer to SINGLE POINT REFUELING SYSTEM and AIR REFUELING SYSTEM, Section IV. Normally fuel is fed to each engine fuel feed system (figure 1-10) through the normally open fuel fire shutoff valve from its respective main tank. However, the engine can be fed directly from any tank or tanks in the airplane, except the reserve tanks, through the engine manifold which interconnects the engines for crossfeed operations. See figure 1-22. Each main tank has two electrically driven centrifugal boost pumps. These pumps are normally used for all operations of the airplane except under conditions noted in FUEL SYSTEM EMERGENCY OPERATION, Section III, and FUEL SYSTEM OPERATION, Section VII. The center wing tank has two electrically driven centrifugal override pumps which are capable of overriding the main tank boost pumps whenever the engines are being fed from the center wing tank. This feature is incorporated so that boost pumps in tanks 1, 2, 3 and 4 can be left on while using fuel from the center wing tank, thus preventing engine fuel starvation if the center wing tank is pumped dry. Engine feed operations from the body tanks to the engines are conducted through a control valve and pressure regulator-check valve interconnecting 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 1-66. For alternate fuels, refer to Section V.

FUEL QUANTITY DATA

See figure 1-21 for fuel quantity data.

NOTE

For fuel loading, refer to Section VIII, figure 8-5, and also T.O. 1C-135(K)A-2-2.

SINGLE POINT REFUELING

A single point refueling receptacle is in the right wheel well (figure 4-64) for refueling and defueling the airplane on the ground. Refer to SINGLE POINT REFUELING in Section IV.

AIR REFUELING

This airplane is equipped to transfer fuel in flight to receiver airplanes and to receive fuel from tanker airplanes. See figures 1-22, 4-49, 4-57 and 4-58. Air refueling fuel is carried in two body tanks with additional fuel available from any other tank or tanks in the airplane. All fuel in the airplane is available for transfer except amounts in each main tank, as indicated in figure 7-6, which are available to the engines only. Refer to AIR REFUELING TANKER SYSTEM and AIR REFUELING RECEIVER SYSTEM, Section IV, and FUEL SYSTEM OPERATION, Section VII.

FUEL SYSTEM THERMAL RELIEF

The dual check valves in the main wing 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

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 reserve tank. The vent system is required to prevent fuel boil off in ascent and tank collapse in descent. The surge tank 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.

TANK TO ENGINE MANIFOLD VALVE SWITCHES

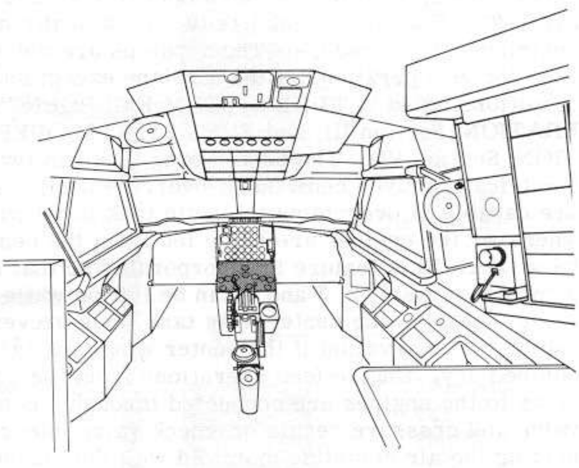
Four tank to engine manifold valve switches (3, figure 1-23) on the fuel panel control electric motor operated slide valves between the tank to engine lines and the engine manifold. When the switch is rotated to align the white stripe on the switch with the flow line on the fuel panel, the valve is open. These valves are used in the control of engine crossfeed operations. Operating power is 28 volt DC through circuit breakers marked TANK TO ENG MANIFOLD 1, 2, 3 and 4 located on the SBCBP, (figure 1-33, sheet 4).

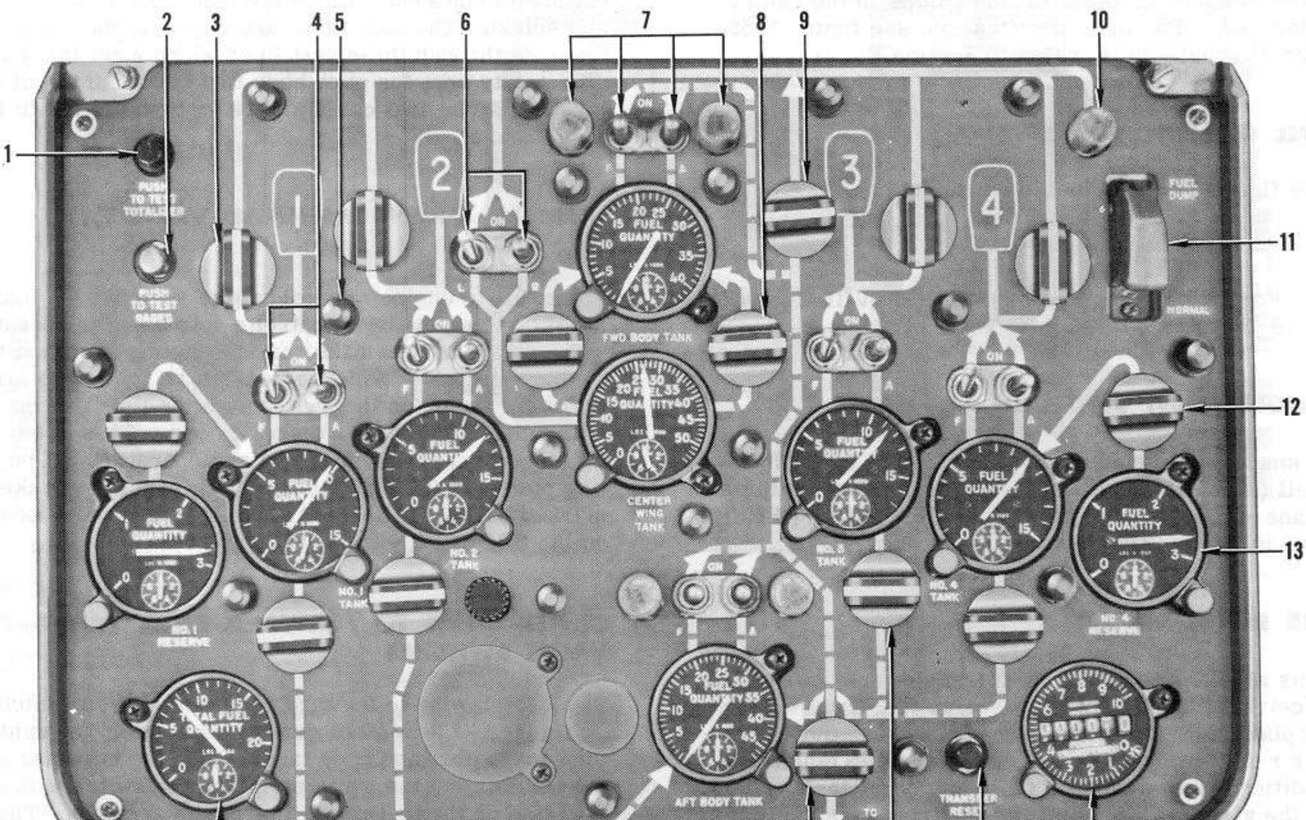
CENTER WING TO FORWARD BODY TANK VALVE SWITCHES

Two center wing to forward body tank valves switches (8, figure 1-23) 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 panel, the valves are open. These valves are used to transfer fuel to the forward body tank. Operating power is 28 volt DC through circuit breakers marked CENTER WING TO FWD TANK, LH and RH on the SBCBP (figure 1-33, sheet 4).

fuel panel

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





F-1442

Figure 1-23

AIR REFUELING TO ENGINE MANIFOLD VALVE SWITCH

The air refueling manifold to engine manifold valve switch (9, figure 1-23) 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 1-23) so that whenever fuel feed from the body tanks is in progress the line valve will be closed. This prevents 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. Operating power is 28 volt DC through a circuit breaker marked A/R MANF TO ENG MANF and A/R MANF LINE VALVE on the SBCBP (figure 1-33, sheet 4).

RESERVE TANK VALVE SWITCHES

Two reserve tank valve switches (12, figure 1-23) are used to control the gravity flow of fuel from the reserve tanks to main wing tanks 1 and 4. 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 through circuit breakers marked RESERVE NO. 1 TO TANK NO. 1 VALVE on the T-R BUS NO. 1 section and RESERVE NO. 4 TO TANK NO. 4 on the T-R BUS NO. 2 section of the MCBP (figure 1-33, sheet 1).

WING TO AFT BODY TANK VALVE SWITCHES

Four wing to aft body tank valve switches (17, figure 1-23) 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 through circuit breakers marked WING TO AFT TANK, TANK 1, TANK 2, TANK 3, and TANK 4 on the SBCBP (figure 1-33, sheet 4).

AIR REFUELING LINE VALVE SWITCH

The air refueling line valve switch (17, figure 1-23) 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. Refer to 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 OPEN--CLOSE positions. Operating power is 28 volt DC through a circuit breaker marked A/R MANF LINE VALVE on the SBCBP (figure 1-33, sheet 4).

BOOST PUMP SWITCHES

Eight boost pump switches (4, figure 1-23) are on the fuel 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 unmarked center position is OFF. The left switch is marked F for the forward pump in the tank and the right switch is marked A for the aft pump in the tank. The reserve tanks do not have fuel pumps. Control power is 28 volt DC through circuit breakers marked FUEL BOOST CONTROL, NO. 4 FORWARD, NO. 3 FORWARD, NO. 2 AFT, and NO. 1 FORWARD on the T-R BUS NO. 1 section and FUEL BOOST CONTROL, NO. 4 AFT, NO. 3 AFT, NO. 2 FORWARD, and NO. 1 AFT on the T-R BUS NO. 2 section of the MCBP (figure 1-33, sheet 1). Operating power is 115/200 volt AC through circuit breakers marked FUEL BOOST NO. 1 FORWARD, FUEL BOOST NO. 2 AFT, FUEL BOOST NO. 4 FORWARD on the ENG 1 GENERATOR section, FUEL BOOST NO. 2 FORWARD, FUEL BOOST NO. 3 AFT on the ENG 2 GENERATOR section, FUEL BOOST NO. 1 AFT and FUEL BOOST NO. 3 FORWARD on the ENG 4 GENERATOR section of the MCBP (figure 1-33, sheet 2).

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 (6, figure 1-23) on the fuel 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 unmarked 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; refer to CENTER WING TANK TO ENGINES, Section VII. Operating power is 115/200 volt AC through circuit breakers marked OVERRIDE PUMP RIGHT HAND on the ENG 2 GENERATOR section and OVERRIDE PUMP LEFT HAND on the ENG 4 GENERATOR section of the MCBP (figure 1-33, sheet 5). When operating the override pumps to feed engines from the center wing tank, monitor fuel quantity frequently as the center wing tank approaches empty.

CAUTION

Override pumps should not be run dry. If override pumps operate dry for a period exceeding 5 minutes, damage to pumps may result.

AIR REFUELING PUMP SWITCHES

Four air refueling pump switches (7, figure 1-23) on the fuel 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 aft pump in the forward body tank is also used to scavenge the ARR manifold. The two switches marked F (one for each tank) control the forward pumps of each tank. The two switches marked 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 unmarked position is OFF. When the switch is ON, the solenoid valve is armed, but the pump relays are not energized until one of the following occurs: (1) the A/R manifold to engine manifold valve switch is open, (2) the A/R signal system is in the contact made condition, (3) the fuel dump circuit is energized or (4) the emergency contact made switch is depressed when the emergency override switch is in the OVERRIDE position. The A/R pump control relay (figure 4-58) has a 10 to 14 second time delay when turning on the forward pump in the forward body tank and the aft pump in the aft body tank. This prevents 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 through circuit breakers marked REFUEL PUMP, FWD TANK, FWD and AFT, AFT TANK, FWD and AFT on the SBCBP (figure 1-33, sheet 4).

CAUTION

Air refueling pumps should not be run dry. If air refueling pumps operate dry for a period exceeding 2 minutes, damage to pumps may result.

FUEL DUMP SWITCH

A guarded two position switch (11, figure 1-23) with FUEL DUMP--NORMAL positions is provided on the fuel panel to control fuel dumping through the boom. With the guard up the switch may be placed in the up, FUEL DUMP position. With the guard down the switch is in the NORMAL position. When the fuel dump switch is placed in the FUEL DUMP position, the main ARR valve is energized closed, 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, the A/R fuel bypass valve is closed and the fuel dump valve is actuated, depressing the nozzle check valve. See figure 4-49. Operating power is 28 volt DC through a circuit breaker marked FUEL DUMP on the SBCBP (figure 1-33, sheet 4).

FUEL QUANTITY GAGES

A fuel quantity gage (13, figure 1-23) is provided for each tank in the airplane. These nine gages are on the fuel panel. Each tank contains fuel probes which transmit fuel quantity indication to the gages. The gages indicate the pounds of fuel in each tank. Control power is 28 volt DC and operating power for these gages is 115 volt AC. Control power circuit breakers are marked FUEL QUANTITY, NO. 3, NO. 2, NO. 1, RESERVE NO. 4 and RESERVE NO. 1 on the T-R BUS NO. 1 section and FUEL QUANTITY, FORWARD BODY, CENTER WING, AFT BODY AND NO. 4 on the T-R BUS NO. 2 section of the MCBP (figure 1-33, sheet 1). Operating power circuit breakers with the same markings are on the ENG 1 GENERATOR section of the MCBP (figure 1-33, sheet 2).

Push-to-Test Gages Button

A push-to-test gages button (2, figure 1-23) is on the fuel 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. Refer to FUEL QUANTITY GAGES in this Section for power source and circuit protection.

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.

TOTAL FUEL QUANTITY GAGE

A total fuel quantity gage (18, figure 1-23) on the fuel panel sums, in pounds, the quantity indications from all other fuel quantity gages. Control power is 28 volt DC through a circuit breaker marked FUEL QUANTITY, TOTAL on the T-R BUS NO. 1 section and operating power is 115 volt AC through a circuit breaker with the same marking on the ENG 1 GENERATOR section of the MCBP (figure 1-33, sheets 1 and 2).

Push-To-Test Totalizer Button

A push-to-test totalizer button (1, figure 1-23) 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. Refer to TOTAL FUEL QUANTITY GAGE for power source and circuit protection.

FUEL FLOW RATE AND TOTALIZER GAGE

The fuel flow rate and totalizer gage (14, figure 1-23) on the fuel panel indicates the rate of fuel flow through the boom and the total quantity of fuel transferred to a receiver airplane. Control power is 28 volt DC and operating power is 115 volt AC through circuit breakers marked INDICATOR, FUEL TRANSFERRED on the BOCBP (figure 1-33, sheet 10).

Transfer Reset Button

A transfer reset button (13, figure 1-23) 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 the fuel flow rate and totalizer gage. Refer to FUEL FLOW RATE AND TOTALIZER GAGE for power source and circuit protection.

FUEL LOW PRESSURE WARNING LIGHTS

An engine manifold, fuel low pressure warning light (10, figure 1-23) 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 increases 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 WARN on the SBCBP (figure 1-33, sheet 4). A warning light (7, figure 1-23) 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 the lights is 28 volt DC through four circuit breakers marked REFUEL PUMP CONTROL, FWD TANK, FWD and AFT, AFT TANK, FWD and AFT on the SBCBP (figure 1-33, sheet 4).

ELECTRICAL SYSTEMS

The airplane electrical system is primarily AC (400 cycles), consisting of a 3-phase 115/200 volt system and single phase 115, 32 and 28 volt systems. The 28 and 10 volt DC systems receive primary power from transformer-rectifiers (T-R); a battery is a secondary source of power for the 28 volt DC system. 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 because touching any wire while in contact with the airplane can be deadly.

115/200 VOLT ALTERNATING CURRENT SYSTEM

The primary AC power system (figure 1-25) consists of three 120 KVA generators driven by engines 1, 2 and 4 through generator drives. The generators produce 3-phase, 115/200 volts at 400 cycles. The generators are connected to the generator busses through generator breakers, and in turn connected to the communication center busses through the communication center power breakers. The busses are interconnected by bus tie breakers to a synchronizing bus through which the generators may be paralleled; the generators may be operated in parallel or isolated, but are normally operated in parallel. Main external power is connected from the main external power receptacle through a power breaker to the synchronizing bus, then through the bus tie breakers to the generator busses for distribution throughout the airplane. The airplane has an auxiliary power unit (APU) with a 30 KVA generator. The APU generator is connected to the main airplane electrical system through the main external power breaker. The external power breaker will not close when any generator breaker is closed, and closing any generator breaker will TRIP the external power breaker if closed; therefore, the APU generator cannot be paralleled with the engine driven generators. See APU, Section IV, for APU electrical power distribution. Communication center external power is connected from the communication center external power receptacle through a power breaker to the communication center busses for distribution throughout the communication center. The communication center external power can be momentarily paralleled with airplane power without power interruption. For uninterrupted power transfer procedures, see "Electrical System Operation," Section VII.

External Power Receptacles

The airplane external AC power receptacle and communication center external AC power receptacle are located on the outside of the airplane just aft of and to the right of the nose wheel well. The communication center external AC power receptacle is adjacent to and aft of the airplane external AC power receptacle.

CAUTION

Both external power receptacles require power plug which supplies both AC and DC power; therefore, a jumper wire must not be connected between pin E and F on the receptacle or external power plug.

Generator Switch

Each engine generator circuit has a guarded generator switch (3, figure 1-28) on the electrical control panel with TRIP--CLOSE positions. The three switches are spring loaded from these positions to a guarded neutral position. The CLOSE position returns the generator to service, closes the generator breaker, and closes the bus tie breaker. The TRIP position removes the generator from service, trips the generator breaker, and closes the bus tie breaker. When the generator is in service and operating isolated from the synchronizing bus (bus tie breaker is open), the CLOSE position closes the associated bus tie breaker for parallel operation. The generator switch electrically operates the generator control relay which is mechanically latched in the TRIP or CLOSE condition when the generator switch is momentarily moved to either the TRIP or CLOSE position. The generator control relay can be moved from the TRIP to the CLOSE condition only by the generator switch. The relay is moved from the CLOSED to the TRIP condition by the generator switch, fire switch, or system automatic protective devices. Conditions which will automatically trip the relay (and generator breaker) are a short in the power feeder between the generator ground and synchronizing bus, generator under/over-voltage, and generator under/over-speed. Control power for the generator switch is 28 volt DC with circuit protection through circuit breakers marked GENERATOR CONTROL ENG 1, ENG 2, and ENG 4 on the Battery Circuit Breaker Panel (figure 1-33, sheet 3).

Generator Circuit Breaker Open Lights

Three red press-to-test generator circuit breaker open lights (4, figure 1-28) are on the electrical control panel forward of each of the three generator switches. With the battery switch in the NORMAL or EMERGENCY position the light will illuminate when the generator breaker is in the trip condition. Operating power is 28 volt DC through circuit breakers marked GENERATOR CONTROL ENG 1, ENG 2, and ENG 4 on the battery circuit breaker panel (figure 1-33, sheet 3).

Bus Tie Circuit Breaker Open Lights

Three amber press-to-test bus tie circuit breaker open lights (2, figure 1-28) are on the electrical control panel aft of each of the three generator switches. The lights will illuminate when the bus tie breaker is in the trip condition. The bus tie breaker is mechanically latched in the CLOSE position when the generator switch is placed in either the CLOSE or TRIP position and is mechanically latched in the TRIP position by the bus tie isolate switch, or system protective devices. Conditions which will automatically trip the bus tie breaker are a short in the power feeder between the generator bus and synchronizing bus, a short in the synchronizing bus (causing negative sequence), generator overheat, undervoltage, or overexcitation of the generator. The bus tie breaker will normally close automatically any time the generator control relay is manually or automatically tripped. Operating power for the bus tie breaker circuit open lights is 28 volt DC with circuit protection through circuit breakers marked BTB OPEN IND on the SBCBP (figure 1-33, sheet 4).

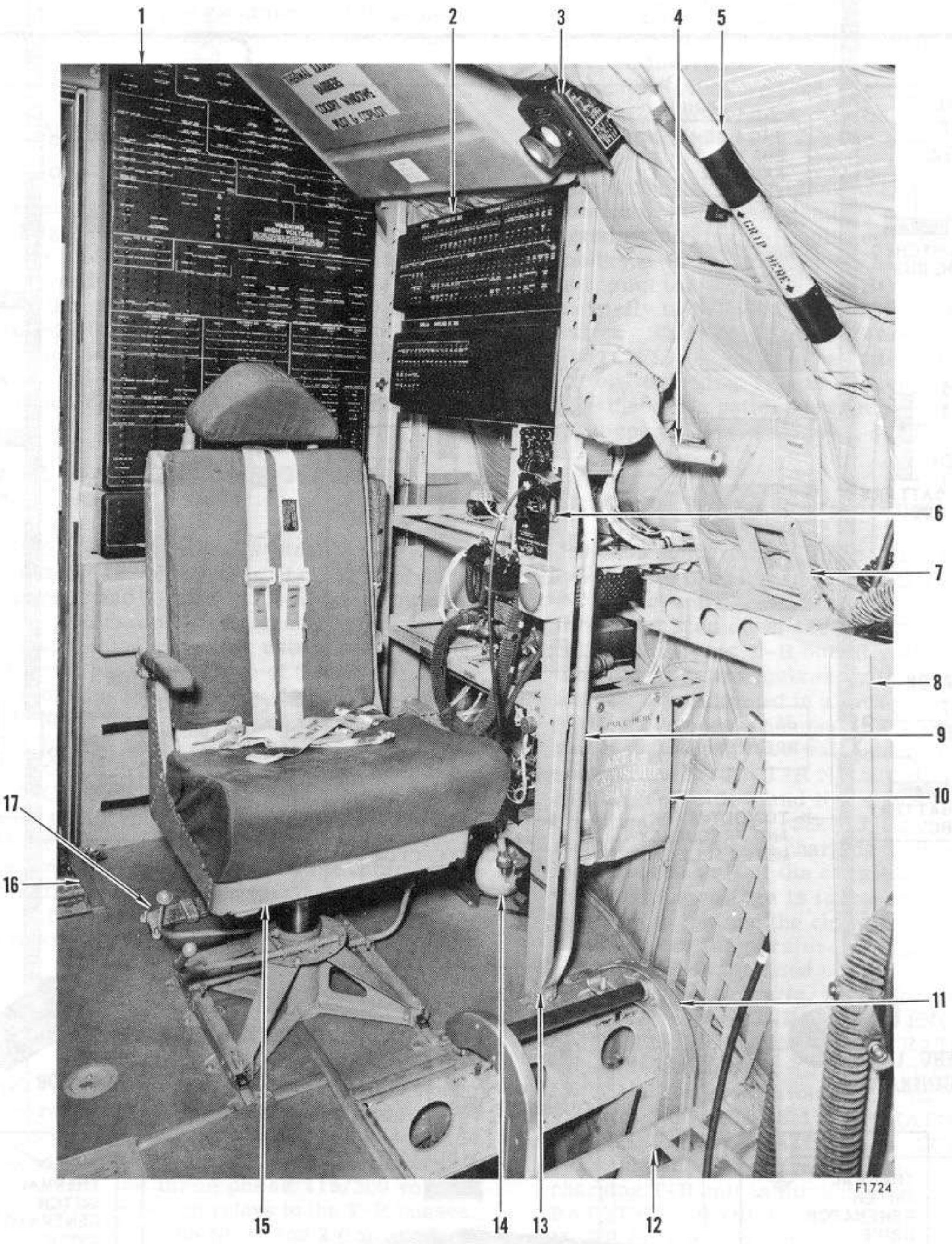
Generator Drive Overheat Lights and CSD Disconnect Switches

See GENERATOR DRIVE SYSTEM in this Section.

Bus Tie Isolate Switch

The bus tie isolate switch (, figure 1-28) on the electrical control panel, is a push-button switch and is spring loaded to the open position. Pressing the switch to the closed position trips all three bus tie breakers. Control power for the bus tie isolate switch is 28 volt DC with circuit protection through circuit breakers marked EXTERNAL POWER & BUS TIE ISOLATE on the Battery Circuit Breaker Panel (figure 1-33, sheet 3).

fwd electrical equipment area



1 MAIN CIRCUIT BREAKER PANEL (SEE FIGURE 1-33)
2 SWITCHED DC BUS CIRCUIT BREAKER PANEL (SEE FIGURE 1-33)
3 EMERGENCY EXIT LIGHT
4 CREW ENTRY DOOR WINCH
5 CHINNING BAR
6 OXYGEN REGULATOR PANEL (SEE FIGURE 4-35)
7 CREW ENTRY DOOR INTERIOR LATCH HANDLE
8 EMERGENCY EXIT SPOILER
9 ASSIST HANDLE
10 ANTI-EXPOSURE SUIT STOWAGE (2 SUITS)
11 CREW ENTRY DOOR LOCK INDICATOR
12 CREW ENTRY CHUTE FLOOR GRILLE
13 ELECTRICAL EQUIPMENT RACK
14 OXYGEN BOTTLE
15 BOOM OPERATOR'S SEAT (SEE FIGURE 4-71)
16 NOSE GEAR DOOR RELEASE AND ACCESS COVER
17 SURVIVAL KIT TIEDOWN

Figure 1-24

ac power system generation

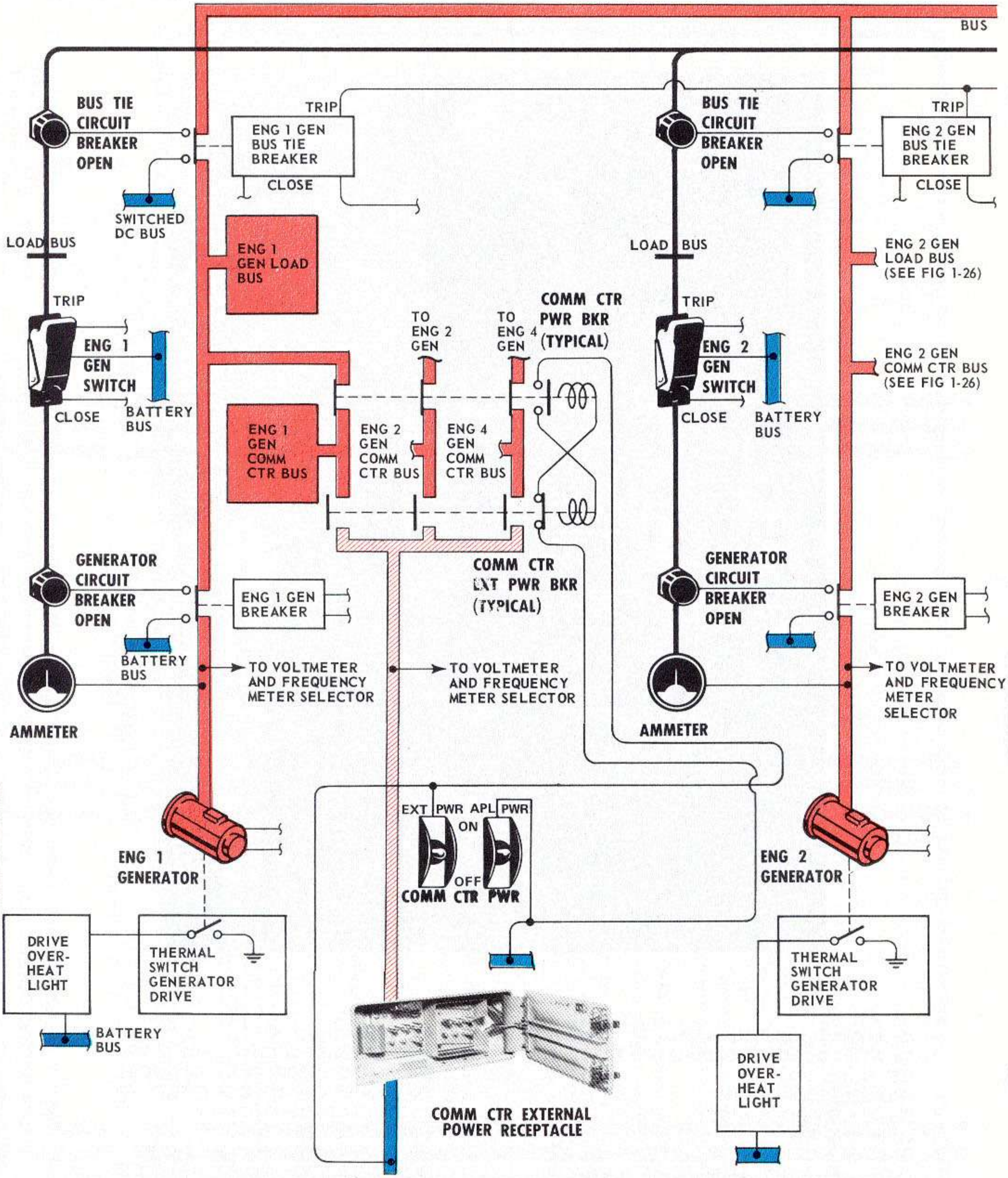


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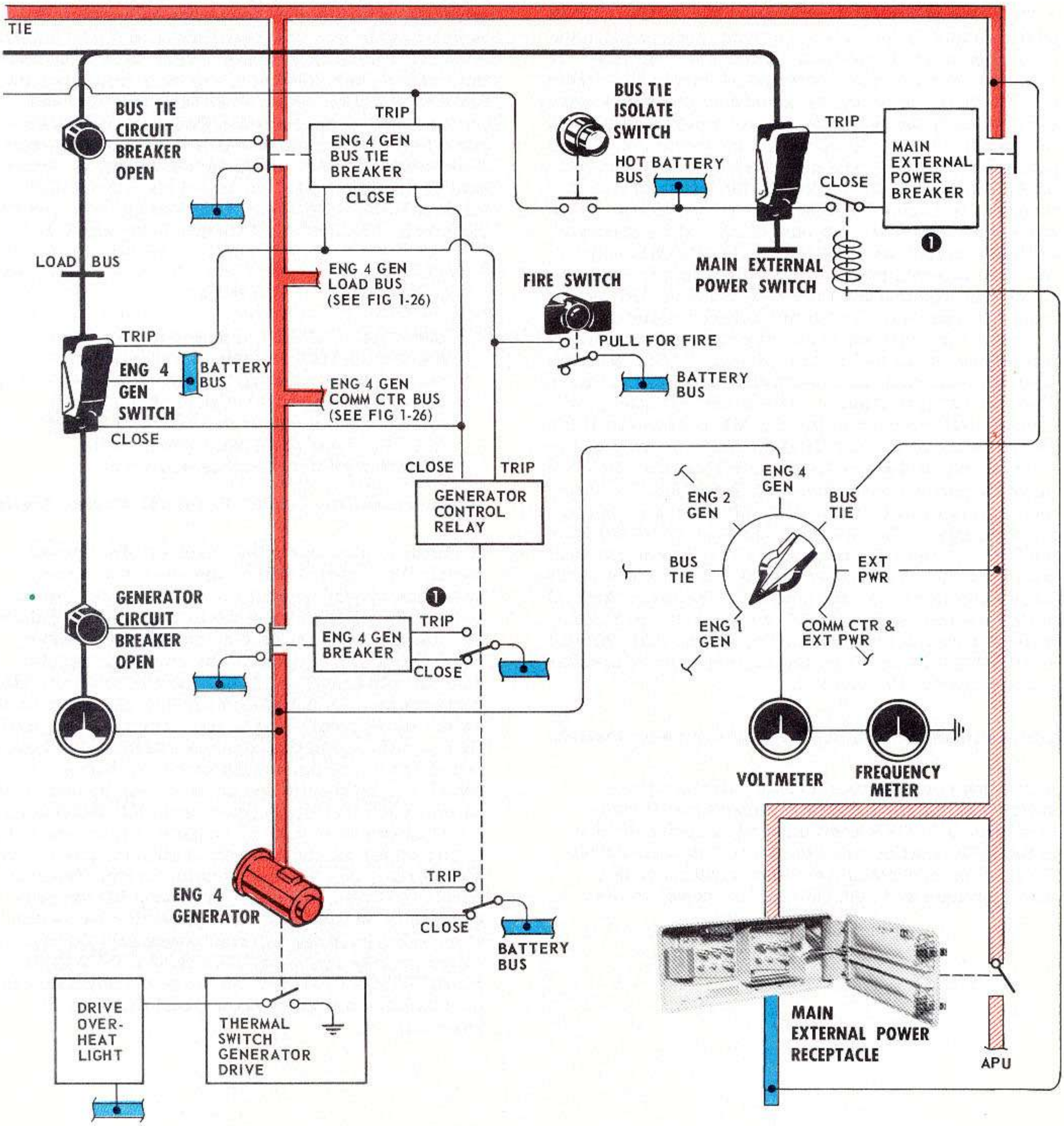
Figure 1-25 (Sheet 1 of 2)



❶ Main external power breaker TRIPS when any generator control relay CLOSES. Main external power breaker will not CLOSE when any engine generator breaker is in CLOSE condition.

Figure 1-25 (Sheet 2 of 2)

Main External Power Switch

The guarded main external power switch (7, figure 1-28) on the electrical control panel has TRIP--CLOSE positions and is spring loaded from these positions to a guarded neutral position. When external power is connected to the airplane external AC power receptacle or APU power is on and all generator power breakers (controlled by the generator control relay) are tripped, the switch can be momentarily moved to the CLOSE position to connect external or APU power. External or APU power is connected to the generator busses through the normally closed bus tie breakers. When any engine generator is operating and its generator switch is placed momentarily to the CLOSE position, the main external power breaker will automatically go to the trip condition and remove external or APU power from the system. The main external power switch controls the main external power breaker which is mechanically latched in the TRIP or CLOSE position when the main external power switch is moved to either of these two positions. The main external power breaker will remain in the CLOSE position until the switch is moved to the TRIP position or until one of the system's protective devices operates to unlatch and move the power breaker to the TRIP position. Removing the external power plug will automatically trip the power breaker. 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 condition. Control power for the main external power switch is 28 volt DC with circuit protection through a circuit breaker marked EXTERNAL POWER & BUS TIE ISOLATE on the battery circuit breaker panel (figure 1-33, sheet 3).

Communication Center Airplane Power Switch

A guarded communication center airplane power switch (17, figure 1-28) on the electrical control panel has ON--OFF positions and is spring-loaded to the OFF position when the circuit is deenergized. ON position energizes the communication center power breakers to connect airplane power to the communication center buses. A holding coil is energized to hold the switch in ON position when the circuit is energized. OFF position removes airplane power from the communication center buses. The switch can be used in conjunction with the communication center external power switch to provide uninterrupted power during changeover from airplane to communication center external power and vice versa. See "Communication Center External/Airplane Power Transfer" in Section VII for procedures to be used. Control power for the switch is switched battery and is supplied through a circuit breaker marked "COMM CTR AC CONT" on the switched DC bus circuit breaker panel (figure 1-33, sheet 4).

NOTE

Interruption of control power for the communication center airplane power switch, such as occurs during movement of the battery switch, will cause the holding coil to be deenergized and the switch to return to OFF. Loss of airplane power to the communication center bus will result.

Communication Center External Power Switch

A guarded communication center external power switch (18, figure 1-28) on the electrical control panel has ON-OFF positions and is spring-loaded to the OFF position when the circuit is deenergized. ON position energizes the communication center power breakers to connect communication center external power (aft receptacle) to the communication center buses. A holding coil is energized to hold the switch in ON position when the circuit is energized. OFF position removes communication center external power from the communication center buses. The switch can be used in conjunction with the communications center airplane power switch to provide uninterrupted power during changeover from communication center external power to airplane power and vice versa. See "Communication Center External/Airplane Power Transfer" in Section VII for procedures to be used. Control power for the switch is supplied from the external power cart through a circuit breaker marked "EXTERNAL PWR COMMUNICATION CENTER" on the communication center auxiliary circuit breaker panel (figure 1-33, sheet 12).

Voltmeter and Frequency Meter Selector

The voltmeter and frequency meter selector (6, figure 1-28) on the electrical control panel is a rotary type switch with ENG 1 GEN--BUS TIE--ENG 2 GEN--ENG 4 GEN--BUS TIE--EXT PWR--COMM CTR EXT PWR positions (see figure 1-25). When the voltmeter and frequency meter selector is placed in the ENG 1 GEN, ENG 2 GEN, or ENG 4 GEN position the voltmeter and frequency meter (9 and 10, figure 1-28) will be connected to the applicable generator to indicate voltage and frequency output. BUS TIE positions will give voltage and frequency of the synchronizing bus. The EXT PWR position will give voltage and frequency of the external power connected to the airplane external AC power receptacle or APU power input to the external power system. The COMM CTR EXT PWR position will give voltage and frequency of the external power connected to the communication center external AC power receptacle. Circuit protection for the different switch positions is as follows:

SWITCH POSITION	MARKINGS
	On Main AC Power Panel (see figure 1-33, sheets 5 and 6)
ENG 1 GEN	ENG 1 GEN VOLT INDICATION
BUS TIE (2 positions)	BUS TIE VOLT INDICATION
ENG 2 GEN	ENG 2 GEN VOLT INDICATION
ENG 4 GEN	ENG 4 GEN VOLT INDICATION
EXT PWR	MAIN EXTERNAL POWER
	On Communication Center CBP PL-25 (see figure 1-33, sheet 9)
COMM CTR EXT PWR	COMM CENTER EXTERNAL POWER

Generator Ammeters

The three generator ammeters (11, figure 1-28) on the electrical control panel indicate the current output for each of the airplane engine generators. The ammeters are red-lined for 310 amperes maximum generator output.

115 VOLT ALTERNATING CURRENT SYSTEM

The 115 volt AC system is single phase which is supplied by each phase of the 3-phase 115/200 volt AC system. Engine 4 generator supplies 3-phase power to the pilot's instrument transformer whose output is 3-phase 115 volt line to line with one phase grounded so that the line to ground voltage is also 115 volts. See figure 1-26 for 115 volt single phase distribution. Circuit protection for the system is through circuit breakers marked 115/200V AC POWER SUPPLY on the main circuit breaker panel (figure 1-33, sheet 2).

28 AND 32 VOLT ALTERNATING CURRENT SYSTEM

Power for the 32 and 28 volt AC system is provided by the single phase 115 volt system. Low voltage single phase power of 32 and 28 volts AC is provided by small single phase distribution transformers. Figure 1-27 shows the distribution and phase used for each transformer. Circuit protection for 5 of the 28 volt transformers is on the MCBP through circuit breakers marked 28 VOLT TRANSFORMER, two on ENGINE 1 GENERATOR, one on ENGINE 2 GENERATOR, and three on ENGINE 4 GENERATOR with one marked A/R CONTROL PANEL (figure 1-33, sheet 2) which also supplies the 32 volt transformer. Circuit protection for the 8 communication center 28 volt transformers is through circuit breakers on the communication center circuit breaker panel PL-25 marked 28V XFMR No. (1 through 8), three on ENGINE 1 GENERATOR, and five on ENGINE 2 GENERATOR (figure 1-33, sheet 9).

28 VOLT DIRECT CURRENT SYSTEM

The primary DC electrical system consists of two transformer-rectifiers (T-R) for the airplane equipment and two transformer-rectifiers for the communication center equipment. The four T-R units which receive input power from the three phase 115/200 volt AC system, are connected through relays to the T-R busses. (See figure 1-29.) T-R BUS No. 1 and 2 (for airplane equipment) are normally connected together through a current limiter, and T-R BUS No. 2 is normally connected to the SWITCHED DC BUS through the battery power switch. The boom operator's panel receives power through the SWITCHED DC BUS. T-R No. 3 and T-R No. 4 share a common bus, T-R BUS No. 3 and 4, through individual current limiters and T-R control switches (3,4, figure 1-33, sheet 9). T-R BUS No. 2 and T-R BUS No. 3 and 4 may be connected through the DC system tie switch and two current limiters.

The secondary DC system consists of a 24 volt nickel-cadmium battery and a battery charging T-R unit. The battery charging T-R unit receives input power from the three phase 115/200 volt AC system. The battery is connected direct to the HOT BATTERY BUS and normally to the BATTERY BUS by the battery power switch. The BATTERY BUS may be connected to the SWITCHED DC BUS by the battery power switch. The battery charging T-R is connected to the BATTERY BUS through a battery charge rate relay. For equipment operated on DC power, see figure 1-30.

28 Volt DC Transformer-Rectifiers

The T-R units receive three phase 115/200 volt AC power from the primary AC power system, rectify it to DC power, and step down the voltage. T-R units No. 1 through 4 step down the voltage to 28 volts and the battery charging T-R output voltage is dependent on the charge rate required by the battery. T-R No. 1 and No. 2 are mounted in a rack in the lower nose compartment (accessible through the door in the crew entry chute) on the outboard wall just inside the lower nose compartment with T-R No. 2 mounted on top of T-R No. 1. T-R No. 3 and No. 4 are mounted in the aft electrical equipment rack (35, figure 1-3) in compartment 1. The battery charging T-R unit is mounted on the outboard wall of the crew toilet (4, figure 4-73); the charging voltage is increased when battery temperature is low and the charging voltage is decreased when battery temperature is high. The temperature sensing unit is mounted on the battery. Circuit protection for T-R units No. 1 and No. 2 is through circuit breakers marked T-R No. 1 on ENG 1 GENERATOR and T-R No. 2 on ENG 2 GENERATOR of the MCBP (figure 1-33, sheet 2). Circuit protection for T-R units No. 3 and No. 4 is through circuit breakers marked T-R No. 3 on ENGINE 1 GENERATOR and T-R No. 4 on ENGINE 2 GENERATOR on the CCBP PL-25 (figure 1-33, sheet 9). Circuit protection for the battery charging T-R unit is through circuit breakers marked BATTERY CHARGE on ENG 4 GENERATOR of the MCBP (figure 1-33, sheet 2).

115/200 volt AC power distribution

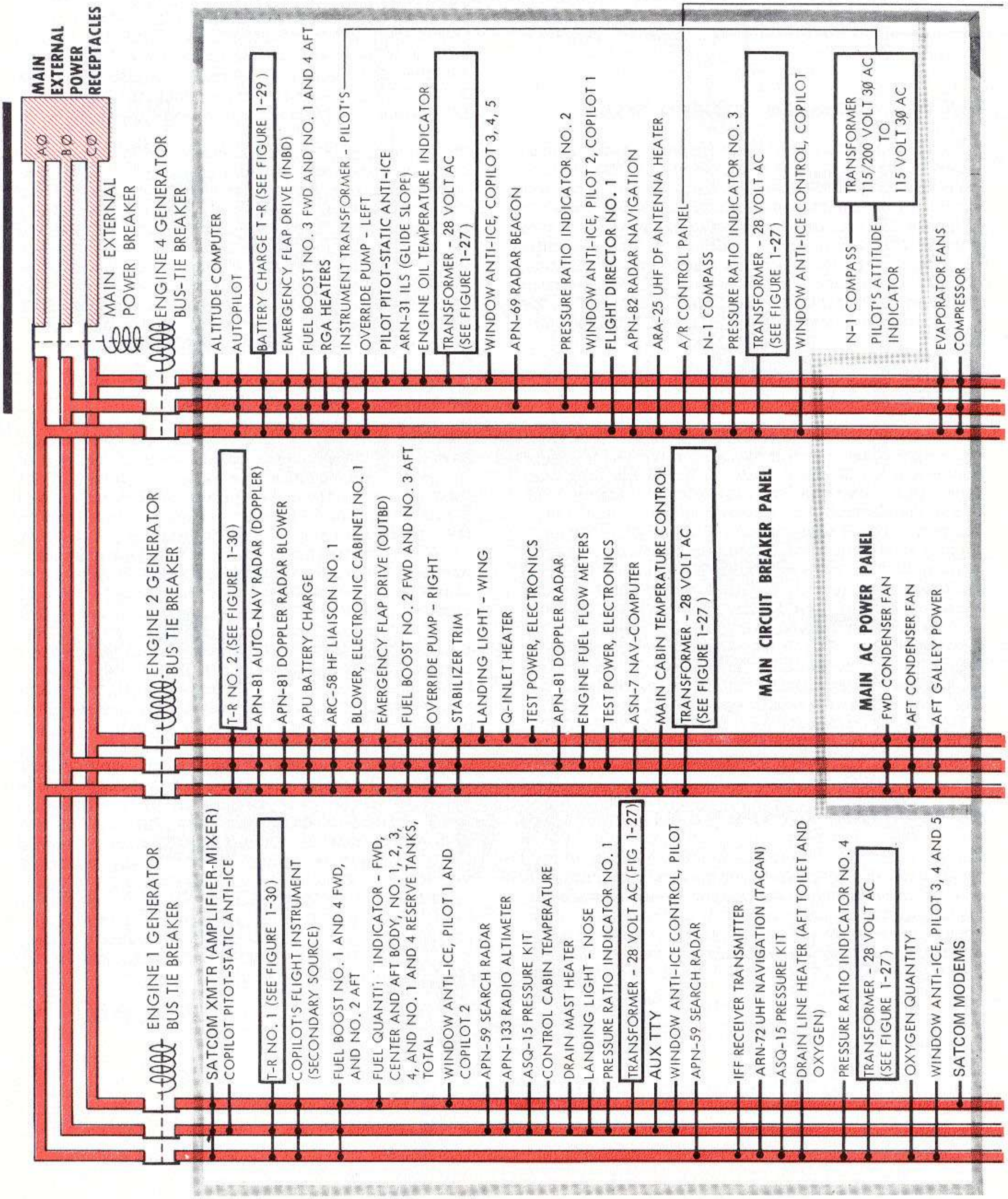


Figure 1-26 (Sheet 1 of 2)

NOTE

Power for the communication center buses can be transferred from communication center external power to airplane power (and vice versa) without power interruption during switching operation.

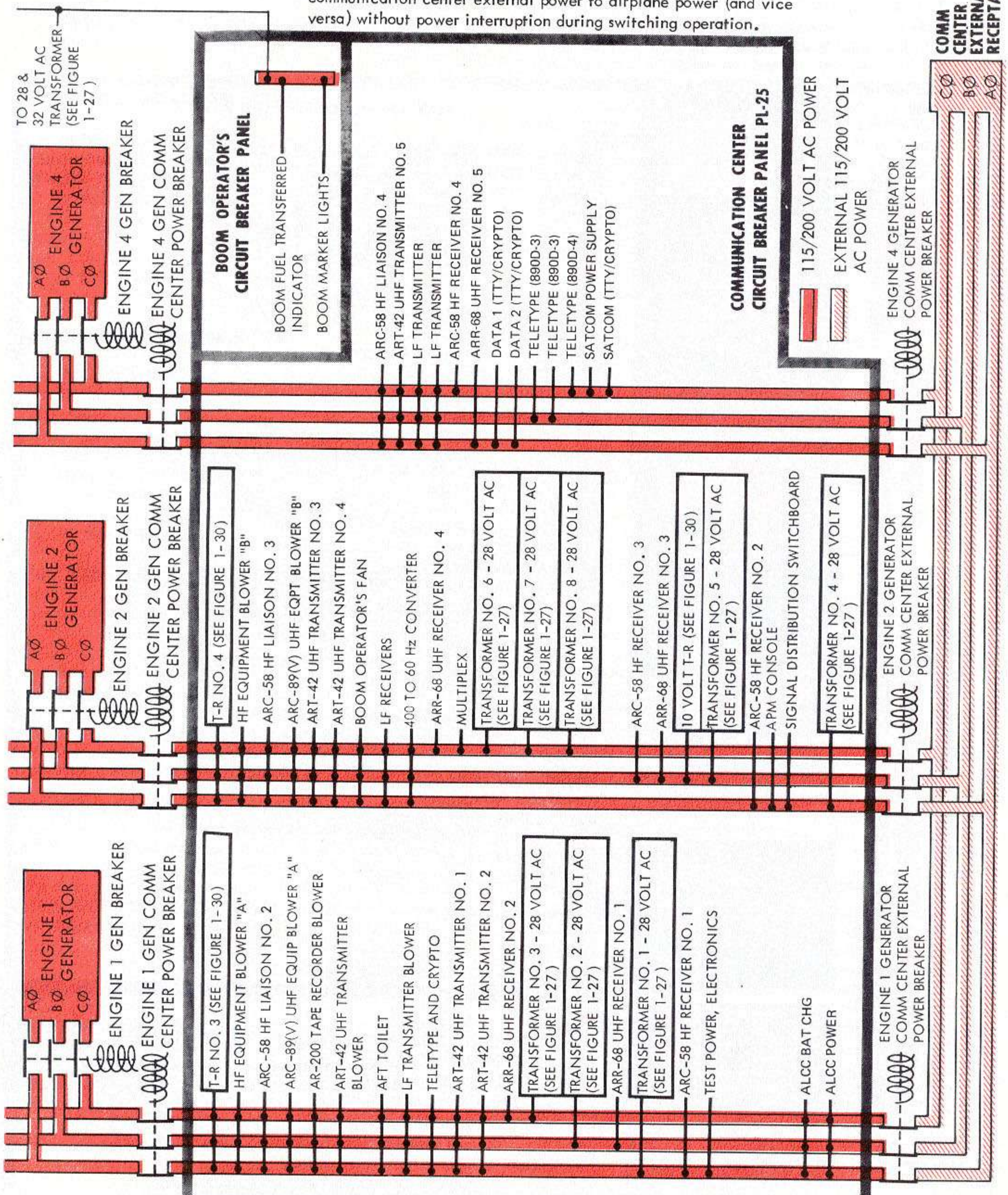


Figure 1-26 (Sheet 2 of 2)

28 & 32 volt AC power distribution

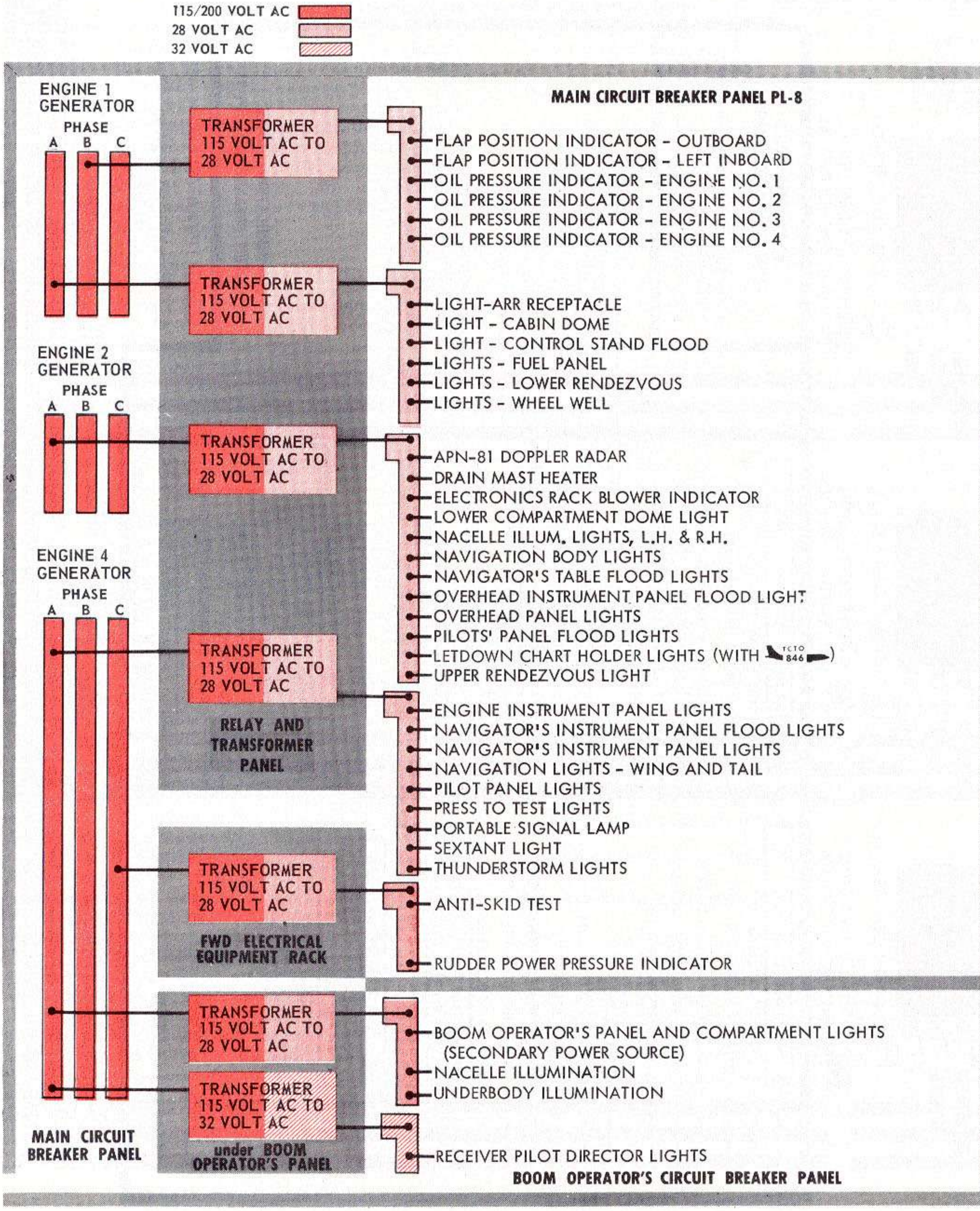


Figure 1-27 (Sheet 1 of 2)

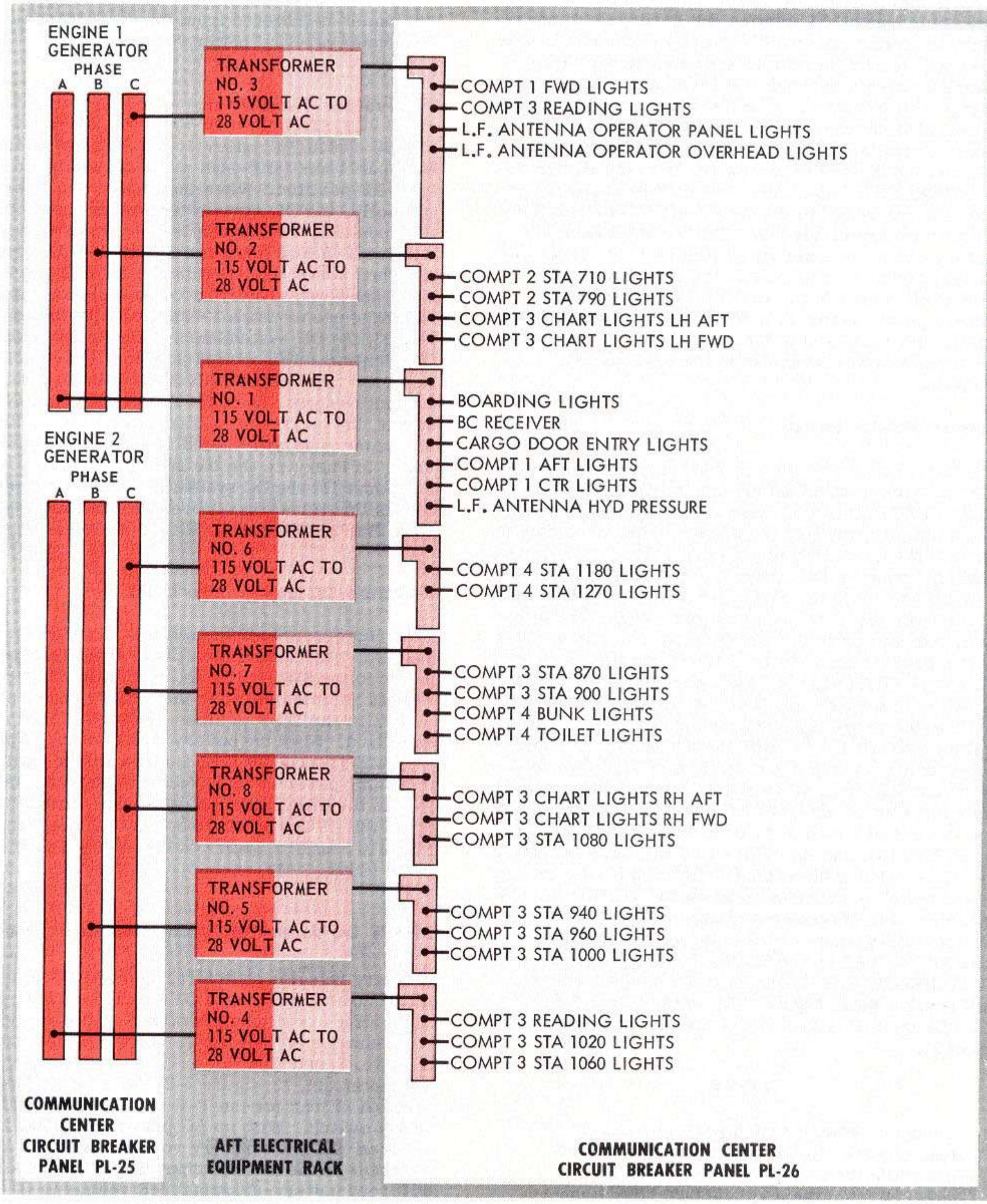


Figure 1-27 (Sheet 2 of 2)

Battery

A 24-volt 22-ampere hour nickel-cadmium battery (50, figure 1-3) is located in the forward cabin below the forward electrical equipment rack. A nickel-cadmium battery differs from a lead-acid battery in that the electrolyte in a nickel-cadmium battery is a potassium hydroxide solution and 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 battery charging T-R unit is provided for charging the battery anytime AC power is available from the main AC electrical system and the battery power switch is in the NORMAL or EMERGENCY position. The battery charging T-R output is connected to the BATTERY BUS through a circuit breaker marked BATTERY CHARGE on the battery circuit breaker panel (figure 1-33, sheet 3). 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 (20, figure 1-15) on the pilot's 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 (see figure 1-29). This switch position connects DC power from T-R BUS No. 1 and T-R BUS No. 2 to the SWITCHED DC BUS When DC power from the T-R busses is lost, the battery power switch should be in the EMERGENCY position. This switch position connects DC power from the BATTERY BUS to the SWITCHED DC BUS. 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 de-energized. Battery power is always on the HOT BATTERY BUS regardless of switch position. When the AC electrical system is not operating or external AC power is not connected, and the battery switch is in NORMAL, only the HOT BATTERY BUS and BATTERY BUS will have DC power available. Under the same conditions with the battery power switch in EMERGENCY, the SWITCHED DC BUS will also have DC power available. Circuit protection for the battery power switch is through circuit breakers marked DC DIST on the SBCBP (figure 1-33, sheet 4), SWITCHED DC BUS POWER SUPPLY on the battery circuit breaker panel (figure 1-33, sheet 3), and SWITCHED BUS on T-R BUS No. 2 of the MCBP (figure 1-33, sheet 1).

NOTE

Changing battery switch positions can cause loss of power to the communication center bus while the communication center is powered from the airplane bus. The communication center airplane power switch will return to OFF, requiring reconnection of communication center power by placing the communication center airplane power switch to ON. Changing battery switch position will not cause communication center power interruption when communication center is powered from the communication center external power receptacle.

DC System Tie Switch

The DC system tie switch (16, figure 1-28) on the overhead panel has OFF--ON positions and is guarded to the OFF position. When the DC system is operating normally, the DC system tie switch should be in the OFF position. (See figure 1-29.) This switch position isolates T-R BUS No. 1 and 2 from T-R BUS No. 3 and 4. When power to T-R BUS No. 1 and 2, or T-R BUS No. 3 and 4 is partially or completely lost (due to the failure of one or more T-R units or partial loss of AC power), the DC system tie switch can be moved to the ON position. This switch position connects T-R BUS No. 1 and 2 to T-R BUS No. 3 and 4 through two 50 amp current limiters. Since the two current limiters are in series, the maximum load transfer must be limited to 50 amps. The switched dc bus must be powered in order to energize the tie switch. Circuit protection and power for the DC system tie switch in the ON position is through a circuit breaker marked COMM CTR D.C. SYSTEM TIE on the SBCBP (figure 1-33, sheet 4).

Switched DC Bus Failure Light

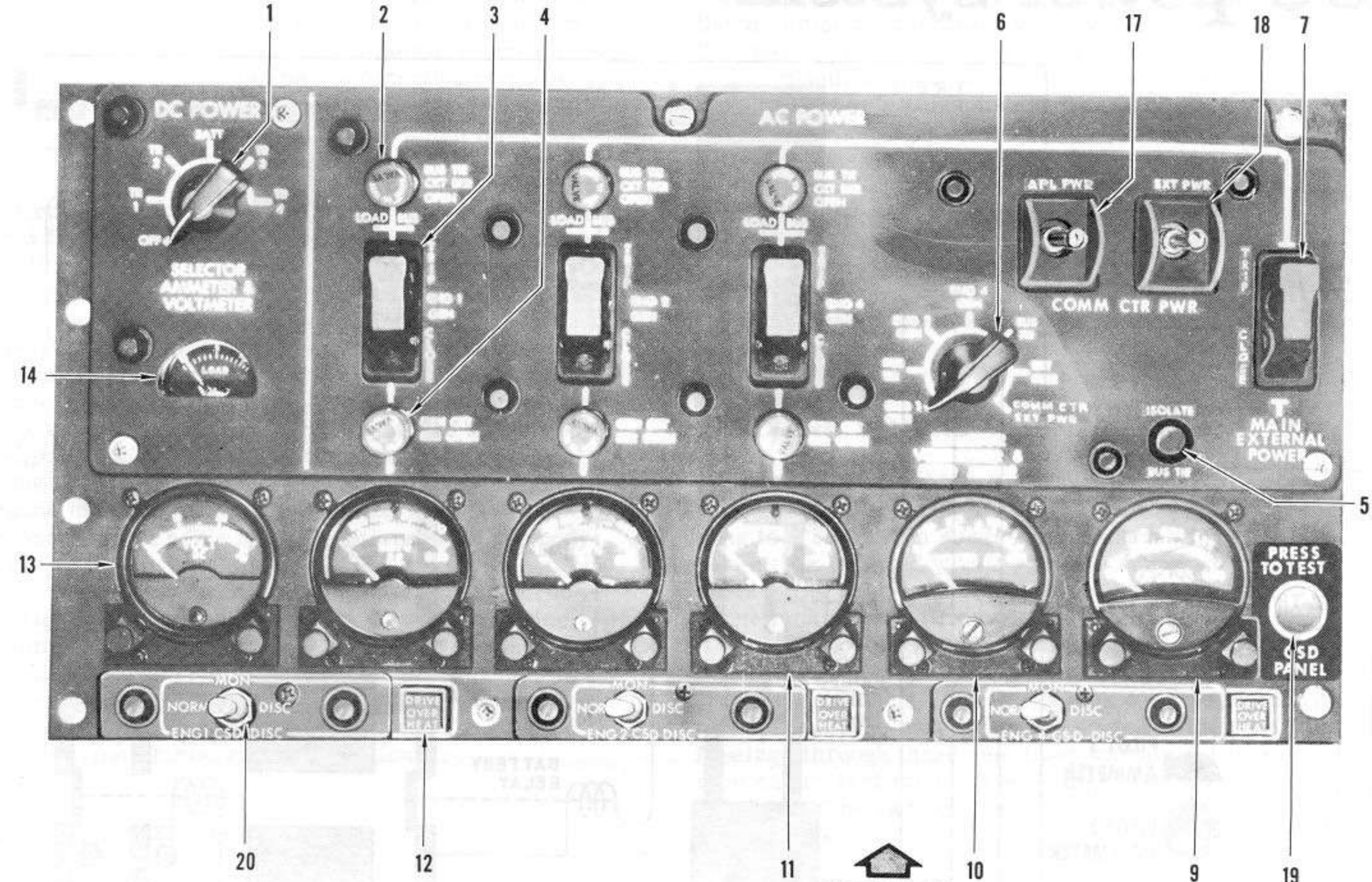
This red press-to-test light (19, figure 1-15) on the pilot's center instrument panel will illuminate when power to the SWITCHED DC BUS fails. The light will remain illuminated when the battery power switch is placed in the OFF position if the BATTERY BUS is energized. When the battery power switch is 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 and protected by a circuit breaker marked SW. BUS FAILURE LIGHT on the battery circuit breaker panel (figure 1-33, sheet 3).

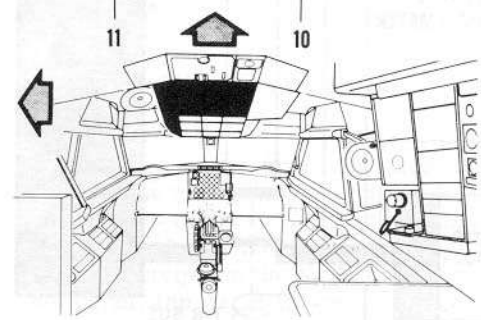
Pilot's DC Ammeter, Voltmeter and Selector

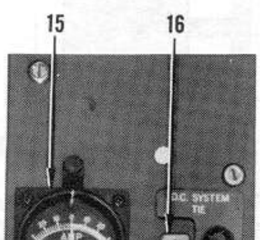
A rotary selector switch (1, figure 1-28) on the electrical control panel with OFF--TR 1--TR 2--BATT--TR 3--TR 4 positions provides a means of monitoring operation of T-R No. 1, T-R No. 2, the battery, T-R No. 3, and T-R No. 4. The DC ammeter and voltmeter (14, 13, figure 1-28) will indicate volts and fraction of load for the T-R unit selected by the selector switch. With no AC power available, BATT position will show battery voltage. With AC power available to the battery-charging T-R, the voltmeter will read battery-charging T-R voltage in BATT position. The voltmeter may pulse between approximately 31.5 and 27 volts when the battery approaches full charge.

All data on page 1-46A and 1-46B (Deleted)

electrical control panel



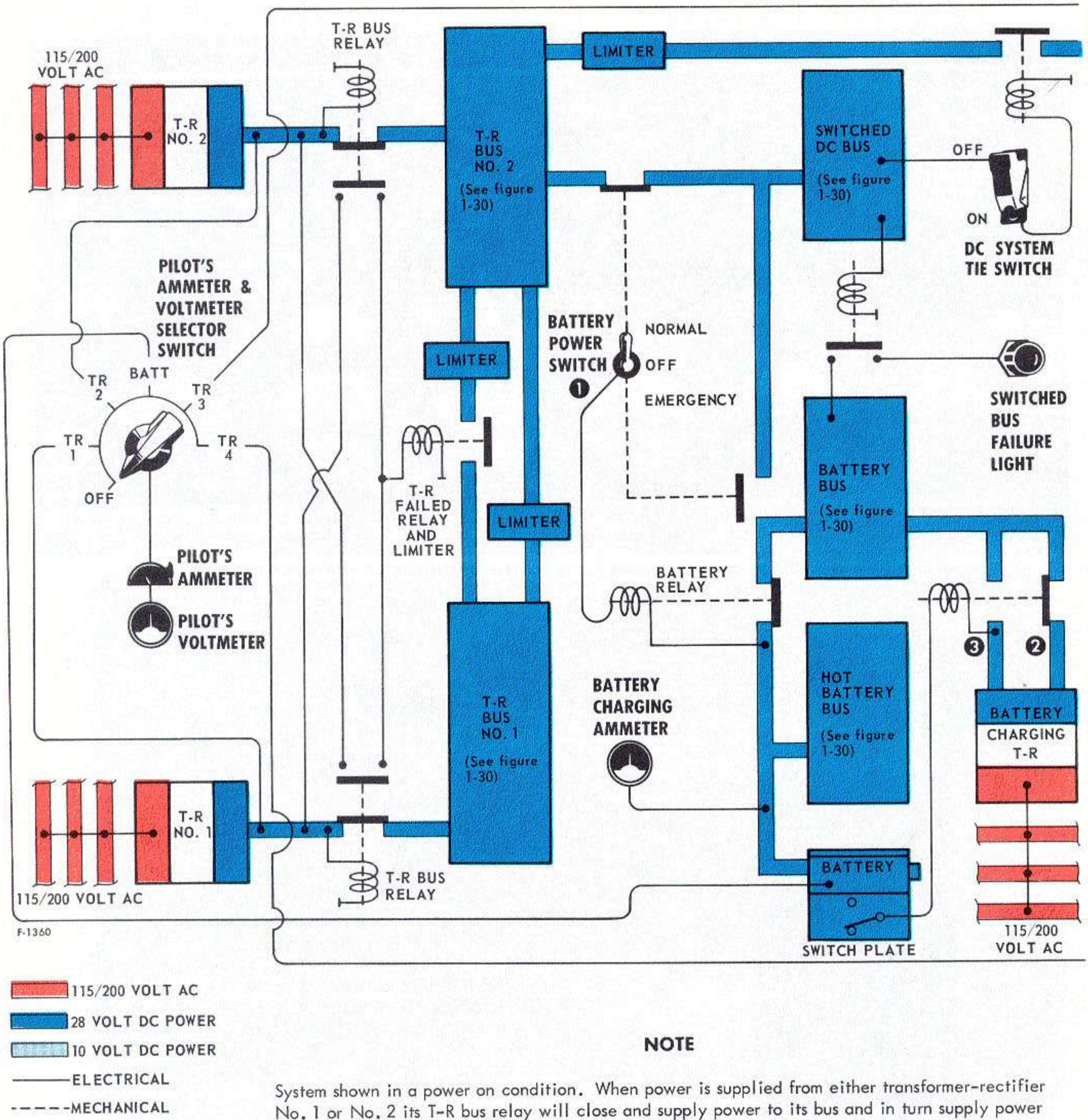




1 DC AMMETER AND VOLTMETER SELECTOR
2 BUS TIE CIRCUIT BREAKER OPEN LIGHTS (TYPICAL)
3 GENERATOR SWITCH (TYPICAL)
4 GENERATOR CIRCUIT BREAKER OPEN LIGHT (TYPICAL)
5 BUS TIE ISOLATE SWITCH
6 VOLTMETER AND FREQUENCY METER SELECTOR
7 MAIN EXTERNAL POWER SWITCH
8 (DELETED)
9 FREQUENCY METER
10 AC VOLTMETER
11 GENERATOR AMMETER (TYPICAL)
12 GENERATOR DRIVE OVERHEAT LIGHT (TYPICAL)
13 DC VOLTMETER
14 DC AMMETER
15 BATTERY AMMETER
16 DC SYSTEM TIE SWITCH
17 COMMUNICATION CENTER AIRPLANE POWER SWITCH
18 COMMUNICATION CENTER EXTERNAL POWER SWITCH
19 CSD PANEL PRESS-TO-TEST BUTTON
20 CSD DISCONNECT SWITCH (TYPICAL)

Figure 1-28

DC power system

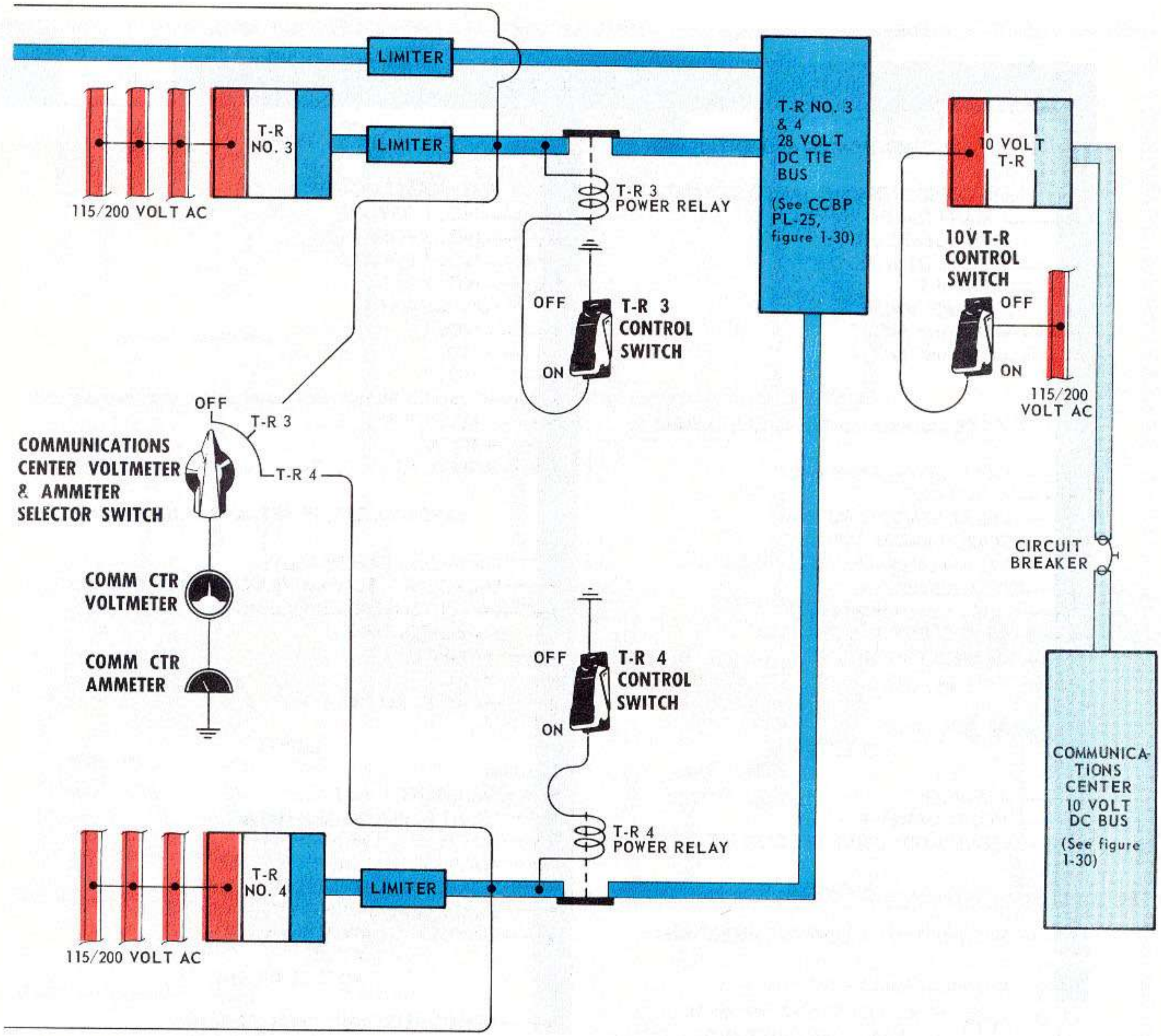


NOTE

System shown in a power on condition. When power is supplied from either transformer-rectifier No. 1 or No. 2 its T-R bus relay will close and supply power to its bus and in turn supply power to the other bus. Current limiters between the busses are provided to prevent loss of both busses in the event either T-R is faulted.

❶ When this switch is in the NORMAL position, power is routed from T-R No. 2 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.

Figure 1-29 (Sheet 1 of 2)



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.

Figure 1-29 (Sheet 2 of 2)

DC power distribution

28 VOLT DC POWER

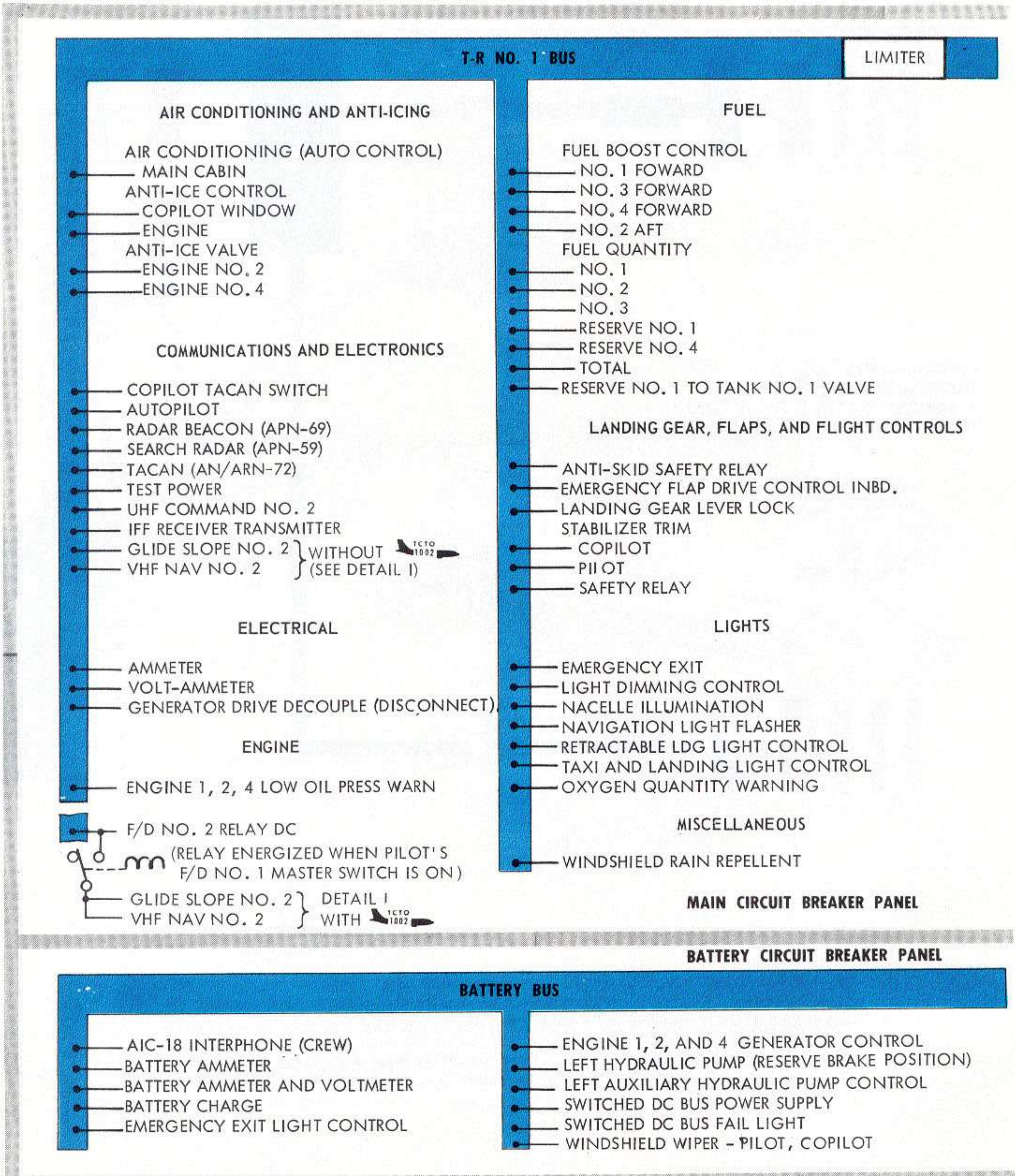


Figure 1-30 (Sheet 1 of 4)

MAIN CIRCUIT BREAKER PANEL

T-R NO. 2 BUS

AIR CONDITIONING AND ANTI-ICING

- AIR CONDITIONING (AUTO CONTROL)
  - CONTROL CABIN
- ANTI-ICE CONTROL
  - PILOT WINDOW
- ANTI-ICE VALVE
  - ENGINE NO. 1
  - ENGINE NO. 3
- CABIN TEMPERATURE INDICATOR
- FREE AIR TEMPERATURE INDICATOR

AUXILIARY COOLING SYSTEM

- COMPRESSOR SYSTEM
- EVAPORATOR FANS

COMMUNICATIONS AND ELECTRONICS

- FLIGHT DIRECTOR NO. 1
- DOPPLER RADAR (APN-81)
- HF LIAISON NO. 1 (ARC-58)
- MARKER BEACON (ARN-12)
- NAV-COMPUTER (ASN-7)
- N-1 COMPASS & PILOT ATTITUDE IND
- UHF HOMING (ARA-25)
- TRANSPONDER TEST SET
- GLIDE SLOPE NO. 1
- PILOT'S TACAN SWITCH
- VHF NAV NO. 1

ELECTRICAL

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

ENGINE

- ENGINE OIL TEMPERATURE INDICATOR

FUEL

- FUEL BOOST CONTROL
  - NO. 2 FORWARD
  - NO. 1 AFT
  - NO. 3 AFT
  - NO. 4 AFT
- FUEL QUANTITY
  - AFT BODY
  - CENTER WING
  - FORWARD BODY
  - NO. 4
- OVERRIDE PUMP (CONTROL)
  - LEFT HAND
  - RIGHT HAND
- RESERVE NO. 4 TO TANK NO. 4 (VALVE)

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, INBOARD, OUTBOARD
- EMERGENCY FLAP DRIVE CONTROL OUTBD

LIGHTS

- BOARDING LIGHT CONTROL
- DOOR WARNING
- OXYGEN WARNING SIGNS

MISCELLANEOUS

- Q-INLET HEATER WARNING

BATTERY CIRCUIT BREAKER PANEL

HOT BATTERY BUS

- ALARM BELL
- BOARDING LIGHTS
- WARNING HORN
- ENTRY DOOR LIGHT
- EXTERNAL POWER & BUS TIE ISOLATE
- L.F. ANTENNA CABLE CUTTER
- CARGO DOOR HYD PUMP & CONTROL

Figure 1-30 (Sheet 2 of 4)

DC power distribution (cont)

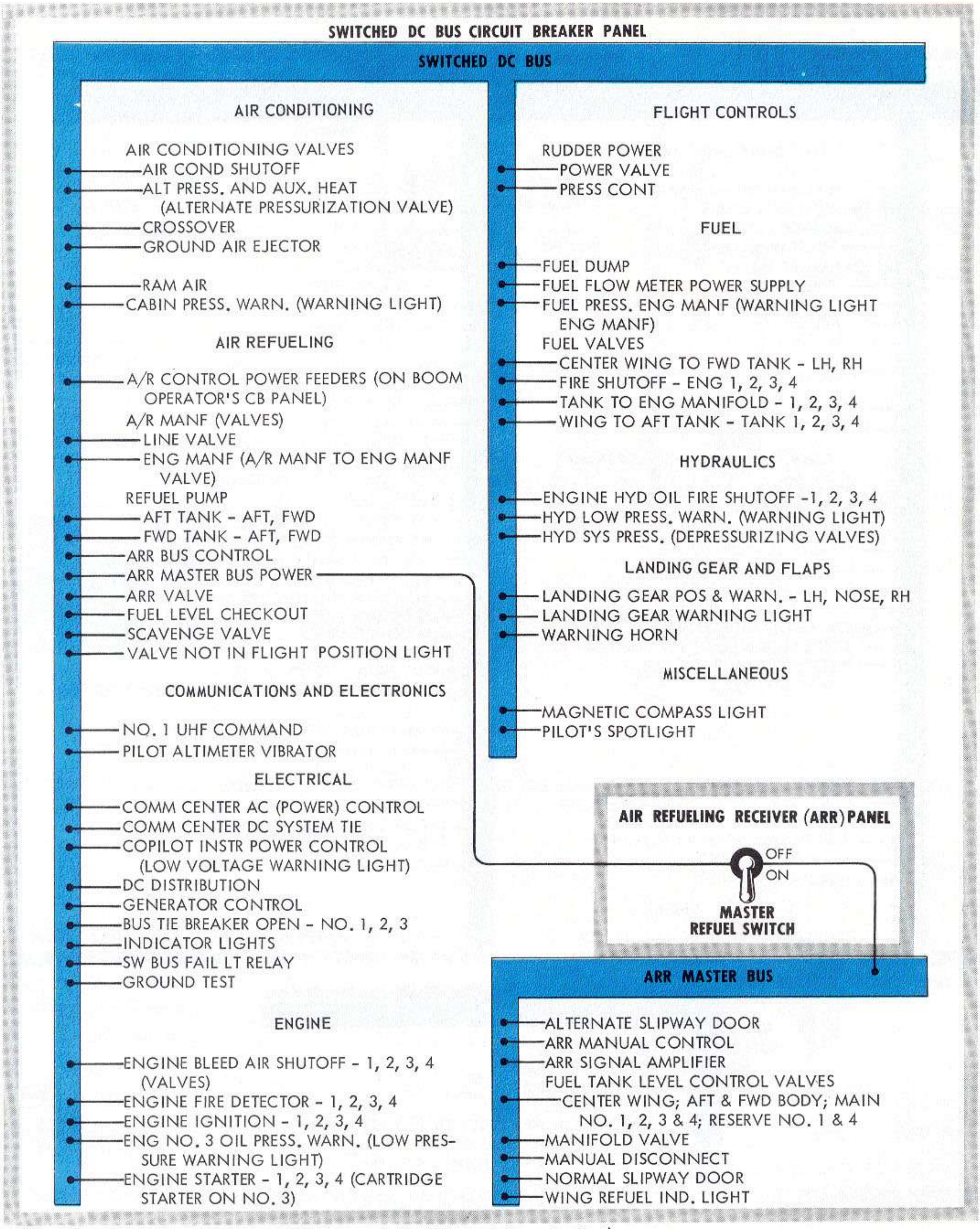


Figure 1-30 (Sheet 3 of 4)

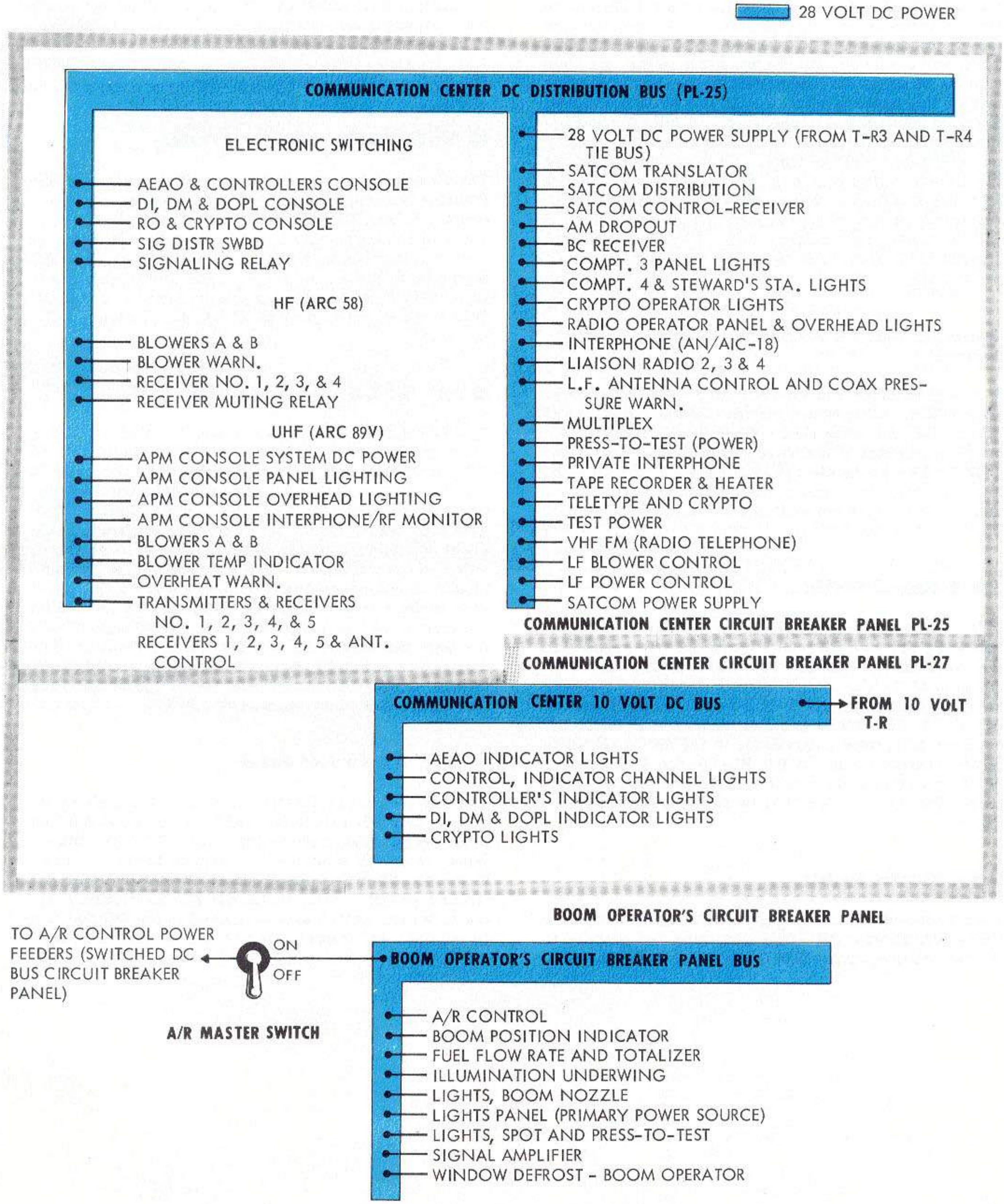


Figure 1-30 (Sheet 4 of 4)

Battery Charging Ammeter

The battery charging ammeter (15, figure 1-28) 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 charging rate to the right and a minus 30 amps 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 inrush 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. The ammeter may pulse when the battery approaches full charge.

Comm. Center DC Ammeter, Voltmeter and Selector

A rotary selector switch (5, figure 1-33, sheet 9) on the communication center circuit breaker panel PL-25 (CCBP PL-25) with OFF--T-R 3--T-R 4 positions provides a means of monitoring operation of T-R 3 and T-R 4. The voltmeter (2, figure 1-33, sheet 9) and the ammeter (6, figure 1-33, sheet 9) will display volt and ampere information for either T-R No. 3 or T-R No. 4.

T-R 3 Control Switch

T-R 3 control switcn (3, figure 1-33, sheet 9) on the CCBP PL-25 with ON--OFF positions and guarded to the ON position, controls T-R 3 power relay. The OFF position of T-R 3 control switch opens T-R 3 power relay and disconnects T-R 3 power output from the CCBP PL-25. When the switch is moved to the ON position, and power is available to ENGINE 1 GENERATOR section of the CCBP PL-25, the T-R 3 power relay will close and connect T-R 3 power output to the CCBP PL-25 for distribution to the communication center.

T-R 4 Control Switch

T-R 4 control switch (4, figure 1-33, sheet 9) on the CCBP PL-25 with ON--OFF positions and guarded to the ON position, controls T-R 4 power relay. The OFF position of T-R 4 control switch opens T-R 4 power relay and disconnects T-R 4 power output from the CCBP PL-25. When the switch is moved to the ON position, and power is available to ENGINE 2 GENERATOR section of the CCBP PL-25, the T-R 4 power relay will close and connect T-R 4 power output to the CCBP PL-25 for distribution to the communication center.

10 VOLT DIRECT CURRENT SYSTEM

The 10 volt DC system (figure 1-29) consists of one transformer-rectifier for indicator light power at the crypto, AEAO, DI, DM, DOPL, and controller's consoles in compartments 2 and 3. The 10 volt T-R unit receives input single phase AC power from the AC power from the AC power system, and output power is connected to the communication center 10 volt DC BUS and distributed through CCBP PL-27 (figure 1-33, sheet 7).

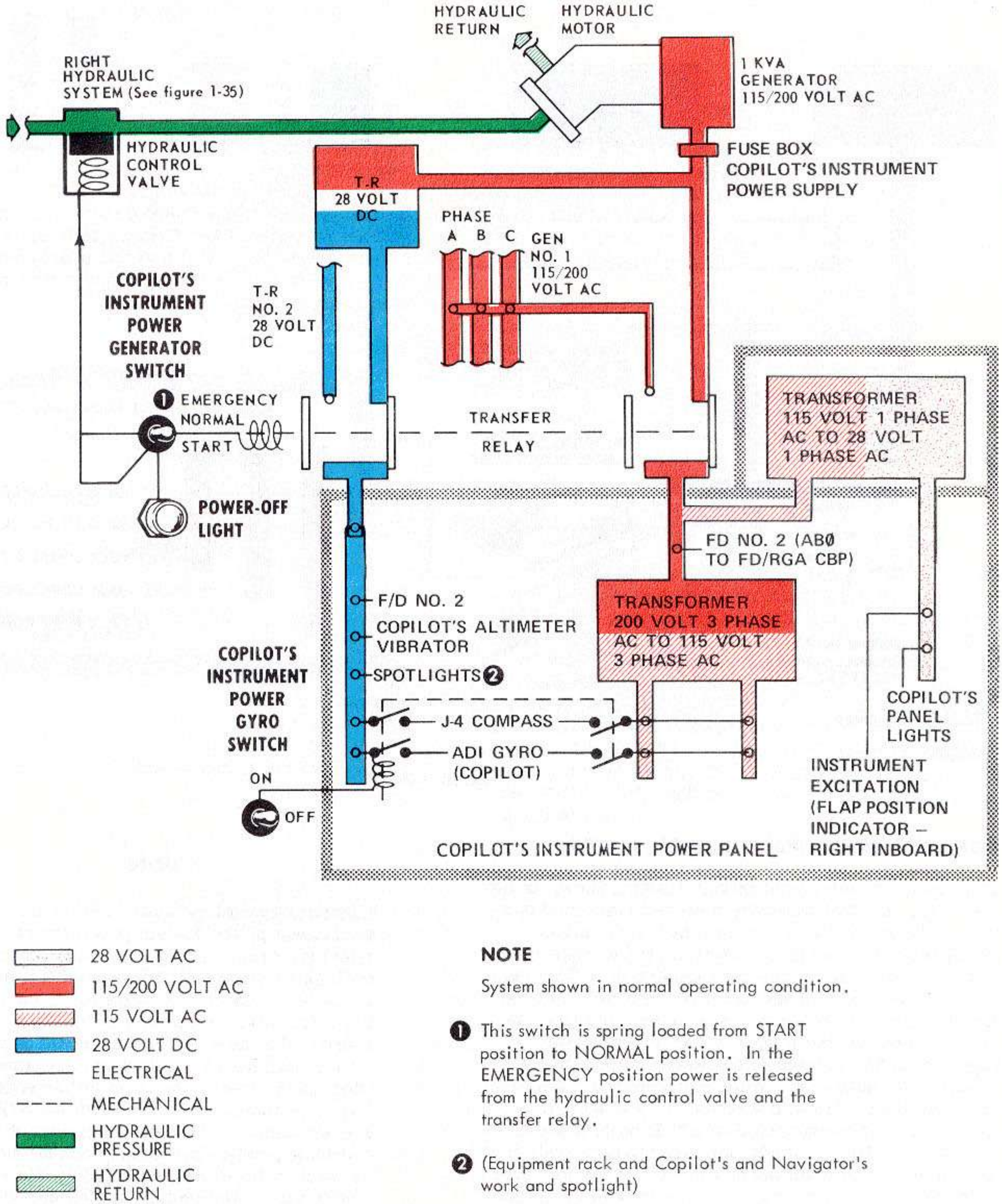
10 Volt DC Transformer-Rectifier

The T-R unit receives single phase 115 volt AC power from the primary AC power system, rectifies it to DC power, and steps the voltage down to 10 volts. Input 115 volt single phase AC power is through a circuit breaker marked 10V T-R UNIT on ENGINE 2 GENERATOR, PHASE B on the CCBP PL-25 (figure 1-33, sheet 9), and is connected to the T-R through the 10 volt T-R control switch. T-R output power to the communication center 10 volt DC bus (figure 1-30, sheet 4) is through a circuit breaker marked 10V DC DISTR adjacent to the T-R unit. Distribution is through circuit breakers marked 10V DC CONTROL INDICATOR LIGHTS on the CCBP PL-27 (figure 1-33, sheet 7). The T-R unit is mounted in the aft electrical equipment rack (35, figure 1-3) in compartment 1.

10 Volt T-R Control Switch

The 10V T-R control switch (1, figure 1-33, sheet 9) on the CCBP PL-25 with ON--OFF positions and guarded to the ON position, controls the 10 volt T-R input power. When the switch is in the OFF position, the input circuit is open. When AC power is available to ENGINE 2 GENERATOR section of CCBP PL-25 (figure 1-33, sheet 9) the switch may be moved to the ON position to connect AC input power to the 10 volt T-R unit.

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 Copilot's and Navigator's work and spotlight)

Figure 1-31

apu & external power distribution

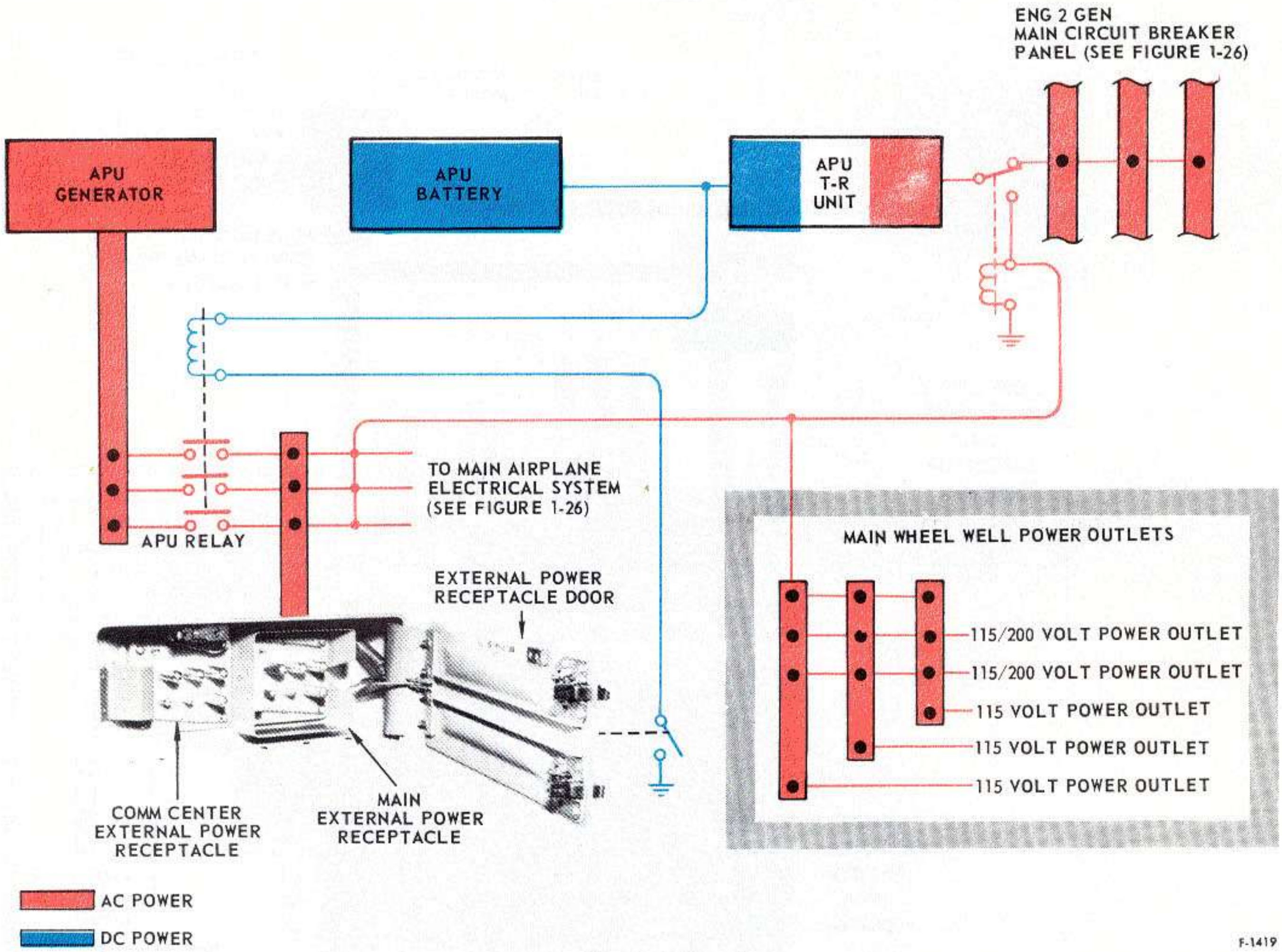


Figure 1-32

COPILOT'S INSTRUMENT POWER SYSTEM

The copilot's instrument power system, shown in figure 1-31, 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 1-33 sheet 3A. 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 1-31. 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 (20, figure 1-17) 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 115/200 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 1-31. 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 1-31. If the copilot's instrument power generator fails completely, the copilot's 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 (19, figure 1-17) is on the copilot's instrument panel next to the copilot's instrument power generator switch. The 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 1-33, sheet 4).

SPARE FUSES AND BULBS

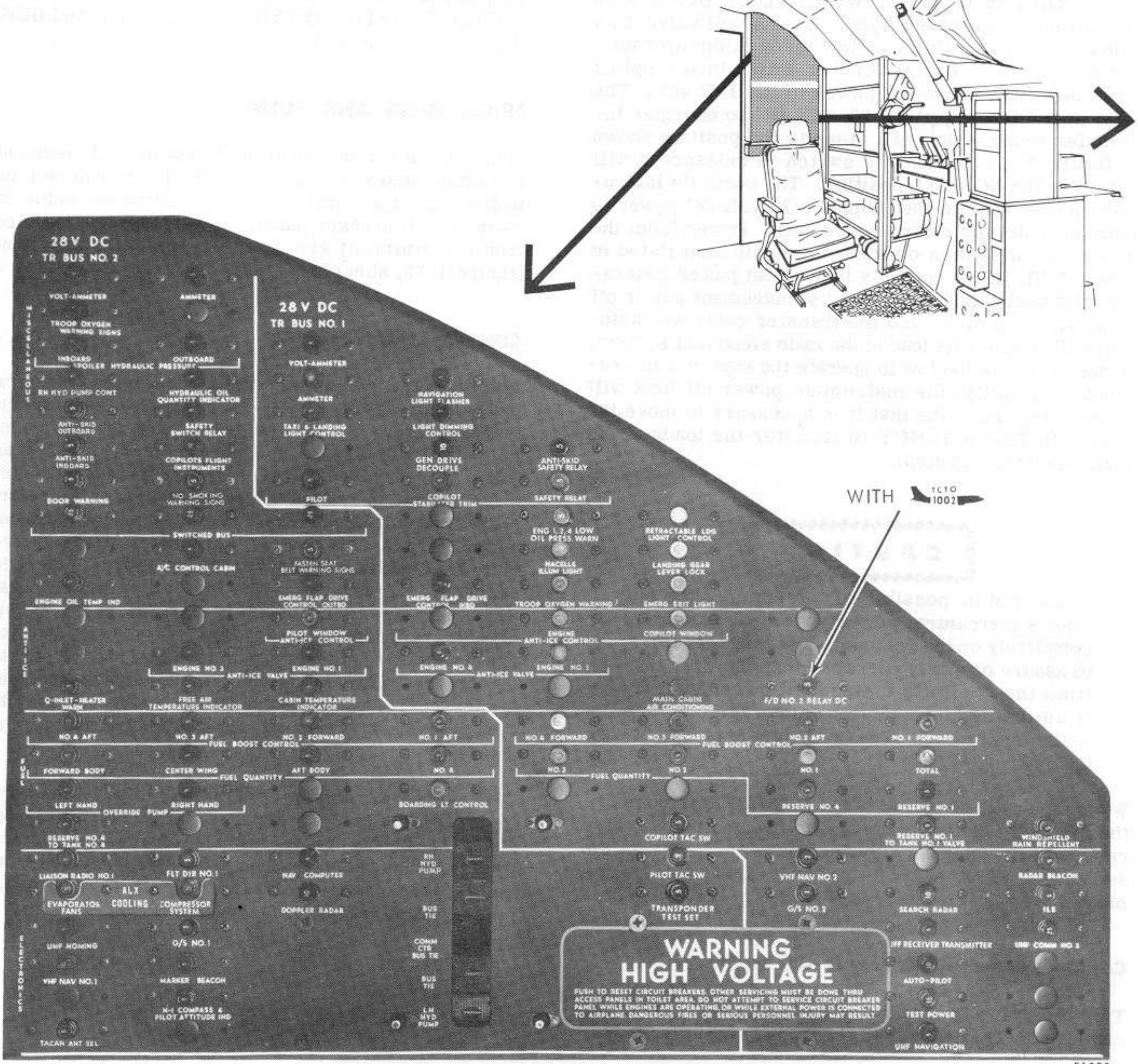
Spare fuses for the electrical system and electronic equipment and spare bulbs for the lights can be found in the spare fuse and bulb stowage container below the main circuit breaker panel. Spare fuses for the electronic equipment are on the electronics fuse panel (figure 1-33, sheet 3).

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 not be visible when reset.

Circuit breakers used for 3-phase (3Ø) AC load protection on the communications center circuit breaker panel PL-25 (figure 1-33, sheet 9) are single circuit breakers that afford 3-phase protection. A fault on any single phase will cause the circuit breaker to trip cutting off power to all 3-phases.

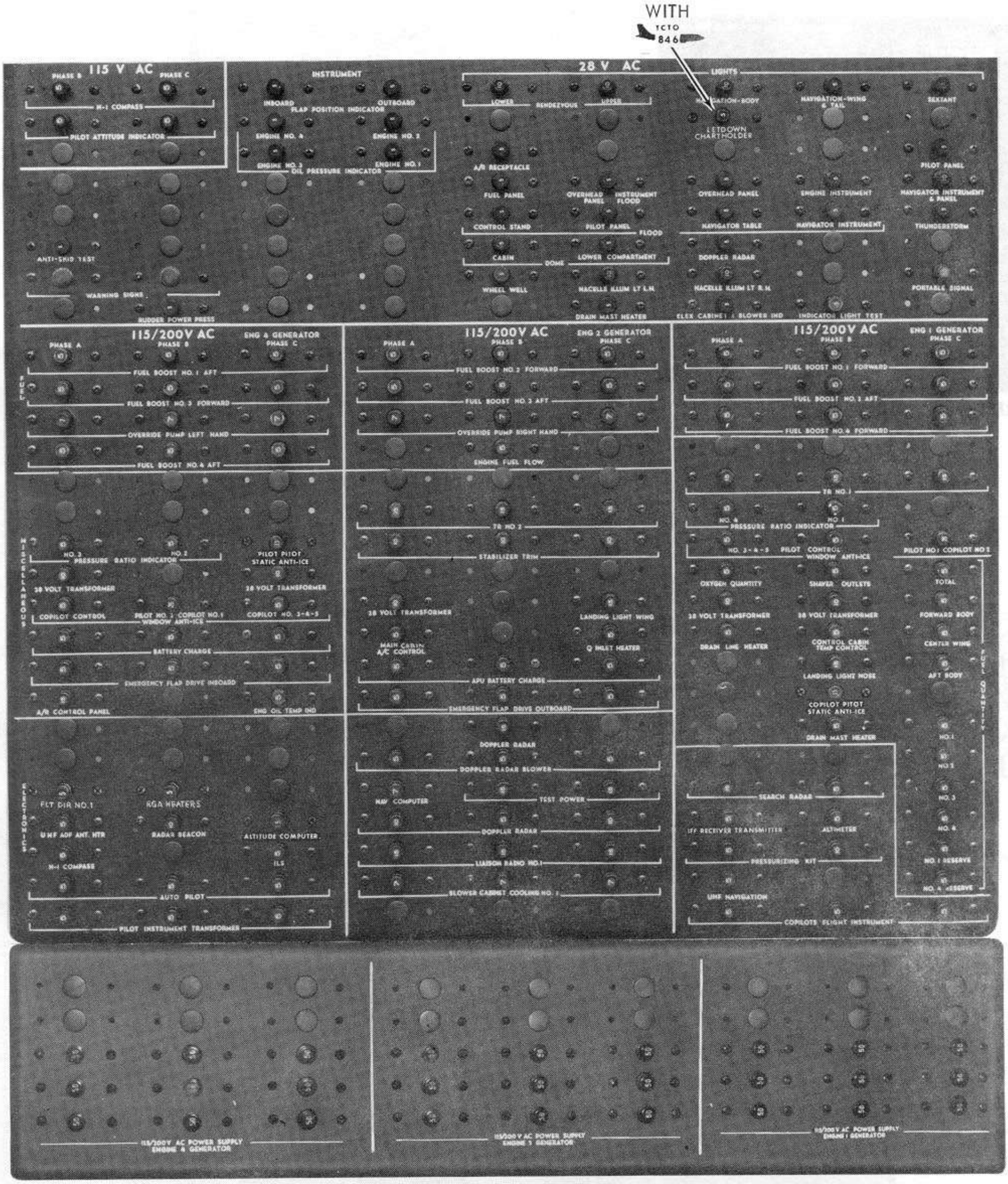
circuit breaker panels (typical)



● MAIN CIRCUIT BREAKER PANEL (MCBP)

28 VOLT DC POWER

Figure 1-33(Sheet 1 of 12)



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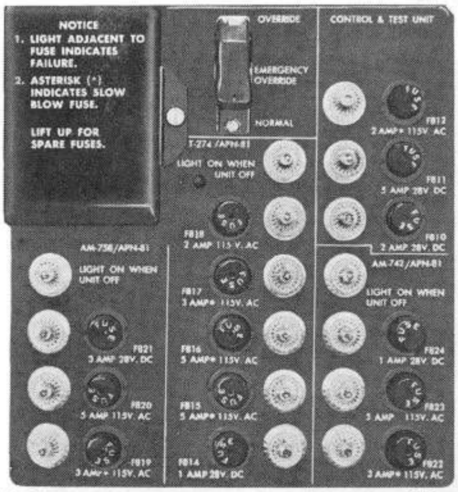
● MAIN CIRCUIT BREAKER PANEL (MCBP) AC POWER

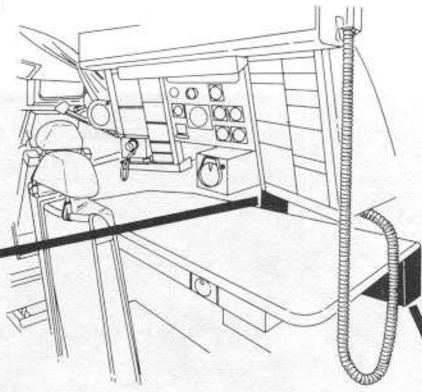
Figure 1-33 (Sheet 2 of 12)

circuit breaker panels (cont)

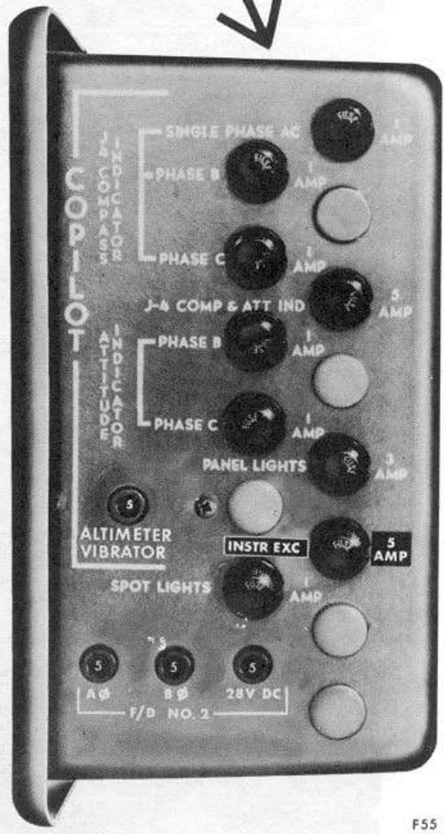


●ELECTRONICS FUSE PANEL

F-59



● COPILOT'S INSTRUMENT POWER PANEL (CIPP)



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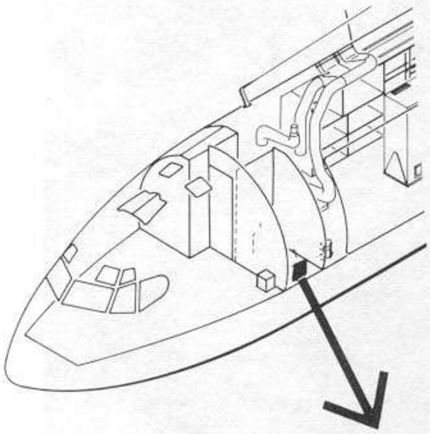

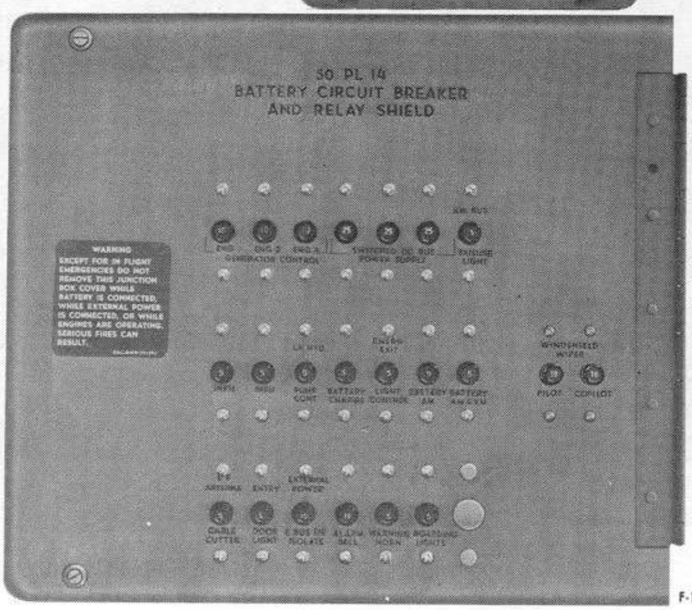

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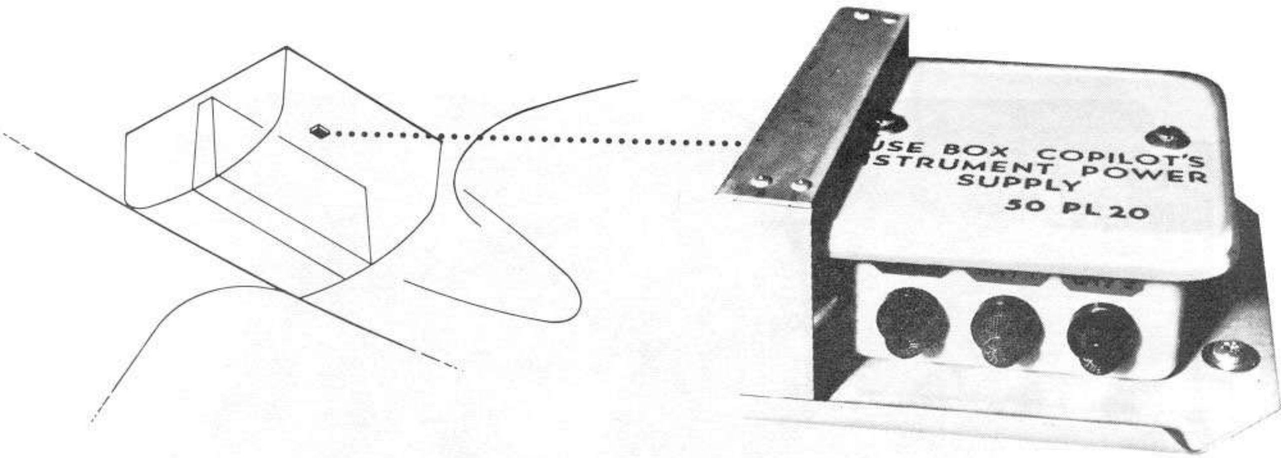
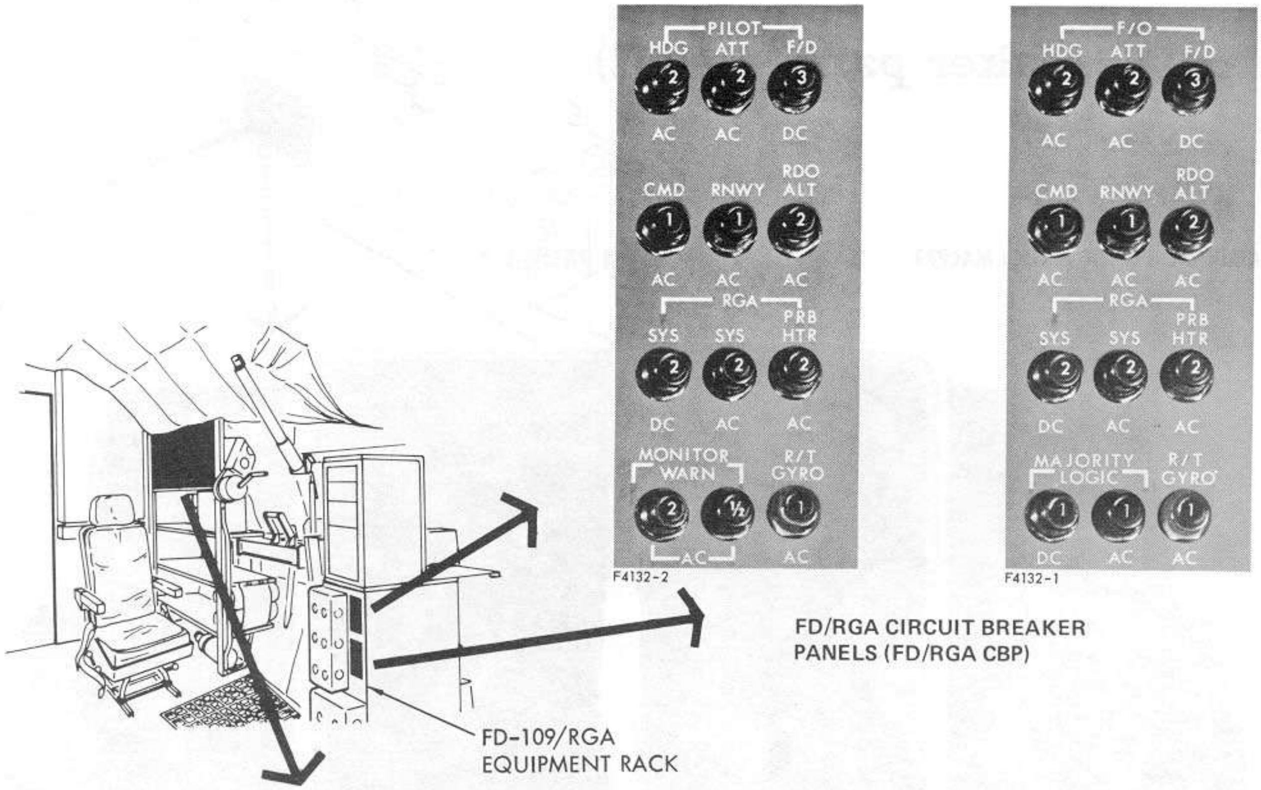
● BATTERY CIRCUIT BREAKER PANEL (BATTERY CBP)

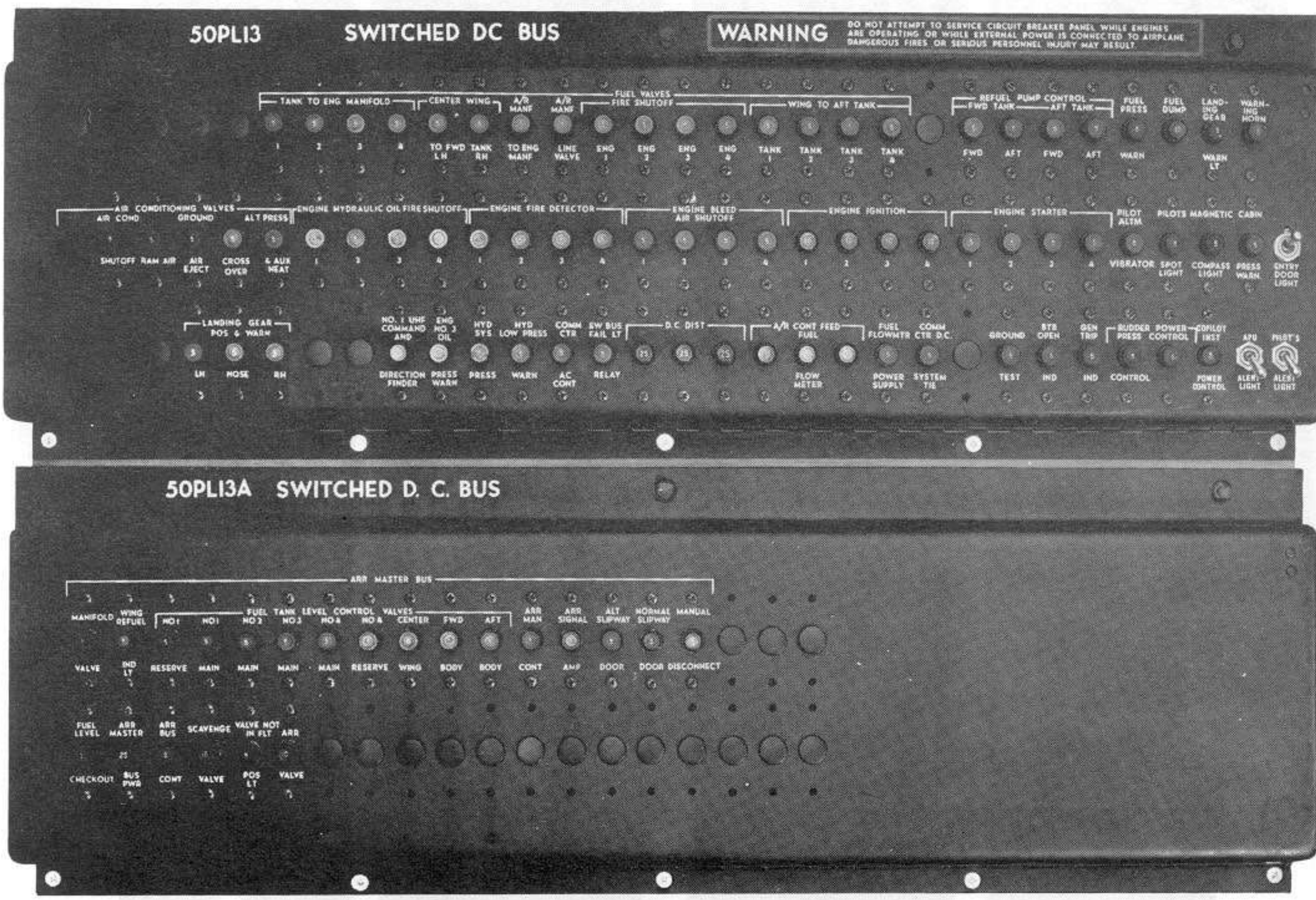
Figure 1-33 (Sheet 3 of 12)



●COPILOT'S INSTRUMENT POWER SUPPLY FUSE BOX

Figure 1-33(Sheet 3A of 12)



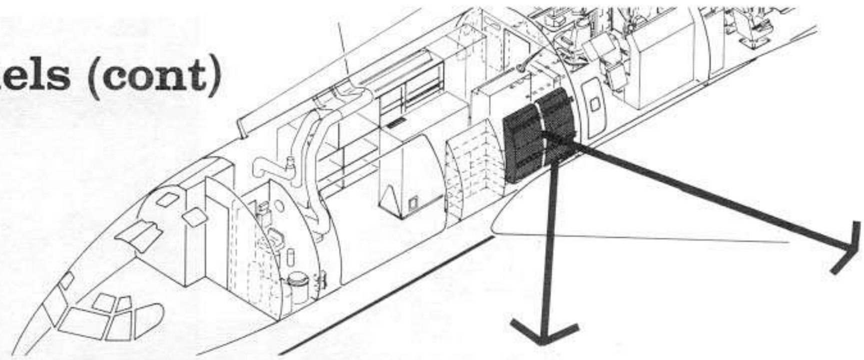


● **SWITCHED DC BUS CIRCUIT BREAKER PANEL (SBCBP)**

Figure 1-33 (Sheet 4 of 12)

F-1387

circuit breaker panels (cont)



- MAIN AC POWER PANEL (MACPP)

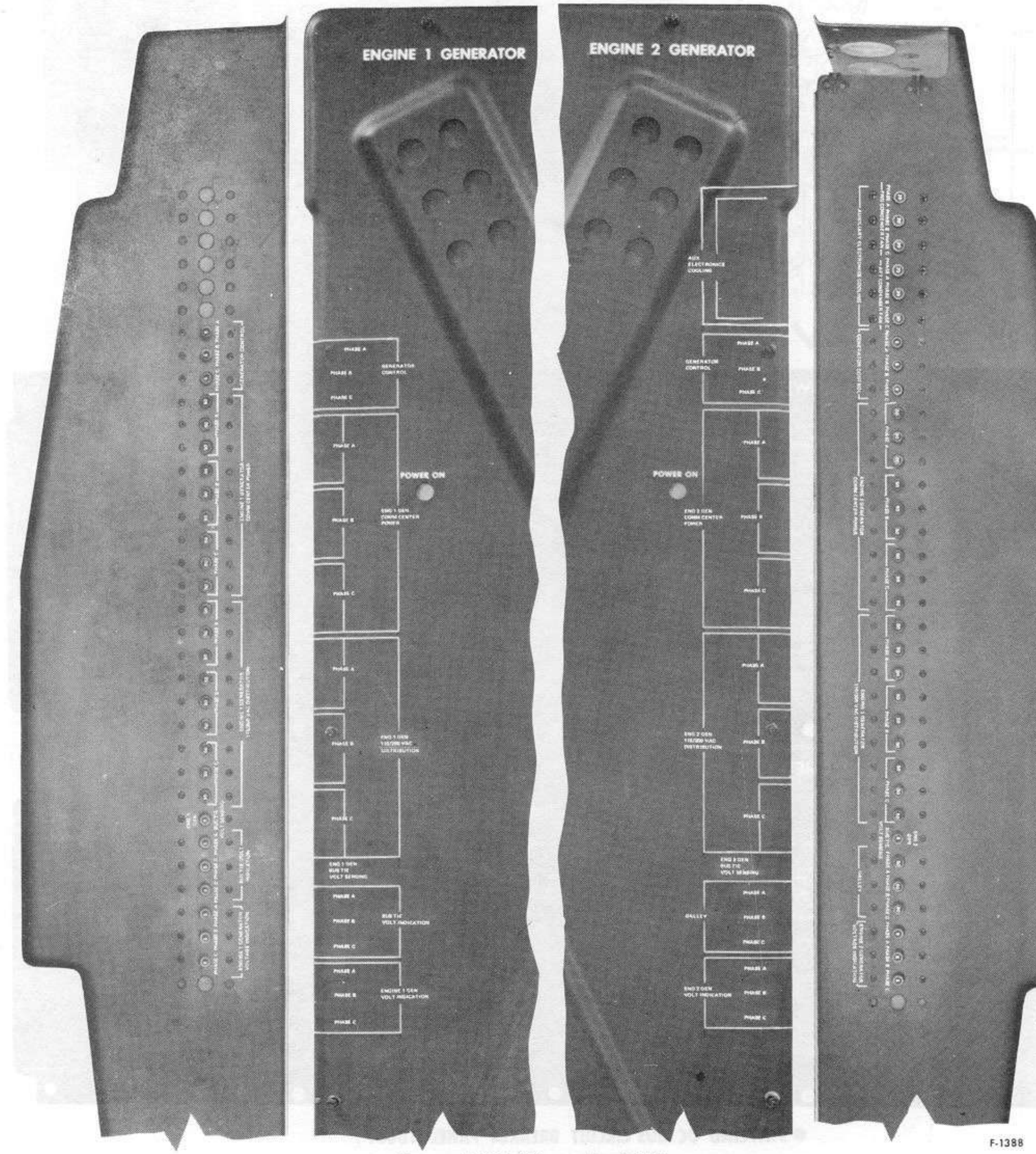


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Figure 1-33 (Sheet 5 of 12)

● MAIN AC POWER PANEL

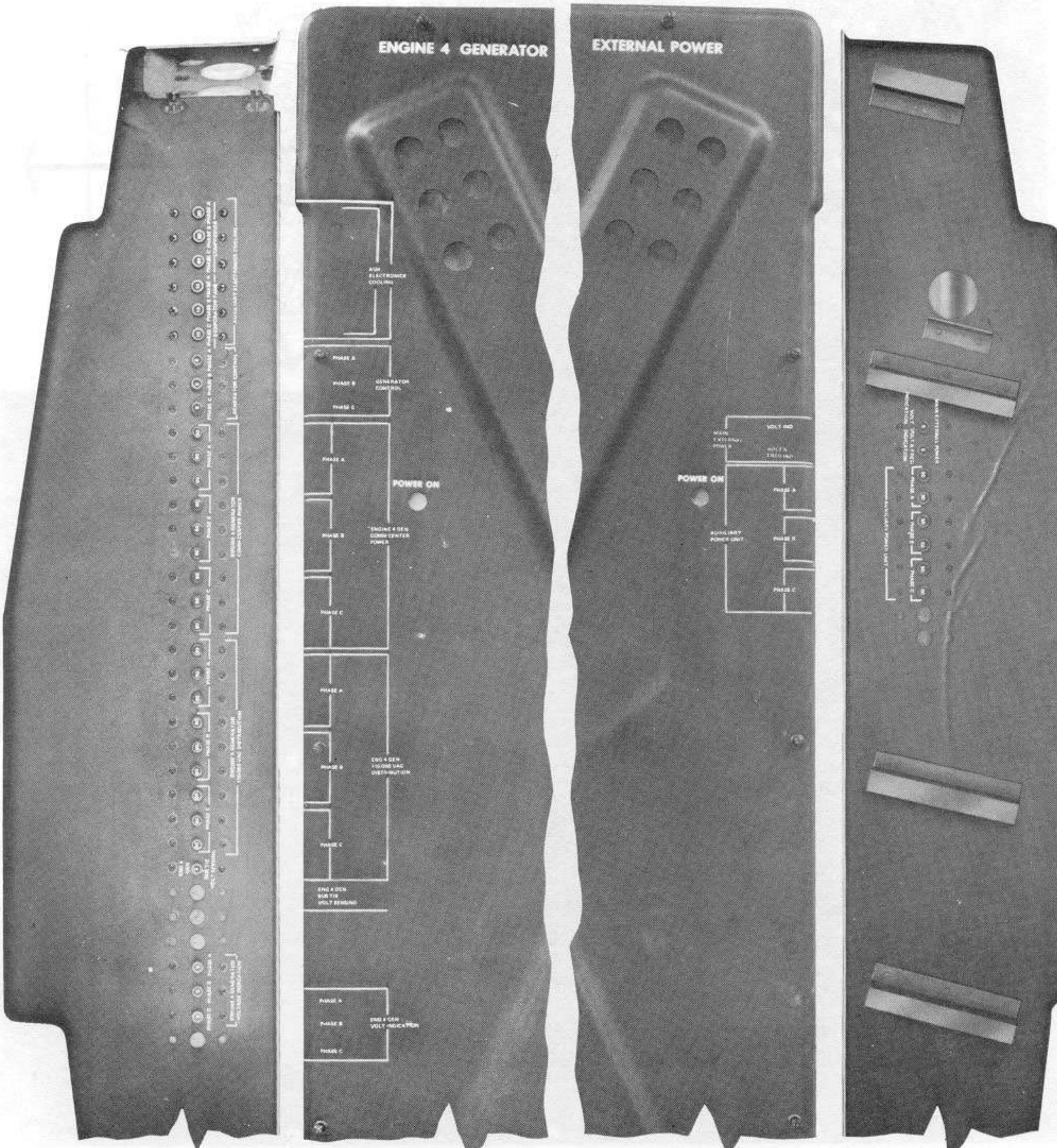

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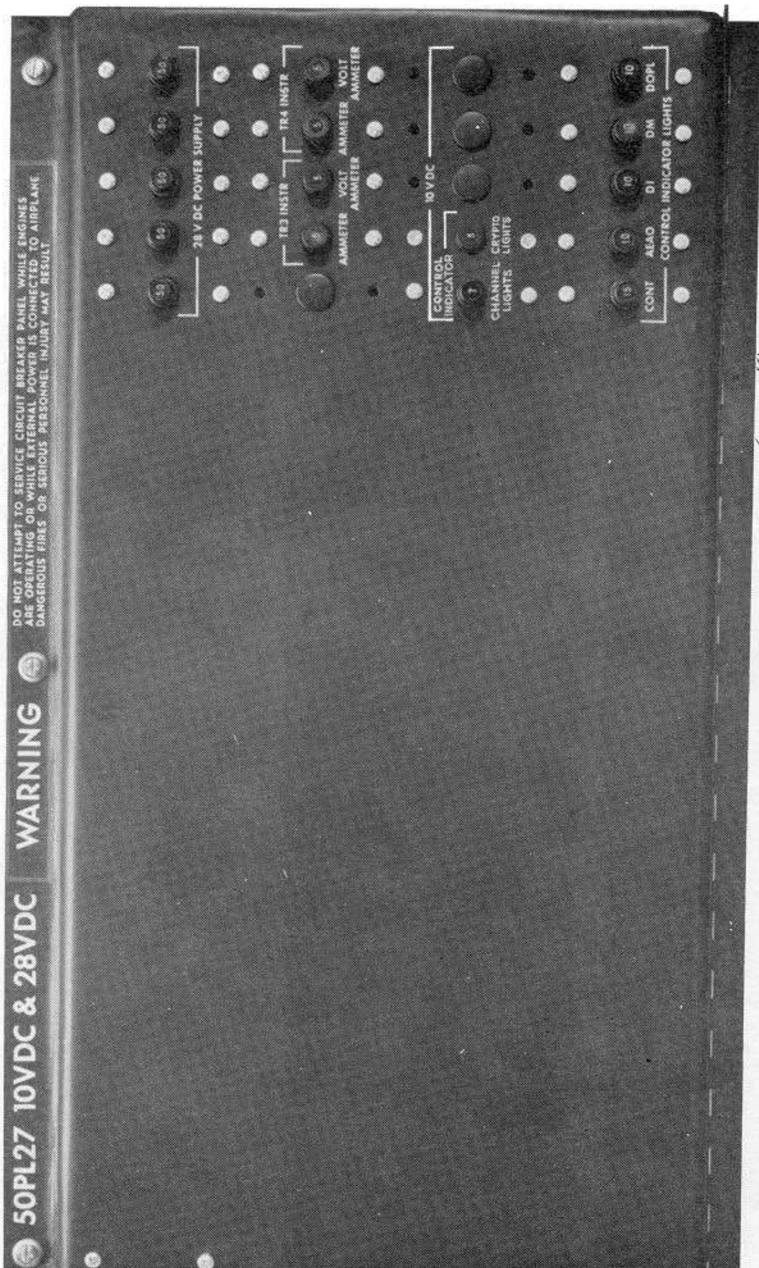
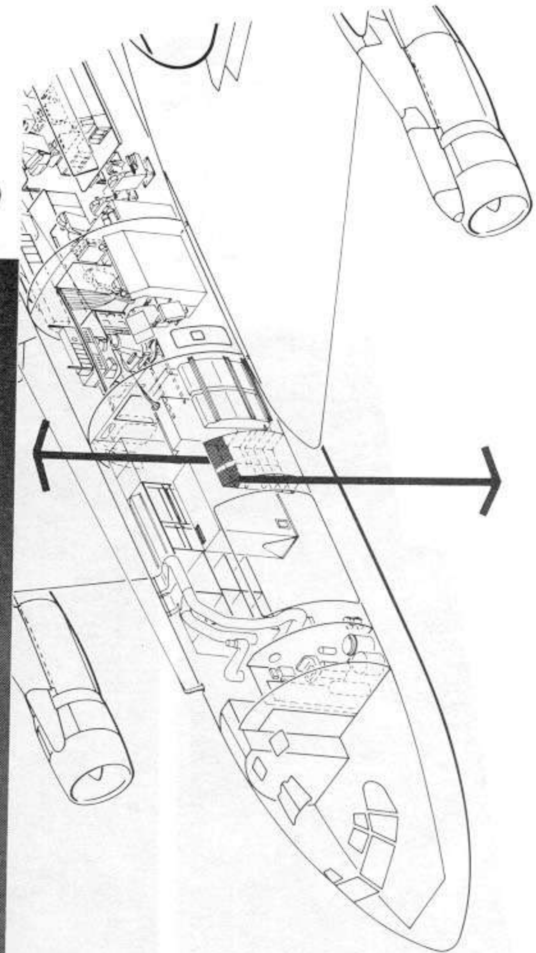
Figure 1-33 (Sheet 6 of 12)

circuit breaker panels (cont)

● COMMUNICATION CENTER CIRCUIT BREAKER PANEL PL-27 (CCBP PL-27)





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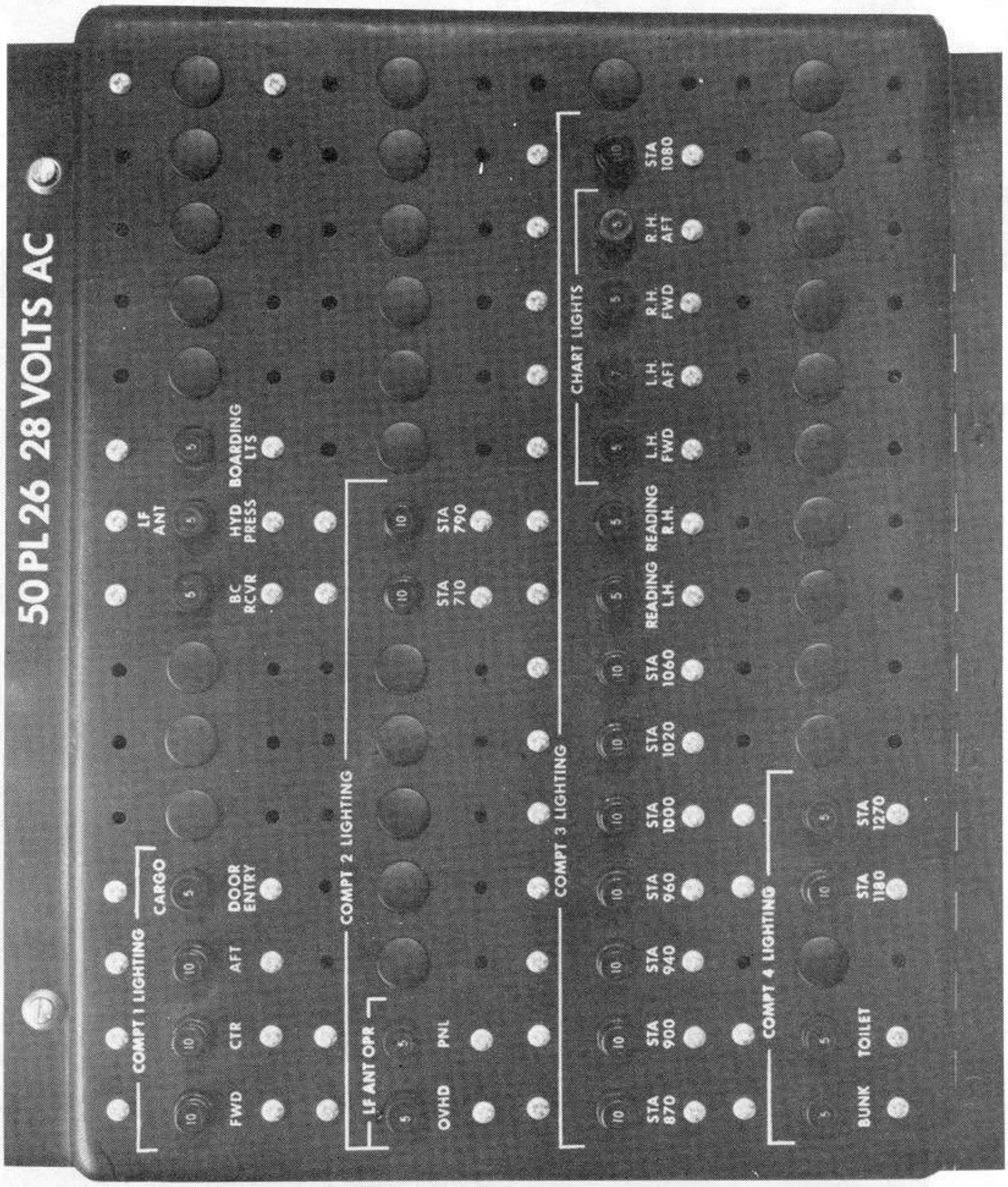
F-1385

Figure 1-33 (Sheet 7 of 12)



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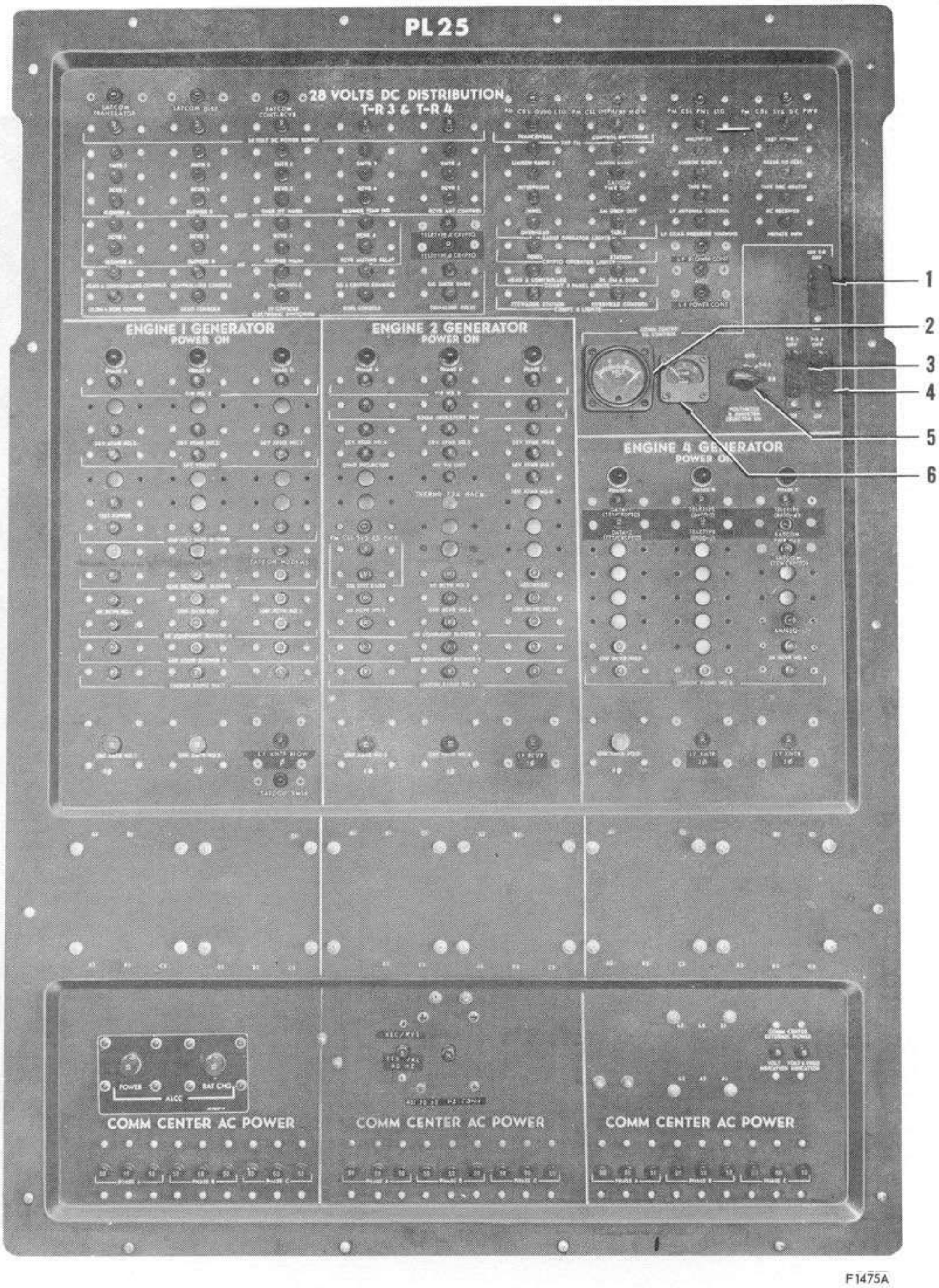
● **COMMUNICATION CENTER CBP PL-26 (CCBP PL-26)**

Figure 1-33 (Sheet 8 of 12)

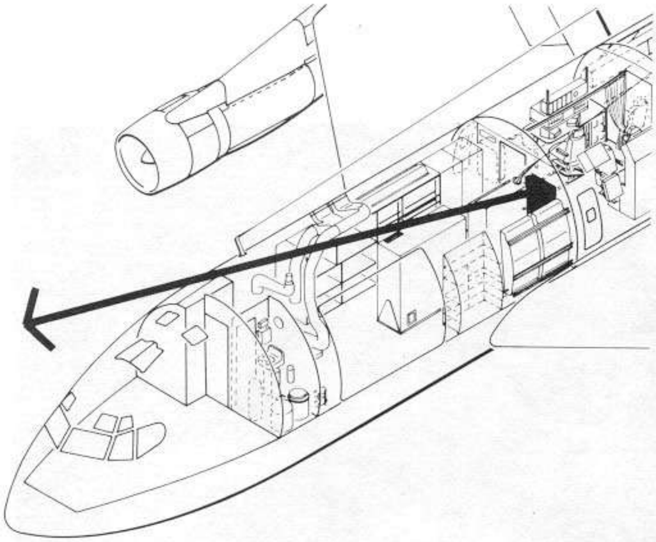
circuit breaker panels (cont)

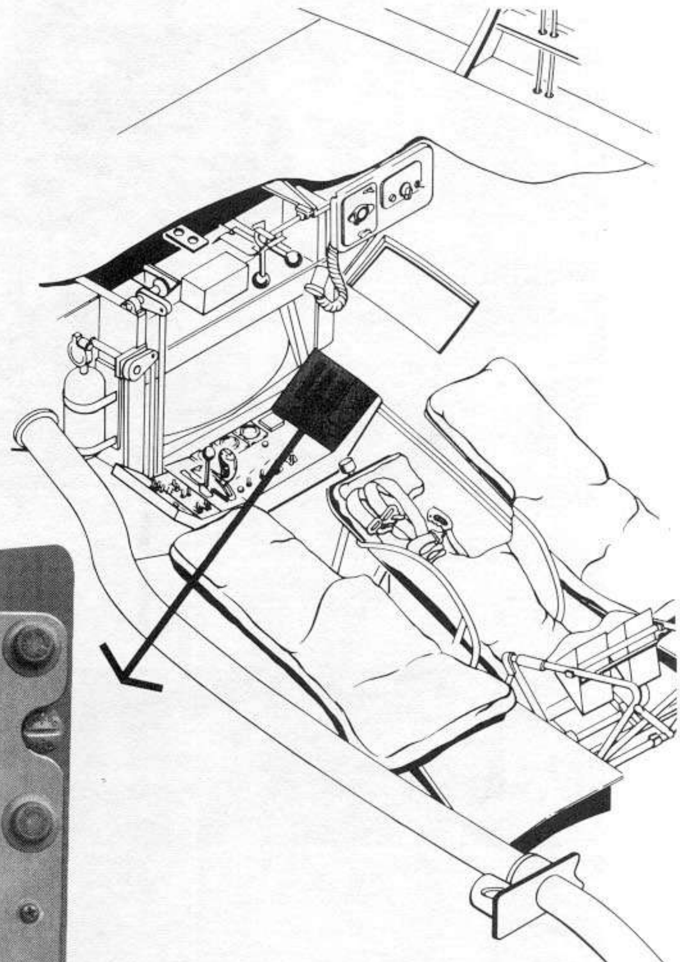
1 10 VOLT T-R CONTROL SWITCH
2 COMM CENTER DC VOLTMETER
3 T-R 3 CONTROL SWITCH
4 T-R 4 CONTROL SWITCH
5 COMM CENTER DC AMMETER & VOLTMETER SELECTOR
6 COMM CENTER DC AMMETER

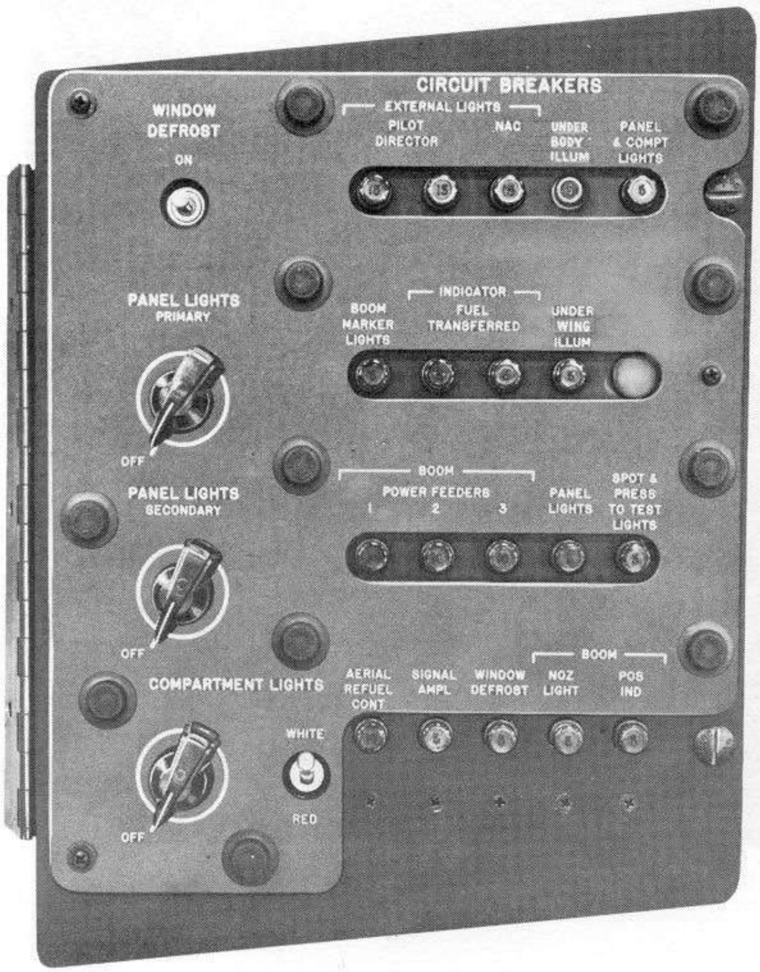


● COMMUNICATION CENTER CIRCUIT BREAKER PANEL (CCBP PL-25)

Figure 1-33 (Sheet 9 of 12)







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● **BOOM OPERATOR'S CIRCUIT BREAKER PANEL (BOCBP)**

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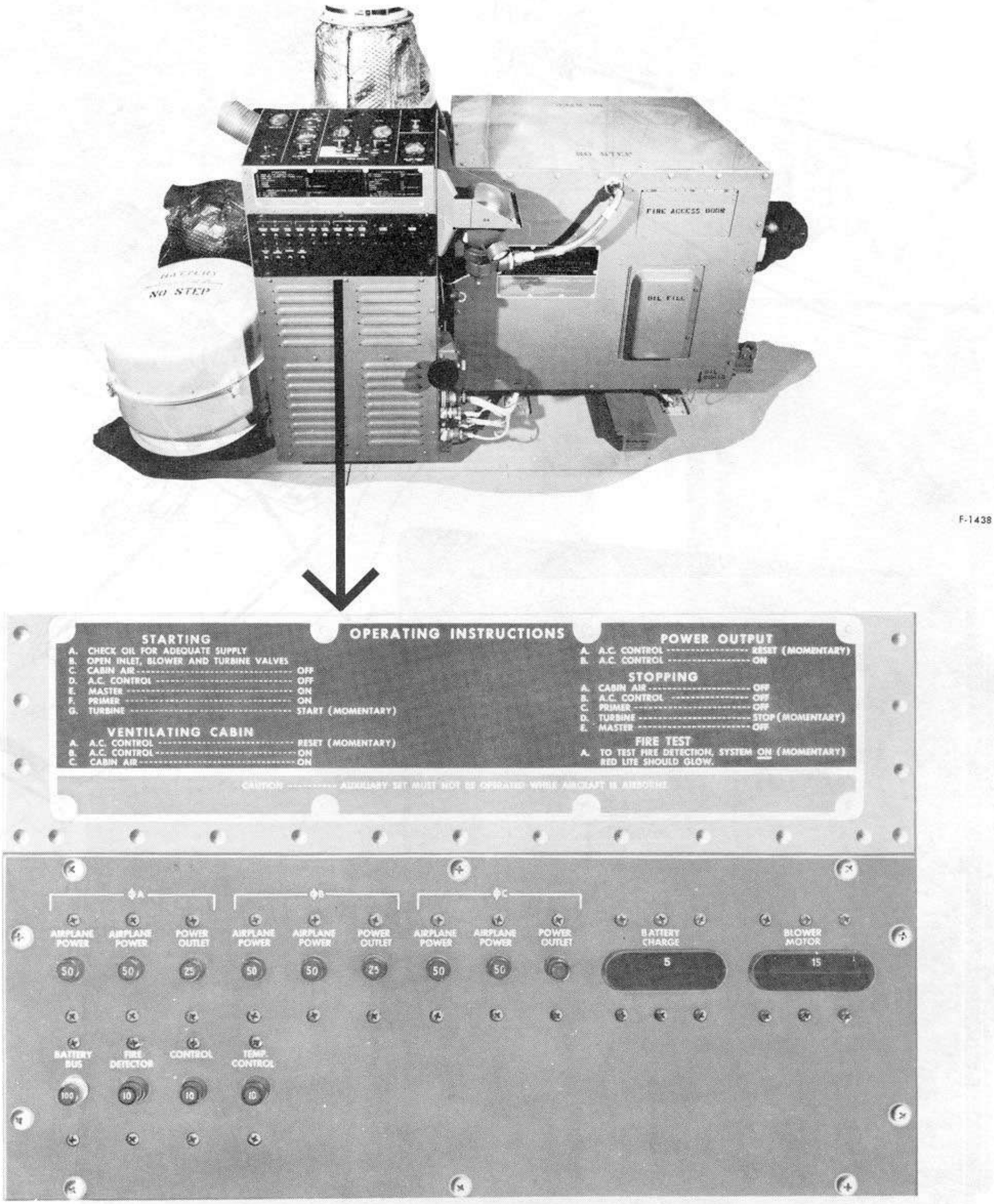
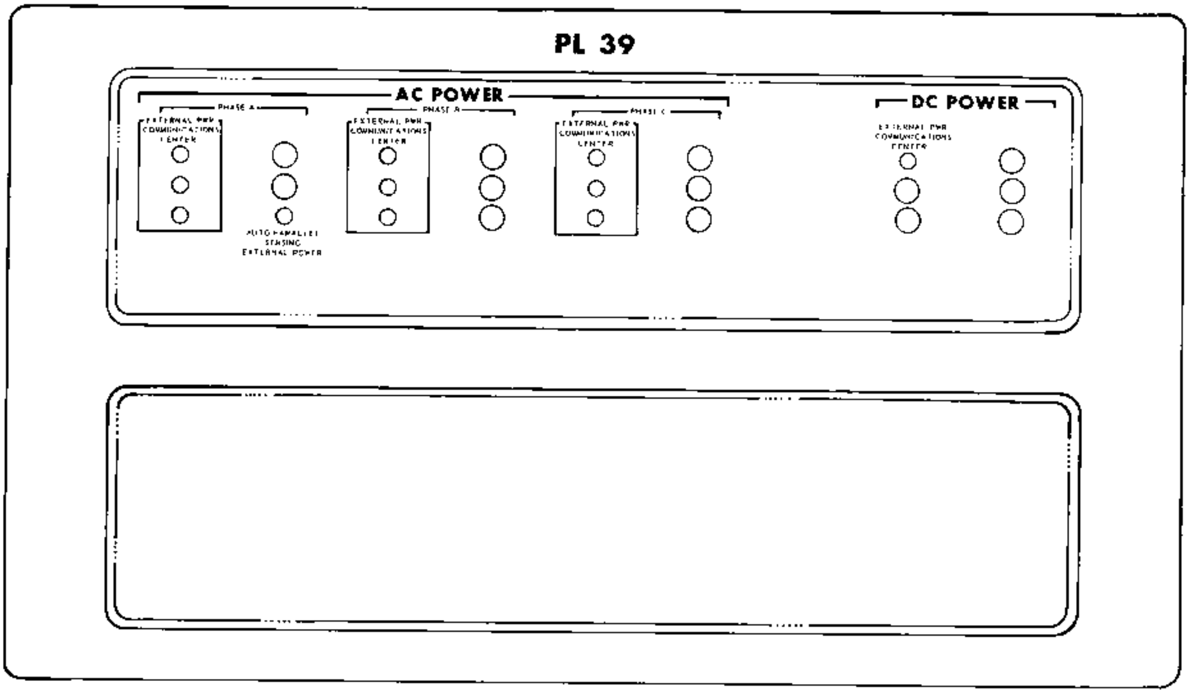
Figure 1-33 (Sheet 10 of 12)

circuit breaker panels (cont)



● **APU CIRCUIT BREAKER PANEL**

Figure 1-33 (Sheet 11 of 12)



- PL 39 COMMUNICATIONS CENTER AUXILIARY CIRCUIT BREAKER PANEL

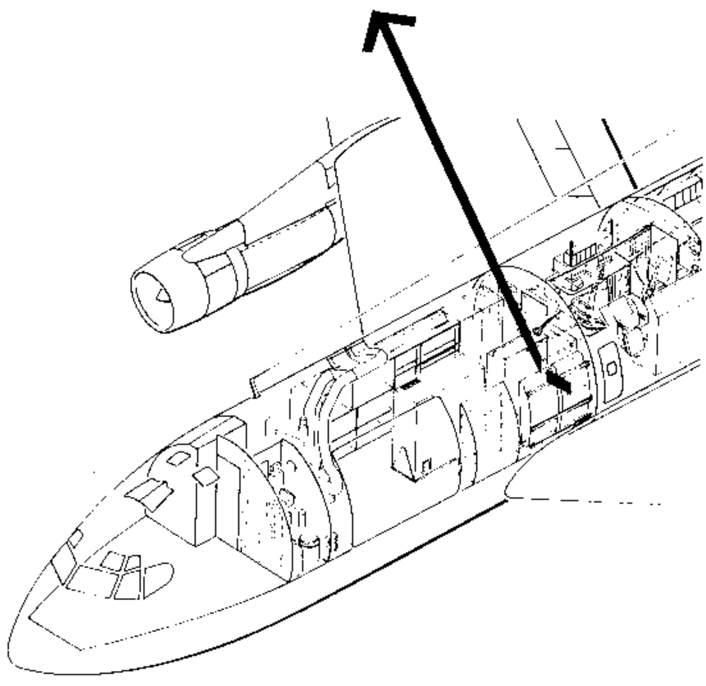


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Figure 1-33 (Sheet 12 of 12)

circuit protection & 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
- Battery Circuit Breaker Panel - BATTERY CBP
- Communication Center Circuit Breaker Panel 25 - CCBP PL-25
- Communication Center Circuit Breaker Panel 26 - CCBP PL-26
- Communication Center Circuit Breaker Panel 27 - CCBP PL-27
- Boom Operator's Circuit Breaker Panel - BOCBP
- Copilot's Instrument Power Panel - CIPP
- Main AC Power Panel - MACPP
- Communication Center Auxiliary Circuit Breaker Panel 39 -CCABP PL-39

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
AIR CONDITIONING, PRESSURIZATION AND VENTILATING			
A/C CONTROL CABIN (cabin temperature)	1	28V DC	T-R BUS NO. 2 MCBP
AIR CONDITIONING VALVES			
AIR COND SHUTOFF	1	28V DC	SBCBP
ALTERNATE PRESSURIZATION & AUXILIARY HEAT	1	28V DC	SBCBP
CROSS OVER	1	28V DC	SBCBP
GROUND AIR EJECT	1	28V DC	SBCBP
RAM AIR	1	28V DC	SBCBP
CABIN PRESSURE WARN (light)	1	28V DC	SBCBP
CABIN TEMPERATURE INDICATOR	1	28V DC	T-R BUS NO. 2 MCBP
CONTROL CABIN TEMP CONTROL	1	115V AC	ENG 1 GENERATOR MCBP
ENGINE BLEED AIR SHUTOFF (valves) - NOS. 1, 2, 3, 4	4	28V DC	SBCBP
MAIN CABIN AIR CONDITIONING	1	28V DC	T-R BUS NO. 1 MCBP
MAIN CABIN A/C CONTROL	1	115V AC	ENG 2 GENERATOR MCBP
AIR REFUELING SYSTEM (A/R)			
AERIAL REFUEL CONTROL	1	28V DC	BOCBP
AIR REFUELING CONTROL PANEL	1	115V AC	ENG 4 GENERATOR MCBP
A/R CONT FEED FUEL FLOW METER	3	28V DC	SBCBP
BOOM OPERATORS FAN	3	115/200V AC	ENGINE 2 GENERATOR CCBP PL-25
BOOM POS IND	1	28V DC	BOCBP
BOOM POWER FEEDERS (BOCBP distribution)	3	28V DC	BOCBP
FUEL TRANSFERRED INDICATOR	1	28V DC	BOCBP
	1	115V AC	BOCBP
LIGHTS, BOOM MARKER	1	115V AC	BOCBP
LIGHTS, EXTERNAL			
PILOT DIRECTOR	2	32V AC	BOCBP
NACELLE (illum)	1	28V AC	BOCBP
LIGHTS, PANEL	1	28V DC	BOCBP
LIGHTS, PANEL & COMPT	1	28V AC	BOCBP
LIGHTS, SPOT AND PRESS TO TEST	1	28V DC	BOCBP
LIGHTS, UNDER BODY ILLUM	1	28V AC	BOCBP
LIGHTS, UNDER WING ILLUM	1	28V DC	BOCBP
REFUEL PUMP CONTROL			
FWD TANK - FWD, AFT	2	28V DC	SBCBP
AFT TANK - FWD, AFT	2	28V DC	SBCBP
SIGNAL AMPLIFIER	1	28V DC	BOCBP

Figure 1-34 (Sheet 1 of 10)

circuit protection & location (cont)

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
AIR REFUELING RECEIVER SYSTEM (ARR)			
ARR BUS CONTROL	1	28V DC	SBCBP
ARR MASTER BUS PWR	1	28V DC	SBCBP
ARR MASTER BUS			
ALTERNATE SLIPWAY DOOR	1	28V DC	SBCBP
ARR MAN CONTROL	1	28V DC	SBCBP
ARR SIGNAL AMPLIFIER	1	28V DC	SBCBP
FUEL TANK LEVEL CONTROL VALVES			
NO. 1 RESERVE; NOS. 1, 2, 3, 4 MAIN;			
NO. 4 RESERVE; CENTER WING;			
FWD BODY; AFT BODY	9	28V DC	SBCBP
MANIFOLD VALVE	1	28V DC	SBCBP
MANUAL DISCONNECT	1	28V DC	SBCBP
NORMAL SLIPWAY DOOR	1	28V DC	SBCBP
WING REFUEL IND LT	1	28V DC	SBCBP
ARR VALVE	1	28V DC	SBCBP
FUEL LEVEL CHECKOUT (ARR)	1	28V DC	SBCBP
SCAVENGE VALVE	1	28V DC	SBCBP
VALVE NOT IN FLT POS LT (ARR)	1	28V DC	SBCBP
ANTI-ICING SYSTEM			
COPILOT PITOT-STATIC ANTI-ICE	1	115V AC	MCBP
DRAIN LINE HEATER	1	115V AC	ENG 1 GENERATOR MCBP
DRAIN MAST HEATER	1	115V AC	ENG 1 GENERATOR MCBP
	1	28V AC	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
PILOT PITOT-STATIC ANTI-ICE	1	115V AC	MCBP
Q INLET HEATER	1	115V AC	ENG 2 GENERATOR MCBP
Q-INLET-HEATER WARNING	1	28V DC	T-R BUS NO. 2 MCBP
RGA HEATERS	1	115V AC	ENG 4 GENERATOR MCBP
WINDOW ANTI-ICE			
COPILOT WINDOW ANTI-ICE CONTROL (controller)	1	28V DC	T-R BUS NO. 1 MCBP
PILOT WINDOW ANTI-ICE CONTROL (controller)	1	28V DC	T-R BUS NO. 2 MCBP
WINDOW ANTI-ICE COPILOT 3-4-5	1	115V AC	ENG 4 GENERATOR MCBP
WINDOW ANTI-ICE PILOT CONTROL	1	115V AC	ENG 1 GENERATOR MCBP
WINDOW ANTI-ICE PILOT NO. 1 COPILOT NO. 2	1	115V AC	ENG 1 GENERATOR MCBP
WINDOW ANTI-ICE PILOT NO. 2 COPILOT NO. 1	1	115V AC	ENG 4 GENERATOR MCBP
WINDOW ANTI-ICE PILOT NO. 3-4-5	1	115V AC	ENG 1 GENERATOR MCBP
WINDOW DEFROST (BO control power)	1	28V DC	BOCBP
(Window defrost, BO operating power) A/R CONTROL	1	115V AC	ENG 4 GENERATOR MCBP
APU			
APU BATTERY CHARGE	3	115/200V AC	ENG 2 GENERATOR MCBP
AUXILIARY COOLING SYSTEM			
COMPRESSOR SYSTEM	1	28V DC	MCBP
EVAPORATOR FANS	1	28V DC	MCBP
FWD CONDENSER FAN	3	115/200V AC	MACPP
AFT CONDENSER FAN	3	115/200V AC	MACPP
EVAPORATOR FANS	3	115/200V AC	MACPP
COMPRESSOR	3	115/200V AC	MACPP

Figure 1-34 (Sheet 2 of 10)

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT			
COMMUNICATION CENTER			
400 TO 60 Hz CONVERTER	1,3Ø	115/200V AC	ENGINE 2 GEN CCBP PL-25
ALCC ECTO ES12			
BAT CHG	1	115/200V AC	ENG 1 GEN CCBP PL-25
POWER	1	115/200V AC	ENG 1 GEN CCBP PL-25
AM DROPOUT	1	28V DC	T-R3 & T-R4 CCBP PL-25
APM CONSOLE INTERPHONE/RF MONITOR	1	28V DC	T-R3 & T-R4 CCBP PL-25
APM CONSOLE OVERHEAD LIGHTING	1	28V DC	T-R3 & T-R4 CCBP PL-25
APM CONSOLE PANEL LIGHTING	1	28V DC	T-R3 & T-R4 CCBP PL-25
APM CONSOLE SYSTEM AC POWER	1	115V AC	ENGINE 2 GEN CCBP PL-25
APM CONSOLE SYSTEM DC POWER	1	28V DC	T-R3 & T-R4 CCBP PL-25
BC RECEIVER	1	28V DC	T-R3 & T-R4 CCBP PL-25
	1	28V AC	CCBP PL-26
DATA 1 (TTY/CRYPTO)	1	115V AC	ENGINE 4 GEN CCBP PL-25
DATA 2 (TTY/CRYPTO)	1	115V AC	ENGINE 4 GEN CCBP PL-25
ELECTRONIC SWITCHING			
AEAO & CONTROLLERS CONSOLE	1	28V DC	T-R3 & T-R4 CCBP PL-25
AEAO CONSOLE	1	28V DC	T-R3 & T-R4 CCBP PL-25
CONTROLLERS CONSOLE	1	28V DC	T-R3 & T-R4 CCBP PL-25
DI CONSOLE	1	28V DC	T-R3 & T-R4 CCBP PL-25
DI, DM, & DOPL CONSOLE	1	28V DC	T-R3 & T-R4 CCBP PL-25
DM CONSOLE	1	28V DC	T-R3 & T-R4 CCBP PL-25
RO & CRYPTO CONSOLE	1	28V DC	T-R3 & T-R4 CCBP PL-25
SIGNALLING RELAY	1	28V DC	T-R3 & T-R4 CCBP PL-25
SIGNAL DISTRIBUTION SWITCHBOARD	1	28V DC	T-R3 & T-R4 CCBP PL-25
HF EQUIPMENT BLOWER A	3	115/200V AC	ENGINE 1 GEN CCBP PL-25
HF EQUIPMENT BLOWER B	3	115/200V AC	ENGINE 2 GEN CCBP PL-25
HF BLOWER A & B, BLOWER WARN, RCVR MUTING RELAY	4	28V DC	T-R3 & T-R4 CCBP PL-25
HF RECEIVER NO. 1, ARC-58	1	115V AC	ENGINE 1 GEN CCBP PL-25
HF RECEIVER NOS. 2 & 3, ARC-58	2	115V AC	ENGINE 2 GEN CCBP PL-25
HF RECEIVER NO. 4, ARC-58	1	115V AC	ENGINE 4 GEN CCBP PL-25
HF RCVR NOS. 1, 2, 3, 4, ARC-58	4	28V DC	T-R3 & T-R4 CCBP PL-25
INTERPHONE	1	28V DC	T-R3 & T-R4 CCBP PL-25
LIAISON RADIO NO. 2, ARC-58	3	115/200V AC	ENGINE 1 GEN CCBP PL-25
LIAISON RADIO NO. 3, ARC-58	3	115/200V AC	ENGINE 2 GEN CCBP PL-25
LIAISON RADIO NO. 4, ARC-58	3	115/200V AC	ENGINE 4 GEN CCBP PL-25
LIAISON RADIO NOS. 2, 3, 4, ARC-58	3	28V DC	T-R3 & T-R4 CCBP PL-25
LF ANTENNA CABLE CUTTER	1	28V DC	BATTERY CBP
LF ANTENNA CONTROL	1	28V DC	T-R3 & T-R4 CCBP PL-25
LF ANTENNA HYDRAULIC PRESSURE	**1**	**28V AC**	**CCBP PL-26**
LF BLOWER CONTROL	1	28V DC	T-R3 & T-R4 CCBP PL-25
LF POWER CONTROL	1	28V DC	T-R3 & T-R4 CCBP PL-25
LF RECEIVERS	3	115/200V AC	ENGINE 2 GEN CCBP PL-25
LF TRANSMITTER	2,3Ø	115/200V AC	ENGINE 4 GEN CCBP PL-25
LF TRANSMITTER BLOWER	3	115/200V AC	ENGINE 1 GEN CCBP PL-25
MULTIPLEX	1	115V AC	ENGINE 2 GEN CCBP PL-25
	1	28V DC	T-R3 & T-R4 CCBP PL-25
PRIVATE INPH	1	28V DC	T-R3 & T-R4 CCBP PL-25

Figure 1-34 (Sheet 2A of 10)

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT COMMUNICATION CENTER (Cont)			
SATCOM AMPLIFIER-MIXER	1,3Ø	115/200V AC	ENGINE 1 GEN CCBP PL-25
SATCOM AUX TTY	1	115V AC	ENGINE 1 GEN CCBP PL-25
SATCOM CONTROL-RECEIVER	1	28V DC	T-R3 & T-R4 CCBP PL-25
SATCOM DISTRIBUTION	1	28V DC	T-R3 & T-R4 CCBP PL-25
SATCOM MODEMS	1	115V AC	ENGINE 1 GEN CCBP PL-25
SATCOM POWER SUPPLY	1	115V AC	ENGINE 4 GEN CCBP PL-25
SATCOM POWER SUPPLY	1	28V DC	T-R3 & T-R4 CCBP PL-25
SATCOM TRANSLATOR	1	28V DC	T-R3 & T-R4 CCBP PL-25
SATCOM (TTY/CRYPTO)	1	115V AC	ENGINE 4 GEN CCBP PL-25
SIGNAL DISTRIBUTION SWITCHBOARD	2	115V AC	ENGINE 2 GEN CCBP PL-25
TAPE RECORDER BLOWER	3	115/200V AC	ENGINE 1 GEN CCBP PL-25
TAPE RECORDER	1	28V DC	T-R3 & T-R4 CCBP PL-25
TAPE RECORDER HEATER	1	28V DC	T-R3 & T-R4 CCBP PL-25
TELETYPE & CRYPTO	5	115V AC	ENGINE 4 GEN CCBP PL-25
TELETYPE (890D-3)	2	115V AC	ENGINE 4 GEN CCBP PL-25
TELETYPE (890D-4)	1	115V AC	ENGINE 4 GEN CCBP PL-25
TSEC/KY 3	1	115V AC	ENGINE 2 GEN CCBP PL-25
TTY/VLF INTERFACE	1	115V AC	ENGINE 2 GEN CCBP PL-25
UHF EQUIPMENT BLOWER A	3	115/200V AC	ENGINE 1 GEN CCBP PL-25
UHF EQUIPMENT BLOWER B	3	115/200V AC	ENGINE 2 GEN CCBP PL-25
UHF BLOWER A & B, OVER HT WARN, BLOWER TEMP IND, RCVR ANT CONTROL	5	28V DC	T-R3 & T-R4 CCBP PL-25
UHF NO. 1 XMTR BLOWER	3	115/200V AC	ENGINE 1 GENERATOR CCBP PL-25
UHF RCVR NOS. 1 & 2, ARR-68	2	115V AC	ENGINE 1 GENERATOR CCBP PL-25
UHF RCVR NOS. 3 & 4, ARR-68	2	115V AC	ENGINE 2 GENERATOR CCBP PL-25
UHF RCVR NO. 5, ARR-68	1	115V AC	ENGINE 4 GENERATOR CCBP PL-25
UHF RCVR NOS. 1, 2, 3, 4, 5 ARR-68	1	28V DC	T-R3 & T-R4 CCBP PL-25
UHF XMTR NOS. 1 & 2, ART-42	2, 3Ø	115/200V AC	ENGINE 1 GENERATOR CCBP PL-25
UHF XMTR NOS. 3 & 4, ART-42	2, 3Ø	115/200V AC	ENGINE 2 GENERATOR CCBP PL-25
UHF XMTR NOS. 1, 2, 3, 4, 5, ART-42	1	28V DC	T-R3 & T-R4 CCBP PL-25
VHF FM (radio telephone)	1	28V DC	T-R3 & T-R4 CCBP PL-25
COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT CREW			
ALTITUDE COMPUTER	1	115V AC	MCBP
ALTIMETER VIBRATOR (COPILOT)	1	28V DC	CIPP
ALTIMETER VIBRATOR (PILOT)	1	28V DC	SBCBP
ALTIMETER (high range radio), APN-133	1	115V AC	ENG 1 GENERATOR MCBP
AUTOPILOT	3	115/200V AC	ENG 4 GENERATOR MCBP
	1	28V DC	T-R BUS NO. 1 MCBP
BLOWER ELECTRONIC CABINET NO. 1	1	115V AC	ENG 2 GENERATOR MCBP
COPILOT TACAN SWITCH	1	28V DC	T-R BUS NO. 1 MCBP
DOPPLER RADAR	3	115/200V AC	ENG 2 GENERATOR MCBP
	1	115V AC	ENG 2 GENERATOR MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
	1	28V AC	MCBP
DOPPLER RADAR BLOWER	3	115/200V AC	ENG 2 GENERATOR MCBP
ELEX CABINET 1 BLOWER IND	1	28V AC	MCBP
FLIGHT DIRECTOR NO. 1	1	115V AC	GENERATOR NO. 4 MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
FLIGHT DIRECTOR NO. 2	2	115V AC	CIPP
	1	28V DC	CIPP

Figure 1-34 (Sheet 3 of 10)

circuit protection & location (cont)

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT CREW (cont)			
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
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 AC	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
F/D NO. 2 RELAY DC WITH 1C10 1002	1	28V DC	T-R BUS NO. 1 MCBP
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
ILS	1	115V AC	ENG 4 GENERATOR MCBP
IFF RECEIVER TRANSMITTER	1	28V DC	T-R BUS NO. 1 MCBP
	1	115V AC	MCBP
INPH, AIC-18	2	28V DC	BATTERY CBP
LIAISON RADIO NO. 1, ARC-58	3	115/200V AC	ENG 2 GENERATOR MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
MARKER BEACON, ARN-32	1	28V DC	T-R BUS NO. 2 MCBP
NAV COMPUTER, ASN-7	1	115V AC	ENG 2 GENERATOR MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
N-1 COMPASS	2	115V AC	115V AC MCBP
	1	115V AC	ENG 4 GENERATOR MCBP
N-1 COMPASS & PILOT ATTITUDE INDICATOR	1	28V DC	T-R BUS NO. 2 MCBP
PILOT TACAN SWITCH	1	28V DC	T-R BUS NO. 2 MCBP
PRESSURIZING KIT (RADAR), ASQ-15	2	115V AC	ENG 1 GENERATOR MCBP
RADAR BEACON, APN-69	1	115V AC	ENG 4 GENERATOR MCBP
	1	28V DC	T-R BUS NO. 1 MCBP
SEARCH RADAR, APN-59	2	115V AC	ENG 1 GENERATOR MCBP
	1	28V DC	T-R BUS NO. 1 MCBP
TRANSPONDER TEST SET	1	28V DC	T-R BUS NO. 2 MCBP
UHF ADF ANTENNA HEATER	1	115V AC	ENG 4 GENERATOR MCBP
UHF COMMAND NO. 1 (ARC-34) AND UHF DF (WITHOUT 1C10 1044)	1	28V DC	SBCBP
UHF COMMAND NO. 1 (ARC-164) AND UHF DF (WITH 1C10 1044)			

Figure 1-34 (Sheet 4 of 10)

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT CREW (cont)			
UHF COMMAND NO. 2, ARC-34 (WITHOUT 1044)	1	28V DC	T-R BUS NO. 1 MCBP
UHF COMMAND NO. 2, ARC-164 (WITH 1044)			
UHF HOMING, ARA-25	1	28V DC	T-R BUS NO. 2 MCBP
UHF NAVIGATION, ARN-72 (TACAN)	1	28V DC	T-R BUS NO. 1 MCBP
	1	115V AC	ENG 1 GENERATOR 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
AUTOPARALLELING SENSING EXTERNAL POWER	1	115V AC	CCABP PL-39
AUXILIARY POWER UNIT	3	115/200V AC	EXTERNAL POWER MACPP
BATTERY AM (ammeter)	1	28V DC	BATTERY CBP
BATTERY AM & VM (ammeter & voltmeter)	1	28V DC	BATTERY CBP
BATTERY CHARGE (T-R unit input)	3	115/200V AC	ENG 4 GENERATOR MCBP
BATTERY CHARGE (T-R unit output)	1	28V DC	BATTERY CBP
BOOM POWER FEEDERS (BOCBP distribution)	3	28V DC	BOCBP
COMMUNICATION CENTER			
COMM CTR AC CONTROL	1	28V DC	SBCBP
COMM CTR DC SYSTEM TIE	1	28V DC	SBCBP
COMM CENTER EXTERNAL POWER			
VOLT INDICATION	1	200V AC	ENGINE 4 GENERATOR CCBP PL-25
VOLT & FREQ INDICATION	1	200V AC	ENGINE 4 GENERATOR CCBP PL-25
COMM CENTER POWER	3	115/200V AC	ENGINE 4 GENERATOR MACPP
TEST POWER (electronic cabinet No. 2)	1	115V AC	ENGINE 1 GENERATOR CCBP PL-25
	1	28V DC	T-R3 & T-R4 CCBP PL-25
T-R 3 INSTRUMENTS			
AMMETER	1	28V DC	CCBP PL-27
VOLT AMMETER	1	28V DC	CCBP PL-27
T-R 4 INSTRUMENTS			
AMMETER	1	28V DC	CCBP PL-27
VOLT AMMETER	1	28V DC	CCBP PL-27
T-R NO. 3	3	115/200V AC	ENGINE 1 GENERATOR CCBP PL-25
T-R NO. 4	3	115/200V AC	ENGINE 2 GENERATOR CCBP PL-25
10V T-R UNIT	1	115V AC	ENGINE 2 GENERATOR CCBP PL-25
28V XFMR NOS. 1, 2, 3	3	115V AC	ENGINE 1 GENERATOR CCBP PL-25
28V XFMR NOS. 4, 5, 6, 7, 8	5	115V AC	ENGINE 2 GENERATOR CCBP PL-25
BTB (bus tie breaker) OPEN IND	1	28V DC	SBCBP
COPILOTS FLIGHT INSTRUMENTS (Emergency position of copilot's instrument power switch)	3	115/200V AC	ENG 1 GENERATOR MCBP
COPILOTS FLIGHT INSTRUMENTS	1	28V DC	T-R BUS NO. 2 MCBP
COPILOT'S INSTR POWER SYSTEM	3 FUSES	115/200 VAC	CIP SUPPLY FUSE BOX
COPILOT INSTR POWER CONTROL (relay, light & hydraulic valve)	1	28V DC	SBCBP
DC DISTRIBUTION	3	28V DC	SBCBP

Figure 1-34 (Sheet 5 of 10)

circuit protection & location (cont)

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
ELECTRICAL (cont)			
ENGINE 1 GENERATOR			
BUS TIE VOLT INDICATION	3	115/200V AC	ENGINE 1 GENERATOR MACPP
BUS TIE VOLT SENSING	1	115V AC	ENGINE 1 GENERATOR MACPP
COMM CENTER POWER	3	115/200V AC	ENGINE 1 GENERATOR MACPP
GENERATOR CONTROL	3	115/200V AC	ENGINE 1 GENERATOR MACPP
VOLT INDICATION	3	115/200V AC	ENGINE 1 GENERATOR MACPP
115/200V AC DISTRIBUTION	3	115/200V AC	ENGINE 1 GENERATOR MACPP
ENGINE 2 GENERATOR			
BUS TIE VOLT SENSING	1	115V AC	ENGINE 2 GENERATOR MACPP
COMM CENTER POWER	3	115/200V AC	ENGINE 2 GENERATOR MACPP
GALLEY	3	115/200V AC	ENGINE 2 GENERATOR MACPP
GENERATOR CONTROL	3	115/200V AC	ENGINE 2 GENERATOR MACPP
VOLT INDICATION	3	115/200V AC	ENGINE 2 GENERATOR MACPP
115/200V AC DISTRIBUTION	3	115/200V AC	ENGINE 2 GENERATOR MACPP
ENGINE 4 GENERATOR			
BUS TIE VOLT SENSING	1	115V AC	ENGINE 4 GENERATOR MACPP
COMM CENTER POWER	3	115/200V AC	ENGINE 4 GENERATOR MACPP
GENERATOR CONTROL	3	115/200V AC	ENGINE 4 GENERATOR MACPP
VOLT INDICATION	3	115/200V AC	ENGINE 4 GENERATOR MACPP
115/200V AC DISTRIBUTION	3	115/200V AC	ENGINE 4 GENERATOR MACPP
EXTERNAL POWER & BUS TIE ISOLATE	1	28V DC	BATTERY CBP
EXTERNAL POWER COMMUNICATION CENTER	9	115/200 AC	CCABP PL-39
EXTERNAL POWER COMMUNICATION CENTER	1	28V DC	CCABP PL-39
GENERATOR CONTROL			
ENGINE 1, 2, 4	3	28V DC	BATTERY CBP
GEN TRIP INDICATOR	1	28V DC	SBCBP
GROUND TEST (generator test control)	1	28V DC	SBCBP
MAIN EXTERNAL POWER	3	115/200V AC	EXTERNAL POWER MACPP
PILOT INSTRUMENT TRANSFORMER	3	115/200V AC	ENG 4 GENERATOR MCBP
SWITCHED BUS	3	28V DC	T-R BUS NO. 2 MCBP
SW BUS FAIL LT	1	28V DC	BATTERY CBP
SW BUS FAIL LT RELAY	1	28V DC	SBCBP
SWITCHED DC BUS POWER SUPPLY	3	28V DC	BATTERY CBP
T-R NO. 1	3	115/200V AC	ENG 1 GENERATOR MCBP
T-R NO. 2	3	115/200V AC	ENG 2 GENERATOR MCBP
VOLT-AMMETER (T-R NO. 1)	1	28V DC	T-R BUS NO. 1 MCBP
VOLT-AMMETER (T-R NO. 2)	1	28V DC	T-R BUS NO. 2 MCBP
28 VOLT TRANSFORMER	2	115V AC	ENG 1 GENERATOR MCBP
28 VOLT TRANSFORMER	1	115V AC	ENG 2 GENERATOR MCBP
28 VOLT TRANSFORMER	2	115V AC	ENG 4 GENERATOR MCBP
TEST POWER (electronic cabinet No. 1)	2	115V AC	ENG 2 GENERATOR MCBP
(Fwd electrical equip rack)	1	28V DC	T-R BUS NO. 1 MCBP

Figure 1-34 (Sheet 6 of 10)

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
ENGINES			
ENGINE FIRE DETECTOR - NOS. 1, 2, 3, 4 (lights)	4	28V DC	SBCBP
ENGINE FUEL FLOW (Indicator)	1	115V AC	ENG 2 GENERATOR MCBP
ENGINE IGNITION - NOS. 1, 2, 3, 4	4	28V DC	SBCBP
ENGINE NO. 3 OIL PRESS WARN (light)	1	28V DC	SBCBP
ENG OIL PRESS IND - NOS 1, 2, 3, 4	4	28V AC	MCBP
ENGINE 1, 2, 4 OIL PRESS WARNING LIGHTS	1	28V DC	T-R BUS NO. 1 MCBP
ENGINE OIL TEMPERATURE INDICATOR	1	28V DC	T-R BUS NO. 2 MCBP
ENGINE OIL TEMPERATURE INDICATOR	1	115V AC	ENG 4 GENERATOR and ENG 1 GENERATOR MCBP
ENGINE STARTER (switches & valves) - NOS 1,2,3,4	4	28V DC	SBCBP
FLIGHT CONTROLS			
EMERGENCY INBOARD FLAP DRIVE CONTROL	1	28V DC	T-R BUS NO. 1 MCBP
EMERGENCY INBOARD FLAP DRIVE	3	115/200V AC	ENG 4 GENERATOR MCBP
EMERGENCY OUTBOARD FLAP DRIVE CONTROL	1	28V DC	T-R BUS NO. 2 MCBP
EMERGENCY OUTBOARD FLAP DRIVE	3	115/200V AC	ENG 2 GENERATOR MCBP
FLAP POSITION INDICATOR			
OUTBOARD	1	28V AC	MCBP
INBOARD	1	28V AC	MCBP
INSTRUMENT EXCITATION (right pointer of inboard flap position indicator)	1 FUSE	28V AC	CIPP
RUDDER POWER			
CONTROL (shutoff valve, power switch)	1	28V DC	SBCBP
PRESS CONTROL (airspeed switch and press control)	1	28V DC	SBCBP
RUDDER POWER PRESS (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	ENG 2 GENERATOR 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	BATTERY CBP
FUEL			
BOOST PUMP SWITCHES			
FUEL BOOST NO. 1 AFT	3	115/200V AC	ENG 4 GENERATOR 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	ENG 1 GENERATOR 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	ENG 2 GENERATOR MCBP
FUEL BOOST CONTROL NO. 3 AFT	1	28V DC	T-R BUS NO. 2 MCBP
FUEL BOOST NO. 4 AFT	3	115/200V AC	ENG 4 GENERATOR 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	ENG 1 GENERATOR 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	ENG 2 GENERATOR 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	ENG 4 GENERATOR 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	ENG 1 GENERATOR MCBP
FUEL BOOST CONTROL NO. 4 FORWARD	1	28V DC	T-R BUS NO. 1 MCBP

Figure 1-34 (Sheet 7 of 10)

circuit protection & location (cont)

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
FUEL (cont)			
FUEL DUMP (switch)	1	28V DC	SBCBP
FUEL FLOW MOTOR POWER SUPPLY (boom)	1	28V DC	SBCBP
FUEL PRESS WARN (light)	1	28V DC	SBCBP
FUEL QUANTITY (gages control power)			
TOTAL, NO. 1, NO. 2, NO. 3, RESERVE NO. 1, RESERVE NO. 4	6	28V DC	T-R BUS NO. 1 MCBP
NO. 4, AFT BODY, CENTER WING, FORWARD BODY	4	28V DC	T-R BUS NO. 2 MCBP
FUEL QUANTITY (gages operating power)	10	115V AC	ENG 1 GENERATOR MCBP
TOTAL, FORWARD BODY, CENTER WING, AFT BODY, NO. 1, NO. 2, NO. 3, NO. 4, NO. 1 RESERVE, NO. 4 RESERVE			
FUEL VALVE SWITCHES			
CENTER WING TO FWD TANK - LH, RH	2	28V DC	SBCBP
FIRE SHUTOFF - ENG 1, 2, 3, 4	4	28V DC	SBCBP
RESERVE NO. 4 TO TANK NO. 4 VALVE	1	28V DC	T-R BUS NO. 2 MCBP
RESERVE NO. 1 TO TANK NO. 1 VALVE	1	28V DC	T-R BUS NO. 1 MCBP
TANK TO ENG MANIFOLD - NOS. 1, 2, 3, 4	4	28V DC	SBCBP
WING TO AFT TANK - NOS. 1, 2, 3, 4	4	28V DC	SBCBP
OVERRIDE PUMP LH	3	115/200V AC	ENG 4 GENERATOR MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
OVERRIDE PUMP RH	3	115/200V AC	ENG 2 GENERATOR MCBP
	1	28V DC	T-R BUS NO. 2 MCBP
HYDRAULIC SYSTEM			
ENGINE HYDRAULIC OIL FIRE SHUTOFF - NOS. 1, 2, 3, 4	4	28V DC	SBCBP
HYD LOW PRESS WARN (light)	1	28V DC	SBCBP
HYDRAULIC OIL QUANTITY INDICATOR	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
(operating power RESERVE BRAKE)	FUSE	28V DC	T-R BUS NO. 2 MCBP
RH HYD PUMP CONTROL	1	28V DC	T-R BUS NO. 2 MCBP
(operating power)	FUSE	28V DC	T-R BUS NO. 2 MCBP
INSTRUMENTS			
COPILOT ATTITUDE INDICATOR	2 FUSES	115V AC	CIPP
	FUSE	115V AC	CIPP
	1	28V DC	T-R BUS NO. 1 MCBP
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	115V AC	ENG 1 GENERATOR MCBP
PILOT ATTITUDE INDICATOR	2	115V AC	115V AC MCBP
	1	28V DC	T-R BUS NO. 2 MCBP

Figure 1-34 (Sheet 8 of 10)

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
LANDING GEAR			
ANTI-SKID, INBOARD, OUTBOARD	2	28V DC	T-R BUS NO. 2 MCBP
ANTI-SKID TEST	1	28V AC	MCBP
ANTI-SKID SAFETY RELAY	1	28V DC	T-R BUS NO. 1 MCBP
LANDING GEAR LEVER LOCK	1	28V DC	T-R BUS NO. 1 MCBP
LANDING GEAR POS & WARN - LH, NOSE, RH	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			
A/R RECEPTACLE LIGHT	1	28V AC	MCBP
BOOM MARKER LIGHTS	1	115V AC	BOCBP
BOOM NOZ LIGHT	1	28V DC	BOCBP
EXTERNAL LIGHTS			
PILOT DIRECTOR	2	32V AC	BOCBP
NACELLE (illum)	1	28V AC	BOCBP
LANDING LIGHT			
WING	1	115V AC	ENG 2 GENERATOR MCBP
TAXI & LANDING LIGHT CONTROL	1	28V DC	T-R BUS NO. 1 MCBP
NOSE (wheel)	1	115V AC	ENG 1 GENERATOR MCBP
RETRACTABLE LDG LIGHT CONTROL	1	28V DC	T-R BUS NO. 1 MCBP
NACELLE ILLUM LIGHT (control)	1	28V DC	T-R BUS NO. 1 MCBP
NACELLE ILLUM LT LH	1	28V AC	MCBP
NACELLE ILLUM LT RH	1	28V AC	MCBP
NAVIGATION - BODY	1	28V AC	MCBP
NAVIGATION LIGHT FLASHER	1	28V DC	T-R BUS NO. 1 MCBP
NAVIGATION - WING & TAIL	1	28V AC	MCBP
PORTABLE SIGNAL (lamp)	1	28V AC	MCBP
RENDEZVOUS - UPPER, LOWER	2	28V AC	MCBP
UNDER BODY ILLUM	1	28V AC	BOCBP
UNDER WING ILLUM	1	28V DC	BOCBP
WHEEL WELL	1	28V AC	MCBP
LIGHTING - INTERIOR			
BOARDING LIGHTS	1	28V AC	CCBP PL-26
BOARDING LIGHT CONTROL	1	28V DC	T-R BUS NO. 2 MCBP
COMPT 1 LIGHTING, FWD, CTR, AFT, CARGO DOOR ENTRY	4	28V AC	CCBP PL-26
COMPT 2 LIGHTING			
LF ANT OPR, OVHD, PNL	2	28V AC	CCBP PL-26
STA 710, STA 790	2	28V AC	CCBP PL-26
COMPT 3 LIGHTING			
CHART LIGTS; LH, RH AFT; LH, RH FWD	4	28V AC	CCBP PL-26
STA 870, 900, 940, 960, 1000, 1020, 1060, LH READING, RH READING	9	28V AC	CCBP PL-26
COMPT 3 PANEL LIGHTS			
AEAO & CONTROLLER, DI, DM & DOPL	2	28V DC	T-R3 & T-R4 CCBP PL-25
ALCC 1519 E512	1	28V DC	T-R3 & T-R4 CCBP PL-25
COMPT 4 LIGHTING			
BUNK, TOILET, STA 1180, STA 1270	4	28V AC	CCBP PL-26
COMPT 4 LIGHTS			
STEWARD'S STATION, OVERHEAD CONTROL	2	28V DC	T-R3 & T-R4 CCBP PL-25

Figure 1-34 (Sheet 9 of 10)

circuit protection & location (cont)

CIRCUIT TITLE	NO. CB'S	OPERATING POWER	CIRCUIT BREAKER LOCATION
LIGHTING – INTERIOR (Cont)			
CONTROL INDICATOR LIGHTS (comm. center staff)			
CHANNEL LIGHTS, CRYPTO LIGHTS, CONTROLLER, AEAO, DI, DM, DOPL	7	10V DC	10V DC CCBP PL-27
CRYPTO OPERATOR LIGHTS	2	28V DC	T-R3 & T-R4 CCBP PL-25
PANEL, STATION			
DOME LIGHTS			
CABIN	1	28V AC	MCBP
LOWER COMPARTMENT	1	28V AC	MCBP
EMERG EXIT LIGHT CONTROL	1	28V DC	BATTERY CBP
EMERGENCY EXIT LIGHT	1	28V DC	T-R BUS NO. 1 MCBP
ENTRY DOOR LIGHT	1	28V DC	BATTERY CBP
FLOOD LIGHTS			
CONTROL STAND	1	28V AC	MCBP
ENGINE INSTRUMENT	1	28V AC	MCBP
FUEL PANEL	1	28V AC	MCBP
NAVIGATOR INSTRUMENT	1	28V AC	MCBP
NAVIGATOR TABLE	1	28V AC	MCBP
OVERHEAD INSTRUMENT PANEL FLOOD	1	28V AC	MCBP
OVERHEAD PANEL	1	28V AC	MCBP
PILOT PANEL	1	28V AC	MCBP
INDICATOR LIGHT TEST (main cabin press-to-test lights)	1	28V AC	MCBP
LIGHT DIMMING CONTROL	1	28V DC	T-R BUS NO. 1 MCBP
MAGNETIC COMPASS LIGHT	1	28V DC	SBCBP
PANEL & COMPT LIGHTS (BO)	1	28V AC	BOCBP
PANEL LIGHTS - COPILOT	FUSE	28V DC	CIPP
PANEL LIGHTS			
PILOT	1	28V AC	MCBP
NAVIGATOR INSTRUMENT & PANEL	1	28V AC	MCBP
LETDOWN CHARTHOLDER LIGHTS (WITH TCTO 846)	1	28V AC	MCBP
PANEL & COMPT LIGHTS (BO)	1	28V AC	BOCBP
PRESS TO TEST (comm center lights)	1	28V DC	T-R3 & T-R4 CCBP PL-25
RADIO OPERATOR LIGHTS	2	28V DC	T-R3 & T-R4 CCBP PL-25
OVERHEAD, TABLE			
SEXTANT LIGHT	1	28V AC	MCBP
SPOT LIGHTS (Copilots, Navigators work & Spot, Fwd electrical equipment rack)	FUSE	28V DC	CIPP
SPOTLIGHT - PILOTS	1	28V DC	SBCBP
THUNDERSTORM	1	28V AC	MCBP
WARNING SIGNS			
NO SMOKING	1	28V DC	T-R BUS NO. 1 MCBP
OXYGEN WARNING SIGNS	1	28V DC	T-R BUS NO. 2 MCBP
	1	28V DC	T-R BUS NO. 1 MCBP
MISCELLANEOUS			
AFT TOILETS (flushing pump)	3	115/200V AC	ENGINE 1 GEN CCBP PL-25
ALARM BELL	1	28V DC	BATTERY CBP
CARGO DOOR HYD PUMP	1	28V DC	BATTERY CBP
DOOR WARNING	1	28V DC	T-R BUS NO. 2 MCBP
LF COAX PRESSURE WARNING (light, crypto station)	1	28V DC	T-R3 & T-R4 CCBP PL-25
OXYGEN QUANTITY	1	115V AC	ENGINE 1 GENERATOR MCBP
OXYGEN QUANTITY WARNING (light)	1	28V DC	T-R BUS NO. 1 MCBP
SHAVER OUTLETS	1	115V AC	ENGINE 1 GENERATOR MCBP
WINDSHIELD RAIN REPELLENT	1	28V DC	T-R BUS NO. 1 MCBP
WINDSHIELD WIPER - PILOT, COPILOT	2	28V DC	BATTERY CBP

Figure 1-34 (Sheet 10 of 10)

HYDRAULIC SYSTEMS

There are 2 independent systems, the left system and right system, to supply hydraulic fluid under pressure to the hydraulically operated components. See figure 1-35. The components supplied by each system are listed 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 in the event 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, powered rudder, alternate ARR, and trailing wire antenna system (TWA) can be operated with pressure from either system through the emergency hydraulic crossover valve at the copilot's station. There are six accumulators: one main accumulator for each system, a reserve brake accumulator, a boom hydraulic accumulator and two rudder hydraulic system accumulators. 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 1-66. 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 TRT (20 gpm at cruise power), with a total system capacity of 45 gpm. For servicing information and hydraulic fluid specifications, see figure 1-66.

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, low frequency antenna cable cutter, pilot's brakes, landing gear and alternate slipway door control valve through the landing gear system. 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 CUTOFF. The total capacity of the left system is 21.5 gallons (this includes 5.5 gallons in the reservoir).

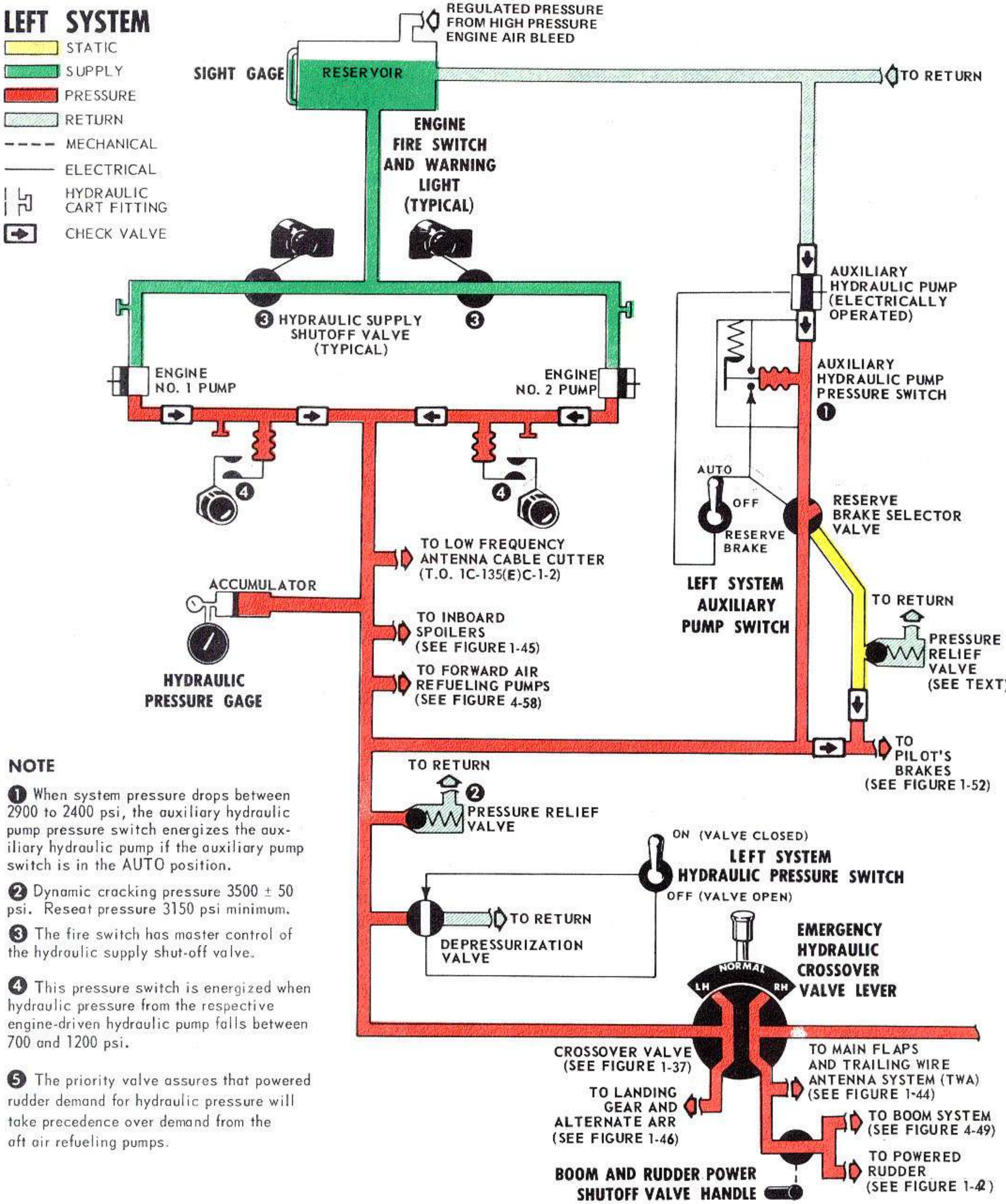
RIGHT HYDRAULIC SYSTEM

The right hydraulic system supplies power to operate the outboard spoilers, the aft refueling pump in each body tank, copilot's brakes, nose gear steering, copilot's instrument power hydraulic motor, slipway doors, boom controls, main flaps, leading edge flaps, powered rudder, and the low frequency antenna controls. A priority valve assures that hydraulic pressure supplied to the powered rudder will take precedence over pressure supplied to the aft air refueling pumps. (See note 5, figure 1-35.) Pressure is normally supplied to the system by two engine-driven pumps, one each on No. 3 and No. 4 engines. In the event 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. The total capacity of the right system is 34.5 gallons; this includes 5.5 gallons in the reservoir.

LEFT SYSTEM AUXILIARY PUMP SWITCH

This switch (7, figure 1-36) 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

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 fire switch has master control of the hydraulic supply shut-off valve.
4. This pressure switch is energized when hydraulic pressure from the respective engine-driven hydraulic pump falls between 700 and 1200 psi.
5. The priority valve assures that powered rudder demand for hydraulic pressure will take precedence over demand from the aft air refueling pumps.

Figure 1-35 (Sheet 1 of 2)

RIGHT SYSTEM

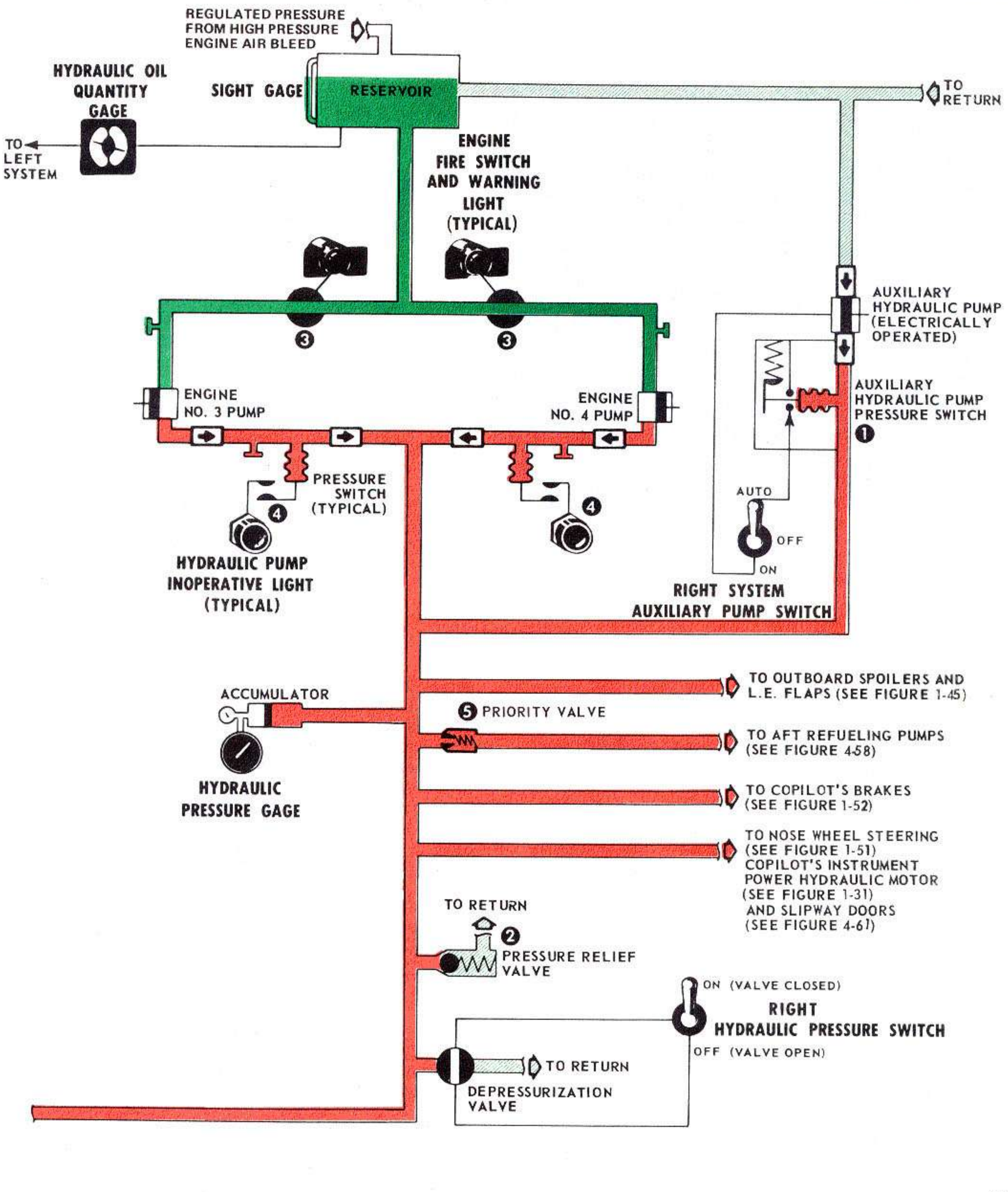
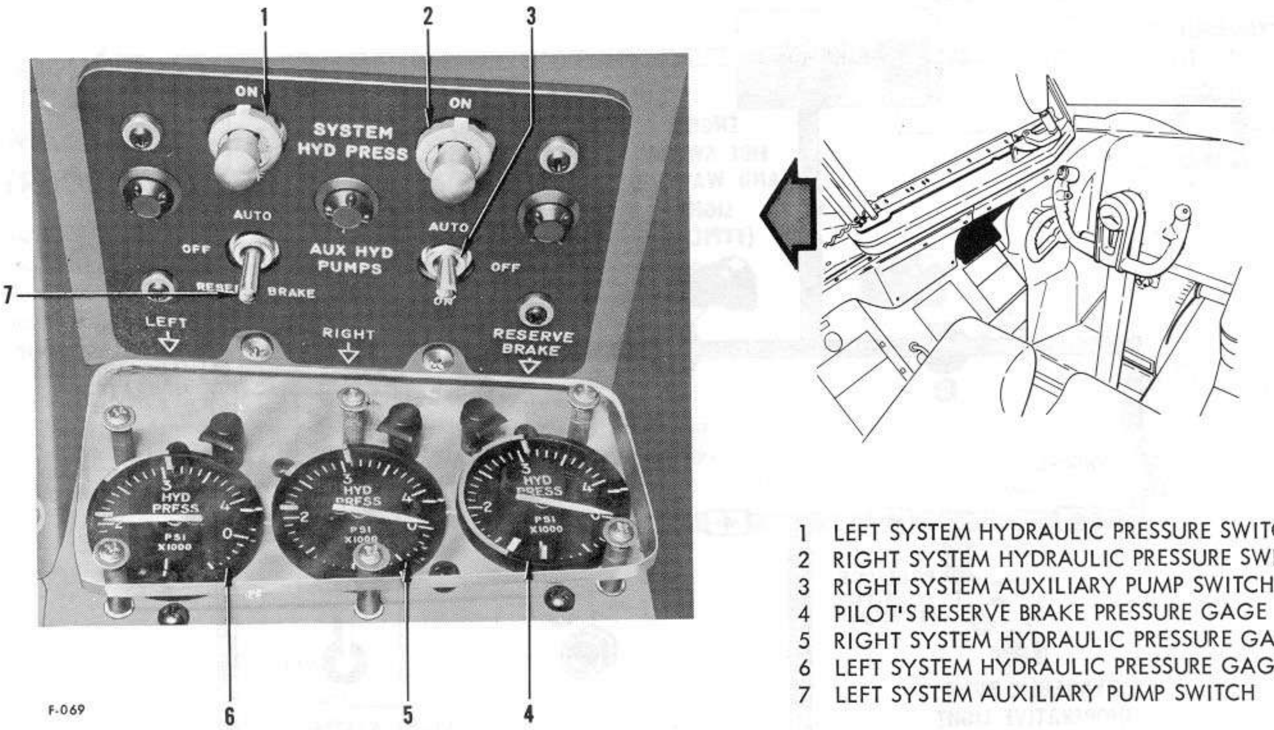


Figure 1-35 (Sheet 2 of 2)

hydraulic control panel



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 1-36

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 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 1-33, sheet 3) 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 1-33, sheet 3) 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 1-33, sheet 1) but receives power from T-R BUS NO. 1.

RIGHT SYSTEM AUXILIARY PUMP SWITCH

This switch (3, figure 1-36) 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 1-33, sheet 1) 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 1-36) 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 1-33, sheet 4).

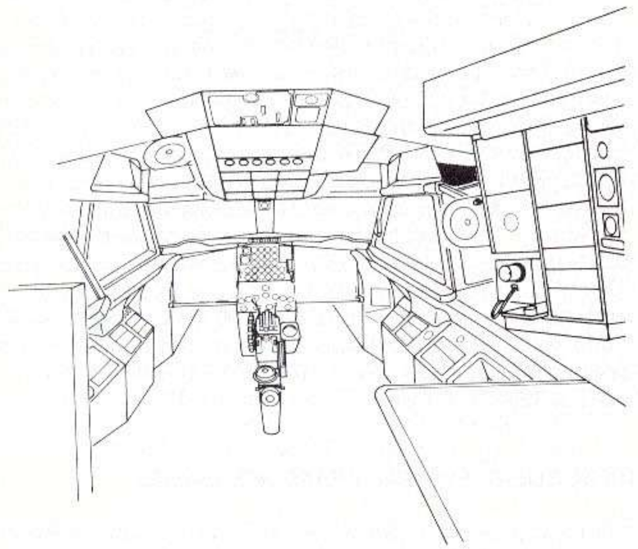
EMERGENCY HYDRAULIC CROSSOVER VALVE LEVER

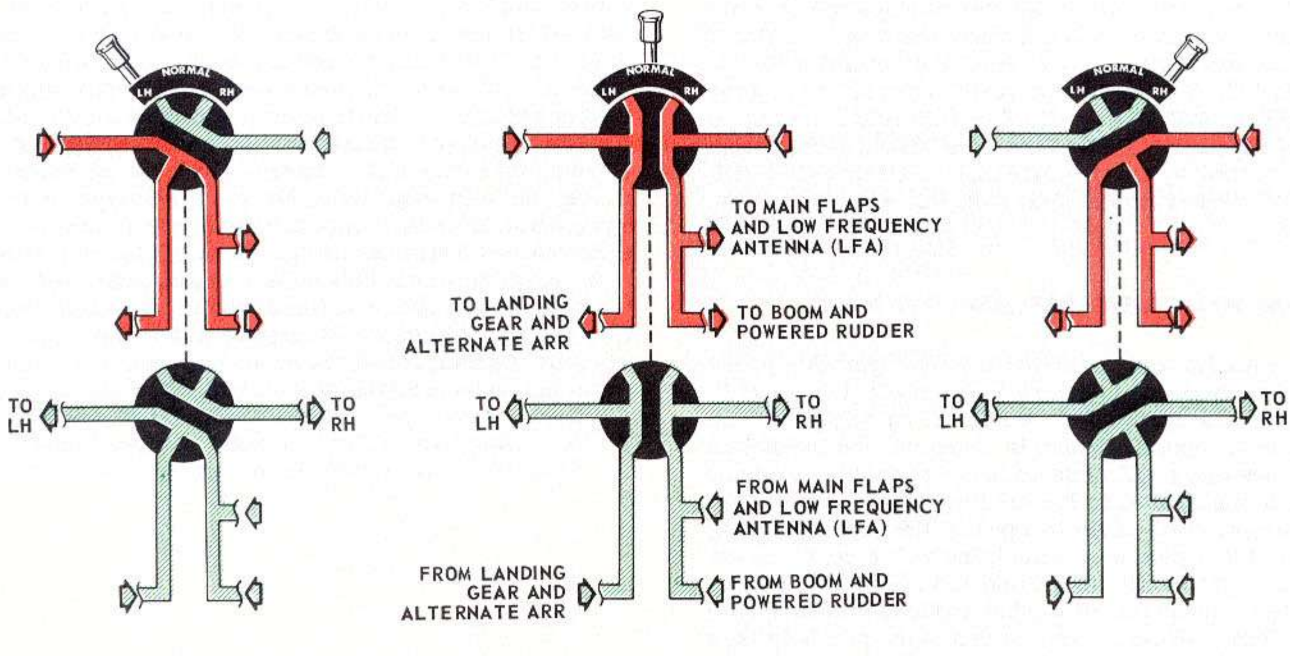
This lever (figure 1-37) with LH--NORMAL--RH positions is aft of the copilot, above and to the right. When positioned to RH, fluid is directed, under pressure, from the right hydraulic system to the landing gear and alternate ARR in the left hydraulic system and all other units of the right system. When positioned to LH, fluid is directed, under pressure, from the left hydraulic system to operate the main flaps, powered rudder, boom controls and low frequency antenna in the right hydraulic 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, alternate ARR, main flaps, boom controls and powered rudder or low frequency antenna. Refer to HYDRAULIC SYSTEM EMERGENCY OPERATION, Section III.

HYDRAULIC SYSTEM PRESSURE GAGES

There are three gages on the hydraulic control panel. One gage (4, figure 1-36) indicates pilot's reserve brake system pressure, another (5, figure 1-36) indicates right system hydraulic pressure, and the third gage (6, figure 1-36) 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 1-66. 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

emergency hydraulic crossover





See figures 1-35, 1-44 and 1-46

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.

Figure 1-37

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 1-35. These gages have color markings which are identical to the markings on the hydraulic pressure gages on the hydraulic control panel.

Rudder Power Hydraulic Pressure Gage

This gage on the pilots' instrument panel (19, figure 1-16) indicates rudder system pressure. This is an indirect reading electrically operated gage connected to a transmitter in the rudder system. Since the rudder system is isolated by a check valve, this gage will read rudder system pressure, until the rudder is actuated when the right hydraulic system is depressurized. At airspeeds below 250 ± 10 KIAS or when the inboard flaps are extended 5 or more degrees, this gage normally reads in the high range 2800 to 3050 psi. At airspeeds above 250 ± 10 KIAS with inboard flaps up this gage reads in the low range, 800 to 1175 psi. Operating power is 28 volt AC protected by the RUDDER POWER PRESS IND circuit breaker on the MCBP (figure 1-33, sheet 2).

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.

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.

HYDRAULIC OIL QUANTITY GAGE

This dual gage (18, figure 1-17), 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 1-33, sheet 1).

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.

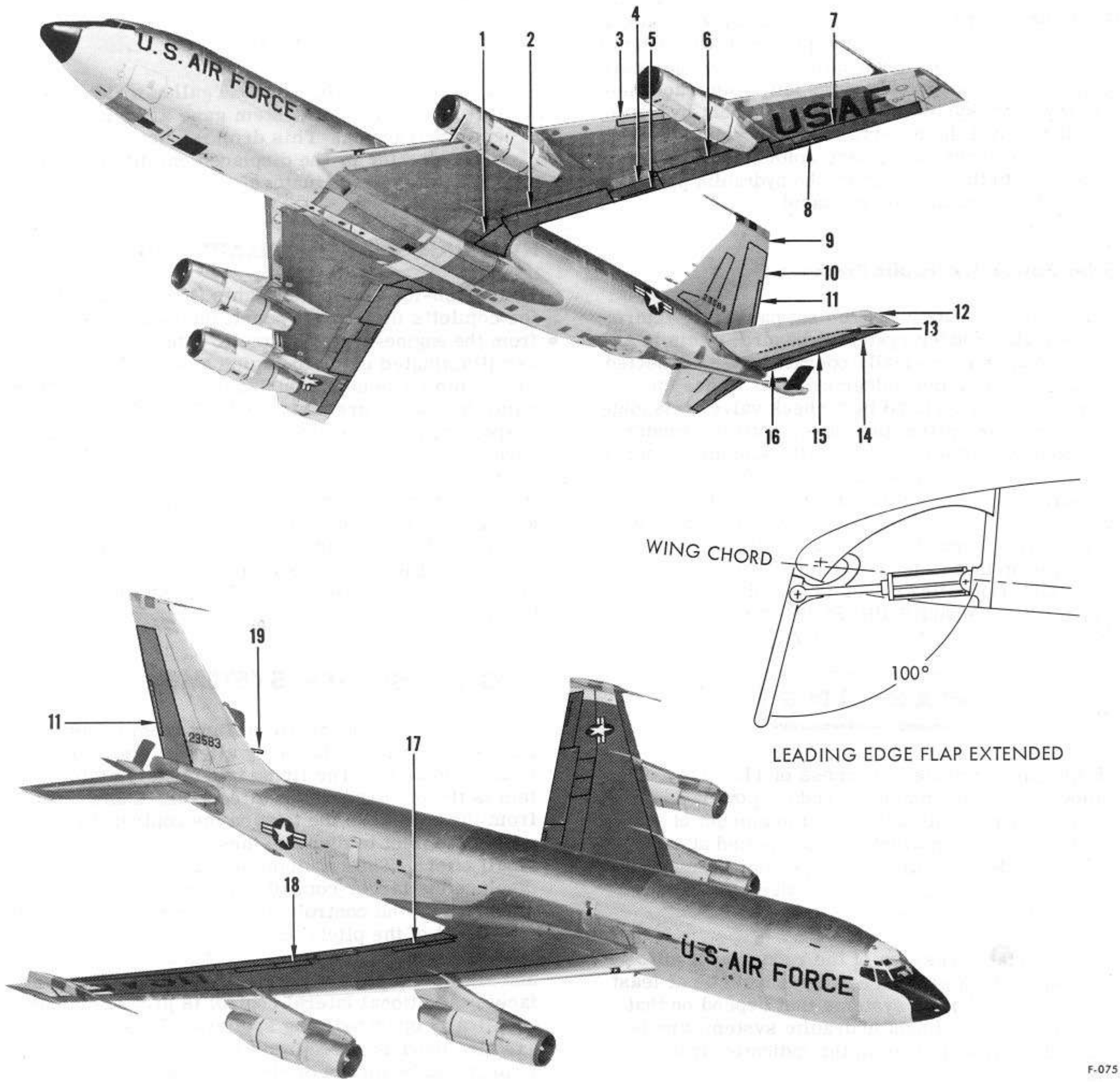
HYDRAULIC PUMP INOPERATIVE LIGHTS

Four push-to-test amber lights (17, figure 1-17), 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 1-33, sheet 4). See HYDRAULIC SYSTEM EMERGENCY OPERATION, Section III.

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. 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 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 1-38.

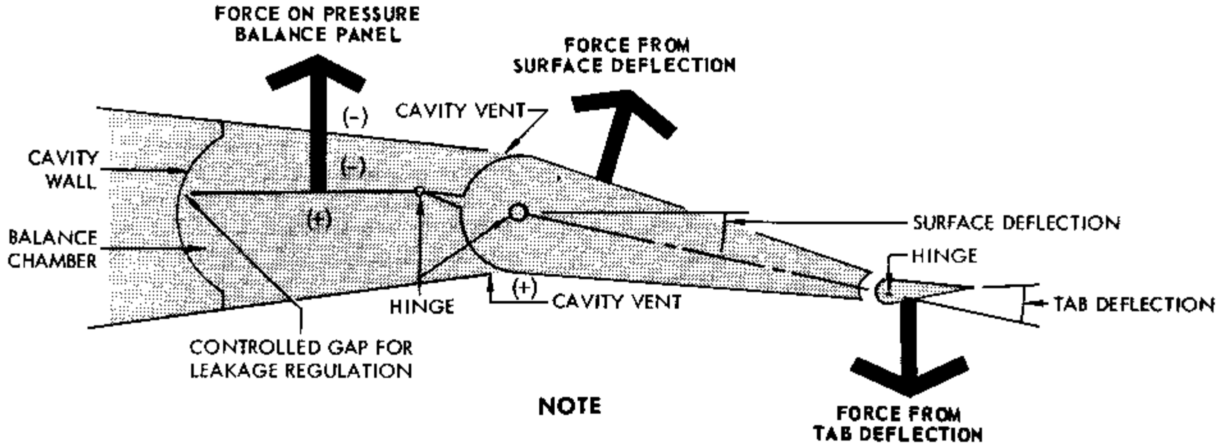
flight control surfaces



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

Figure 1-38

aerodynamic forces



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.

Figure 1-39

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 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 1-39. 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.

AIRPLANE TRIM

Directional trim is obtained with the control tab on the trailing edge of the rudder. 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 jackscrew 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 1-11 and 2, figure 1-12) mechanically position the elevator and aileron tabs. Each control column wheel contains a stabilizer trim switch, an interphone mike switch, an autopilot/ARR disengage/RGA button (6, 8, 9, figure 1-11 and 3, 4, 5, figure 1-12), and on airplanes with 1C10 846, a letdown chartholder (10A, figure 1-11 and 2A, figure 1-12).

WARNING HORN AND CUTOUT SWITCH

The warning horn (2, figure 4-8) on the ceiling just aft of the overhead panel, will sound if any of the following conditions exist, (see figure 1-40):

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 approximately one third open while the airplane is on the ground and the main wing flaps are less than 14 ± 3 degrees or more than 35 ± 3 degrees down.

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

A warning horn cutout switch on the control stand (9, figure 1-20) is available to the pilot or copilot. In the event the warning horn is sounding due to landing gear conditions, the horn may 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 protected by the WARNING HORN circuit breaker on the SBCBP (figure 1-33, sheet 4).

HYDRAULIC SNUBBERS

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.

warning horn system

1. Warning of improper positioning of the flaps or spoilers for takeoff is obtained when the No. 3 throttle is advanced 20 degrees beyond the no-load "IDLE" position.
2. The warning horn sounds when the wing flaps are in the "00," "40" or "50" position or the speed brake lever is pulled back more than 2 degrees.
3. Retarding any throttle to near IDLE will close the warning horn cut-out switch.

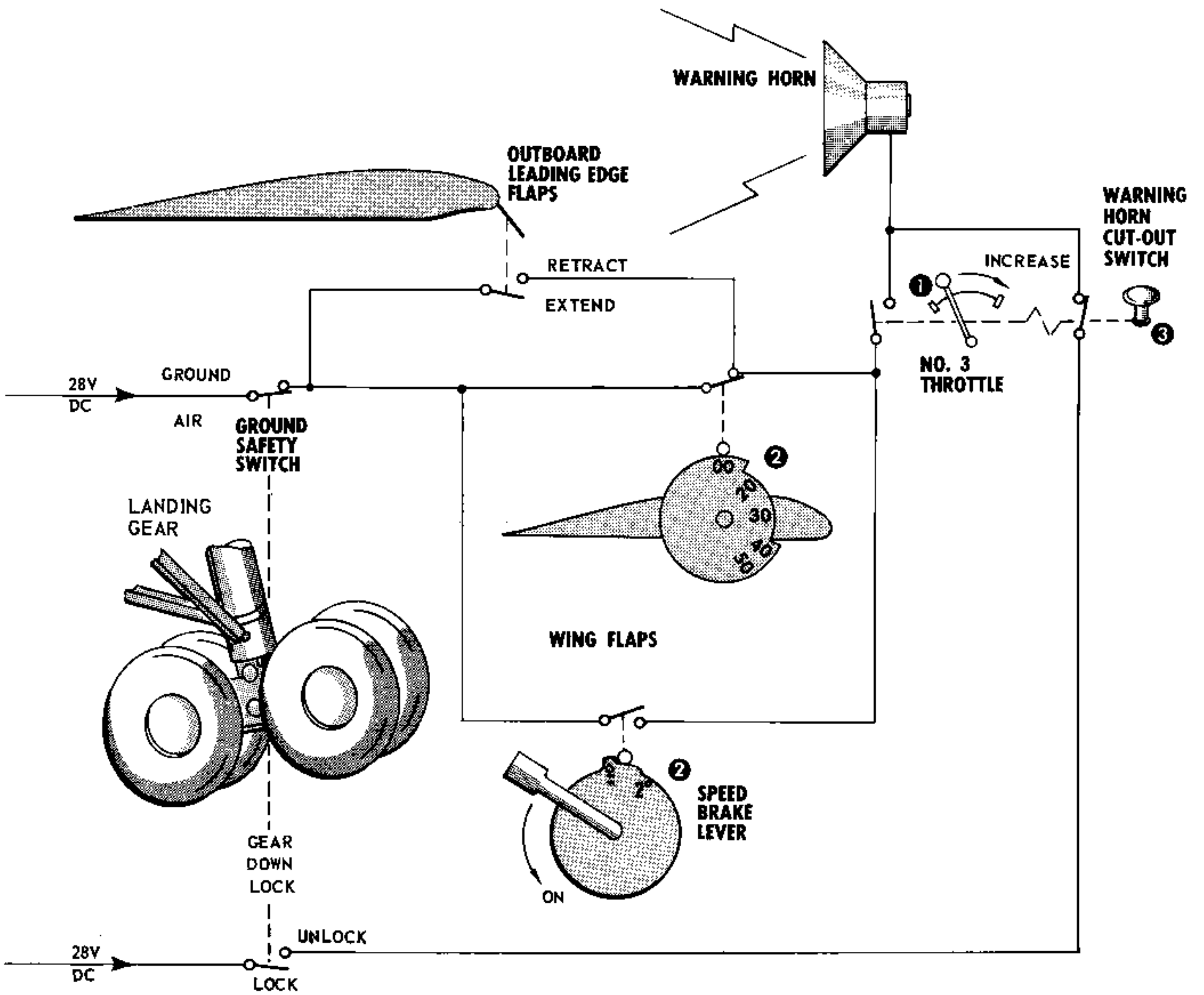


Figure 1-40

AILERON CONTROL SYSTEM

Each wing has two ailerons and four spoilers for lateral control of the airplane. The inboard ailerons (figure 1-38) 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 airloading 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 servomotor 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 (11, figure 1-20) 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) the proper trim procedure is 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.

RUDDER SYSTEM

Directional control is achieved normally by a hydraulically powered rudder. Movement of the rudder pedals is transmitted by a cable and linkage arrangement to a control valve in a rudder power control unit. See figures 1-41 and 1-42. The valve controls hydraulic fluid flow into the power control unit which, in turn, deflects the rudder. A control tab on the rudder aerodynamically assists deflection of the rudder up to 17 degrees of travel. The tab reverses direction of movement and functions as an antibalance tab when the rudder passes 17 degrees of travel. When rudder hydraulic power is off or if the hydraulic pressure fails, the rudder system reverts to a control-tab and balance-panel system; however, rudder travel is limited to approximately ± 12 degrees. System feel, proportional to airspeed and rudder deflection, comes from air loads on the control tab at rudder deflection angles up to 17 degrees and from the Q-spring (dynamic pressure sensor) at deflection angles between 17 and 25 degrees. Ram air is picked up by the Q-inlet on the fin leading edge and vented to a bellows in the Q-spring. The force developed in the bellows is mechanically transmitted to the rudder control linkage. The Q-inlet contains an electrically operated heater to prevent icing of the inlet. Refer to ANTI-ICING SYSTEMS Section IV for a description and operation of the Q-inlet anti-icing system.

A Q-spring lockout assembly, located below the Q-spring, locks the Q-spring in a fixed position when the rudder power is off or if hydraulic pressure should fail. With the Q-spring in a fixed position the Q-rod is held stationary, thus providing a pivot point in the rudder control linkage, which enables the control tab to be positioned by movement of the rudder pedals.

Hydraulic fluid under 3000 psi pressure to operate the rudder system is received from the airplane right hydraulic system through the same supply line that the boom system receives its pressure. A control valve, actuated by an airspeed switch and a rudder pressure switch in series, selects either 3000 psi or 1000 psi to operate the rudder. The airspeed switch is controlled by the pilot's pitot system and the rudder pressure switch is actuated by the main flaps. Operating power is 28V DC through a circuit breaker marked RUDDER POWER PRESS CONTROL on the SBCBP (figure 1-33, sheet 4). High range (2800 to 3050 psi) is selected to provide necessary deflection at airspeeds below 250 ± 10 KIAS or the main inboard flaps extended more than 5 degrees. Refer to figure 6-8. At airspeeds above 250 ± 10 KIAS and with the main inboard flaps completely retracted, low range (800 to 1175 psi) is selected to limit rudder deflections and eliminate the possibility of damage to the vertical fin from large control inputs. One rudder damper and two tab dampers restrict vibration and flutter. The dampers offer little or no resistance to slow movement; however, they offer high resistance to rapid movement 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. Refer to AUTOPILOT SYSTEM in Section IV.

Rudder Pedals

The rudder pedals (13, figure 1-11) 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 provided for the pilot and copilot by use of a handle located near the pedals.

Rudder Pedal Adjustment Cranks and Indicators

Rudder pedal adjustment is provided for the pilot and copilot. A pilot's rudder pedal adjustment handle (12, figure 1-11) and rudder pedal adjustment indicator (14, figure 1-11) are near his rudder pedals. The copilot's rudder pedal adjustment handle (17, figure 1-12) and rudder pedal adjustment indicator (16, figure 1-12) are at the copilot's station. The pilot or copilot may adjust his pedals fore and aft by turning the rudder pedal adjustment handle in the desired direction. By rotating the handle clockwise the rudder pedal distance may be lengthened or by turning the handle counter-clockwise the distance may be shortened.

Rudder Power Switch

This switch (12, figure 1-20) 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 1-42. 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 28V DC through a circuit breaker marked RUDDER POWER VALVE on the SBCBP (figure 1-33, sheet 4).

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 in the event 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.

Q-Inlet Heat Switch

An ON--OFF switch (25, figure 1-17) on the copilot's instrument panel controls the Q-inlet heater. For detailed description see Section IV, ANTI-ICING SYSTEMS, Q-INLET HEAT SWITCH.

Rudder Trim Crank and Indicator

A rudder trim crank and indicator (10, figure 1-20) 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 1-42. 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 porportional 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 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. 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 1-42.

Rudder Power Hydraulic Pressure Gage

The rudder power gage (19, figure 1-16) on the pilot's flight instrument panel is described in this Section, HYDRAULIC SYSTEMS, RUDDER POWER HYDRAULIC PRESSURE GAGE.

Q-Inlet Heat Warning Light

Refer to Q-INLET HEAT WARNING LIGHT in Section IV.

powered rudder system components

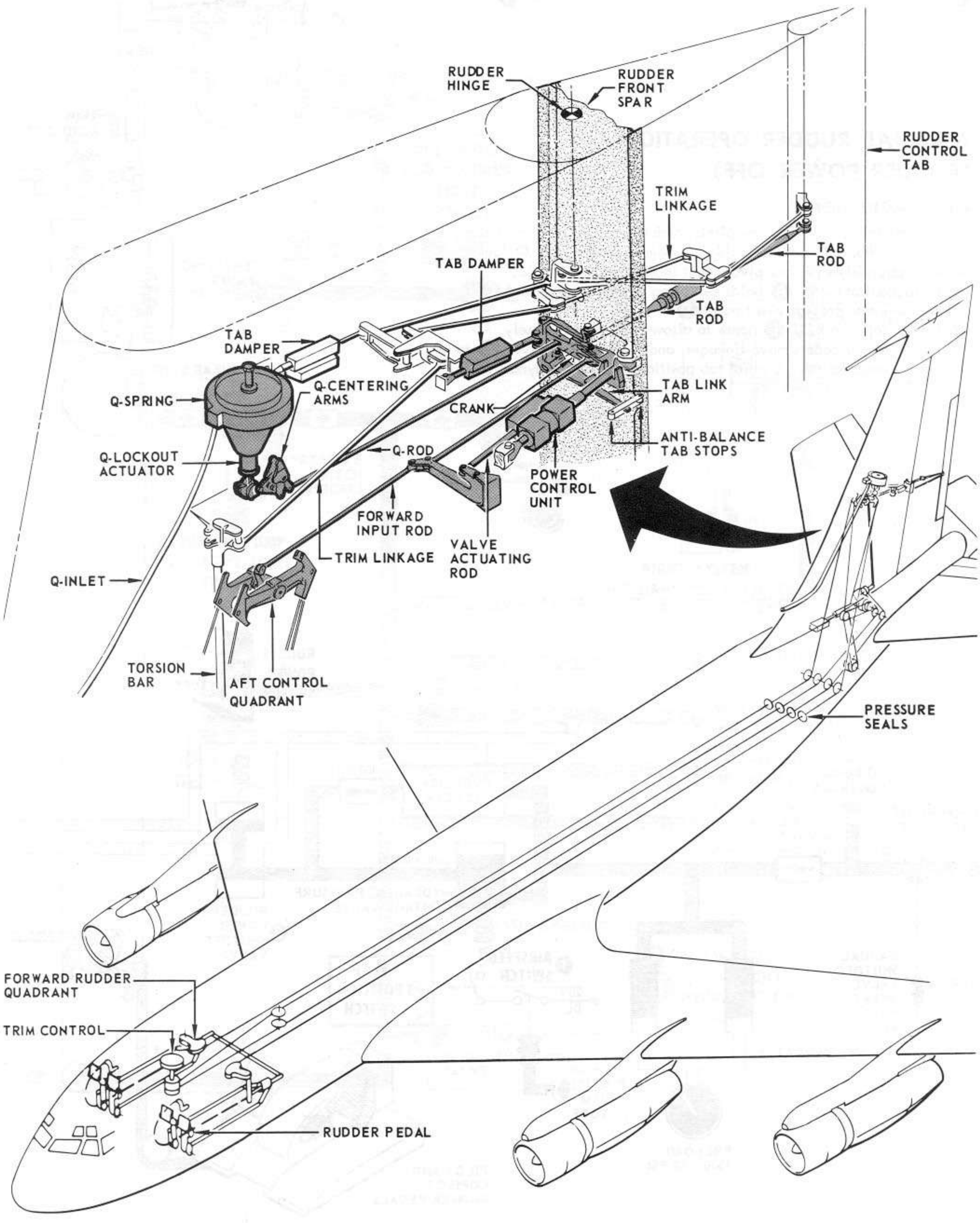


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Figure 1-41

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.

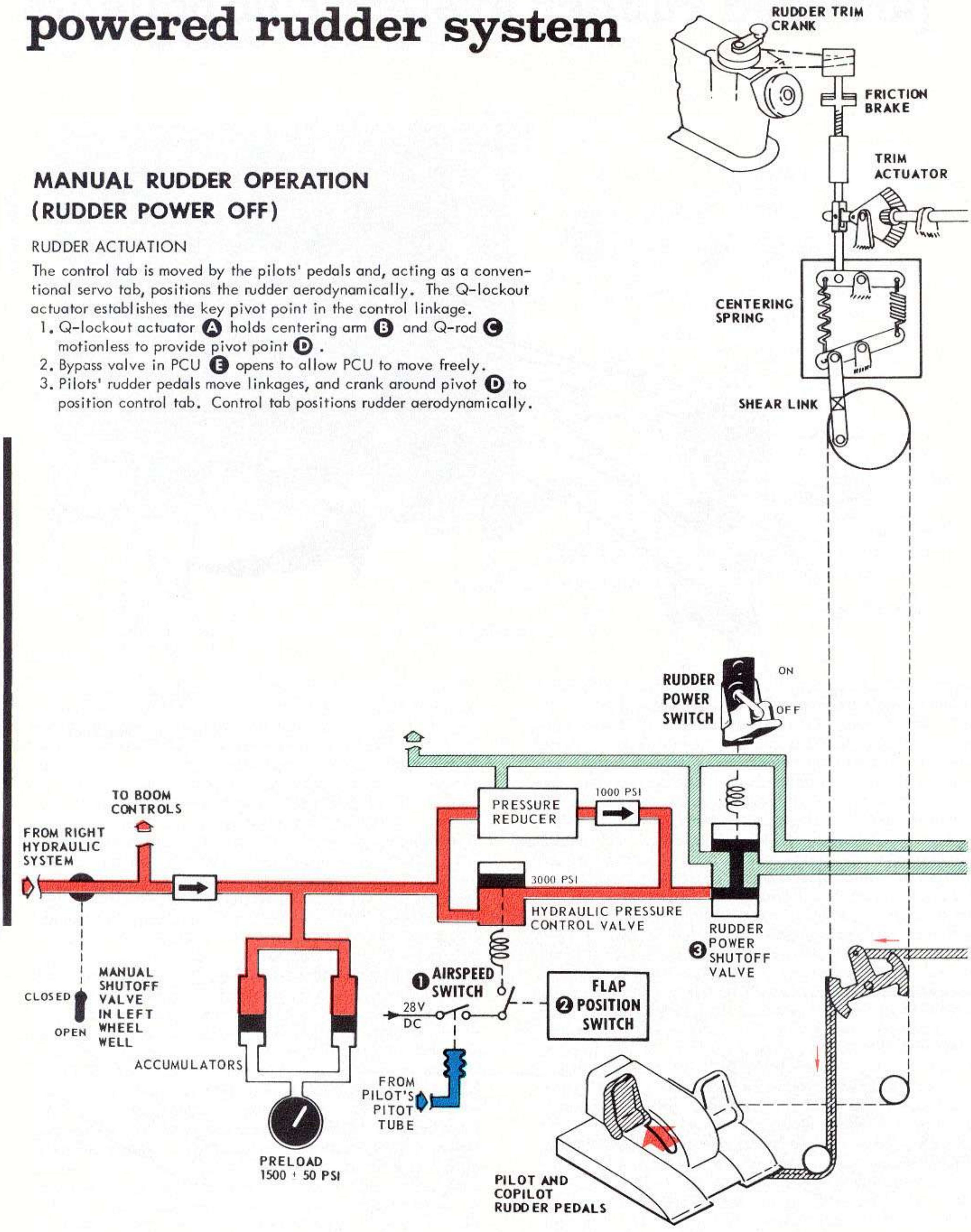
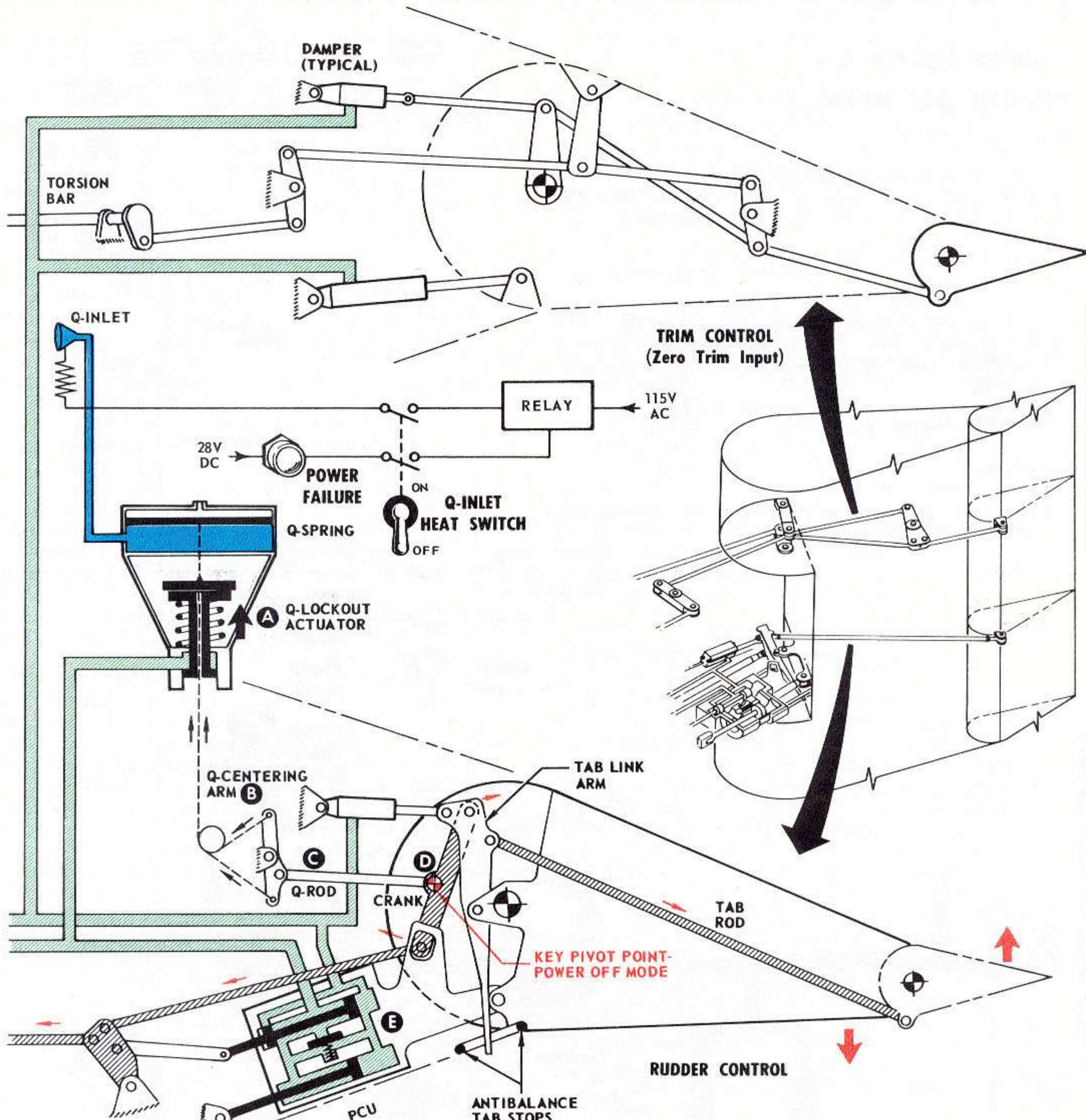


Figure 1-42 (Sheet 1 of 6)



1 Switch closes at 250 ± 10 KIAS. (See figure 6-9.)

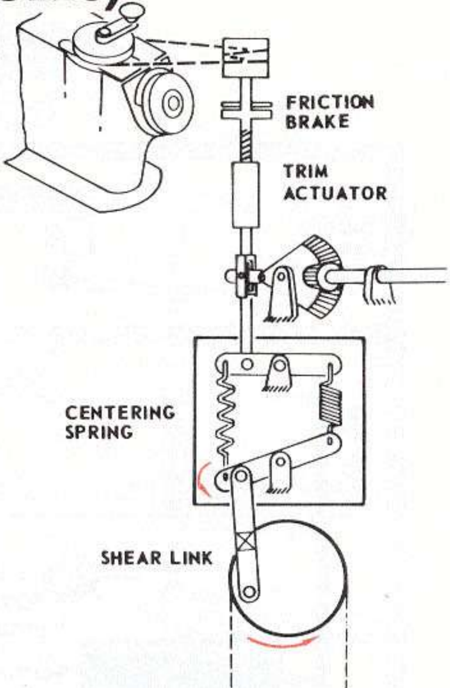
2 Switch opens when main flaps are extended 5 degrees.

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

CONTROL AUTHORITY
HYDRAULIC PRESSURE
HYDRAULIC RETURN
RAM AIR PRESSURE
MECHANICAL
ELECTRICAL

Figure 1-42 (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 Ⓐ.
2. Hydraulic power moves PCU Ⓑ which moves rudder.

CONTROL TAB ACTUATION

The control tab is positioned to provide pedal feel.

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

PEDAL FEEL

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

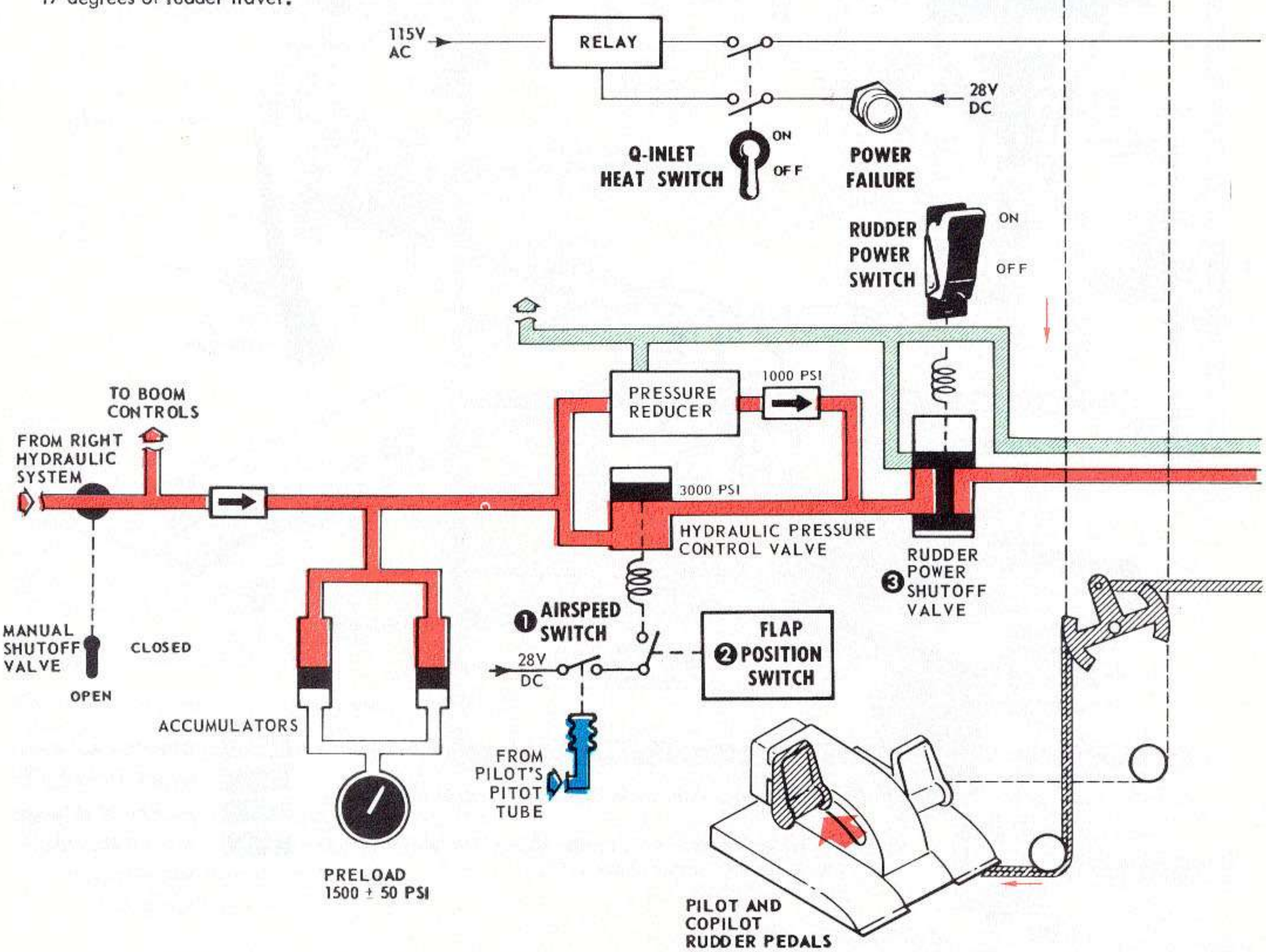
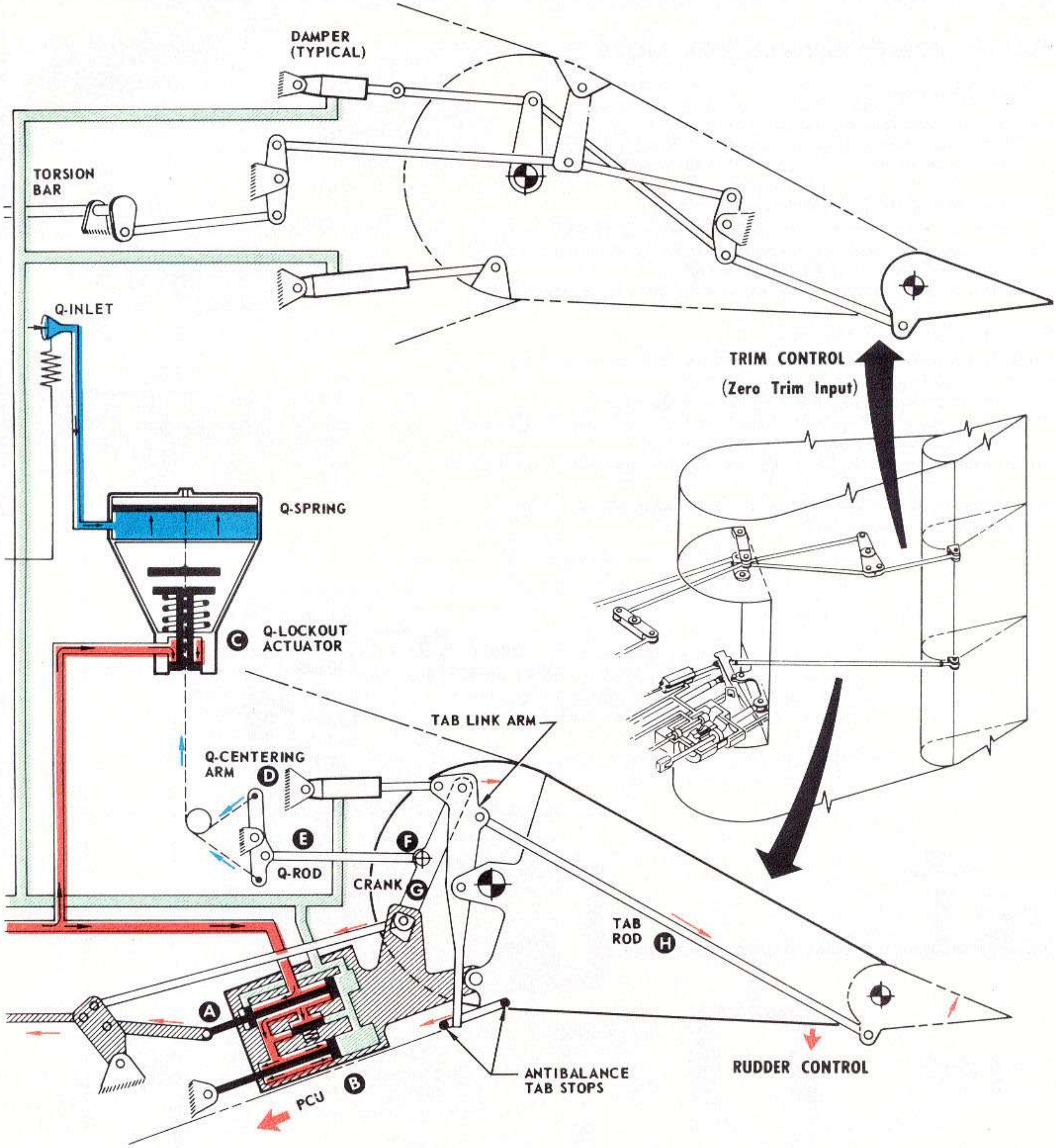


Figure 1-42 (Sheet 3 of 6)



1. Switch closes at 250 ± 10 KIAS. (See figure 6-8.)
2. Switch opens when main flaps are extended 5 degrees.
3. Valve spring-loaded to rudder power ON, electrically energized to rudder power OFF.

Figure 1-42 (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.

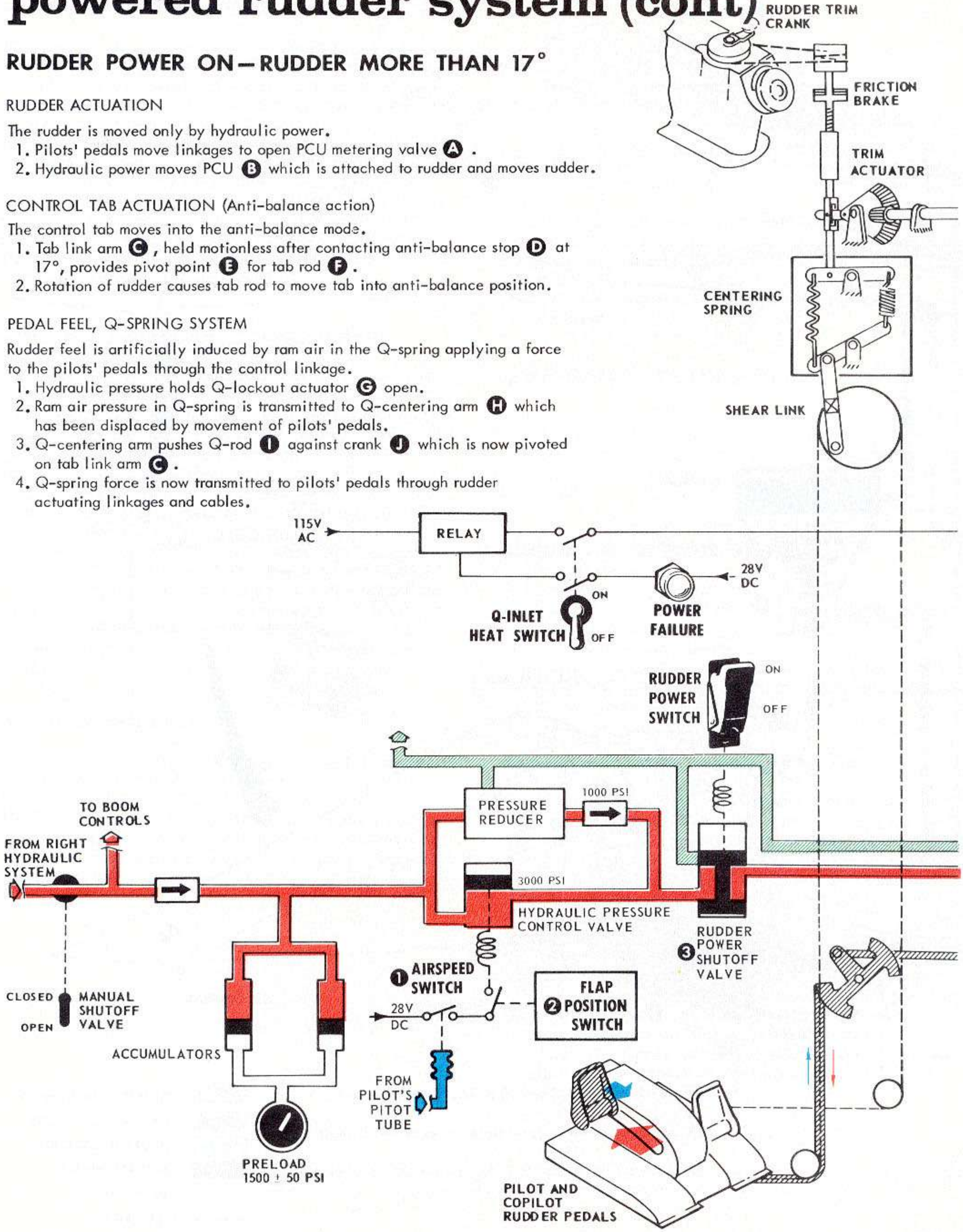
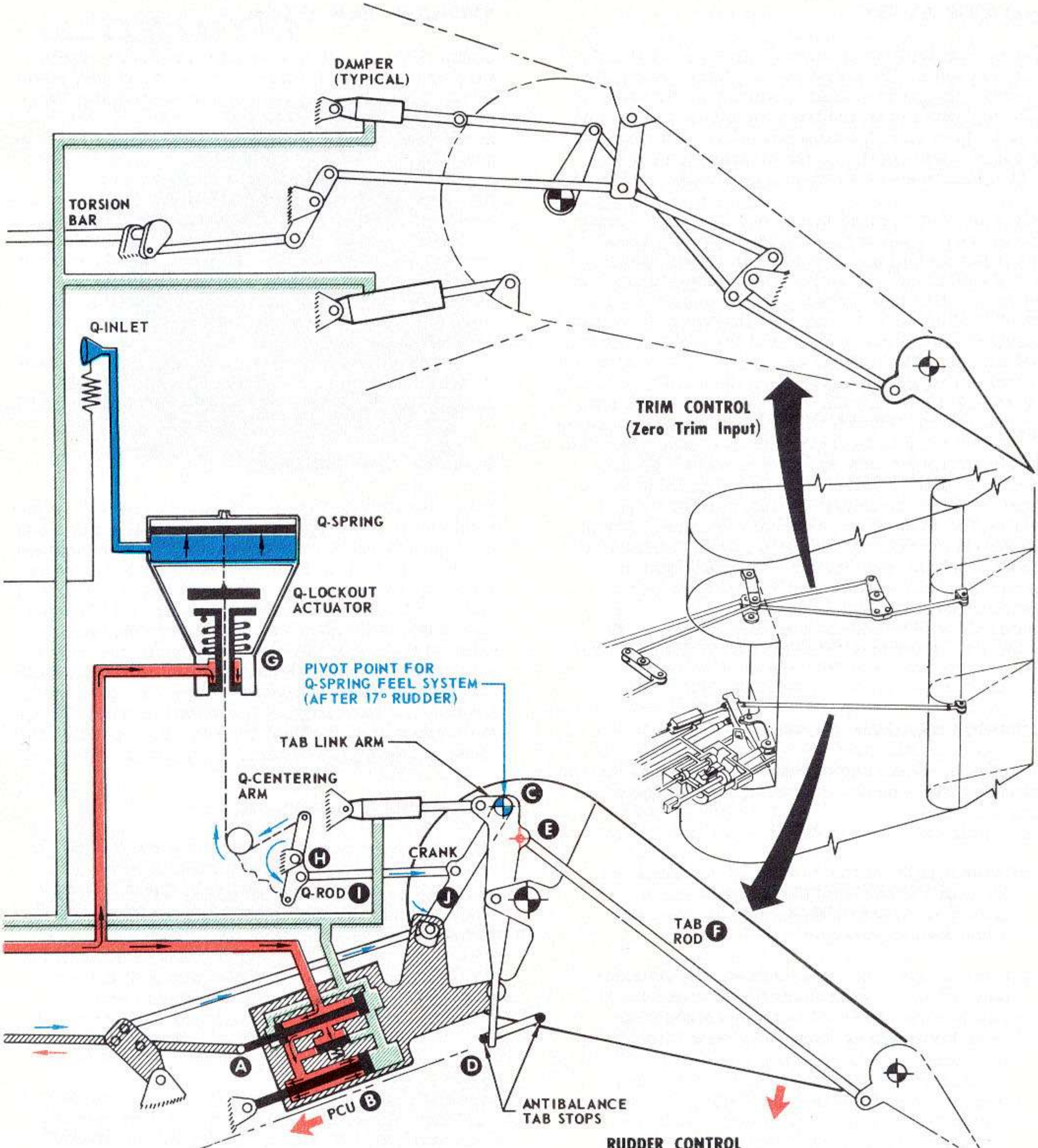


Figure 1-42 (Sheet 5 of 6)



1. Switch closes at 250 ± 10 KIAS. (See figure 6-8.)
2. Switch opens when main flaps are extended 5 degrees.
3. Valve spring-loaded to rudder power ON, electrically energized to rudder power OFF.

Symbol	Meaning
(hatched)	CONTROL AUTHORITY
(red)	HYDRAULIC PRESSURE
(green)	HYDRAULIC RETURN
(blue)	RAM AIR PRESSURE
----	MECHANICAL
——	ELECTRICAL

Figure 1-42 (Sheet 6 of 6)

ELEVATOR SYSTEM

Pitch control of the airplane is provided by the elevator system. The elevators (14, figure 1-38) 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 antibalance 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 servomotor 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 (figure 1-43) controls pitch axis damping for autopilot operation.

NOTE

- If the damper becomes clogged, an additional force of 25 pounds on the control column causes an internal relief valve to open and allow motion.
- If the damper becomes jammed, an additional force of 100 to 160 pounds on the control column 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 1-43. The horizontal stabilizer can 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 be between approximately 2.6 units airplane nose down and 6.6 units airplane nose up. For methods of relieving elevator control forces if stabilizer trim is inoperable, refer to STABILIZER TRIM EMERGENCY OPERATION, Section III.

Stabilizer Trim Indicator

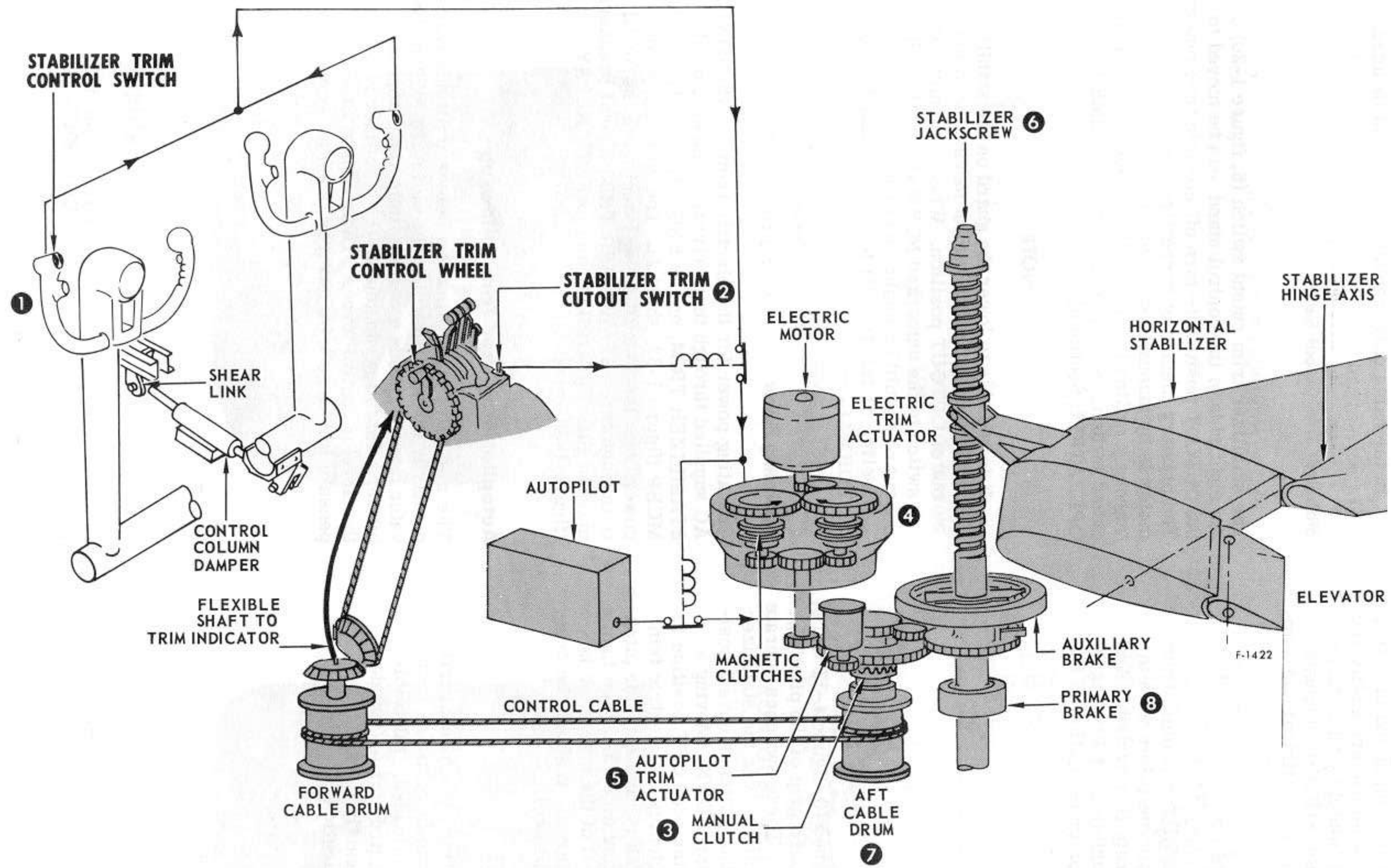
This indicator (5, figure 1-20 and figure 6-6) on the right side of the control stand, shows stabilizer position in trim units which are approximately equal to degrees of stabilizer travel. Each unit on the indicator represents approximately 9 revolutions of the trim control wheel. When the trim indicator reads zero the stabilizer angle of incidence is minus three degrees. The external stabilizer position markings on the body 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(E)C-1-1.

Manual Stabilizer Trim

Stabilizer Trim Control Wheel

This wheel (16, figure 1-20) on the left side of the control stand, is connected by cables to the stabilizer jackscrew assembly. See figure 1-43. This wheel will rotate during all trim operations. Full travel of the stabilizer requires 135 revolutions of the trim control wheel. A force of 16 pounds is required to overcome friction of the gear trains during normal

stabilizer trim system



NOTE

1. When actuated, trim switch energizes motor and magnetic clutch. The direction of stabilizer travel depends upon which magnetic clutch is energized.
2. Actuation of cutout switch removes power from electric trim motor.
3. 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.
4. Electrical trim moves stabilizer at rate of 1/2 degree per second.
5. Autopilot trim follow-up moves stabilizer at rate of 1/20 degree per second.
6. Limit switches remove power from magnetic clutches to prevent jackscrew from jamming against mechanical stops in the extreme upper and lower positions.
7. Cable drum is always mechanically connected to jackscrew.
8. 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.

Figure 1-43

manual operation. If 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 1-42. 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.

Electric Stabilizer Trim

Stabilizer Trim Control Switch

Stabilizer trim control switches (6, figure 1-11 and 5, figure 1-12) 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. The switches have 3 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 1-43. If a precise adjustment of the stabilizer is required (within one or two turns), it 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 and gas chamber explosion test results were negative. However, if fuel vapors are present in the cabin only manual trim should be used.

Stabilizer Trim Cutout Switch

The stabilizer trim cutout switch (6, figure 1-20) on the right side of the control stand, can be moved to the CUTOUT position to turn off electric trim power. The primary method of correcting for a runaway trim motor is by manually stopping the trim wheel, simultaneously calling for the copilot to actuate the trim cutout switch. 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 ENG 2 GEN section of the MCBP (figure 1-33, sheet 2). 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 1-33, sheet 1).

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 a fillet flap, an inboard flap, an outboard flap, and two leading edge flaps (1, 2, 6, and 3, figure 1-38). The inboard and outboard flaps also have a fore flap ahead of their leading edges for improved air flow over these surfaces. 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 1-44. The main flaps can also be positioned electrically. See EMERGENCY FLAP CONTROLS in this Section. 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. Refer to EMERGENCY HYDRAULIC CROSSOVER VALVE LEVER in 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 1-44. 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 CUTOUT 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 (7, figure 1-20) 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

flap system

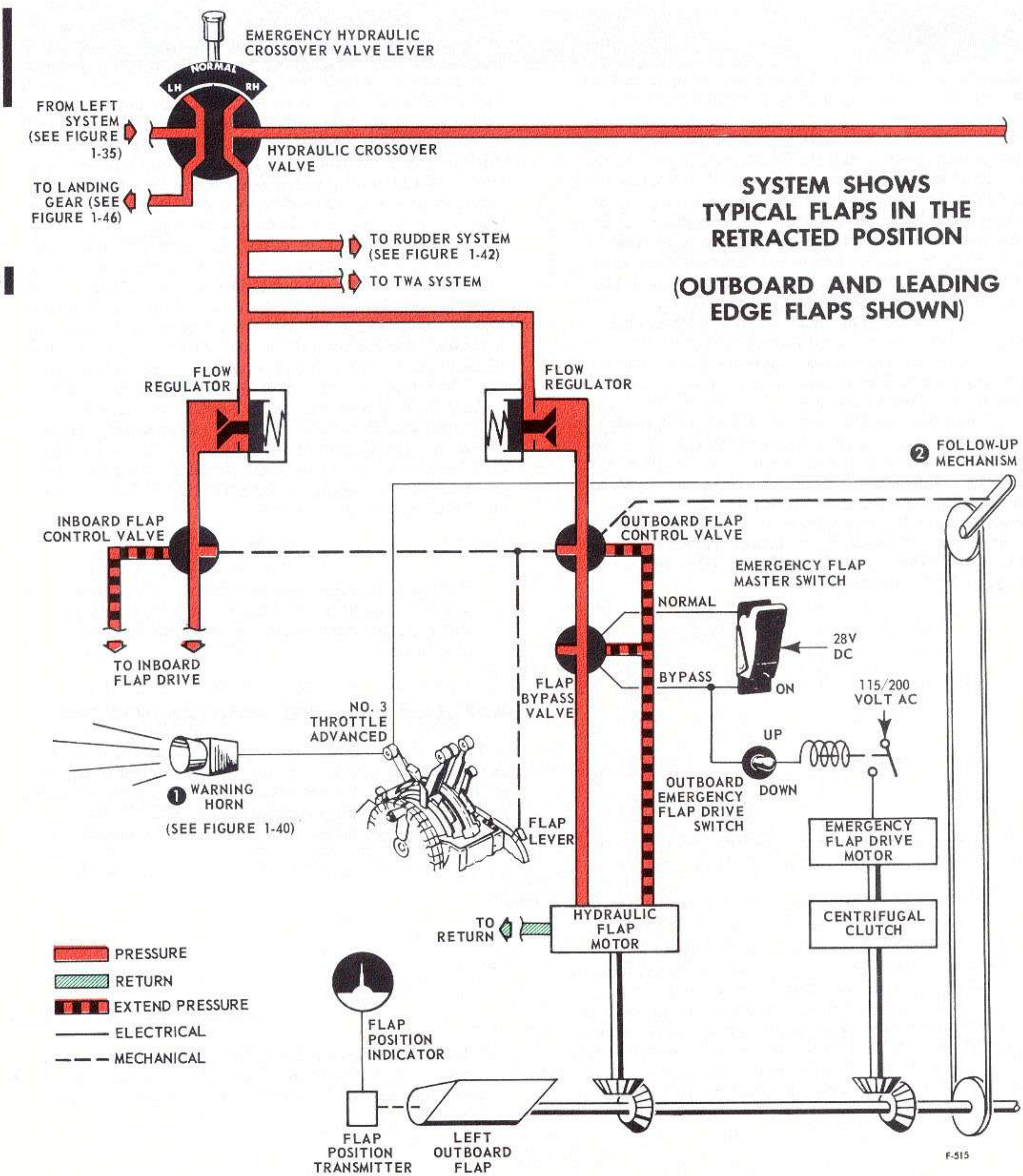
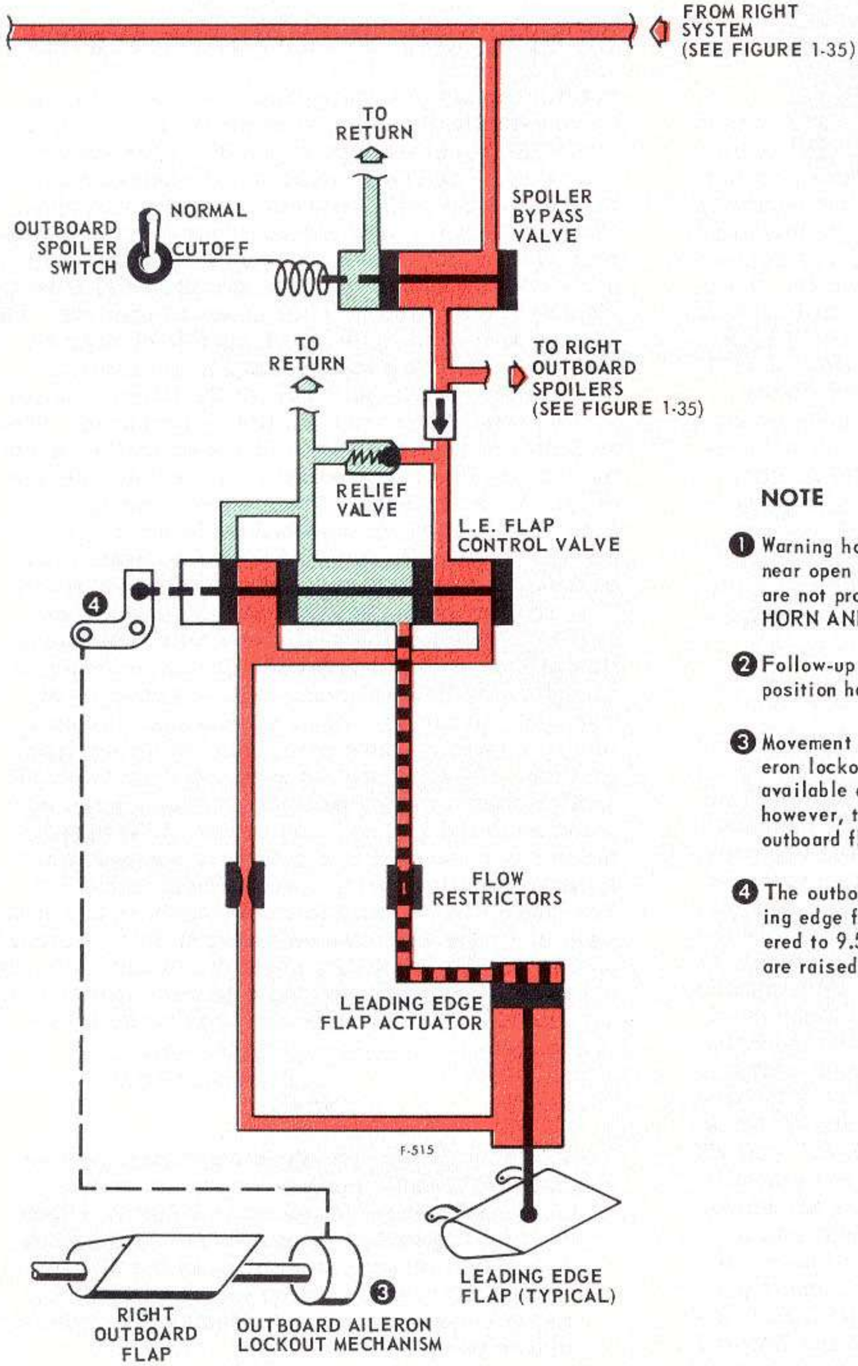


Figure 1-44 (Sheet 1 of 2)



NOTE

1. 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.
2. Follow-up cable positions flap control valve after desired position has been reached.
3. 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.
4. 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 1-44 (Sheet 2 of 2)

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 flap lever must be positively seated in the UP detent to prevent inadvertent flap extension. The indicators with FLAP UP--FLAP DOWN positions will allow a range of flap settings of from 0 to 50 degrees. The fillet flaps (1, figure 1-38) 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 1-15) 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 1-33, sheet 2). 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 1-33, sheet 2). 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 1-33, sheet 3).

EMERGENCY FLAP CONTROLS

Emergency operation of the main flaps is accomplished electrically, after placing the normal flap lever in an extended position greater than the desired flap position. The flaps are then positioned by operating the emergency flap drive motor while monitoring the flap position indicators. During retraction the flap lever remains in the greater than actual position. For example: during retraction from 40 degrees to 30 degrees the lever would remain in the 50 degree position. Three emergency switches, master, inboard and outboard (figure 1-63) are on the overhead emergency panel. The guarded master switch, with ON and unlabeled OFF positions, operates the flap hydraulic bypass valves and controls electrical power to the inboard and outboard drive switches. The drive switches, marked INBOARD and OUTBOARD, with UP--DOWN unmarked OFF center positions, control the respective electric drive motors. These switches are spring loaded when in the DOWN position and will return to the OFF position when released. Control power and bypass valve operating power is 28 volt DC and is protected by the EMERG FLAP DRIVE CONTROL INBD circuit breaker on T-R BUS NO. 1 and the EMERG FLAP DRIVE CONTROL OUTBD circuit breaker on T-R BUS NO. 2 sections of the MCBP. Operating power for the outboard emergency flap drive is 115/200 volt AC and circuit protection is through circuit breakers marked EMERGENCY OUTBOARD FLAP DRIVE on the ENG 2 GEN Section of the MCBP. Operating power for the inboard emergency flap drive is 115/200 volt AC and circuit protection is through circuit breakers marked EMERGENCY FLAP DRIVE INBOARD on the ENG 4 GEN Section of the MCBP (figure 1-33, sheet 2).

FLAP WARNING HORN

See WARNING HORN AND CUTOUT SWITCH, this Section.

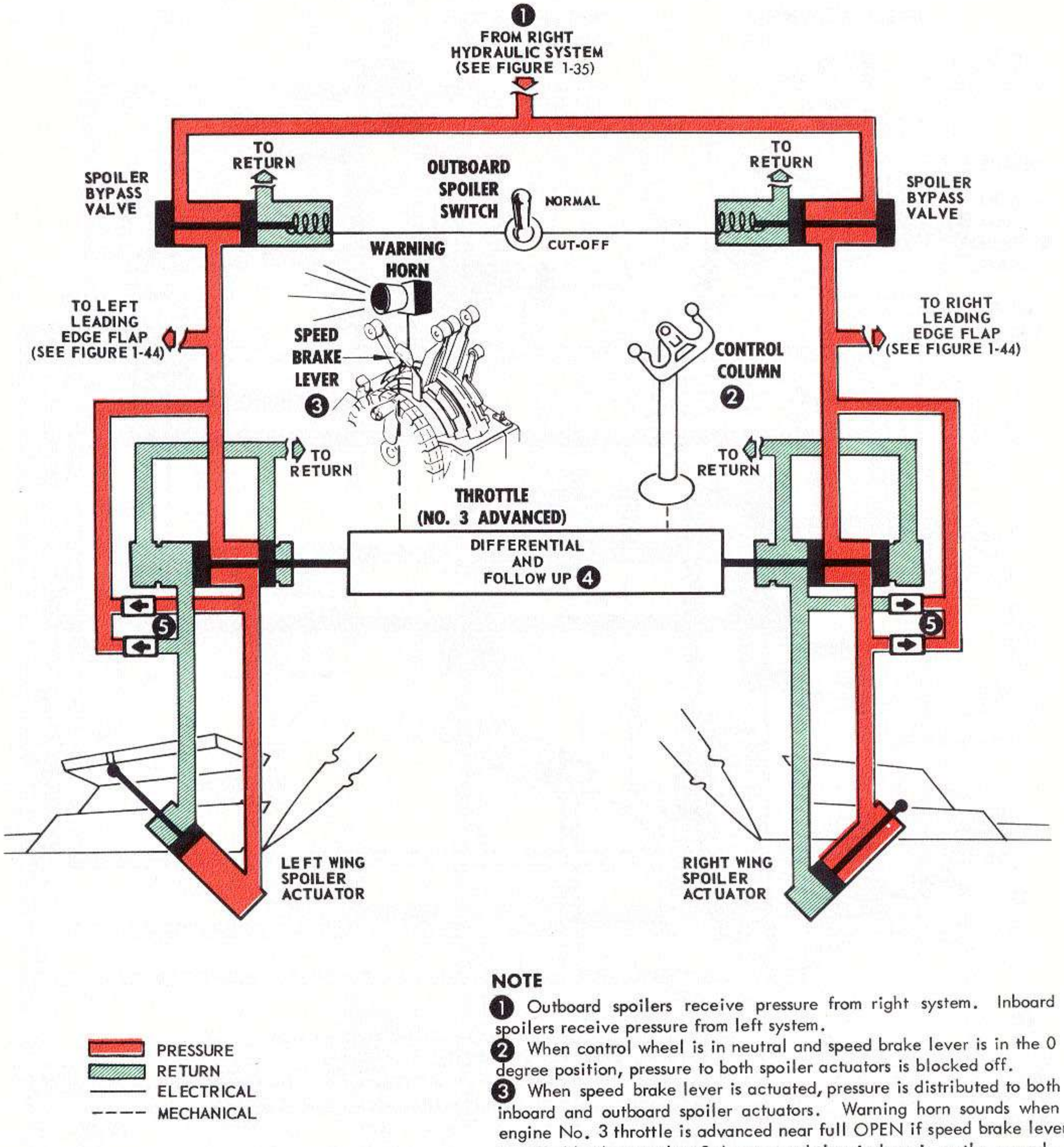
SPOILER AND SPEED BRAKE SYSTEM

Lateral control of the airplane is augmented with four hydraulically operated spoilers (17 and 18, figure 1-38), 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 1-45.

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.

spoiler & speed brake system



TYPICAL SYSTEM
OUTBOARD SPOILERS SHOWN
AIRPLANE TURNING LEFT

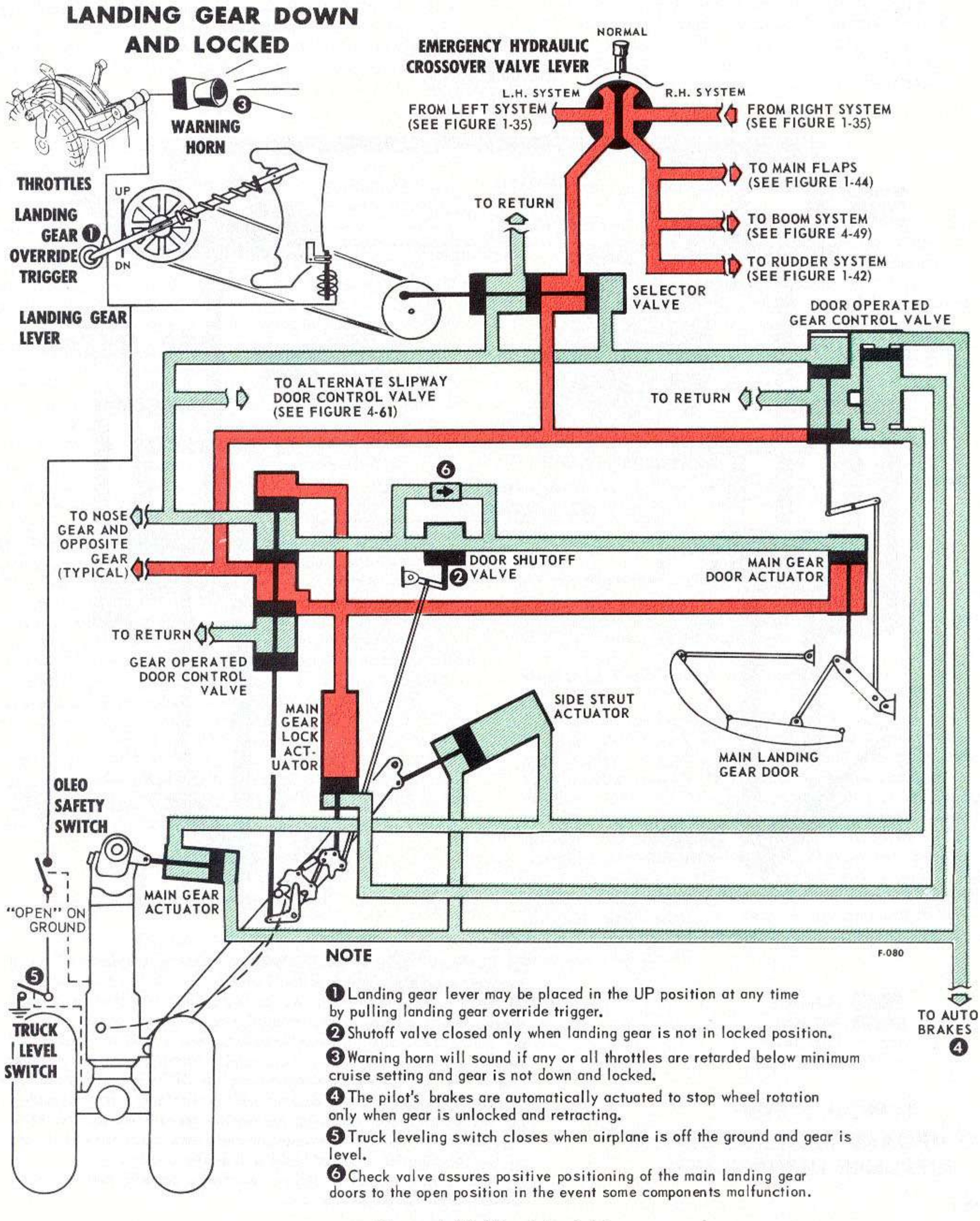
F-079

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 the 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 blowdown or thermal expansion.

Figure 1-45

landing gear system



NOTE

1. Landing gear lever may be placed in the UP position at any time by pulling landing gear override trigger.
2. Shutoff valve closed only when landing gear is not in locked position.
3. Warning horn will sound if any or all throttles are retarded below minimum cruise setting and gear is not down and locked.
4. The pilot's brakes are automatically actuated to stop wheel rotation only when gear is unlocked and retracting.
5. Truck leveling switch closes when airplane is off the ground and gear is level.
6. Check valve assures positive positioning of the main landing gear doors to the open position in the event some components malfunction.

Figure 1-46 (Sheet 1 of 2)

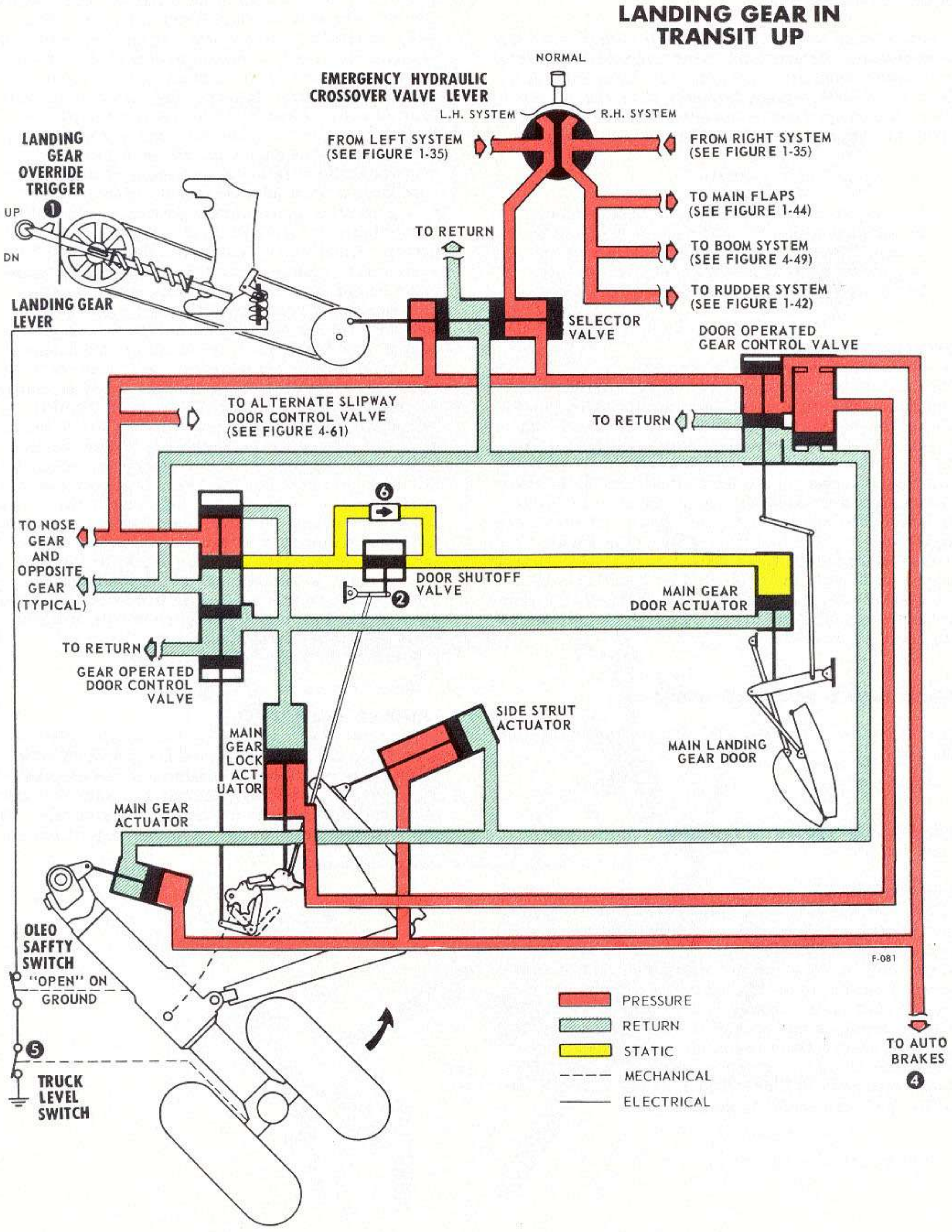


Figure 1-46 (Sheet 2 of 2)

SPEED BRAKE LEVER

A speed brake lever (1, figure 1-20) is located on the control stand. Actuating this lever hydraulically raises the spoilers symmetrically so they act as speed brakes. Decalled 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" mark and in the forward detent. This is due to rigging tolerances and is necessary to ensure that the spoiler valve has moved to the off (closed) position.

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 (5 and 6, figure 1-14). 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 1-44. 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 1-33, sheet 1).

SPEED BRAKE WARNING HORN

See WARNING HORN AND CUTOUT SWITCH, this Section.

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 1-46. 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 level 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 1-33, sheet 1). There are separate manual systems for emergency extension of the main gear and the nose gear. The controls for gear manual extension are on the floor in the rear of the control cabin. The main gear emergency crank is stowed on the floor under the aft end of the electrical equipment rack and the control for the nose gear manual extension is on the floor adjacent to the boom operator's seat. (See figure 1-50.) Windows in the floor allow inspection of both nose and main gear locks. (See figure 1-48.) It is not possible to manually retract any gear.

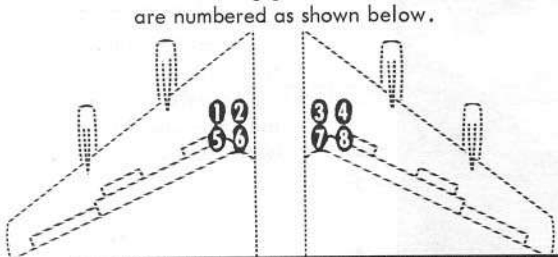
LANDING GEAR LEVER

A landing gear lever (9, figure 1-15) 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

landing gear components

NOTE

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



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

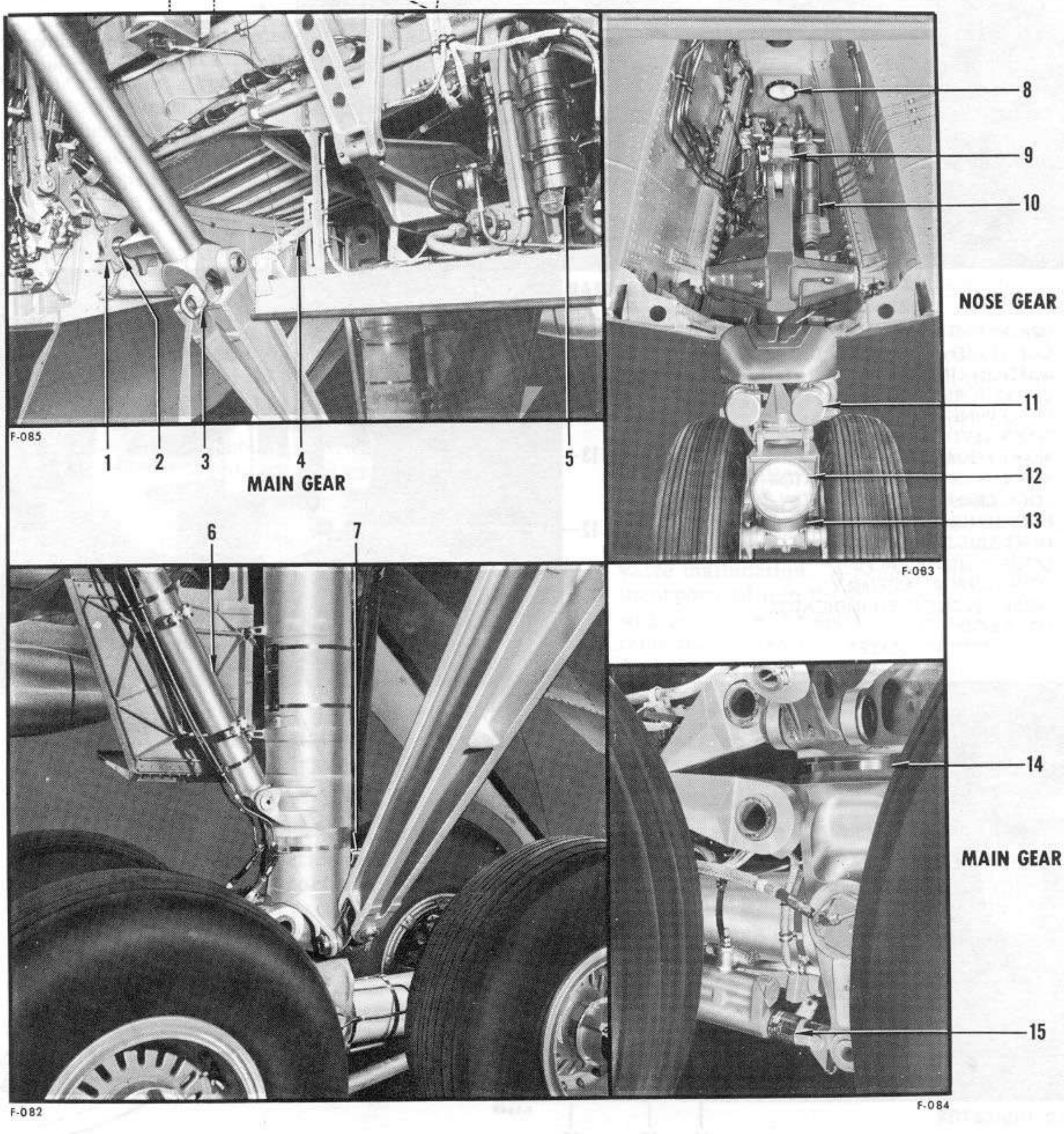
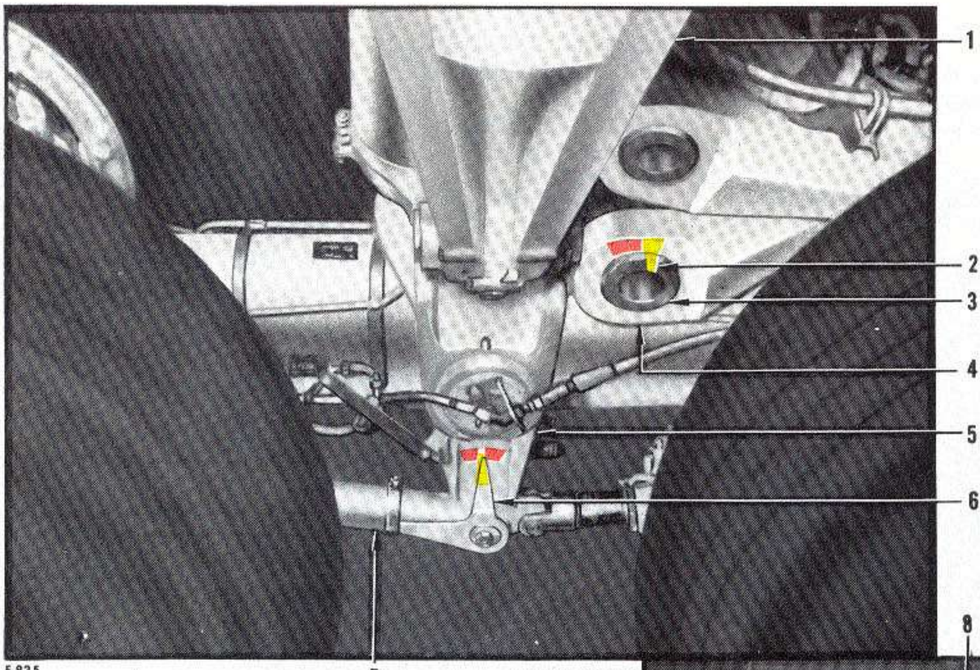


Figure 1-47

gear indicators

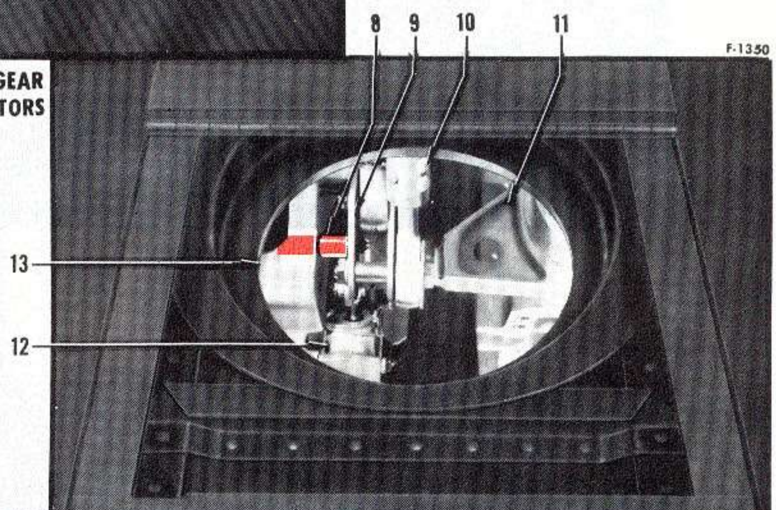


CAUTION

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

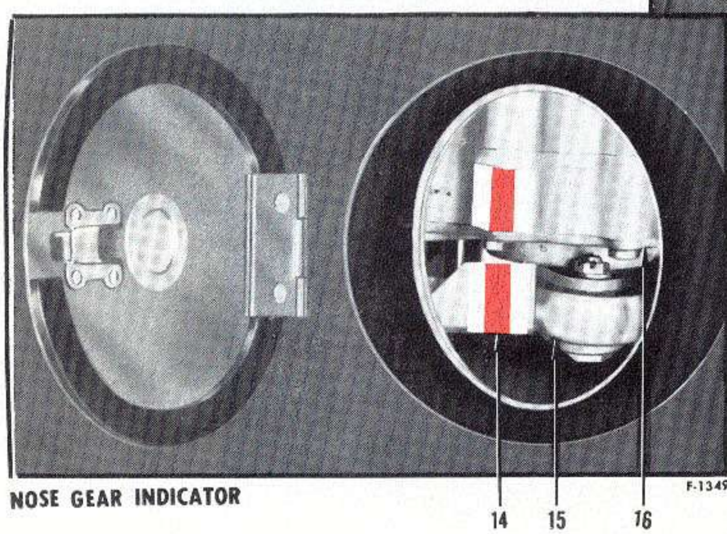
NOTE

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



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 LOCKED INDICATOR
9. LOCK CRANK
10. EMERGENCY UNLOCK ROD
11. UPPER SIDE STRUT
12. DOOR SHUTOFF VALVE
13. LOCK SUPPORT ASSEMBLY
14. NOSE GEAR LOCKED INDICATOR
15. LOCK ROD
16. DRAG STRUT KNUCKLE



NOSE GEAR INDICATOR

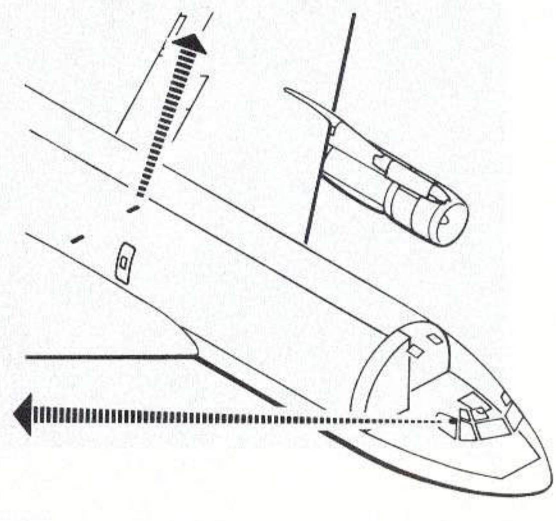


Figure 1-48

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 1-15) 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. There is a truck level indicator and an oleo extension indicator installed on each main gear. (See figure 1-48 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 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 1-15) 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 protected by the LH, NOSE and RH LANDING GEAR POS & WARN circuit breakers on the SBCBP (figure 1-33, sheet 4). Mechanical indicators are also provided to indicate when the gear is locked either up or down. The main gear indicators consist of a red stripe on the lock support assembly and red paint on the adjacent spacer. The nose gear locked indicator consists of a red stripe on the drag strut knuckle and another on a sheet metal part attached to the lock rod. When the stripes are aligned the gear is locked in either the up or the down position. The mechanical indicators can be observed by uncovering the gear inspection windows. See figure 1-48. It may be necessary to turn on the wheel well lights to illuminate the indicators enough to be seen.

TRUCK LEVEL AND OLEO EXTENSION INDICATORS

The airplane has truck level and oleo extension indicators installed on both main gear. (See figure 1-48.) 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.

external ground safety locks

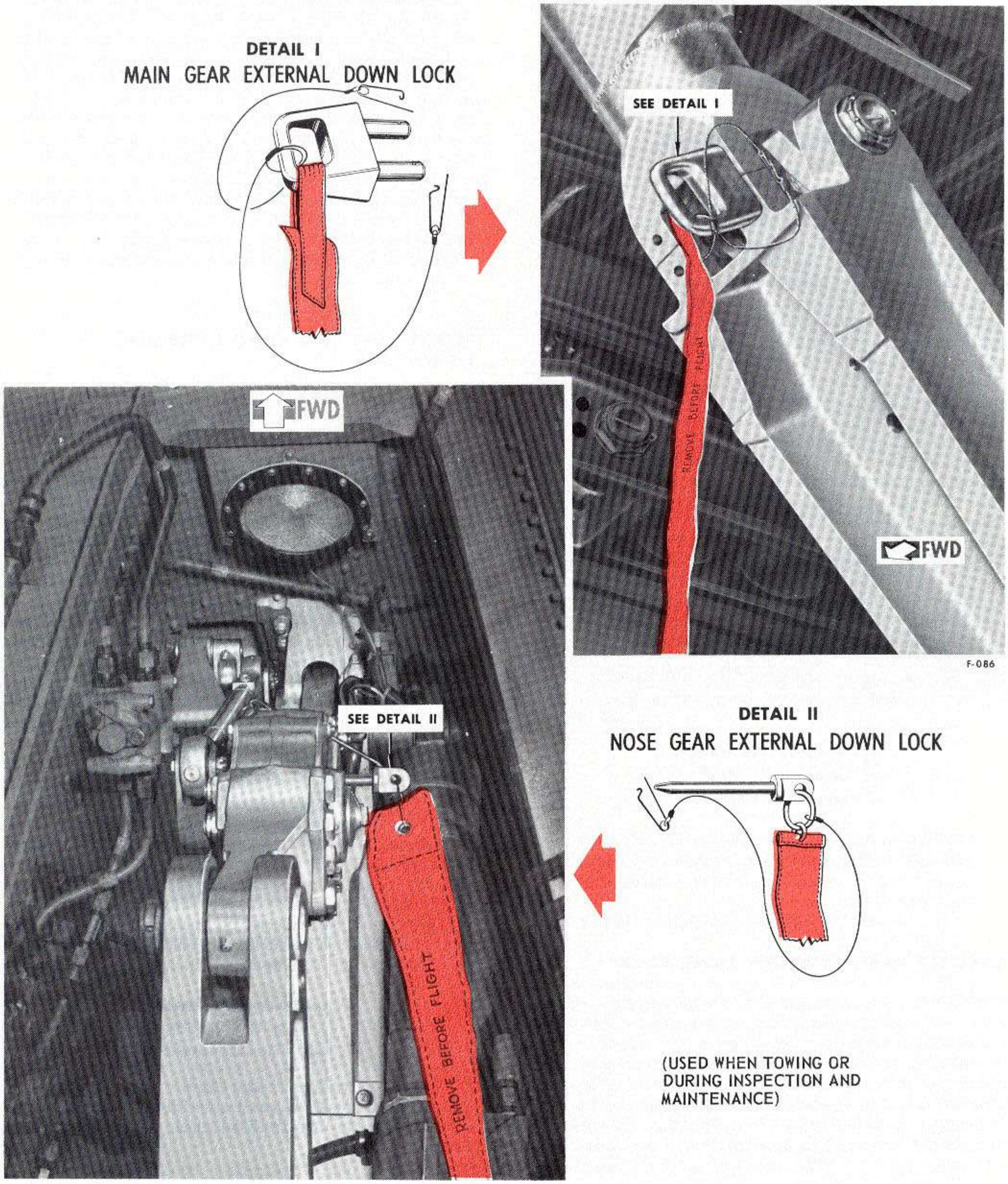
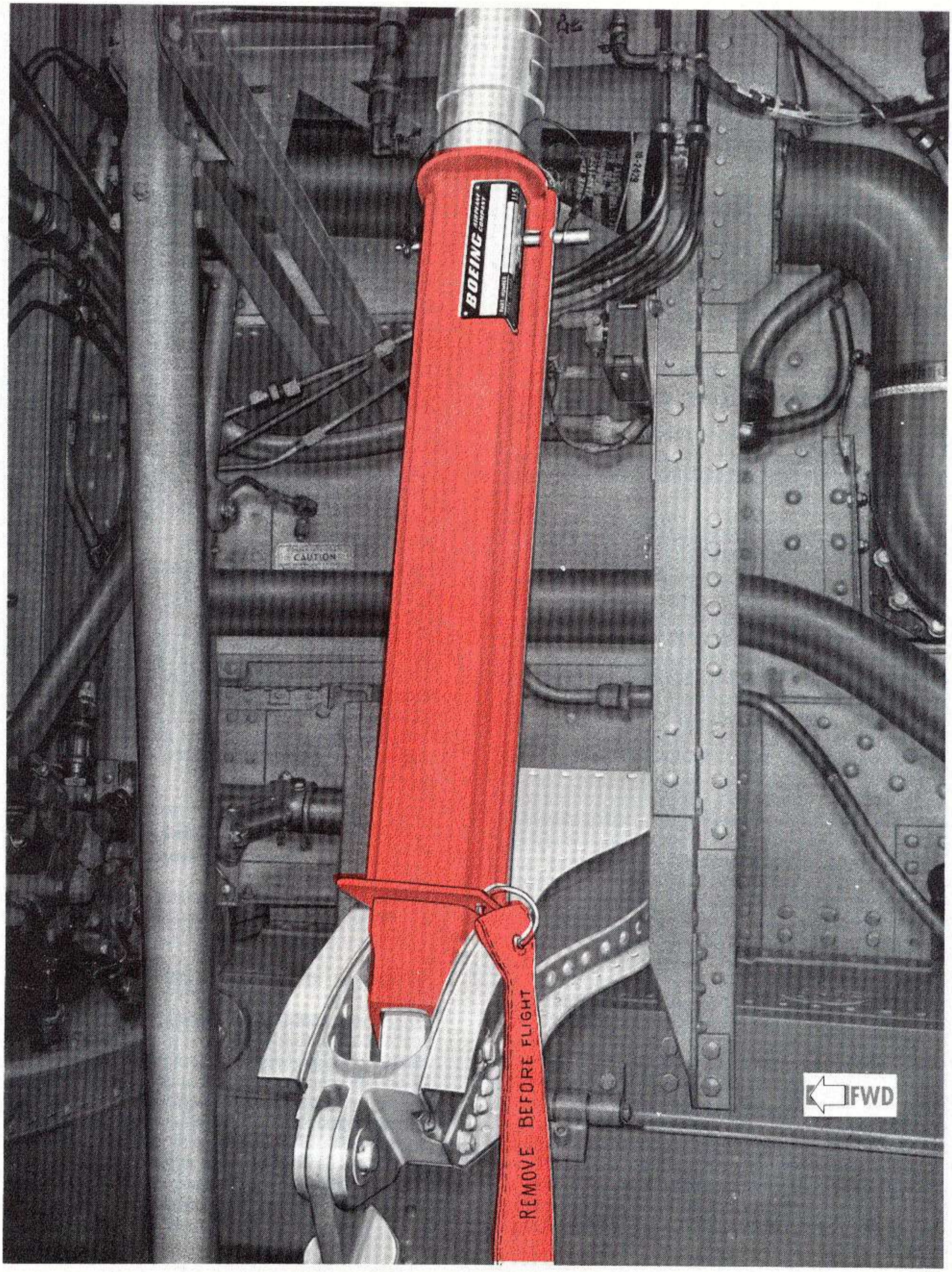


Figure 1-49 (Sheet 1 of 2)



F-088

MAIN LANDING GEAR DOOR EXTERNAL DOWN LOCK

Figure 1-49 (Sheet 2 of 2)

LANDING GEAR WARNING LIGHT KNOB

A landing gear warning light knob (10, figure 1-15) is an integral part of the landing gear lever. The light in the knob can be tested with the landing gear lever in the DN or UP position by 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 door not closed.

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

Operating power is 28 volt DC obtained through a circuit breaker marked LANDING GEAR WARN LT on the SBCBP (figure 1-33, sheet 4).

LANDING GEAR WARNING HORN

See WARNING HORN AND CUTOUT SWITCH, this Section.

EMERGENCY WHEEL WELL DOOR RELEASE ACCESS

This access (figure 1-50) is in the forward center section of the compartment 3 floor. The opening provides access to the wheel well door release cables (uppermost cables) 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 (16, figure 1-24) 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 in the event 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 1-50) serves a twofold purpose. The primary purpose of the handle is to lower the nose gear in the event 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 on the aft inboard side of the electrical equipment rack. See figure 1-50. 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.

WARNING

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

EXTERNAL GROUND SAFETY LOCKS

Three external ground safety locks (figure 1-49), one for each landing gear, are provided to 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 are provided to assure positive locking of the main landing gear doors when the airplane is on the ground. See figure 1-49. 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 compartment No. 1.

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 1-51.

NOSE GEAR STEERING WHEEL

Nose gear steering is accomplished by a steering wheel (5, figure 1-11) 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.

CAUTION

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

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 the steering mechanism.

BRAKE SYSTEM

This airplane has segmented 5-rotor brakes. 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 pressure lines. These fuses will close after 40 cubic inches of fluid have passed, preventing complete depressurization of the hydraulic system. See figure 1-52. 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. An antiskid system for the pilot's brakes provides maximum braking efficiency by continuously modulating applied brake pressure. See figures 1-46 and 1-52. Refer to Section VII and Section IX for additional information concerning brakes.

landing gear emergency controls

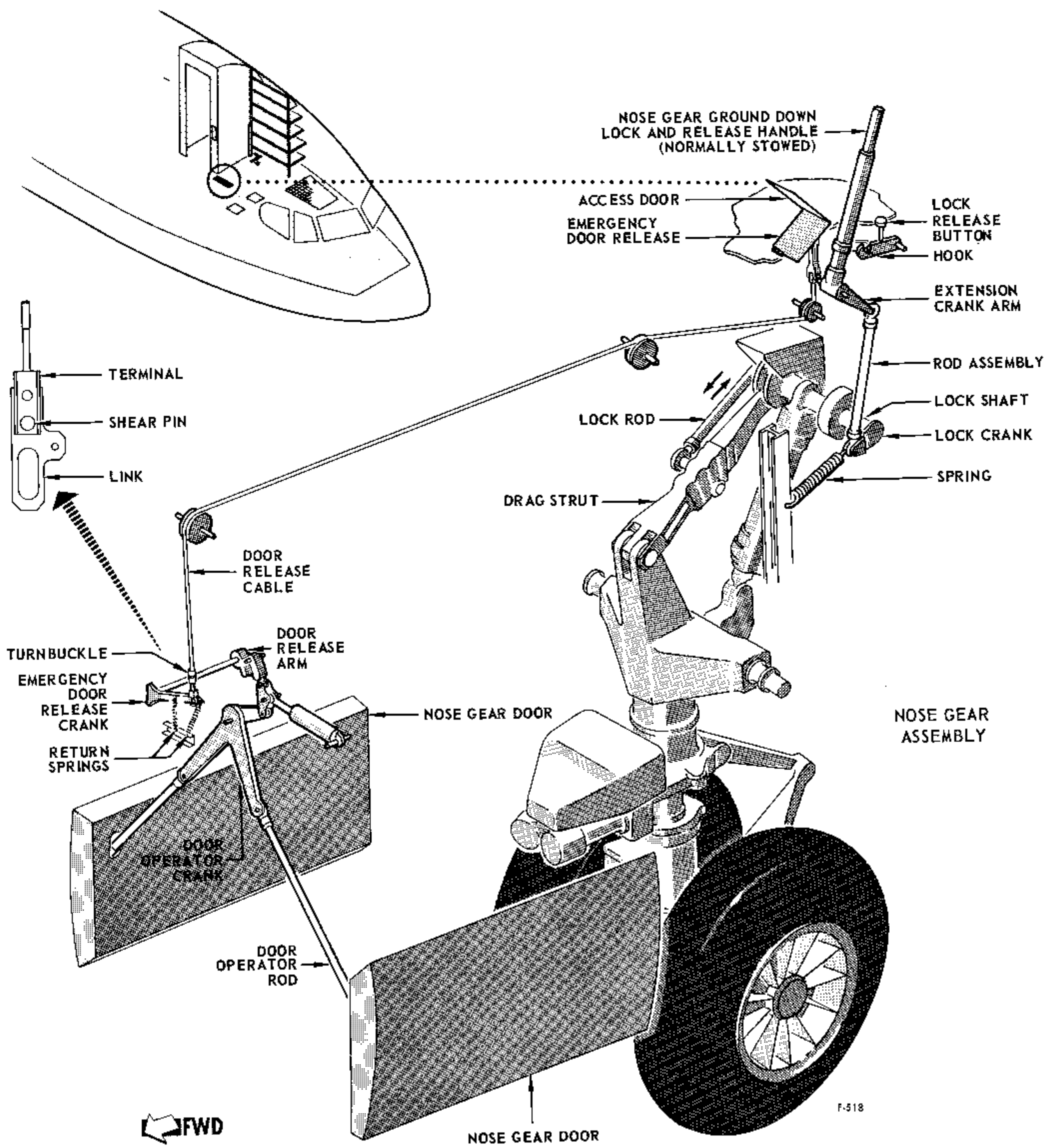


Figure 1-50 (Sheet 1 of 2)

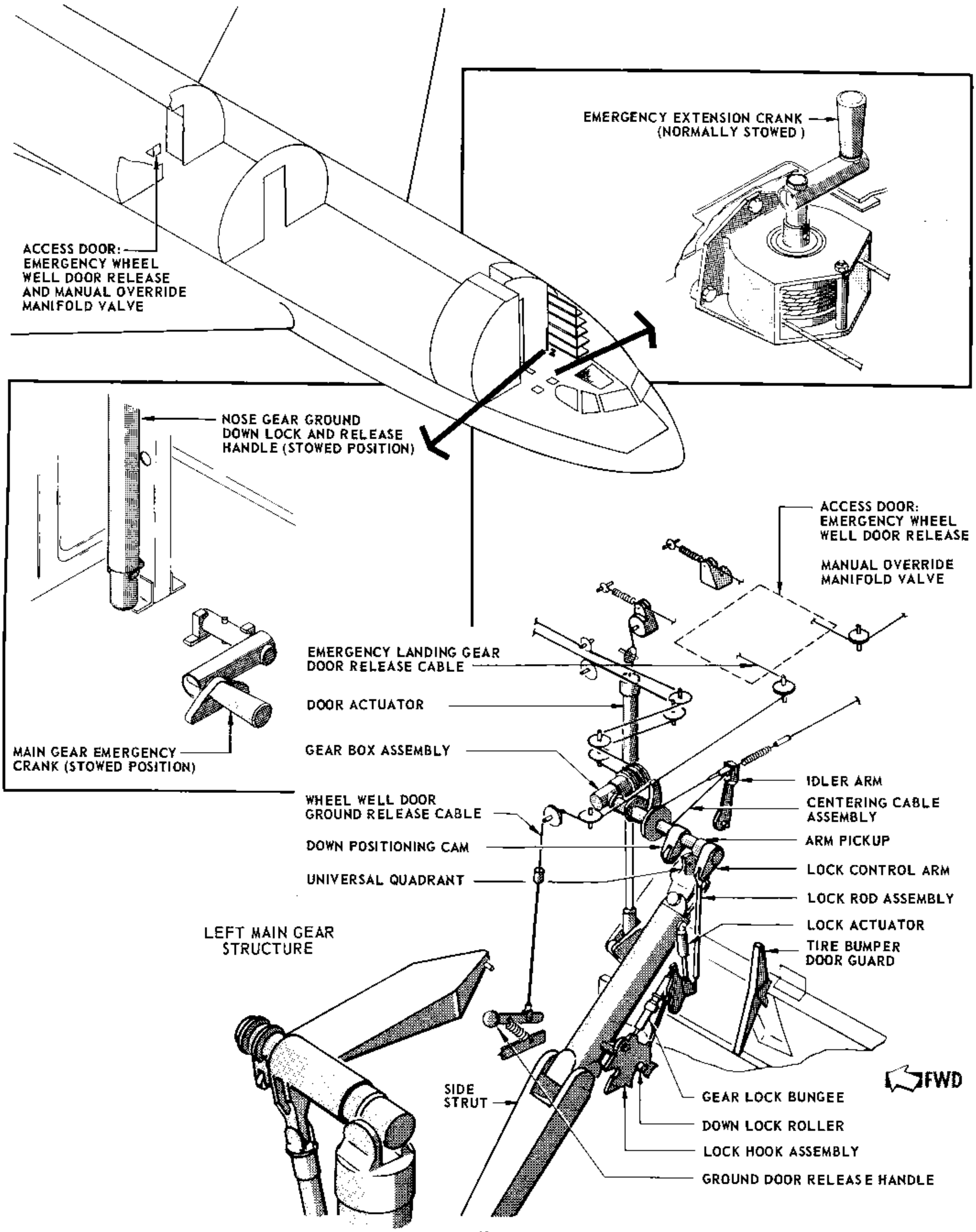
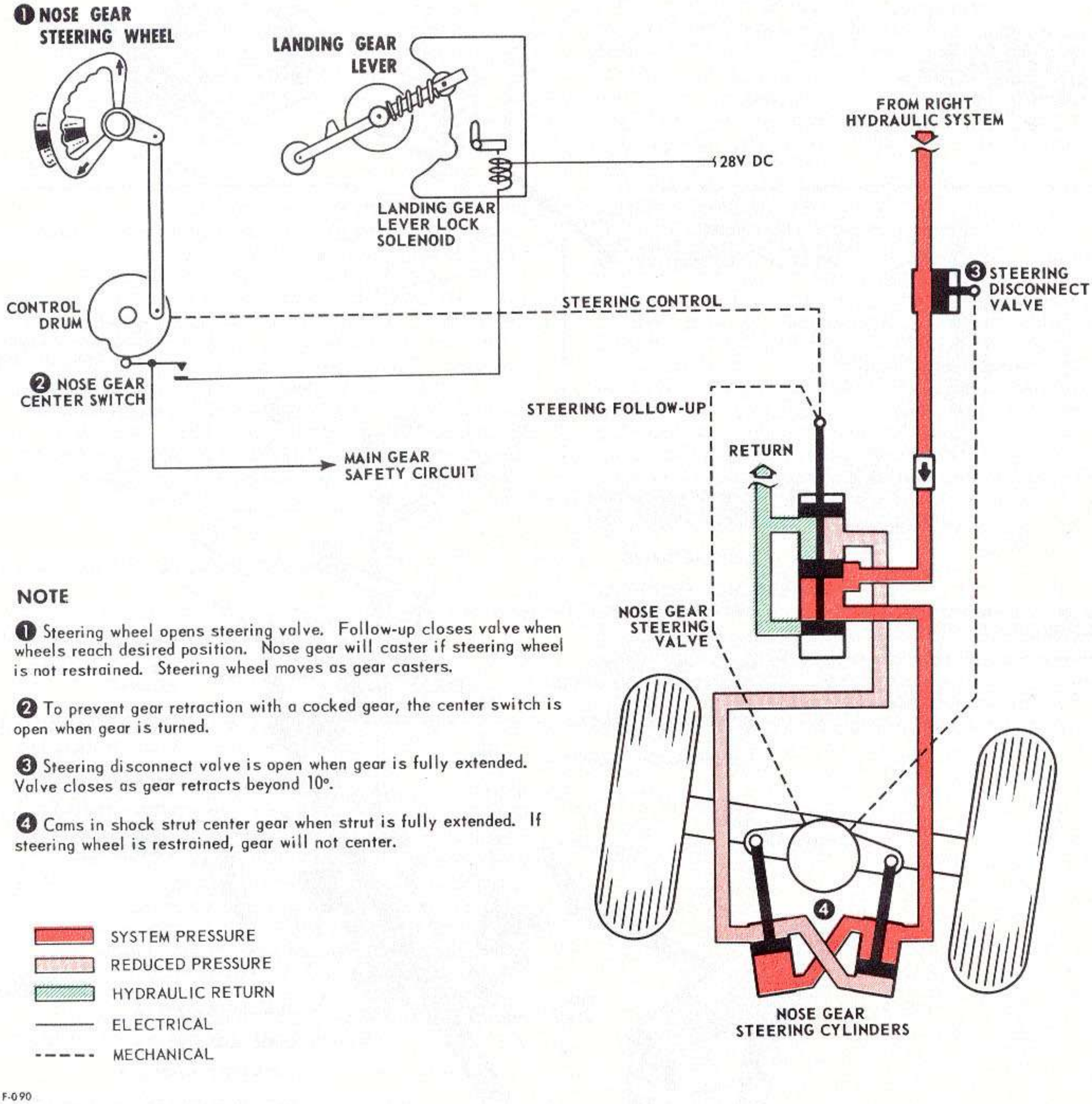


Figure 1-50 (Sheet 2 of 2)

nose gear steering system



NOTE

1. 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.
2. To prevent gear retraction with a cocked gear, the center switch is open when gear is turned.
3. Steering disconnect valve is open when gear is fully extended. Valve closes as gear retracts beyond 10°.
4. Cams in shock strut center gear when strut is fully extended. If steering wheel is restrained, gear will not center.

Figure 1-51

brake system

PILOT'S BRAKES APPLIED

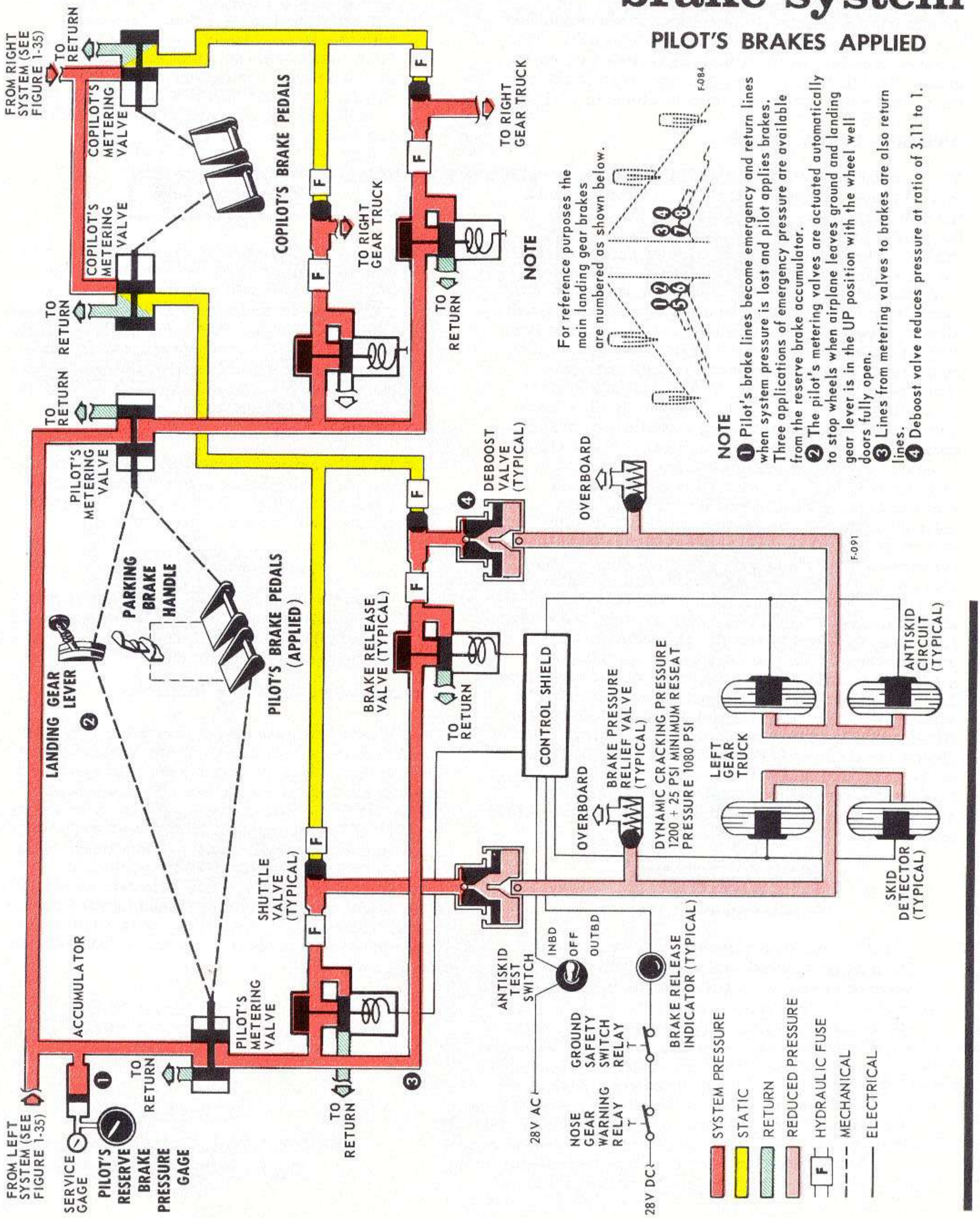


Figure 1-52

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.

ANTISKID BRAKE SYSTEM

The modulating antiskid brake system provides maximum braking efficiency regardless of runway conditions or pilot skill. This system, which affects only the pilot's brakes, can be overriden by the copilot's brakes. The greatest reduction in stopping distance can be realized on wet or icy runways. The modulating antiskid system anticipates an 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 antiskid valve for each pair of wheels. The control panel (figure 1-53) for the system is located on the pilot's side panel and contains a test switch and four antiskid 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 antiskid system is operating normally. The landing gear must be down and locked before the antiskid system is operative. The antiskid system is inoperative at wheel speeds below 160 rpm (20 knots). Operating power is 28V 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 1-33, sheet 1).

CAUTION

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 anti-skid 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 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.
- With the antiskid system deactivated, be careful during brake applications at speeds greater than taxi. Skidding and tire failures could result from excessive braking.

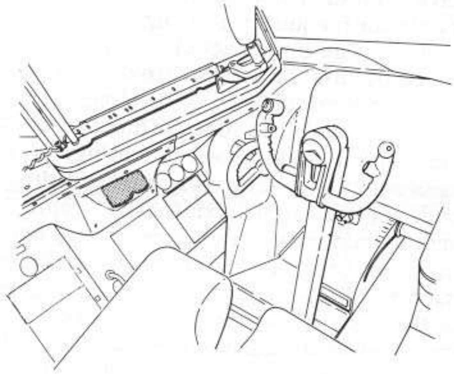
NOTE

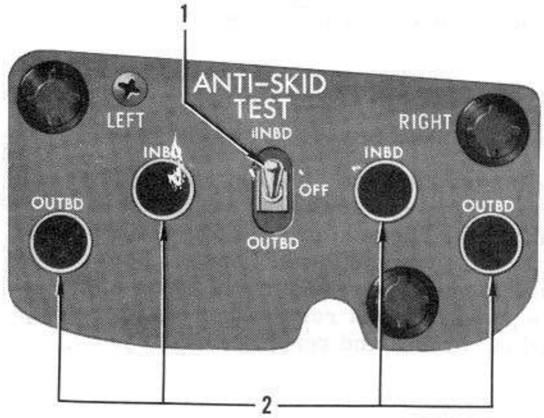
When the parking brake is set, the antiskid valves will be deactivated. In this case a REL (release) indication will not result in a release of the corresponding brakes.

Antiskid Test Switch and Indicators

The antiskid test switch (1, figure 1-53) is on the antiskid panel, and is used with the antiskid indicators (2, figure 1-53) 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.

antiskid panel





1 ANTISKID TEST SWITCH
2 ANTISKID INDICATORS

Figure 1-53

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 1-33, sheet 2).

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 1-36) is on the hydraulic control panel. This gage is read 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 (2, figure 1-20) is on the control stand. Parking brakes are set by applying toe pressure to the pilot's rudder pedals only (13, figure 1-11) 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 pilots 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 1-55. These instruments listed include pitot-static operated instruments (see figure 1-54), alternating-current operated instruments, and direct-current operated instruments, magnetic instruments, and mechanical instruments.

ACCELEROMETER

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 pull-out 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.

An accelerometer (1, figure 1-15) is 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.

FREE AIR TEMPERATURE GAGES (OAT)

The pilots' free air temperature gage (28, figure 1-17) and the navigator's free air temperature gage (16, figure 4-41) are calibrated in degrees Centigrade ranging from +50° C to -70° C. Temperature pickup bulbs for the gages are on the lower surface of the fuselage approximately twenty inches aft of the radome, five inches each side of the airplane centerline. Operating power is 28 volt DC obtained through a circuit breaker marked FREE AIR TEMPERATURE INDICATOR on the T-R BUS NO. 2 section of the MCBP (figure 1-33, sheet 1). The gages will indicate free air temperature (indicates ram air temperature in flight) whenever airplane power is available.

pitot-static system (typical)

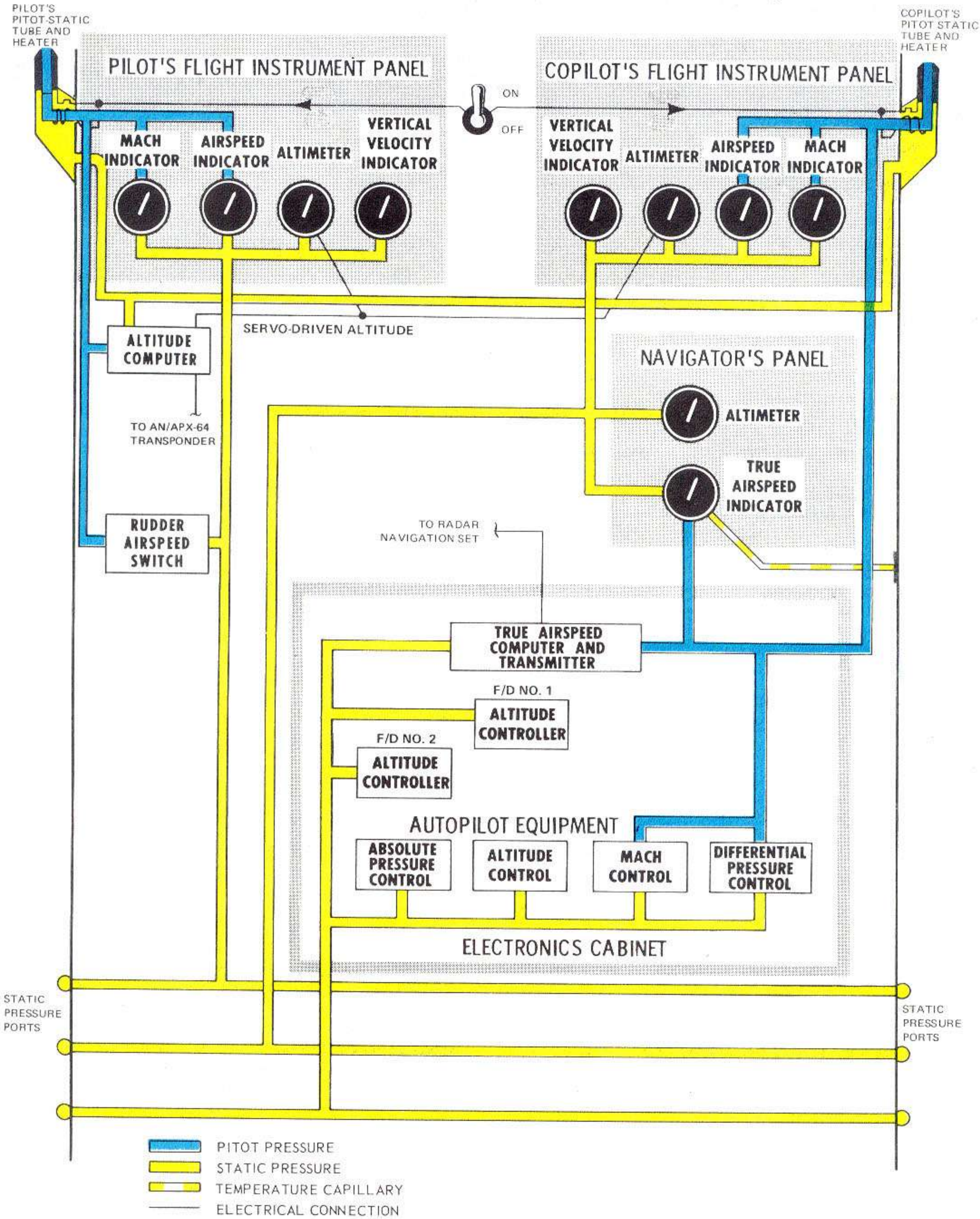


Figure 1-54

miscellaneous instruments

INSTRUMENT	OPERATI[illegible]	[illegible] 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	115V AC	(1)	MCBP
HEADING INDICATORS			
N-1 COMPASS (See Sect IV)	115 Volt AC (28 Volt DC Control)	See Figure 1-34	See Figure 1-34
J-4 COMPASS (See Sect IV)	115 Volt AC	See Figure 1-34	See Figure 1-34
MAGNETIC COMPASS	Earth's Magnetic Field	Earth's Magnetic Field	None
ATTITUDE INDICATORS (See ADI, Section IV)			
RATE OF TURN INDICATORS (See ADI, Section IV)			
SLIP INDICATORS (See ADI, Section IV)			
FREE AIR TEMPERATURE GAGE	28 Volt DC	See Figure 1-34	See Figure 1-34
ACCELEROMETER	Mechanical	None	None
CLOCK	Mechanical	Winding	None
DESTINATION INDICATOR	28 Volt DC	ASN-7 System	None

(1) Remotely Operated from Altitude Computer

Figure 1-55

ALTIMETERS

Altimeter (Navigator's)

A Type AAU-8/A or MA-1 altimeter is installed on the navigator's instrument panel (15, figure 4-41) on all airplanes. 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 1-59) indicates hundreds of feet altitude, the broad pointer (2, figure 1-59) indicates thousands of feet, and the small pointer with the triangular index marker on the outer

Figures 1-56, 1-57, and 1-58 (Deleted)

All data on pages 1-127 and 1-128 (Deleted)

altimeter settings

WITHOUT 1C10 673

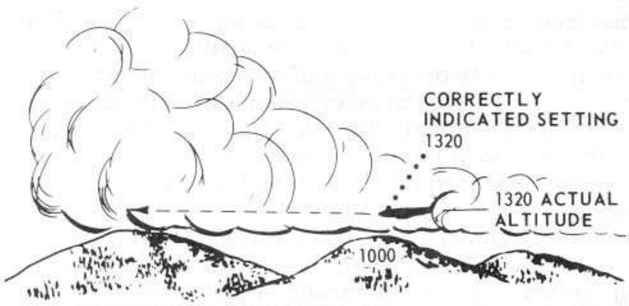
1 TEN THOUSAND FOOT POINTER (INDICATES TENS OF THOUSANDS OF FEET) (2 PLACES)
2 THOUSAND FOOT POINTER (INDICATES THOUSANDS OF FEET) (2 PLACES)
3 BAROMETRIC SCALE (2 PLACES)
4 HUNDRED FOOT POINTER (INDICATES HUNDREDS OF FEET) (2 PLACES)
5 LOW ALTITUDE WARNING SYMBOL (2 PLACES)
6 BAROMETRIC PRESSURE SET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

(SAMPLE ONLY) ALTIMETER CORRECTION CARD

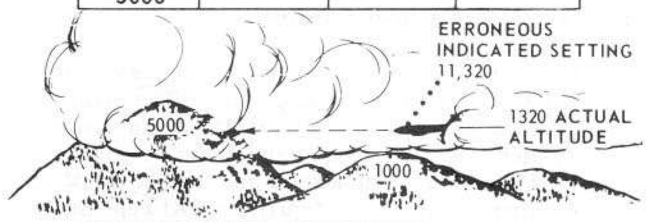
TYPE	EXT CONFIG		
ALTIMETER SERIAL NO			
ASSIGNED ALTITUDE	INDICATED ALTITUDE		
	HOLD AIRSPEED	CRUISE AIRSPEED	MAX AIRSPEED
50,000			
45,000			
40,000			
35,000			
30,000			
25,000			
20,000			
CHANGE TO 29.92 AT 18,000			
15,000			
10,000			
5000			

AFTO FORM 146 AUG 67

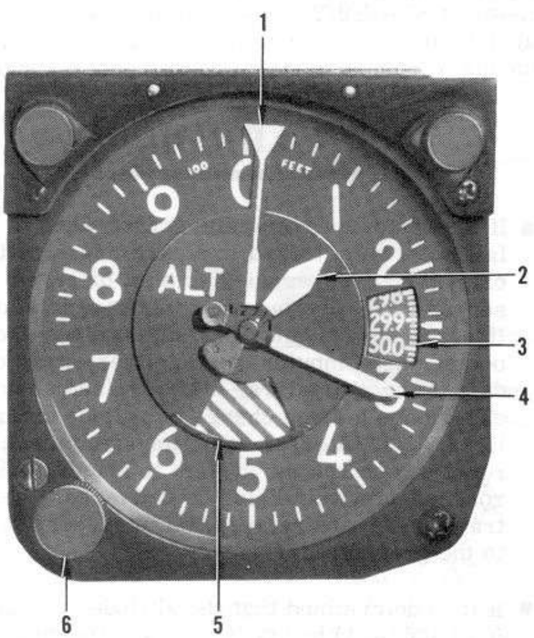
ALTIMETER CORRECTION



CORRECTLY INDICATING ALTIMETER



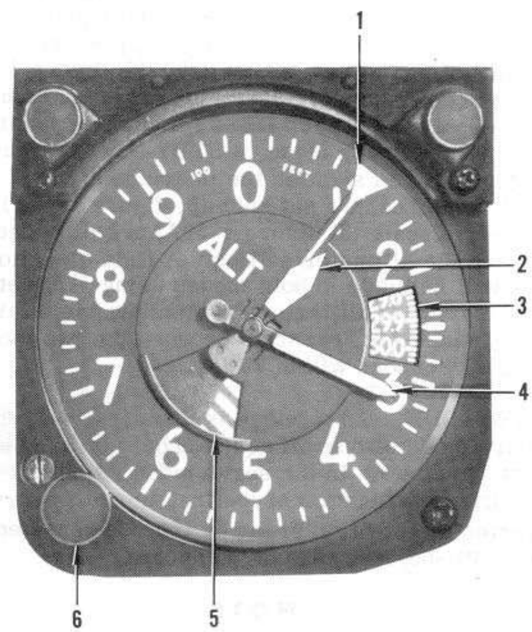
ERRONEOUSLY INDICATING ALTIMETER



INDICATED

F-095

SETTING – 29.92 IN. HG
ALTITUDE – 1320 FEET



INDICATED

F-096

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

Figure 1-59

edge of the dial (1, figure 1-59) indicates tens of thousands of feet. The barometric scale (3, figure 1-59) and the barometric pressure set knob (6, figure 1-59) 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 1-59) 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 1-59A) 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 1-59A) and drum provide a direct digital readout in hundreds and thousands of feet. The single pointer (2, figure 1-59A) 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 1-59A). 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 1-59A) will be in sight on the instrument face. A barometric pressure set knob (6, figure 1-59A) and barometric scale (3, figure 1-59A) 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 3 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

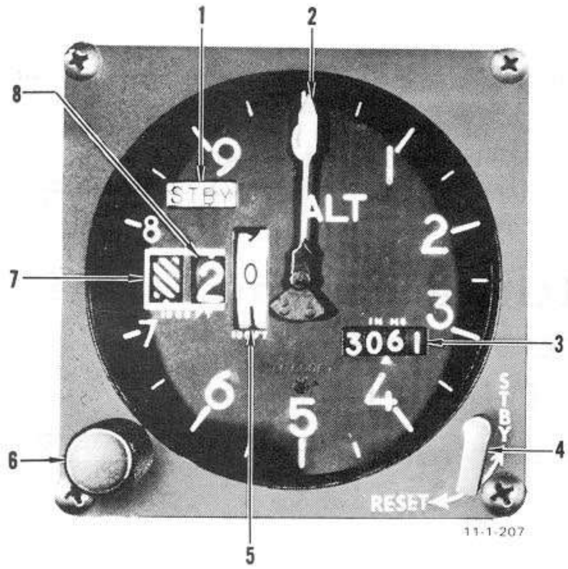
The CPU-66/A-1 computer error sensing system senses error in a servo loop that takes its input from a pneumatic sensor within the computer. All error sensing is downstream of the sensor and as a result there is no monitor function applied to the sensor itself. The AAU-19/A altimeter also has a means 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.

altimeter



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 1-59A

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.

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. Altimeter scale error is not provided.
- 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 baro-counters 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 STANDBY. 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.

Altimeter Correction Card Holders

Altimeter correction card holders are mounted on the metal checklist plate hinged above the pilots' light and glare shield. The holders contain a copy of AFTO Form 146 (figure 1-59), 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 I of the Appendix, T.O. 1C-135(E)C-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 1-59B) 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	200
15,000	210
16,000	220
18,000	240
20,000	260
22,000	280
25,000	310
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 1-59B

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/A 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/A 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 1-59C

PILOT'S INSTRUMENT GYROS SWITCH

This switch (17, figure 1-16) 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 obtained through a circuit breaker marked N-1 COMPASS & PILOT ATTITUDE IND on the T-R BUS NO. 2 section of the MCBP (figure 1-33, sheet 1).

COPILOT'S INSTRUMENT GYROS SWITCH

This switch (21, figure 1-17) on the copilot's flight instrument panel has ON--OFF positions and controls the J-4 compass and 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 power relay is 28 volt DC obtained through a fuse marked J-4 COMP & ATT IND on the CIPP (figure 1-33, sheet 3). Secondary power for the switch and power relay is 28 volt DC obtained through a circuit breaker marked COPILOT'S FLIGHT INSTRUMENT on the T-R BUS NO. 2 section of the MCBP (figure 1-33, sheet 1).

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 (7, figure 4-33) 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 1-33, sheet 4).

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 comprised of 10 detectors for each nacelle and strut combination is provided. In the event of an overheat condition within the nacelle or strut, a warning light on the pilots' glare shield will illuminate, indicating which engine is overheating. A fire detector test switch is provided to check the continuity of the fire detector circuit.

Engine Fire Switches and Warning Lights

There are four engine fire switches and warning lights (1, figure 1-14) on the pilots' light and glare shield. The warning lights are numbered to indicate the engine each light represents. An engine overheat condition 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 oil and fuel flow to the engine and (3) deactivating the engine ignition. (The generator failure light will not indicate that the generator has been tripped.) When the fire switch is returned to its normal position, the respective fire valves and control circuits return to their normal position 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 (12, figure 4-33), 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 28V DC through circuit breakers marked ENGINE FIRE DETECTOR 1, 2, 3, and 4 on the SBCBP (figure 1-33, sheet 4).

EMERGENCY ALARM BELLS

Six emergency alarm bells and one klaxon horn are controlled by an ON--OFF alarm bell switch on the overhead emergency panel (9, figure 1-63). The alarm bells are installed in the following locations: in the control cabin on the ceiling just aft of the overhead panel; in the compartment No. 1 over the cargo door; in compartment No. 2 on the forward bulkhead, above the door on the warning sign; in compartment No. 3, left side, above the console in the light housing; the master bell in compartment No. 4, left side, above the console on the warning sign; and overhead in the boom operator's compartment. The one klaxon horn is located on the forward left bulkhead in compartment No. 1. When the switch is positioned to 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 volts DC obtained through the ALARM BELL circuit breaker on the Battery Circuit Breaker Panel (figure 1-33, sheet 3). The klaxon warning horn is actuated simultaneously with the alarm bells. Operating power is 28 volts DC obtained through the MAIN CABIN WARNING HORN circuit breaker on the Battery CBP (figure 1-33, sheet 3).

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 (6A, figure 1-60) is located in the control cabin above the main entrance hatch. The aft container (21A, figure 4-69) is located on the left side of the forward bulkhead in compartment 4.

HAND FIRE EXTINGUISHERS

The fire 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.

WARNING

Heavy, dense, black, suffocative, toxic smoke occurs when bromochloromethane (CB) is used on hot metal or open fire. 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.

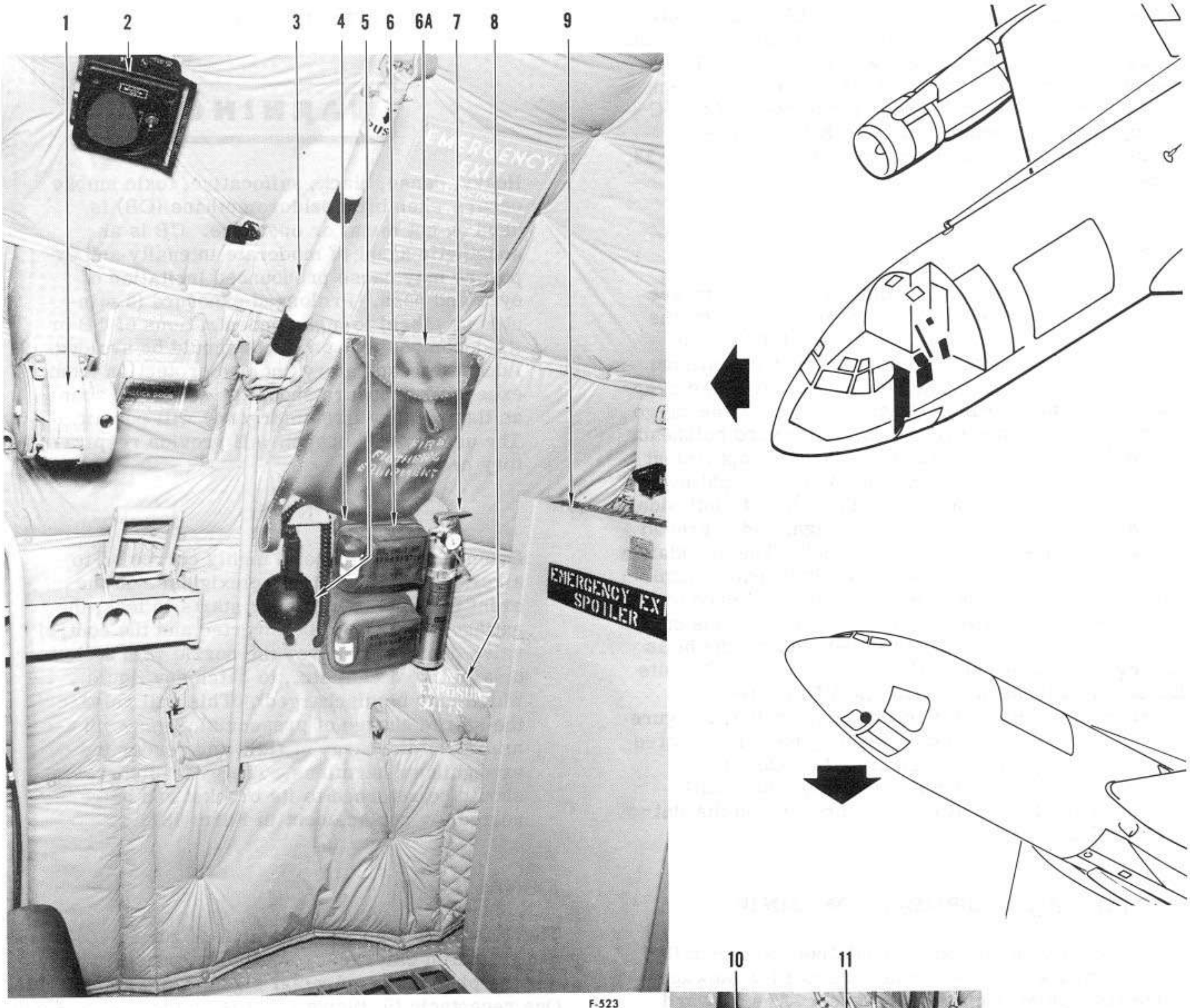
NOTE

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.

SIGNAL LAMP

There is a portable signal lamp (5, figure 1-60) on the control cabin emergency equipment panel. The lamp may be plugged into special signal lamp receptacles. One receptacle (9, figure 1-12) 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 & AUX CREW OXY PANEL LIGHTS located on the 28V AC section of the MCBP (figure 1-33, sheet 2).

control cabin emergency equipment



1 CREW ENTRY DOOR WINCH
2 EMERGENCY EXIT LIGHT
3 CHINNING BAR
4 CONTROL CABIN EMERGENCY EQUIPMENT PANEL
5 SIGNAL LAMP
6 FIRST AID KITS
6A FORWARD FIREFIGHTER'S EQUIPMENT CONTAINER
7 FIRE EXTINGUISHER
8 ANTI-EXPOSURE SUIT STOWAGE
9 EMERGENCY EXIT SPOILER
10 EMERGENCY EXIT SPOILER PRESSURE GAGE
11 EMERGENCY EXIT SPOILER AIR BOTTLE

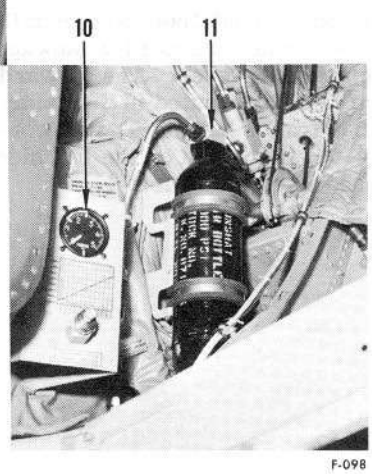


Figure 1-60

emergency equipment panels

THERE ARE FIVE EMERGENCY EQUIPMENT PANELS FOR STOWAGE OF THE HAND FIRE EXTINGUISHERS, CRASH AXES AND FIRST AID KITS; SEE FIGURE 3-1. ONE PANEL ALSO CONTAINS A SIGNAL LAMP (FIGURE 1-60).

PANEL	FIRE EXTINGUISHER	CRASH AXE	FIRST AID KITS	SIGNAL LAMP	LOCATION
CONTROL CABIN	1	1	2	1	AFT OF PILOT'S SEAT AND EMERGENCY EXIT SPOILER
COMPARTMENT NO. 1	1	1	12	NONE	LEFT SIDE FORWARD BULKHEAD ADJACENT CARGO DOOR
COMPARTMENT NO. 2	1	1	1	NONE	LEFT SIDE AFT BULKHEAD ADJACENT TO SEAT NO. 3
COMPARTMENT NO. 3	1	1	4	NONE	LEFT SIDE OF FORWARD BULKHEAD OVER KY-3A SPEECH SECURITY DEVICE
COMPARTMENT NO. 4	1	1	1	NONE	RIGHT SIDE FORWARD BULKHEAD

NOTE: Also see figures 1-60 and 1-63.

Figure 1-61

ANTI-EXPOSURE SUIT STOWAGE

The anti-exposure suits are part of each crew member's equipment. The navigator and boom operator stow their anti-exposure suits on the lower shelf of the electrical equipment rack (13, figure 1-24). A canvas band snaps around the containers to hold them in place.

SURVIVAL KIT STOWAGE

Provisions for stowage of survival kits are located on the floor behind the boom operator's seat (17, figure 1-24). Tiedown straps are provided.

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 in compartment No. 1, are over the wing. The third is on the right side of the fuselage in compartment 4. 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 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.

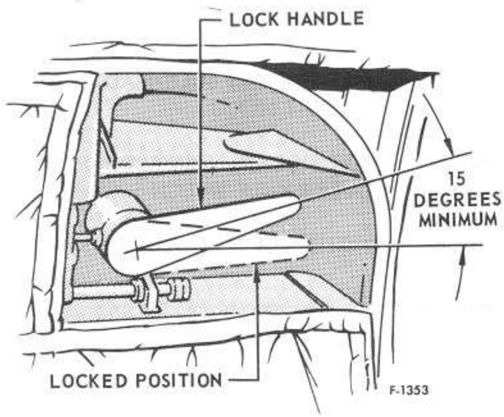
EMERGENCY EXIT LIGHTS

Five emergency exit lights (6, figure 3-1) are provided, one at each airplane exit. Impact switches incorporated in each unit will energize the light circuit if forward motion of the airplane is stopped abruptly. The lights are controlled by the emergency exit lights switch on the overhead emergency panel (8, figure 1-63). The switch has two positions OFF--ARMED with power provided through circuit breakers marked EMERGENCY

ground installation of emergency exit hatches

NOTE

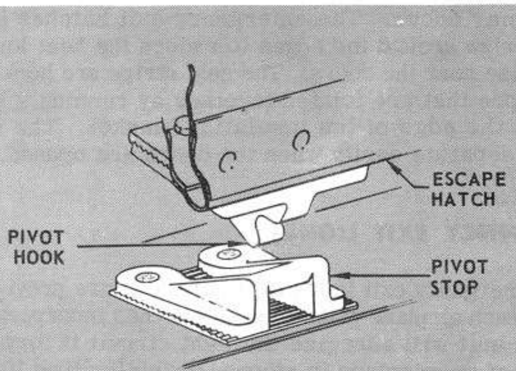
- LOCK HANDLE ON REAR HATCH MUST BE APPROXIMATELY 15 DEGREES ABOVE HORIZONTAL BEFORE INSTALLING HATCH. NO RETENTION IS REQUIRED TO KEEP IT IN THIS POSITION.



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

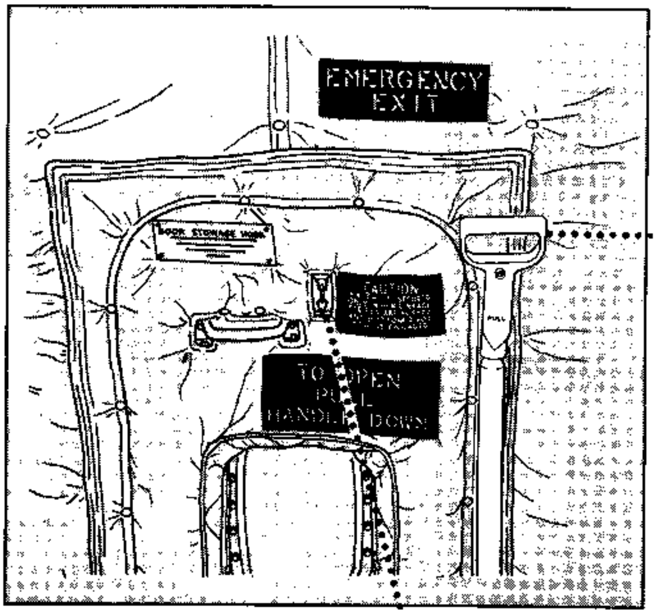
F-101

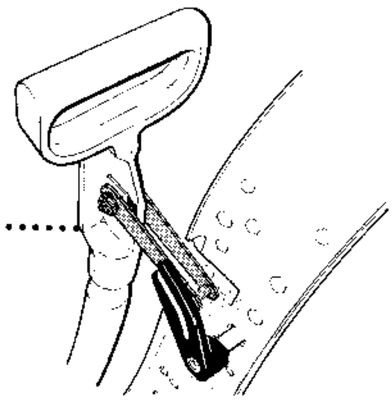
1. MAKE SURE THAT EXTERNAL HANDLE IS FLUSH AND LATCHED.
2. GRASP UPPER FIXED HATCH HANDLE WITH THE LEFT HAND. SUPPORT LOCK HANDLE WITH RIGHT SHOULDER OR ARM TO PREVENT HANDLE DROPPING TO FULL DOWN POSITION.

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.

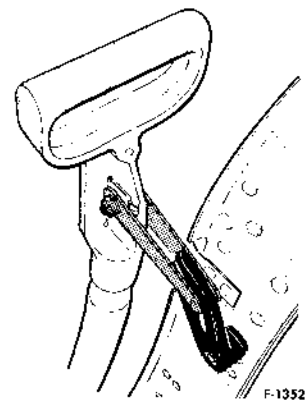
Figure 1-62 (Sheet 1 of 2)

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.

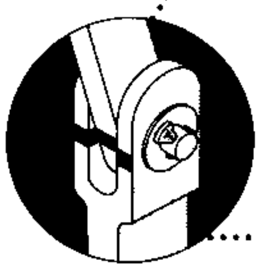




DISENGAGED



ENGAGED

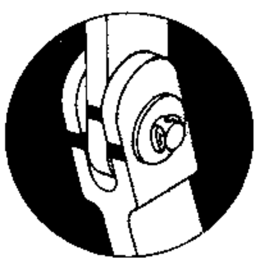


LATCHED

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.



UNLATCHED

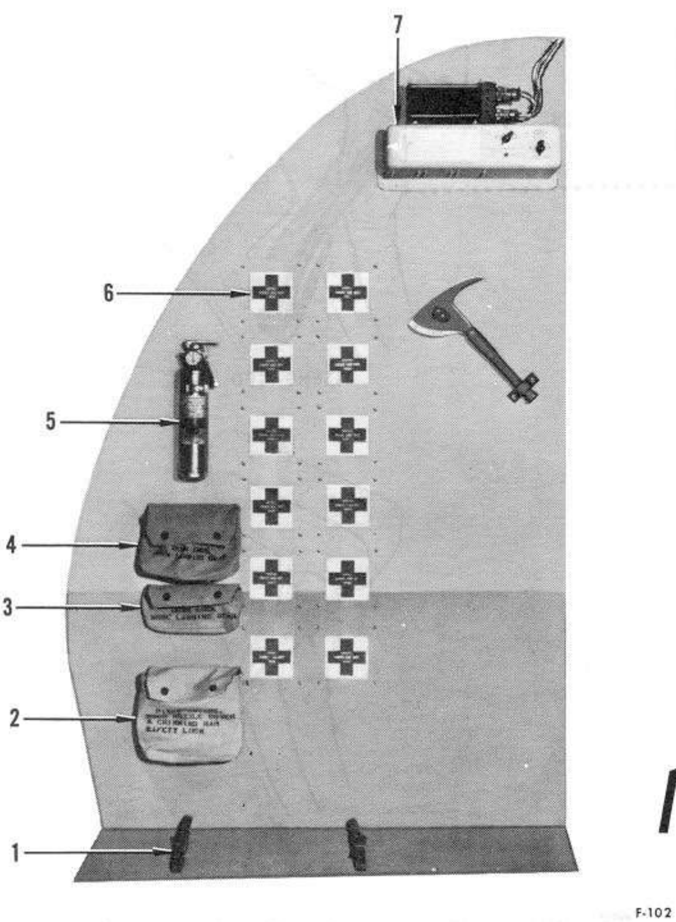
8 AFTER SECURING LOCK, INSPECT PIVOT HOOK AND PIVOT STOP AT CENTER OF LOWER SILL FOR PROPER ENGAGEMENT. IT IS POSSIBLE FOR THE PIVOT HOOK AND PIVOT STOP TO BE OUT OF ENGAGEMENT EVEN THOUGH THE LOCK IS SET AND THE HATCH FEELS SECURE.

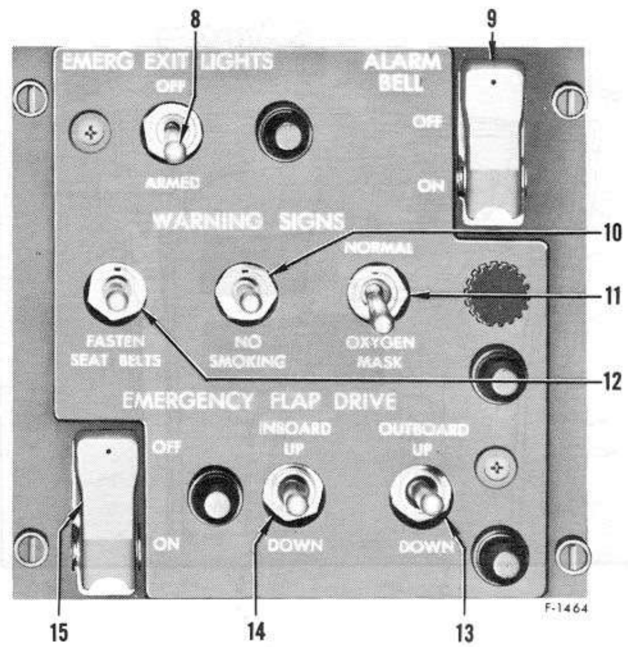
OVER-CENTER MECHANISM
F-100

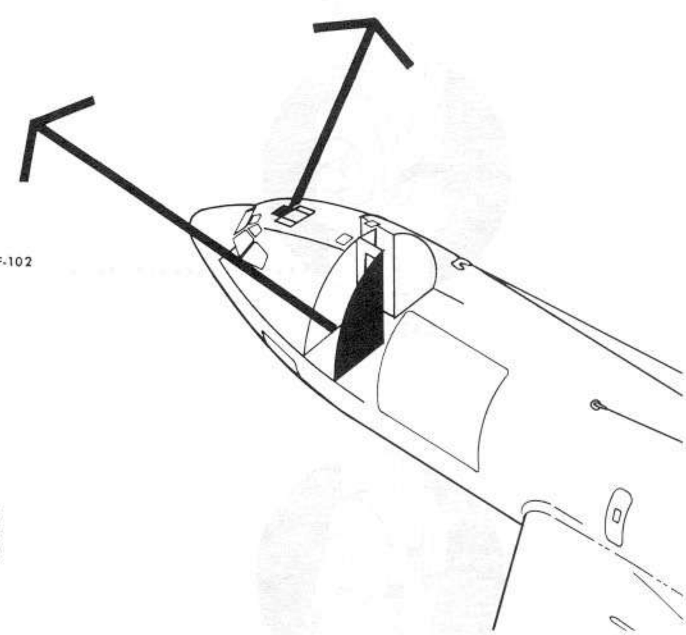
9 INSPECT THE HATCH LATCH PIN AND STRIKER PLATE ON TOP OF THE HATCH FRAME FOR PROPER ENGAGEMENT.

Figure 1-62 (Sheet 2 of 2)

emergency equipment







1 MAIN LANDING GEAR DOOR EXTERNAL DOWN LOCK 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 MAIN CABIN A/C PANEL (SEE FIGURE 4-7)
8 EMERGENCY EXIT LIGHTS SWITCH
9 ALARM BELL SWITCH
10 NO SMOKING WARNING SIGN SWITCH
11 OXYGEN MASK WARNING SIGN SWITCH
12 FASTEN SEAT BELTS WARNING SIGN SWITCH
13 OUTBOARD EMERGENCY FLAP DRIVE SWITCH
14 INBOARD EMERGENCY FLAP DRIVE SWITCH
15 EMERGENCY FLAP MASTER SWITCH

Figure 1-63

EXIT LIGHT on the T-R BUS NO. 1 section of the MCBP (figure 1-33, sheet 1). A switch on each light unit has three positions: ARMED--OFF--RESET--ON. When both switches are in the ARMED position, the lights will illuminate thru a power failure relay if the airplanes power source fails and thru an impact relay if the airplane comes to an abrupt stop. When the EMERGENCY EXIT LIGHTS control switch on the overhead emergency panel is in the OFF position, the light units can be turned on only by placing the switch on the light unit to the ON position. Four dry cells in each unit provide power for illumination. The units can also be removed and operated as hand lanterns.

WARNING SIGNS

There are five warning signs (5, figure 3-1) located in the airplane: one above the APU in compartment No. 1; one above the forward door in compartment 2; one above the left console (seats 13 and 14) and one above the map stowage cabinet in compartment 3 and one above the console in compartment 4. Each sign has three sections which read OXYGEN MASKS, NO SMOKING, FASTEN SEAT BELTS. Illumination of these sections is controlled by three switches on the overhead emergency panel (10, 11 and 12, figure 1-63). The control switches have two positions: OFF, FASTEN SEAT BELTS; OFF, NO SMOKING; NORMAL, OXYGEN MASK. When the oxygen warning switch is placed to the "OXYGEN MASK" position the five warning signs will flash on and off 40 times per minute. When this switch is placed in the "NORMAL" position an armed circuit is provided thru an aneroid switch, which will operate the warning circuit as cabin pressure reaches 14,000 ± 1000 feet. Operating power is 28 volts DC for the oxygen masks lights with circuit protection through a circuit breaker marked OXYGEN WARNING on T-R BUS NO. 2 of the MCBP. Operating power for the smoking and seat belt lights is 28 volts AC with circuit protection through circuit breakers marked NO SMOKING and FASTEN SEAT BELTS on the MCBP (figure 1-33, sheet 2).

ESCAPE ROPES

Four escape ropes (2 and 7, figure 3-1) enable the crew members to lower themselves from the airplane in an emergency. Two are located 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 covers. A hook is installed by the chinning bar latch above the crew entry chute, and for emergency ground egress, 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.

ESCAPE SLIDE

One escape slide, located at the aft escape hatch in compartment No. 4 (8, figure 3-1) is provided for rapid emergency exit of personnel from the airplane. See figure 3-7 for escape slide operation.

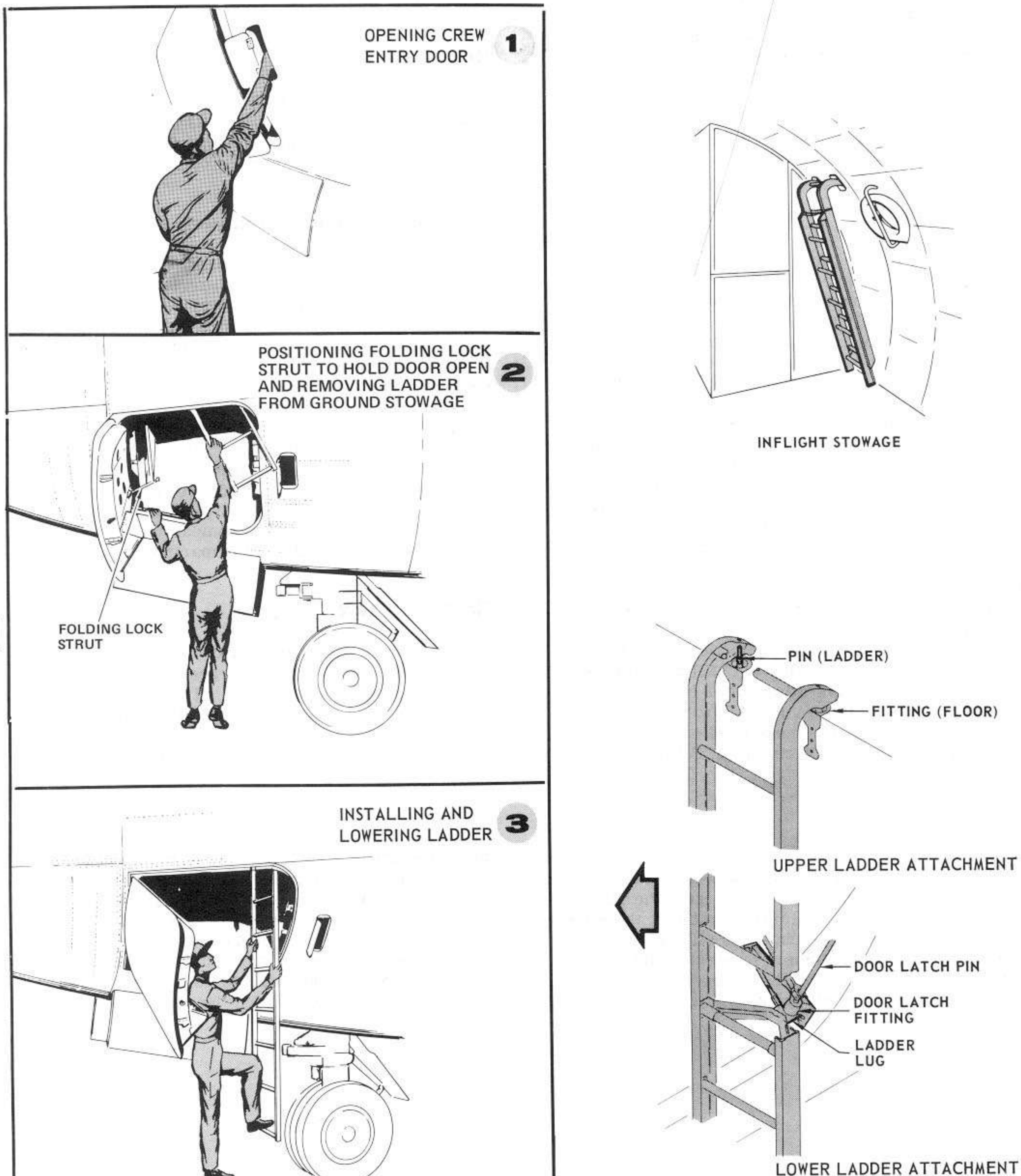
THERMAL RADIATION CURTAINS

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 curtain 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 (4, figure 3-1) are in the control cabin, adjacent to the cargo compartment windows and in the boom operator's compartment.

CREW ENTRY 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 lock 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 (7, figure 1-24) 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

entrance to airplane



F-1427

Figure 1-64

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 (4, figure 1-24) 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.

WARNING

The folding lock strut shall be positioned to hold the crew door open when personnel are utilizing this door for entry or exit.

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 1-17) 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 (11,figure 1-24) 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 (12, figure 1-24) 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.
- Make certain that the grille is completely latched open when entering or exiting the airplane. This will prevent the possibility of the grille dropping and causing personal injury.

CHINNING BAR

The crew entry door can be jettisoned for emergency exit by pulling the chinning bar (3, figure 1-60) 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 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. There are two black bands marked GRIP HERE, that indicate the proper hand location on the chinning bar for best emergency egress.

WARNING

- Depressurize 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 shall be installed prior to opening the crew entry door

CREW ENTRY LADDER

A 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 ladder telescopes for stowage and handling Inflight stowage is on the right side of the compartment No. 1 just aft of the electronics cabinet

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 1-65. 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.

pilots' seat

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.

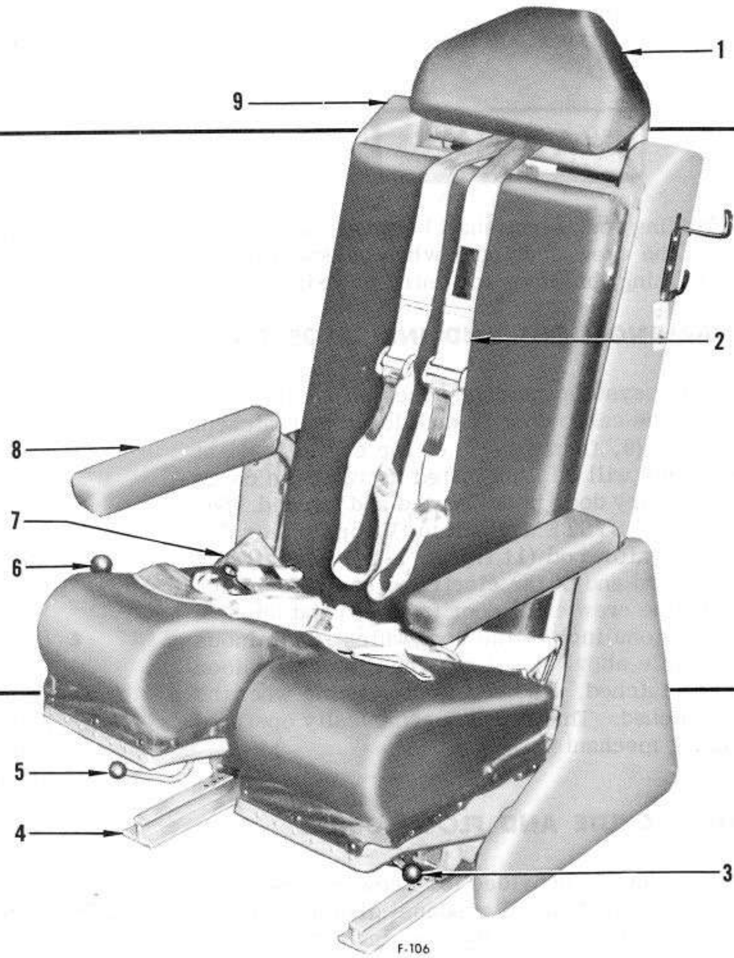


Figure 1-65

SHOULDER HARNESS INERTIA REEL LOCK HANDLE

A handle (3, figure 1-65) 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.

servicing

SERVICING SPECIFICATIONS

ITEM	LOCATION
FUEL USAF Specification MIL-J-5624 (JP-4) NATO Symbol F-40 **NOTE** See Section V for alternate fuels.	5 Wing Tanks 2 Reserve Wing Tanks 1 Forward Body Tank 1 Aft Body Tank (Above tanks may be filled through single point system)
ENGINE OIL USAF Specification MIL-L-7808F (USAF) **NOTE** Refer to ENGINE OIL LIMITATIONS in Section V.	**4 Engine Oil Tanks** **3 Generator Drive Oil Tanks** **1 Auxiliary Power Unit** **3 Pneumatic Starters** **1 Cartridge/Pneumatic Starter**
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
OXYGEN USAF Specification MIL-O-27210 NATO Symbol None available	3 Liquid Oxygen Converter Tanks (Two in LH aft toilet and one in RH aft toilet)
BATTERY Distilled Water CAUTION Nickel-cadmium batteries which appear to have dry plates do not necessarily require the addition of water. Refer to T.O. 1C-135(K)A-2-2 for correct servicing instructions.	1 In Crew Toilet

Figure 1-66 (Sheet 1 of 3)

servicing (cont)

SERVICING SPECIFICATIONS (cont)

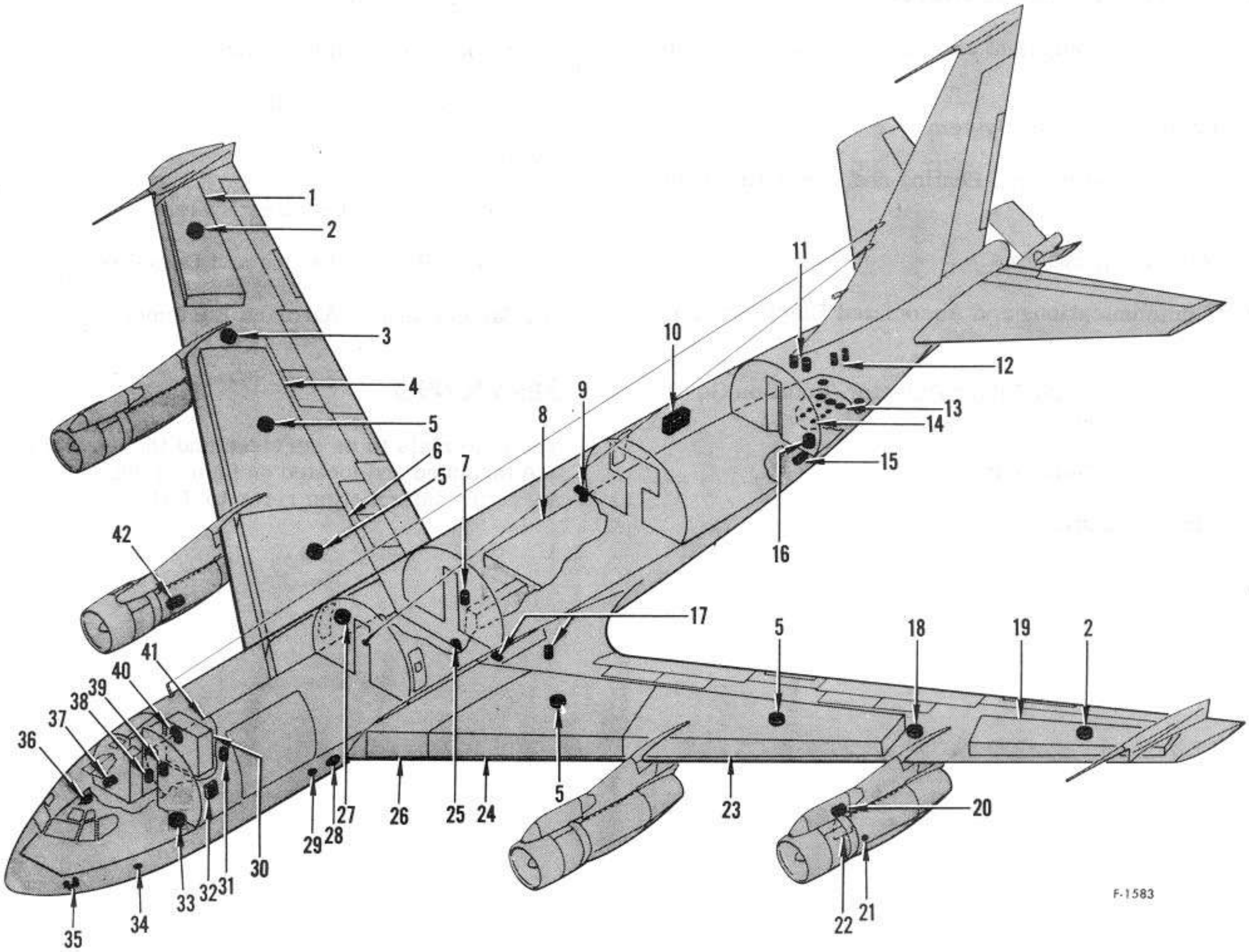
ITEM	LOCATION
AIR CYCLE MACHINES (ACM)	
BMS 3-7 Oil	1 Tank on ACM
CARTRIDGE STARTER	
Solid Propellant Cartridge MXU-4 A	1 on No. 3 engine, 2 spares stowed in main cabin
RAIN REPELLENT CONTAINERS	
Type 3 Repellent	2 Containers under navigator's table (Pressurized, not to be refilled)
SERVICING CARTS	
External Electrical Type MD-3 (or equivalent)	Connection on right side of fuselage, forward end
External Ground Blower Type A-2 (or equivalent)	Connection in crew entry chute
Starting Compressor Type MA-1A (or equivalent)	Connection on left side of fuselage near wing leading edge

ACCUMULATOR PRELOAD

MAIN SYSTEM ACCUMULATORS - 2000 PSI EQUIVALENT PRELOAD PRESSURES FOR VARYING TEMPERATURES			RUDDER POWER ACCUMULATOR - 1500 PSI EQUIVALENT PRELOAD PRESSURES FOR VARYING TEMPERATURES			RESERVE BRAKE ACCUMULATOR - 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	-50	750

◁ DENOTES NORMAL ACCUMULATOR PRELOAD FOR 70°F DAY

Figure 1-66 (Sheet 2 of 3)



1 NO. 4 RESERVE TANK
2 RESERVE TANK FUEL FILL PORT (2 PLACES)
3 RIGHT SYSTEM HYDRAULIC RESERVOIR
4 NO. 4 MAIN TANK
5 MAIN TANK FUEL FILL PORT (4 PLACES)
6 NO. 3 MAIN TANK
7 RIGHT SYSTEM ACCUMULATOR
8 AFT BODY TANK
9 ABT EXTERNAL FWD FILL PORT
10 GALLEY WATER CONTAINER
11 LAVATORY WATER CONTAINERS
12 RUDDER POWER ACCUMULATORS
13 OXYGEN CONVERTERS (THREE; TWO IN LH AFT TOILET AND ONE IN RH AFT TOILET)
14 LOX FILLER RECEPTACLES (THREE)
15 BOOM SYSTEM ACCUMULATOR (SIGHTING DOOR CAVITY)
16 BOOM HOIST HAND PUMP RESERVOIR
17 LEFT SYSTEM AND RESERVE BRAKE ACCUMULATORS
18 LEFT SYSTEM HYDRAULIC RESERVOIR
19 NO. 1 RESERVE TANK
20 AC GENERATOR DRIVE OIL TANK (ENGINES 1, 2 AND 4)
21 GENERATOR DRIVE FILLER PORTS (ENGINES 1, 2 AND 4)
22 ENGINE OIL TANK AND FILLER PORT (TYPICAL ALL ENGINES RH SIDE)
23 NO. 1 MAIN TANK
24 NO. 2 MAIN TANK
25 SINGLE POINT REFUELING/DEFUELING RECEPTACLE
26 CENTER WING TANK
27 CENTER WING TANK EXTERNAL FILL PORT
28 GROUND AIR SERVICING CONNECTION
29 LOW FREQUENCY ANTENNA HYDRAULIC MOTOR ACCUMULATOR (MOUNTED ON THE LH FORWARD BULKHEAD WITHIN THE CENTER WING EQUIPMENT BAY)
30 APU
31 CARGO DOOR PUMP RESERVOIR
32 SPARE STARTER CARTRIDGES (2)
33 BATTERY
34 CONDITIONED AIR CONNECTION (CREW COMPARTMENT)
35 EMERGENCY EXIT SPOILER AIR BOTTLE
36 RAIN REPELLENT CONTAINERS
37 SLIPWAY DOOR ACCUMULATOR
38 AIRPLANE EXTERNAL POWER RECEPTACLE
39 COMMUNICATION CENTER EXTERNAL POWER RECEPTACLE
40 FORWARD BODY TANK EXTERNAL FILL PORT
41 FORWARD BODY TANK
42 CARTRIDGE STARTER

Figure 1-66 (Sheet 3 of 3)

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. Auxiliary Power Unit

K. Air Refueling Tanker System

L. Air Refueling Receiver System

M. Single Point Refueling and Defueling

N. Miscellaneous Airplane Equipment

SERVICING

The materials to be serviced and the servicing points are tabulated and located on figure 1-66. For complete servicing information refer to T.O. 1C-135(K)A-2-2.

section II

NORMAL PROCEDURES

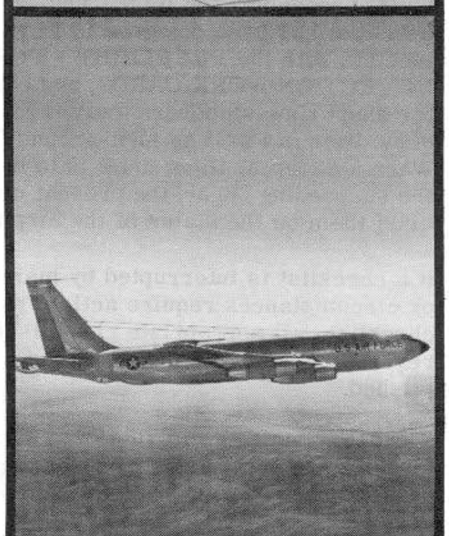


TABLE OF CONTENTS

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, (RO) Radio Operator, (MCCC) Missile Combat Crew Commander 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 indicate 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(*) preceeding the item. The Thru-Flight checklist has been designed to work in conjunction with the PREFLIGHT - POSTFLIGHT INSPECTION 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. Separate abbreviated checklists, T.O. 1C-135(E)C-1CL-1, are provided for the pilots. These checklists repeat the numbered line items of the amplified checklists but do 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 and initial climb procedures and emergency considerations will again be reviewed with the copilot just prior to takeoff. See 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 performance data from the Appendix, T.O. 1C-135(E)C-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 stopping 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 weight and center of gravity information. Refer to Section V, OPERATING LIMITATIONS, for weight and center of gravity limitations. Do not attempt takeoff or landing with the center of gravity 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

The aircrew visual inspection procedures outlined in this Section are predicated on the fact that maintenance personnel have completed all the requirements of T.O. 1C-135(K)A-6, Aircraft Scheduled Inspection and Maintenance Requirements, 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.

EXTERIOR INSPECTION

NOTE

- The ground crew will be at the airplane at the time of the flight crew's arrival to answer questions as to the status of the airplane and its systems. The crew chief will have the Form 781 available for the pilot, all dust covers and plugs removed, the wing flaps extended, and the hydraulic systems depressurized.
- Upon arrival at the airplane, the pilot will check with the ground crew to insure that the airplane is ready for preflight. While the pilot is performing the airplane safety check outlined below, the other crew members will load and stow all personal and professional equipment, unless previously accomplished, and initiate interior inspection.

* 1. Airplane Safety Check - Complete (P, GC)

*a. Nose Compartment Door - Closed

*b. Nose Door Actuators - Connected

CAUTION

Failure of the nose door linkage pins to actuate to the self-locked position may allow the pins to vibrate free during flight and result in the nose gear door(s) separating from the airplane.

*c. Forward Fairlead Section - Check

Open the forward fairlead section and check for evidence of hydraulic leaks, any mechanical interference between hoses, or loose fasteners.

*d. Fairlead Latches - Secure

Inspect the fairlead latches to ensure that they are secured.

NOTE

The pin located in the center of each rotary latch will not depress if the latch is secure.

EXTERIOR INSPECTION (Cont)

*e. Drogue - Inspect

Inspect the drogue to insure that it is properly nested.

NOTE

When properly nested, the drogue shall be immovable by hand.

WARNING

Do not stand directly behind the drogue at any time while making inspection.

*f. Manual Defueling Valve Access Cover - Closed

If access cover is closed, valve is in the closed position.

*g. Single Point Refueling Receptacle - Checked

Check for fuel leaks and security of cover.

*h. Ramp Area - Clear of foreign objects, maintenance stands, etc.

*i. Ground Safety Locks, Static Ground Wires and Pitot Covers - Removed

Pilot checks that ground crew has removed ground locks, static ground wires and pitot covers. (Ground crew may remove ground safety locks and static ground wires as EXTERIOR INSPECTION progresses.)

INTERIOR INSPECTION (CP reads)

(Copilot performs items 1 through 29 as the pilot is accomplishing the Exterior Inspection.)

* 1. Switchboard/Cabin Cooling Valve - SWITCHBOARD COOLING, locked (CP, RO)

Copilot will coordinate with radio operator to insure that valve is positioned for switchboard cooling.

CAUTION

Damage to auxiliary cooling system can occur if air conditioning system is operated with switchboard/cabin cooling valve improperly positioned.

* 2. Nose Gear Ground Down Lock and Release Handle - Stow (CP)

* 3. Circuit Breakers - Close (CP)

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

4A. Portable Oxygen Bottle - Checked (CP)

Insure the portable oxygen bottle at the pilot and copilot station is serviced and that the altitude selector knob is set to the NORMAL position.

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

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

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

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)

INTERIOR INSPECTION (Cont)

* c. Cabin Pressure Controller - Set
* d. Cabin Pressure Rate of Change Knob - Set
* e. Engine Bleed Switches - OPEN
* f. Air Conditioning Crossover Switch - OPEN
* g. Cabin Temperature Control - Set
* h. ACM Bypass Switch - NORMAL
* i. Main Cabin Air Conditioning Override Switch - OFF, guard closed
* j. Air Conditioning Master Switch - RAM AIR

7. Overhead Panel - Checked (CP)

Check all switches off or in proper position.

a. DC System Tie Switch - OFF

b. CSD Disconnect Switch - NORM

c. FD Mode Selectors - GYRO

* 8. Fire Switches - Checked IN (CP)

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

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

*11. Airplane Fuel Panel - Checked (CP)

All fuel valves CLOSED and all switches OFF.

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

*13. Throttles - CUT-OFF (CP)

14. Rudder Power Switch - OFF (CP)

14A. Window Heat Switches - OFF (CP)

*15. All Starter Switches - OFF (CP)

*16. Hydraulic Pressure Switches - OFF (CP)

17. Antenna Wire Cutter Controls - OFF and safety wired (CP)

Check pilot and copilot antenna wire cutter controls to ensure the arm switches are OFF and the cut switches are OFF and safety wired.

18. ALCC Switch - As required (CP)

Operation of switch will be accomplished upon request of MCCC IAW applicable command directives.

19. Drogue Deployed Lamp - Out (CP)

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

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

*21. Battery Power Switch - EMERGENCY (CP)

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

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

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

*23. Main External Power - Checked, switch CLOSE (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.

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

Check voltage on T-R1 and T-R2

a. Comm Ctr Power Switch - As required

If external power is not connected to the aft external power receptacle, the communication center airplane power switch must be moved to ON position to check T-R3 and T-R4.

*25. Battery Power Switch - NORMAL (CP)

*25A. FD No. 1 and No. 2 Master Power Switches - ON (CP)

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

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

*27. RGA Power Switches - ON (CP)

*28. ARR Panel - Checked (CP)

a. Master Refuel Switch - ON

b. Lights - Check

Check all press-to-test indicator lights which are not illuminated.

c. Slipway Door Switches - CLOSED

d. Main ARR Valve - CLOSED

e. Manifold Valves Switch - FLIGHT

f. Fuel Level Control Switches - CLOSED

g. Scavenge Pump - OFF

h. Reverse Refuel Pumps - OFF

i. Manual Toggle Latch Switch - RELEASE

j. Signal Amplifier Power Switch - NORMAL

k. Master Refuel Switch - OFF

Turn master refuel switch OFF after manifold valves NOT IN FLIGHT light goes out.

INTERIOR INSPECTION (Cont)

*29. Required Publications - Complete (CP)

29A. Parachute Preflight - Complete, if required (P, CP)

a. Inspection Record - Inspection and repack date checked

b. Personal Locator Beacon Lanyard - Snapped/Unsnapped (as required)

For peacetime operations, the personal locator beacon lanyard must be configured for automatic operation. When mission requirements dictate the necessity to avoid detection, the lanyard must be configured for non-automatic (manual) operation.

c. Bailout Bottle Pressure and Hose Connector - Checked

d. Personnel Lowering Device - Check condition (if attached)

e. Canopy Release, Ripcord and Arming Knob - Checked for defects and security

f. Pack and Harness- General condition checked

g. Parachute Straps - Adjusted (as required)

*30. 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.

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

See Section IV for Oxygen Check.

*32. 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 crew member switches to CALL position and reports, "Interphone and oxygen checked."

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

INTERIOR INSPECTION (Cont)

33. 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. T/O ARM annunciators should remain illuminated.

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

d. 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, landing gear warning light knob, engine manifold low pressure warning light, engine oil low pressure warning light (No, 1, 2, 3, and 4), 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.

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

NOTE

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

*34. Battery Charging Current - Checked (P)

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

WARNING

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

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

a. Hydraulic Quantity - Checked (CP)

b. System Pressure Switches - ON (P)

Hydraulic quantity should indicate a minimum of 4.5 gallons.

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)

*37. Anti-Skid System - Checked (P)

a. Anti-Skid Indicators - 4 blanks

b. Anti-Skid Test Switch - INBD

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

c. Anti-Skid 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 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.

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

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

INTERIOR INSPECTION (Cont)

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

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

WARNING

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

*40. Hydraulic Pressure - Checked (P)

Left system, right system, and pilot's reserve brake pressure gages should read in the normal pressure range (2400 psi - 3050 psi).

*41. Gear-Warning Light - Extinguished (CP)

*42. 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"

*43. Inboard Spoiler Switch - NORMAL (P)

44. 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 Brakes - 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 Brakes - 0 degrees** (P)

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

"All spoilers down" (GC)

45. 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 up, 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 up, 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)

INTERIOR INSPECTION (Cont)

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 T.O. 1C-135(K)A-2-8 for further information.

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

Pilot checks for forward movement of trim control wheel and trim indicator. Ground crew reports movement of leading edge, "Stabilizer 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 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.

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 be caused by insufficient ram air pressure in the Q-spring. The control tab will streamline with an increase in ram air pressure (approx 70 KIAS) in the Q-inlet.

46. Flap, Speed Brakes Warning Horn and Emergency Flaps - Checked (P, CP)

NOTE

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

Check flap handle in 50 degree detent and turn the flap emergency master switch ON. Actuate the inbd and outbd emergency flap switches UP. Move the No. 3 throttle to the OPEN position and check for horn. Retard throttle. As flaps near the 30 degree position, advance throttle. Horn should not sound while flaps are passing through the 30 to 20 degree positions. While flaps are between the 30 and 20 degree positions, actuate the speed brake lever and check that horn sounds. Reset speed brake lever full forward and check for no horn until flaps reach approximately the 15 degree position. Retard No. 3 throttle. As the flaps approach 0 degrees, turn flap switches OFF, place flap handle in UP position, then turn the flap emergency master switch OFF. Pilots check visually to see that the leading edge flaps have retracted.

INTERIOR INSPECTION (Cont)

47. 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.

48. Altimeters - Checked and RESET (P); checked and STBY (CP)

a. Altimeters - Set, STBY flag in sight

Note altimeter reading. Ensure 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 and that both altimeters indicate within 75 feet of each other.

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.

*49. 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 degrees pitchup position.

50. 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 CMPTR flags appear. The appropriate red attitude warning lights should 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.

50A. 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 check that both ADI's indicate proper rotation commands.

51. Autopilot - Checked (P, CP)

Refer to 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 nose down position.

NOTE

Setting the stabilizer trim to full airplane nose down position during icing conditions may allow the nose down limit switch to freeze and prevent electric nose down trimming after takeoff.

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

Set mode selector switch to GYRO for taxiing.

NOTE

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

*53. 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 takeoff 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.

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

*55. Warning Signs - Set for takeoff (CP)

INTERIOR INSPECTION (Cont)

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

a. All 8 fuel boost pump switches ON, all other pump switches OFF (CP)

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

Check engine fuel manifold low pressure warning light extinguished.

c. Line Valve Switch - OPEN (CP)

*56A. 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.

57. ALCC Switch - OFF (P)

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.

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

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

*59. Battery Power Switch - OFF (P)

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

Pilot checks start switches and No. 3 start selector switch in the OFF position and requests GC to insert cartridge in starter. Refer to T.O. 1C-135(E)C-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.

61. Cockpit Thermal Radiation Curtains and Eye Protective Devices - Stowed and sealed or installed (as applicable (P, CP)

See ALERT PROCEDURES, this Section.

NOTE

- If, after the above 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.
- 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.

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. Main 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 reading 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 Lever - 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 engine, motor the engine with starter for 10 to 20 seconds with throttle in CUT-OFF.
- Under all conditions, if the throttle lever is inadvertently retarded to the CUT-OFF position, there will be an immediate flameout. Do not reopen the throttle lever. Introducing unburned fuel into the tailpipe area can create a fire hazard.

STARTING ENGINES AND BEFORE TAXIING (Cont)

NOTE

- If No. 3 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. Engine No. 1, 2, and 4 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 Starter

When starting No. 3 engine with a cartridge, move the No. 3 start switch to GROUND START and pull out the No. 3 start selector switch and hold it in CTG START position. After positive indication of rpm on the tachometer release the No. 3 start selector switch to OFF and upon reaching 12% engine rpm move the No. 3 throttle to START. When starting No. 3 engine pneumatically, actuate the start switch to GROUND START and place the selector switch to PNEU START. Upon reaching 15% engine rpm, move the No. 3 throttle to START. Movement of the throttle from CUT-OFF to START, in all cases, will be accomplished smoothly, in approximately one second. Pilot carefully observes fuel flow 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 external 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 start switch (followed by start selector switch, after a pneumatic start) to OFF and throttle to IDLE after passing 50% rpm. See Section V for cartridge starter limitations. Check hydraulic pump inoperative light extinguished. Hydraulic quantity should indicate a minimum of 4.0 gallons after engine start. If external pneumatic power is to be used for starting remaining engines, pilot will place No. 3 throttle into IDLE position; otherwise, advance throttle to 90-95% rpm for cross-starting.

NOTE

Use approximately 95% rpm for ambient temperatures above 60°F. Reduce rpm 1% for each 20°F below 60°F. If electrical power is available, observe EPR gage to insure that TRT is not exceeded.

CAUTION

- Due to high starting temperatures associated with cartridge starter operation, a man with a 50 pound CO_2 bottle or one 10 gallon bromochloromethane (CB) will be stationed adjacent to No. 3 engine during starting. The man should stand between the engine inlet and the plane of the starter turbine on right side of the engine.
- 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.

b. Pneumatic Starter

(1) Pilot reports "Ready to start No. 4" 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 1 second. Pilot carefully observes fuel flow and EGT for indication of hot start and observes oil pressure normal. 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. After reaching 50% rpm, the pilot will move the starter switch to OFF and place the throttle in IDLE. Check hydraulic pump inoperative light extinguished. Hydraulic quantity should indicate a minimum of 4.0 gallons after engine start.

NOTE

- During alert response, after one engine is running and advanced to TRT, 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, return the starter switch for the slowest engine to OFF, but 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. (See ELECTRICAL SYSTEM OPERATION, Section VII.) The generators may be placed on the line without rear coordination <u>only</u> if the comm ctr external power switch is in the ON position.

(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. 4 engine.

7. **GENERATOR SWITCHES—CLOSED (CP, RO, MCCC)**

NOTE

- The altimeters may go to STBY due to power interruption during power transfer.
- If the auxiliary cooling system is in operation, power interruption on the main airplane buses (such as during transfer from main external power to airplane generator power) may cause the compressor to shut down.

Refer to ELECTRICAL SYSTEM OPERATION, Section VII. Copilot will coordinate with radio operator and/or MCCC prior to putting the first generator on the line, if the comm ctr airplane power switch is in ON position. (Generators may be placed on the line without rear end coordination only if the comm ctr external power switch is in ON position.)

8. (Deleted)

9. **ROTATING BEACON AND NAVIGATION LIGHTS - BOTH ON, STEADY (CP)**

Both beacon light colors will be used.

10. **BATTERY SWITCH—NORMAL (P)**

11. **COMM CTR AIRPLANE POWER SWITCH — ON (CP, RO, MCCC)**

To utilize airplane power instead of communication center external power on the communication center buses, see COMMUNICATION CENTER EXTERNAL/AIRPLANE POWER TRANSFER, Section VII.

NOTE

Power interruption to the communication center will not occur when using uninterrupted power transfer procedures.

To utilize airplane power on the communication center buses when not on communication center external power, copilot will coordinate with radio operator and/or MCCC to ensure comm center/ALCC equipment is ready for power turn-on, then place comm center airplane power switch to ON. Copilot confirms airplane generator power is stable and notifies the RO/MCCC that power is stable so that comm center/ ALCC equipment can be placed in operation.

12. **EXTERNAL POWER, CHOCKS, AND INTERPHONE—REMOVE (P, GC)**

Clear the ground crew to disconnect external power and remove chocks. Ground crew reports: "Overwing 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."

STARTING ENGINES AND BEFORE TAXIING (Cont)

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 "13" thru "15" may be accomplished while waiting for the ground crew report.

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

After light is extinguished, release switch.

14. **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.

15. 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.

16. Radio Call - Completed (P, CP)

Request taxi and takeoff instructions.

17. **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.

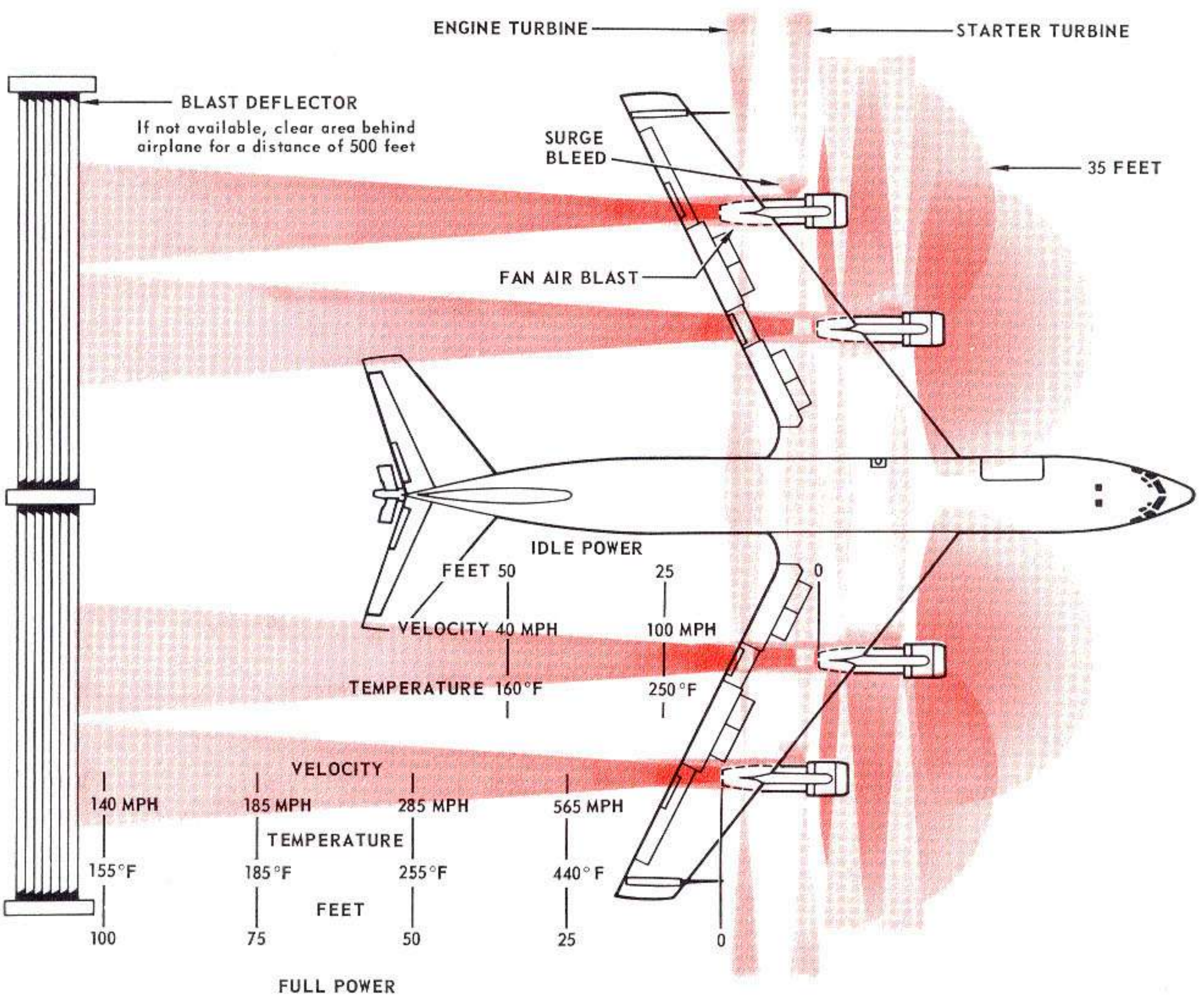
CAUTION

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

engine danger areas

WARNING

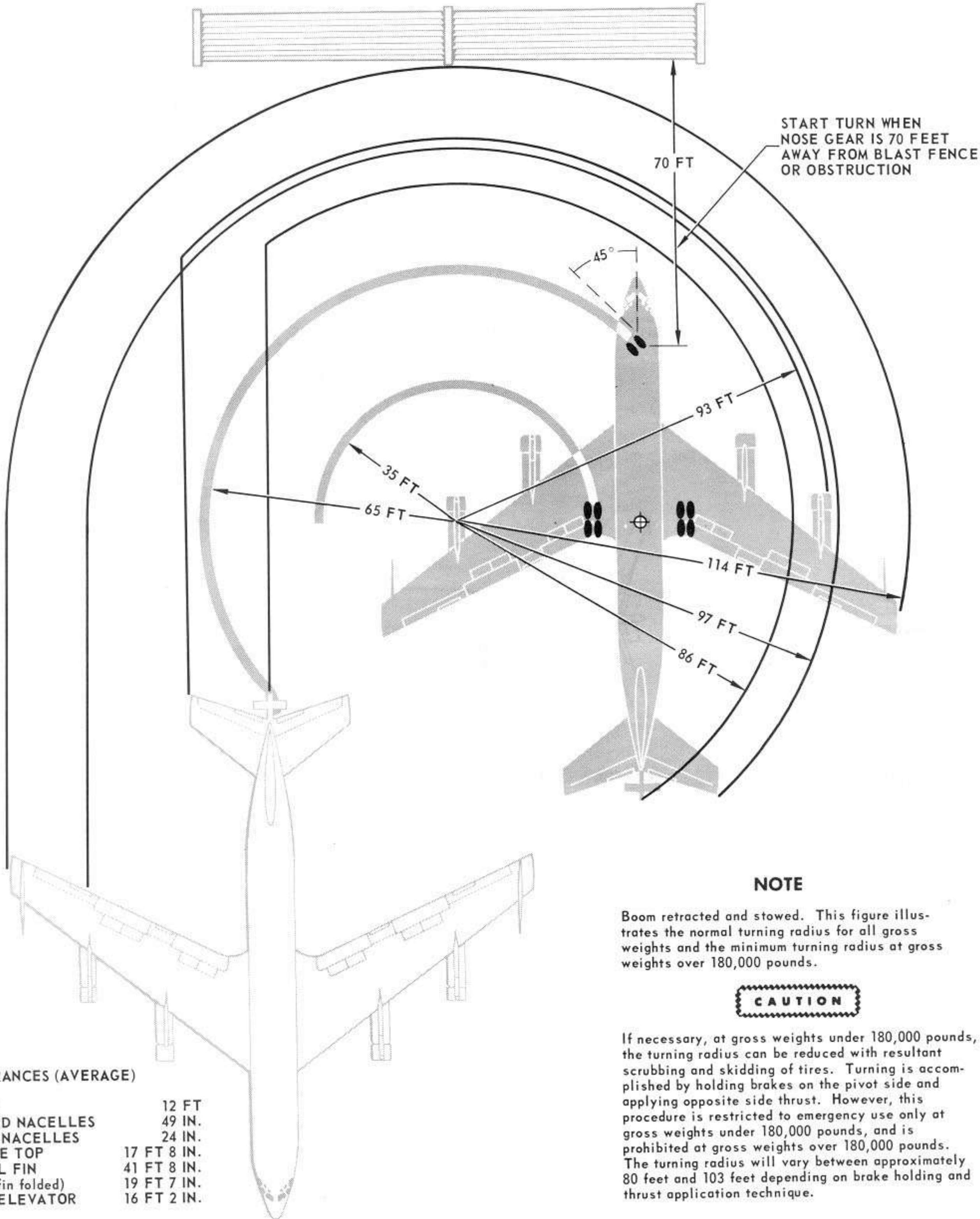
(FULL AND IDLE POWER)



F-528

Figure 2-1

minimum turning radius



CLEARANCES (AVERAGE)

WING TIP	12 FT
OUTBOARD NACELLES	49 IN.
INBOARD NACELLES	24 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.

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.

F-1478

Figure 2-2

ENGINE GROUND OPERATION

Only after prolonged soak at subzero temperatures is any engine warmup required. If other engine indications are normal, no minimum oil temperature need be observed for takeoff.

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 tha 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 deflection more than limits imposed by placard located behind 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 crewman can complete the check prior to takeoff.

TAXIING (CP reads) (Cont)

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

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, snow, or visibility 1 mile or less in fog) turn the engine anti-icing switch ON for taxi and takeoff.

CAUTION

In severe icing conditions (heavy supercooled fog, freezing rain or snow), ice buildup 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 director indicators (including turn and slip indicators), horizontal situation indicators, RMI's, and magnetic compasses for proper operation and indications during a turn in either direction.

5. Emergency Exit Lights Switch - ARMED (CP)

BEFORE TAKEOFF (CP reads)

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 nose-up). (Excessive control column push forces.)
b. Longer than predicted takeoff ground runs if the stabilizer is set too nose low (airplane nose down). (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 SWITCH — 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.

NOTE

Objects should not be placed on the control stand which may block access to or operation of the rudder power switch or warning horn cutout switch.

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.

8. **TAKEOFF DATA—CHECKED (P, CP)**

Recompute takeoff data (if applicable). Review EPR settings, and S_1 and rotation speeds. 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(E)C-1-1. Stabilizer trim setting should be recomputed for any increase in takeoff speed.

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%.

- 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)

When a certified ground checkpoint is available, check VOR/TACAN/Altimeter.

10. EPR Index - Set TRT (P, CP)

BEFORE TAKEOFF (Cont)

11. **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 if objects are not removed.

12. **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.

13. Oxygen - ON and 100% (P, CP)
14. Pressurization and Air Conditioning Panel - Set (CP)
15. **PITOT AND Q-INLET HEAT—AS REQUIRED (CP)**
16. **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.

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

WARNING

The AC-CL position will not be used for EWO operations. 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

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

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

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

Copilot announces over interphone "Takeoff report." Each crewmember will respond with "Ready for takeoff," prefixed by crew position in the order boom operator, navigator and copilot. If passengers and/or additional crew personnel have been onloaded between the completion of the Taxi Report and the Takeoff Report, ensure that all doors and hatches are rechecked, closed, and latched, and the cargo door or hatch not latched warning light is extinguished.

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(E)C-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(E)C-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 degrees or 8 degrees 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(E)C-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(E)C-1-1.

Thrust Settings

Since EPR is the only engine parameter that indicates thrust, the charted EPR values as given in Part 2 of the Appendix, T.O. 1C-135(E)C-1-1, shall not be exceeded. The charted EPR setting should be corrected in accordance with existing instructions when air conditioning is to be used. If an engine fails to reach the EPR setting for TRT between 40 and 80 knots, the takeoff shall be aborted.

Takeoff Planning

Adequate takeoff planning must always include the possibility of loss of thrust or other malfunction during the takeoff run. Pilots must be prepared to cope with any circumstance which may require optimum technique in order to safety complete the takeoff. Refer to TAKEOFF EMERGENCIES, Section III.

WARNING

- Do not attempt to take off 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 10,500 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

As the airplane is aligned with the runway, advance throttles smoothly so that TRT is obtained between 40 and 80 knots. Do not change throttle position during the remainder of the takeoff, except to avoid exceeding EGT or RPM limits.

STATIC TAKEOFF

After the airplane is aligned with the runway, the pilot will hold with brakes and advance the throttles to approximately 1.2 EPR. After the engines have stabilized, brakes will be released and throttles advanced smoothly so as to obtain TRT between 40 and 80 knots.

ALL TAKEOFFS

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 ensure 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 1A2-21, 1A10-9, 1A10-10) 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.

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(E)C-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(E)C-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(E)C-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.

GEAR RETRACTION

After the airplane is definitely airborne and a positive rate of climb is established (vertical velocity pointer above 0), retract the landing gear.

NOTE

The drag produced by the open gear doors while the gear is in transit, plus the retarding effect of the automatically braked wheels if they touch down again, will preclude any benefit realized from premature gear retraction.

TAKEOFF (CP reads through item 4)

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 - As required (CP)

   Rotating beacon and navigation lights as required and landing lights ON. Landing lights need not be operated if reflections cause distractions while operating in instrument flight conditions. Unless otherwise restricted by operational commitments, both beacon lights colors will be used.

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 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. Throttles - Set TRT (P, CP)

   For running takeoffs, as the airplane is aligned with the runway, advance the throttles slowly to obtain TRT between 40 and 80 knots. For static takeoffs, advance the throttles to obtain approximately 1.2 EPR on all engines before releasing brakes. After brakes have been released, advance throttles smoothly to obtain TRT 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.

   WARNING

   If any engine does not reach the charted EPR setting, the engine is not providing the required rated thrust, and the takeoff will not be accomplished.

typical takeoff and initial climb

TAKEOFF
LIGHTS AS REQUIRED
STARTER SWITCHES FLIGHT START, THROTTLE BRAKE, EPR, ENGINE INSTRUMENTS, STABILIZER TRIM, FIRE WARNING LIGHTS, CONTROL COLUMN

A1 RUNNING TAKEOFF
ENTER RUNWAY, SET EPR

A2 STATIC TAKEOFF
LINE UP, HOLD WITH BRAKES, SET EPR

B AIRSPEED INDICATOR COMPARISON

C S_1

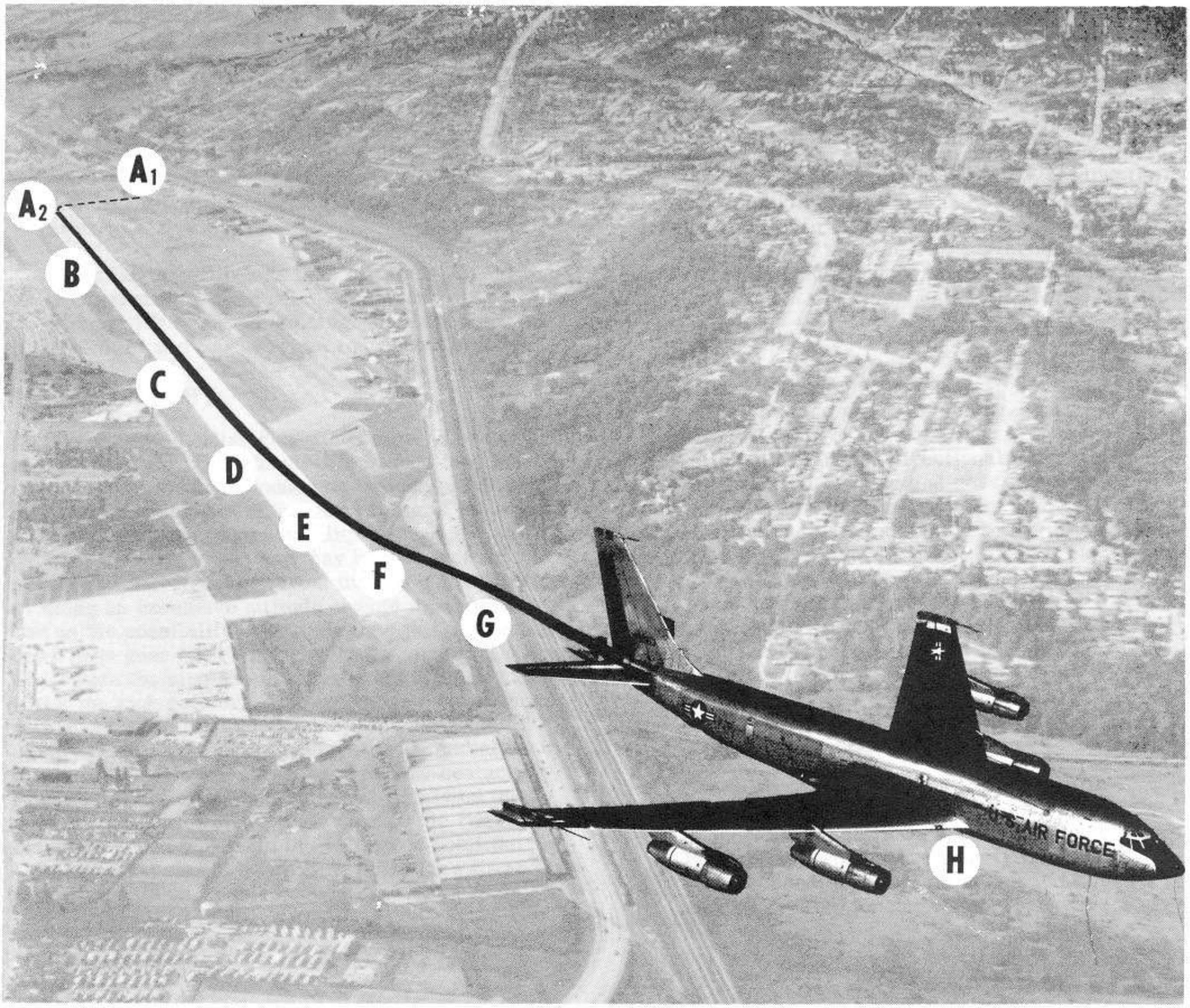
D ROTATION SPEED

E GEAR UP, TRIM

F CLIMB OUT AT CLIMBOUT SPEED

G RETRACT FLAPS PER SCHEDULE

H SET CLIMB POWER, ENGINE ANTI-ICING, STARTER SWITCHES, AUTO PILOT



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F-1394

Figure 2-3

TAKEOFF (CP reads) (Cont)

CAUTION

- During a static takeoff, the pilot must anticipate a possible pitchup at brake release due to the large amount of thrust available. Refer to AIRPLANE PITCHUP DUE TO AFT CG CONDITION, this section.
- On turbofan engines, under certain gusty crosswind conditions when operating statically, engine compressor stall may be encountered on upwind engines while advancing throttles. See ENGINE COMPRESSOR STALL, Section VII, for a discussion of this characteristic.
- Exceeding charted EPR can cause rapid engine deterioration.

NOTE

- If the charted EGT limit (from figure 5-2 of Section V) is reached before the computed EPR for TRT is obtained, the takeoff should not be continued.
- 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.
- If airplane starts to slide on ice or snow during application of thrust for a static takeoff, release brakes immediately and begin takeoff run.

5. 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.

6. 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.

7. 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

Takeoff will not be aborted after S_1 unless in the opinion of the pilot, the emergency renders the aircraft 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.

TAKEOFF (Cont)

8. 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 (FD 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 command 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(E)C-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 speeds plus the allowable speed deviation in figures 1A3-8 and 1A11-8. 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 unstick point. In either mode, acceleration to the proper airspeed is very important since 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 until reaching 1,000 feet above the runway or obstacle clearance height, whichever is higher. If the flaps are still extended, retract them per flap retraction speed schedule in Part 3 of the Appendix, T.O. 1C-135(E)C-1-1. At this point, select HDG or NAV LOC mode with the flight director mode selector switch, decrease rate of climb, and accelerate. Adjust the manual pitch command knob to set the command bars for desired climb 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 2,000 feet above the runway.

WARNING

- If the flight director command bars fail during or immediately after takeoff, climb out at recommended 3-engine climbout airspeed (3 engines) or recommended 3-engine climbout airspeed + 10 knots (4 engines) with the takeoff flap setting (4-engine climbout speed for EWO). If the command bars fail after initiating flap retraction, climb out using speed attained at end of flap retraction. Continue climbout to 1,000 feet above the runway or obstacle clearance height, whichever is higher.
- 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

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 for pitch control during constant 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's commands are not influenced by this 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 three engine climbout speed plus allowable speed deviation (with three engine), 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)

With four engines operating, accelerate to the recommended three engine climbout speed + 10 knots and climbout to 1,000 feet above the runway or obstacle clearance height, whichever is higher, using the command bars for pitch commands. The command bars will direct an attitude which closely approximates the attitude provided by recommended flight manual climbout speeds plus the allowable speed deviation in figures 1A3-8 and 1A11-8. See parts 3 and 11 of the Appendix, T. O. 1C-135(E)C-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 three engine climbout speed or exceeds recommended three engine climbout speed plus the allowable speed deviation (three engines operating) or three engine climbout speed plus 10 knots plus the allowable speed deviation (four engines operating) the command bars are not giving the proper climb 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 to .8 after takeoff flare at 4-engine climbout speed and up to .86 at 3-engine climbout speed.

NOTE

For EWO operations (MAX mode), the speed range is from 4-engine climbout speed to 4-engine climbout speed plus allowable speed deviation.

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 three engine climbout speed; if an engine failure occurs after attaining three 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.

If maneuvering is required immediately after takeoff or prior to flap retraction, maintain required airspeeds and as little bank as possible to complete the manuever. Climbout performance is not significantly reduced if the angle of bank does not exceed 10 degrees.

NOTE

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 three-engine climbout speed + 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 by following engine-out procedures.

ACCELERATED CLIMB MODE (AC-CL)

With three or four engines operating, climb out using the command bars for pitch commands. The RGA system is programmed to command a nosedown pitch change during climbout at the rate of one 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). 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 the command bars until reaching 1,000 feet above the runway unless a higher altitude is dictated by obstacle clearance.

WARNING

- Prior to flap retraction, do not allow airspeed to fall below the minimum recommended flight manual climbout airspeed (3 or 4 engines).
- 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.

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. Takeoff flap settings should be as indicated in Part 2 of the Appendix, T.O. 1C-135(E)C-1-1. For flap procedures on takeoffs see FLAP RETRACTION SPEED SCHEDULE, Part 3 of the Appendix, T.O. 1C-135(E)C-1-1.

ENROUTE CLIMB

Climbs should be made at normal rated thrust since climbs at less than normal rated thrust will result in a loss of range because of the excessive time spent in climbing.

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.

CLIMB DATA

A study of the climb charts, Part 4 of the Appendix, T.O. 1C-135(E)C-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)

NOTE

To help prevent cockpit distractions during this critical phase of flight, only items 1 thru 6 need be accomplished as soon as practical after takeoff.

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 (200 feet - AC-CL mode, 1,000 feet - MAX mode, or obstacle clearance altitude, whichever is higher), 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.

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.

3. Climb Thrust - Set (CP)

Climb thrust will be checked and readjusted as necessary during the climb at approximately 10,000 foot intervals.

4. Engine Anti-Icing Switch - As required (CP)

If engine anti-icing was used during takeoff, the engine anti-icing switch may be returned to the OFF position when engine icing conditions no longer exist.

CAUTION

- Before turning on engine anti-ice, set engine ignition switches to FLIGHT START and then turn engine anti-ice switch ON. This procedure is to prevent engine surge or flame-out. As soon as RPM and EPR stabilize, turn engine ignition OFF.
- 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.

5. Starter Switches - OFF (P)

Perform this step after establishing climb power.

6. Autopilot - Rudder axis ON, aileron and elevator axis as required (P)

Complete the autopilot FLIGHT check in Section IV, before engaging the 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.

7. Fuel Panel - Set (P, CP)

Place all four tank to engine manifold valve switches to OPEN and turn override pumps on. Close air refueling line valve switch.

8. Warning Signs - As desired (CP)

AFTER TAKEOFF—CLIMB (Cont)

9. Slipway Doors - OPEN, CLOSED (CP)

The doors will be opened for approximately 30 seconds, then closed to insure any accumulated moisture due to clogged drains is eliminated.

NOTE

Do not exercise the slipway doors when climbing through visible precipitation or known icing conditions as the doors may be rendered inoperative due to freezing.

10. RGA Power Switches - OFF (P, CP)

11. 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.

12. Landing Lights - OFF (CP)

13. Altimeters - Set at 29.92 (as applicable) (P, CP, N)

Set altimeter to 29.92 in. Hg when climbing through transition altitude. Pilot and copilot set radio altimeter MDA index to 2000 feet. Pilot and copilot will periodically crosscheck altimeter readings inflight. 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.

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(E)C-1-1.

The cruise Mach number should be checked frequently by means of the airspeed indicator. 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 thirty minutes. Excess speed acquired during level flight with constant power will be used to climb to the proper altitude for the airplane gross weight. Refer to Part 4 of the Appendix, T.O. 1C-135(E)C-1-1, for additional information.

FUEL SYSTEM ICING

The first indication of fuel system icing will be evidenced by erratic engine operation. When fuel system icing is evident, consideration should be given to landing as soon as practicable. When using emergency fuel or when fuel icing is suspected, the following precautions should be observed. Every 2 hours, when above 25,000 feet altitude, move the throttles slowly from cruise power to NRT to cruise power, two engines at a time. When moving the throttles, monitor fuel flow for fluctuations. 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

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 between "0" and "2" trim units nose down to keep the cg 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.

CRUISE WITH AN/ARC-96 INSTALLED

Close coordination between the flight crew and the trailing wire antenna operator are required during all normal and emergency procedures for the TWA system. In addition, the pilot must consider the performance degradation for the ARC-96 system as outlined in the Appendix, T.O. 1C-135(E)C-1-1.

CAUTION

- Do not operate any equipment on the airplane right hydraulic system except rudder boost, copilot instrument power generator, and outboard spoilers during trailing wire antenna extend or retract operation.
- Extension of the landing gear should be avoided with the trailing wire antenna deployed except in emergency. Damage to the antenna, antenna housing, or landing gear doors could occur. If the gear is extended while the antenna is deployed, the right gear door will contact the antenna approximately 3 feet aft of the antenna housing. This is due to TWA housing location, and would result in approximately a 2-foot antenna displacement by the gear door for full gear door opening. With high antenna tension loads, this could cause breakage of the antenna wire, damage to the antenna housing or damage to the gear doors. Door opening could be restricted which in turn would prevent right gear extension. Further, if antenna was deployed between 1 and 14 feet, the drogue would be located between the gear doors when they opened. Since the drogue is larger than the space between the gear doors when opened, damage could occur to the drogue or gear doors, or prevent full gear door opening, and thus hamper gear extension.

- Close coordination between TWAO and pilot is essential during wire operations. The TWAO will notify pilot prior to initiating each extend and retract cycle. The boom operator or other designated observer will be on interphone in the boom pod to observe the drogue and cable during the first 1,000 feet of extension and the final 1,000 feet of retraction. He will report estimated length and any irregular or unstable movement of the drogue or cable to the wire operator.

TWA droop chart

DATA BASIS: FLIGHT TEST

CONDITIONS: 222 KCAS

NOTE

A 14 KNOT DEVIATION IN AIRSPEED WILL RAISE OR LOWER THE DROGUE APPROXIMATELY 100 FEET WHEN AT MAXIMUM EXTENSION.

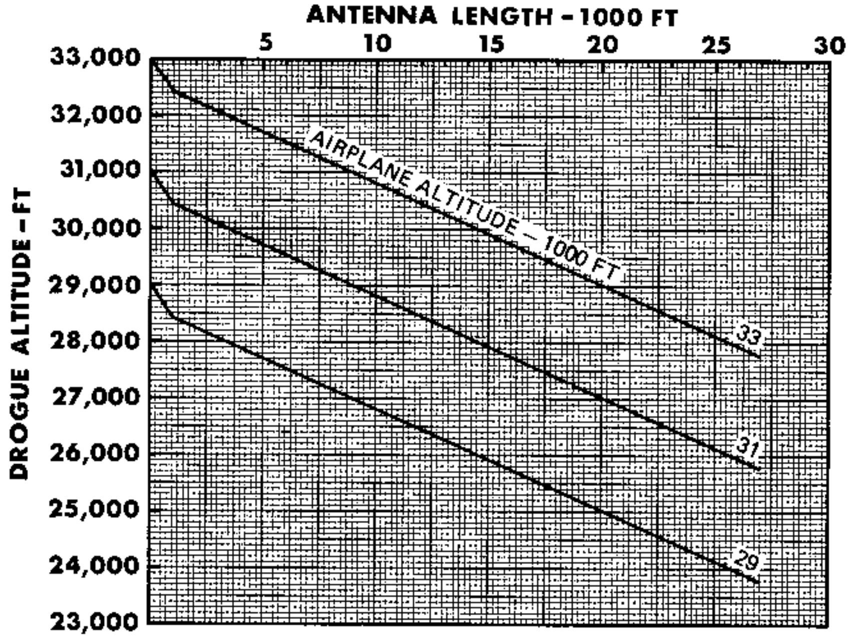


Figure 2-3A

During operation of the trailing wire antenna, the following airplane limitations will be observed.

a. Altitude - 31,000 (±1000) ft (normal planning altitude)

b. Bank Angle - 15°

Bank angles up to 15° are permissible at all fixed antenna lengths when the VLF speed control is OFF and the brakes switch is ON.

c. Airspeed - 223 to 338 knots calibrated airspeed

CAUTION

If turbulance (moderate or greater) is encountered during operation of the antenna, system operation shall be stopped until clear of the turbulence or cable breakage may result.

NOTE

- Extend or retract operation of the trailing wire antenna will normally not be performed during airplane turns. If a turn is required, pilot will notify TWAO to stop antenna operation prior to initiating the turn. After completion of the turn pilot will notify TWAO, turn complete. The airplane is permitted to make a turn during extend or retract operation if the antenna tension is less than 500 lbs. During the turn, the VLF speed control shall be in EXTEND 1 or RETRACT 1 position and the airplane bank angle shall not exceed 15 degrees. (Bank angles should be held to 2 degrees or less while changing antenna, lengths when tension is in excess of 500 lbs.)
- The airplane should not be turned more than 360 degrees when the trailing wire antenna is extended due to the excessive droop of the drogue. Continuous turns should be avoided at all times.

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(E)C,-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(E)C-1-1.

FLIGHT CHARACTERISTICS

Refer to Section VI.

AIR REFUELING

Refer to T.O. 1-1C-1, T.O. 1C-135(E)C-1-1 and Section IV of this manual.

DESCENT TO CRUISE OR HOLDING ALTITUDE

Descent may be accomplished by retarding 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 1.5 EPR at 40,000 feet and reducing 0.15 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 FPM 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.

JET 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 call off altitudes to the pilot passing each multiple of 5000 feet down to level-off altitude by stating over interphone, "Passing ____ feet for ____ feet." He will continue altitude calls passing 2000 feet and 1000 feet above any assigned or published level-off altitude by stating, "Passing ____ feet for ____ feet." In addition, the pilot will be alerted 100 feet above level-off altitude.

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 conditions 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 brake, 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. Extreme caution should be used any time rates of descent are required that exceed 5000 feet per minute, due to the limitations of the vertical velocity indicator.

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. See 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(E)C-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 12., "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.

   CAUTION

   On the ground with the cg at more than approximately 35% MAC, the airplane can be tipped over on the boom by movement of very few persons or cargo to the aft end of the airplane.

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 transition level, any intermediate altitude restrictions, minimum altitude, and minimum visibility for the type approach, and missed approach procedures. Notify crew to prepare for landing.

4. Radio Altimeters - Set (P, CP)

The pilot flying the approach will set the radio altimeter MDA index to the HAT or HAA for the approach being flown. The other pilot will leave his MDA index set at 2000 feet until the MDA indicator illuminates. He will then announce "Passing 2000 feet AGL" to the crew and set his MDA index to 100 feet above HAT or HAA.

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.

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

6. 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

Before turning on engine anti-ice, set engine ignition switches to FLIGHT START and then turn engine anti-ice switch ON. 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.

7. Electrical Power System Indicators - Checked (CP)

8. Autopilot - Rudder axis ON, other axis as desired (P)

9. SEAT BELT Sign - ON (CP)

10. Cabin Pressure Controller - Set at 500 feet above field pressure altitude (CP)

11. Hydraulic System, Brakes and Rudder - Checked (P, CP)

Pilot checks pressure switches ON, and checks pressures on left, right, reserve brake and 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 occuring. The pilot who will accomplish the braking during ground roll will check brakes last.

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

Set altimeters to station pressure immediately prior to initiating penetration or upon passing transition level.

12A. Landing Lights - ON (CP)

Landing lights will be ON unless reflections cause distractions in instrument flight conditions.

13. Throttles - IDLE, or as required (P)

14. 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 cutout switch 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.

15. Altitude Calls - Report, as required (N, P, CP)

If the navigator is unable to make required altitude calls, the pilot not flying the airplane will ensure that all altitude calls are made. He will call off altitudes passing each multiple of 5000 feet down to level-off altitude by stating, "Passing_____feet for _____feet." He will continue altitude calls passing 2000 feet and 1000 feet above any assigned or published level-off altitude by stating, "Passing/_____ feet for _____feet." In addition, he will alert the pilot 100 feet above level-off altitude and the applicable DH or MDA.

16. Antiskid System - 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 2 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.

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 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 degrees 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 degrees flap approach speed.

NOTE

- Instrument approach procedures are discussed in Section IX.
- Approaches with less than 50 degrees flaps will be flown at the appropriate approach speed.
- 50 degree flap approaches will not be planned with less than four engine operation or with rudder power inoperative.

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 takeoffs and landings with fuel in any main tank below 10,500 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.

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°, however, the pilot may elect to land with flaps set at 40° 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° 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, considerations should be given to using 50° flaps when stopping distance is critical, when the RCR value is 9 or less, or when touchdown speed must be increased by 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.

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.

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 shortly after alignment with the extended runway centerline. 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 centerline 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. 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.

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. Refer to Part 9 of the Appendix, T.O. 1C-135(E)C-1-1, for maximum crosswind component and flap setting.

WARNING

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.

LANDING ON SLIPPERY RUNWAYS

If a landing must be made on a wet or icy runway and 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(E)C-1-1, to insure 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. If crosswind conditions permit, 50° flaps should be used. 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 practical 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 crosswing effects, landing ground roll distances should be increased. Refer to Part 9 of T.O. 1C-135(E)C-1-1.

BEFORE LANDING (CP reads)

1. Speed Brakes - 0 degrees (P)

WARNING

Speed brakes shall not be used at any time below 1000 feet above field elevation during the final approach phase.

2. Autopilot - Disengaged (P)

Disengage autopilot unless to be used in 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 3 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 - Checked if required (P)

   Check antiskid system, if not previously accomplished.

   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 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.

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 Lights - ON (CP)

    Landing lights will be ON unless reflections cause distractions in instrument flight conditions.

11. NO SMOKING Sign - ON (CP)

12. 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.

13. Fuel Panel - Set for landing (P, CP)

All eight boost pumps on, tank to engine manifold valves as required.

14. Flaps - 50 degrees (P, CP)

With four 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 pushbutton switch.

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 have been extended further.

e. Retract the landing gear after descent ceases and a rate of climb has been established. If a climb-out 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 becomes 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(E)C-1-1.

Time and fuel allowance for go-around is 5 minutes and 2500 pounds of fuel.

GO-AROUND

1. RGA Switch - Actuated (P, CP)
2. Throttles - Increase thrust as required (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 required.

6. Speed - Maintain pattern speed (P)

typical landing and go-around

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(E)C-1-1.

A ENTERING TRAFFIC PATTERN

Speed Brakes – 0 degrees
Altitude – Local specified
Flaps – 30 degrees
Speed – 30° flap pattern speed
Landing gear down
Power as required

B BEFORE TURNING BASE LEG

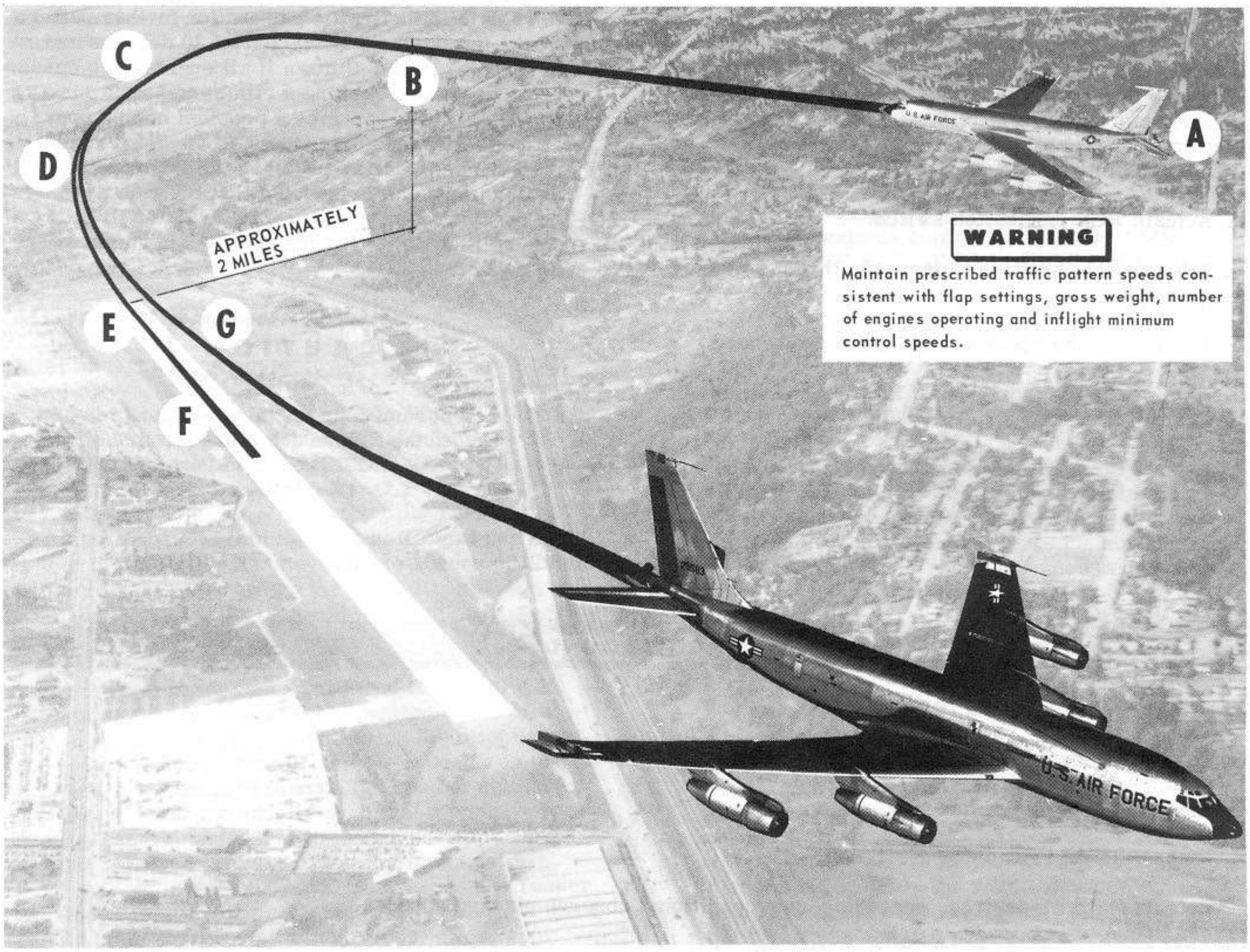
Altitude – Local specified
Flaps – 30 degrees
Speed – 30° flap pattern speed

C BASE LEG (See WARNING)

Altitude – Approx 1000 feet
Flaps – 40 degrees
Speed – 40° flap pattern speed

D FINAL APPROACH

Altitude – As required
Flaps – 50 degrees
Speed – 50° flap approach speed
autopilot disengaged



WARNING

Maintain prescribed traffic pattern speeds consistent with flap settings, gross weight, number of engines operating and inflight minimum control speeds.

E OVER END OF RUNWAY

Threshold speed

F TOUCHDOWN

Throttles to idle
Speed brakes up when in three point attitude

G GO-AROUND PATTERN

Actuate RGA switch
Increase thrust
Speed brakes – 0 degrees
Retract flaps to 30 degrees
Retract landing gear
Speed – 30 degree flap pattern speed
Trim as required

F-1394
F-1396
F-1466

Figure 2-4

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 and landing; however, speeds must be recomputed after each 10,000-pound 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 3 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 Lights - ON (CP)

   Landing lights will be ON unless reflections cause distractions in instrument flight conditions.

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.

TRAFFIC PATTERN (Cont)

11. Fuel Panel - Set for landing (P, CP)

All eight boost pumps on tank to engine manifold valves as required.

12. Flaps - 50 degrees (P, CP)

Flaps may be lowered to 50 degrees after starting turn to final approach. See Section IX for flap procedures during instrument approaches.

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.

TOUCH AND GO LANDING

NOTE

- Touch and go landings introduce a significant element of danger because of the many rapid actions which must be executed while rolling on the runway at high speed or while flying within the immediate proximity of the ground. Compute takeoff and inflight minimum control speed and use whichever is higher.
- This checklist will be accomplished on the runway.
- 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 full charted EPR (P, CP)

This will allow time for equal engine acceleration. Use charted EPR as a target thrust setting. Refer to MAXIMUM RECOMMENDED EPR FOR TOUCH AND GO LANDINGS in the Appendix, T.O. 1C-135(E)C-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.

MULTIPLE FULL STOP LANDINGS (CP reads)

AFTER LANDING

1. Lights - As required (CP)

   Rotating beacon lights BOTH ON, navigation lights BRIGHT and STEADY, and taxi/landing 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__________, S1__________, 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. Takeoff Report - Completed (BO, N, CP)
7. Lights - As required (CP)

   Rotating beacon and navigation lights as required and landing lights ON. Landing lights need not be operated if reflections cause distractions in instrument flight conditions.

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.

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 breakes 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 wheel steering, and differential braking in that order.

CAUTION

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 wheel 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. (Deleted)
3. Starter Switches - OFF (P)
4. Lights - As required (CP)

   Rotating beacon lights BOTH ON, navigation lights BRIGHT and STEADY, and taxi/landing lights as required.
5. Anti-Icing Equipment Q-Inlet Heat and Pitot Heat - OFF (P, CP)

   Window heat may be left on if required.
6. Flaps - UP (CP)
7. Speed Brakes - 0 degrees (P)
8. Cabin Manual Pressure Control - FULL DECREASE (CP)

   Check cabin altimeter to see that cabin is fully depressurized before any hatch is opened.
9. Air Conditioning Master Switch - RAM AIR (CP)
10. Pilots' Search Radar Intensity Control - Full CCW (CP, N)

    Turn intensity control full counterclockwise.
11. FD Mode Selector Switches - GYRO (P, CP)

12. 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, throttles will be advanced to 75% rpm for not less than 15 nor more than 30 seconds to provide proper oil scavenging.

NOTE

During shutdown, if any generator breaker light does not illuminate prior to the engine rpm decreasing to 20%, manually trip the breaker and record in the Form 781.

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. ALCC Switch - OFF (P)

Operation of switch will be accomplished upon request of MCCC IAW applicable command directives.

STEPS 3 & 4 TO BE ACCOMPLISHED ONLY IF COMM CENTER EQUIPMENT TO BE OPERATED AFTER ENGINE SHUTDOWN

3. External Power - Connected to aft receptacle (CP, GC)

Copilot and ground crew coordinate external power connected to the aft external power receptacle. Move the voltmeter and frequency meter selector switch to the COMM CTR EXT POWER position and check frequency and voltage within limits.

4. Comm Ctr External Power Switch - ON (CP)

Power transfer can be accomplished without power interruption. See COMMUNICATION CENTER EXTERNAL/AIRPLANE POWER TRANSFER, Section VII.

5. Battery Power Switch - EMERGENCY (P)

6. Throttles - 75% (P)

7. Throttles - CUT-OFF (P, CP)

Copilot will coordinate with radio operator and MCCC to insure rear end equipment is ready for power source changeover before shutting down the engines. Before shutting down, establish interphone contact with ground crew, advance throttles 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 1 minute after landing, alow 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.

NOTE

During shutdown, if any generator breaker light does not illuminate prior to the engine rpm decreasing to 20%, manually TRIP the breaker and record in the Form 781.

ENGINE SHUTDOWN (Cont)

8. Main External Power Switch - CLOSE, if external power available (CP)
9. Oxygen Supply Lever - OFF and 100% (P, CP)
10. 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
    f. Radios and Autopilot
    g. Hydraulic Pressure Switches

NOTE

Delay placing switches to OFF until engine rpm stops decreasing or is below 10%. This should avoid fluid spillage overboard caused by splashing fluid into the reservoir vent at high engine rpm with switches OFF.

    h. Lights
    i. Warning Signs and Emergency Exit Lights

NOTE

Leave rudder power switch ON.

11. 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.

12. Parking Brakes - OFF (P)

Release brakes after chocks are in place.

13. Manifold Valves - WING REFUEL position (CP)
    a. Master Refuel Switch - ON
    b. Manifold Valves Switch - WING REFUEL

       Check that NOT IN FLIGHT light and WING REFUEL lights illuminate.

    c. Master Refuel Switch - OFF
14. 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 to insure the main gear downlocks and tail support are installed.
- Record number of engine cycles on AFTO Form 781H for the period flown. For definition of engine cycles refer to Section VII, ENGINE LIFE.

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 their proper use.

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 crew members will remain at the airplane until the pilot has ascertained that all crew members 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 airplane 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 airplane is on alert.

If the airplane 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 Form 781 entry. 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.

Operations (Peacetime) Airborne Post Attack Command and Control

When the airplane is being prepared for a Peacetime Airborne Post Attack Command and Control Operation, the aircrew will assure that all thermal radiation curtain stowage containers are properly sealed and that sealed flashblindness gold goggle cases and monocular eyeshields are aboard the aircraft. Inflight use of flashblindness equipment will be in accordance with command directives. Thermal radiation curtains, if required in flight, will be installed and fitted in accordance with EWO alert procedures. When an alert airplane is launched on a peacetime PACCS sortie, thermal radiation curtains will be removed and stowed prior to takeoff.

Hatches

When the airplane is cocked, all hatches will be closed except the crew entrance 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 topoff 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. 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 flashblindness 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.

[redacted]

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)

TAXI BACK (Cont)

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 crew member with a new cartridge in optimum position for reinstallation in number 3 engine.

12. No. 1, 3, and 4 Throttles - Advance to 75% rpm, then CUT-OFF (P)

13. No. 3 Engine Starter Circuit Breaker - Open (CP, BO)

14. Cartridge - Insert (CP, GC)

   The 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. 3 Engine Starter Circuit Breaker - Close (CP, BO)

16. No. 2 Throttle - Advance to 75% rpm, then CUT-OFF (P)

17. Emergency Exit Lights - OFF (CP)

   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 the ground safety locks. Reposition both hydraulic system pressure switches to ON and check wheel well doors closed utilizing left auxiliary pump as necessary.

18. Parking Brakes - OFF (P)

19. Battery Switch - OFF (P)

   NOTE

   Airplane is now cocked.

DAILY PREFLIGHT

1. Circuit Breakers - Set (CP)
2. Battery Power Switch - EMERGENCY (CP)

   See MAIN EXTERNAL POWER in Section VII for electrical system checkout.

3. Main External Power Switch - CLOSE (CP)
4. Battery Power Switch - NORMAL (P)
5. Oxygen Quantity - Checked (CP)
6. Pitot Heat - ON, OFF (P, CP)
7. Inboard Spoiler Switch - CUTOFF (P)

7A. Hydraulic System Auxiliary Pump Switches - AUTO (P)

8. Hydraulic System Pressure and Quantity - Checked (P, CP)

   A complete hydraulic 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.

9. Flight and Trim Controls - Check freedom of movement (P)

   A complete control and trim check is not required.

9A. Hydraulic System Auxiliary Pump Switches - OFF (P)

10. VOR, TACAN, and Command Radios - Checked (P, CP)

10A. 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.

11. Battery Charging Ammeter - Checked (CP)

   Insure that charging rate is less than 7 amps and the DC ammeter and voltmeter selector is not in the BATT position.

12. Inboard Spoiler Switch - NORMAL (P)
13. Main External Power Switch - TRIP (CP)
14. 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. Battery Power Switch - EMERGENCY (CP)

   See MAIN EXTERNAL POWER in Section VII for electrical system checkout.

3. Main External Power Switch - CLOSE (CP)

4. Battery Power Switch - NORMAL (P)

5. Fuel Panel - Checked (CP)

   Check all fuel valves are closed and all switches are off.

6. Instrument Power Gyro Switches - OFF (P, CP)

6A. FD No. 1 and No. 2 Master Power Switches - 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. Main 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 - Remove from starter (P, GC)

    Pilot checks start switches and No. 3 start selector switch in OFF position and requests GC to remove 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 4/5 CHECKLIST

Normally, Posture 4/5 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 TAXI checklist and continues normal "Scramble" procedures.

If any engine has been started, No. 2 engine must be running to assume Posture 4/5 using the following checklist.

COCKING (POSTURE 4/5) (CP reads)

1. Parking Brakes - Set (P)
2. Battery Power Switch - EMERGENCY (P)
3. External or Auxiliary Power - Checked (CP, BO or GC)

   Prior to shutting down engines, preposition a ground crewmember with a new cartridge in optimum position for reinstallation in number 3 engine.
4. No. 1, 3, and 4 Throttles - Advance to 75% rpm, then CUT-OFF (P)
5. No. 3 Engine Starter Circuit Breaker - Pulled (CP, BO)
6. Cartridge - Insert (CP, GC)

   The 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. 3 Engine Starter Circuit Breaker - Set (CP, BO)

8. No. 2 Throttle - Advance to 75% rpm, then CUT-OFF (P)

9. Main External Power Switch - CLOSED (CP)

10. 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.

NOTE

The pilots' normal and alert procedures also appear in T.O. 1C-135(E)C-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 2-51/2-52 may be cut out and removed from the manual.

T.O. 1C-135(E)C-1

EC-135C 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. 2 & 3 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 #3 engine (P, GC)
14. Start #3 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 #2 engine (P, GC)
17. Start #2 Engine - Started (P)
18. Generator #2 - On, bus ties closed (P)
19. Wheel Well Doors - Clear (P, GC)
20. Hydraulic System Pressure Switches - ON (P)
21. Battery Switch - NORMAL (P)
22. Chocks and Interphone - Disconnect and Remove (P, GC)
23. Crew Entry Door - Closed (GC)
24. Rotating Beacon and Navigation Lights - BOTH ON, STEADY (CP)
    Taxi on visual signal from ground crew (if available)
25. Brakes and Steering - Checked (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.

Change 31 EXTRACTED FROM PAGE 2-51

CUT ON LINE

T.O. 1C-135(E)C-1

EC-135C 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. Boost Pump and Fuel Valve Switches
   b. Radios and Autopilot
   c. Lights
   d. Hydraulic Pressure Switches

NOTE

- Wait until engines have stopped rotating (rpm stops decreasing) before turning off.
- 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.

EXTRACTED FROM PAGE 2-52

Change 40

CUT FROM OTHER SIDE

section III

EMERGENCY PROCEDURES

TABLE OF CONTENTS

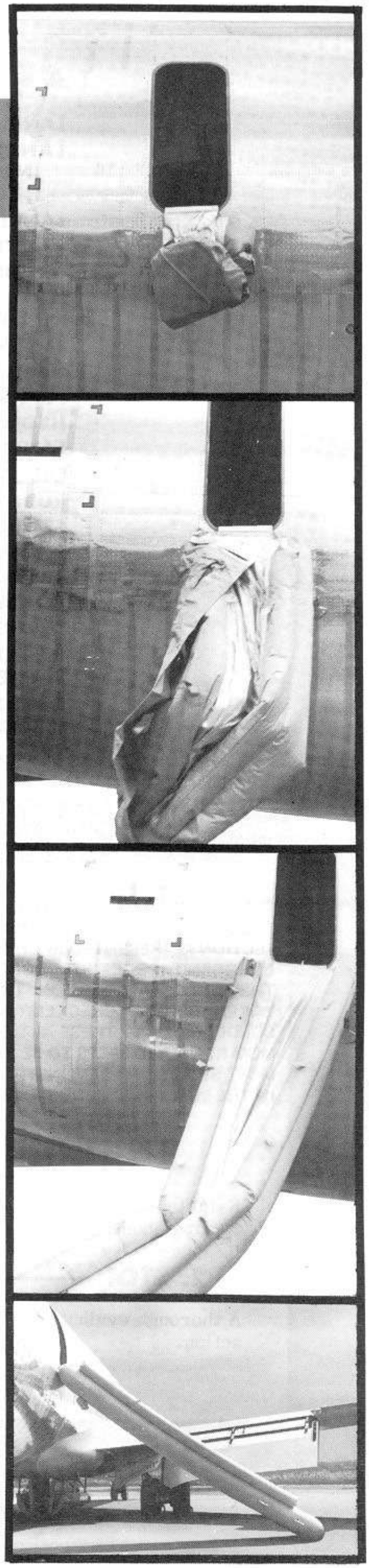


TABLE OF CONTENTS (Cont)

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 BOLDFACE TYPE. THESE ACTIONS ARE CALLED "CRITICAL ACTIONS" AND CONSTITUTE THE MINIMUM REQUIRED STEPS TO BE TAKEN BY A CREWMEMBER TO INSURE SURVIVAL. CREWMEMBERS MUST BE ABLE TO DEMONSTRATE CORRECTLY THE ACCOMPLISHMENT OF BOLDFACED PROCEDURES IN THE PUBLISHED SEQUENCE WITHOUT DIRECTLY REFERRING TO THE CHECKLIST.

1. FLY THE AIRPLANE

Establish a safe airspeed, attitude and power setting. Maintaining airplane control is paramount.

2. STOP ——— THINK ——— COLLECT YOUR WITS

A thorough evaluation of each emergency should be made prior to initiating corrective action.

emergency equipment

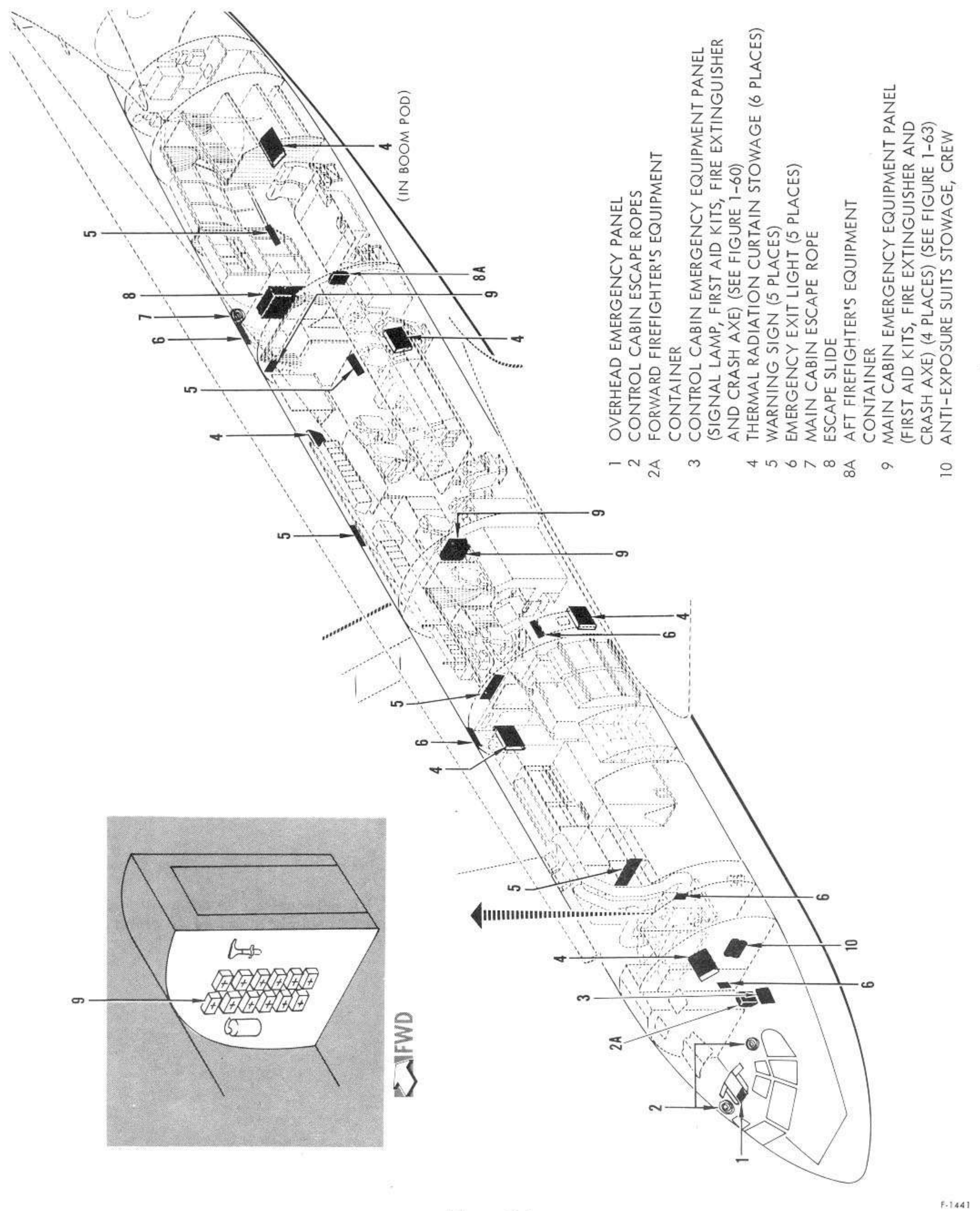


Figure 3-1

CREW COORDINATION

An emergency requires the full, coordinated effort of each crew member. Emergency procedures should be practiced at every opportunity so the crew will become proficient in every procedure. A well trained crew will know the problem and if properly indoctrinated, will react correctly and effectively under any condition.

EMERGENCY SIGNALS

If the time and circumstances permit, the crew should be warned of the emergency, be given instructions, and acknowledge receipt by interphone. The boom operator and/or navigator will insure that passengers and/or extra crew members are notified of the emergency.

ON THE GROUND

1. Prepare to abandon airplane: Three short rings
2. Abandon airplane: One long sustained ring.

IN THE AIR

1. If 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." The pilot will depressurize the airplane; the navigator or boom operator will pull the chinning bar and open the 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 takeoff: One long sustained ring.

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)

If engine No. 3 is on fire, place 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 No. 3 engine) and battery power switch before leaving.

FUEL CONTROL UNIT MALFUNCTION

During start, if a high fuel flow is noted, move the throttle to CUT-OFF to prevent the engine from exceeding the starting limits for EGT. The throttle cannot be used to regulate fuel flow due to the design of the fuel control unit. The starting attempt must be discontinued and the malfunction investigated. During flight, if the thrust fails to reduce upon retarding the throttle from a cruise position, engine operation can be continued if engine or airplane limits are not exceeded. When required, the engine should be shut down by retarding the throttle to CUT-OFF.

NOSE GEAR STEERING FAILURE

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.

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.

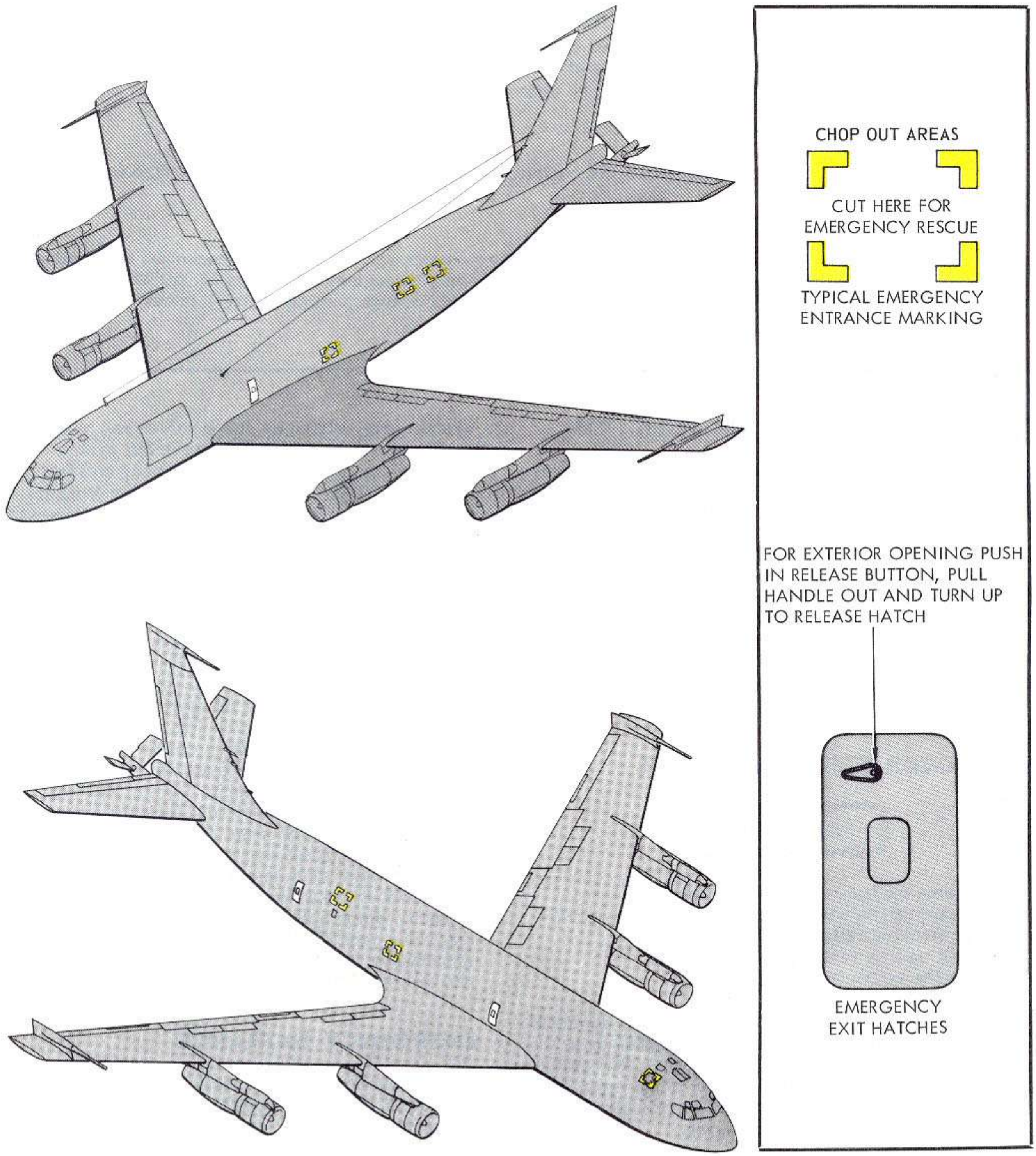
BRAKE EMERGENCY OPERATION

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 breakers should be pulled prior to landing if the left hydraulic system is inoperative. 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 .

emergency entrance



F-1465

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 take-off 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(E)C-1-1.

PILOT'S DECISION

The decision whether or not to abort the takeoff should be based on the following considerations:

A. If an 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 aircraft 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 run-way.

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.

C. 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.

D. Overcome the tendency to relax rudder during rotation and liftoff.

E. 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.

Nose wheel steering effectiveness increases up to 12 to 15 degrees of steering wheel angle. The natural tendency is to attempt to use angles beyond optimum if yaw is severe. Steering angles beyond optimum normally result in skidding or shipping 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 corrective 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. Refer to Part 3 of the Appendix, T.O. 1C-135(E)C-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 DEGREES (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. Starter Switches - OFF (P)
5. Lights - As required (CP)

Rotating beacon lights BOTH ON, navigation lights BRIGHT and STEADY, and taxi lights as required.

ENGINE FAILURE — TAKEOFF CONTINUED (CP reads)

WARNING

- Do not advance the throttles on remaining good engines beyond TRT because serious overspeed and subsequent damage may result.
- 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. Rotate - Rotation speed (CP, P)

2. 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 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)
3. Generator Control Switch - TRIP, if applicable (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 landing gear simultaneously. Slow operation of the gear with reduced climbout performance will result. Do not operate the aft A/R pumps and 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)

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. Crew members unsnap parachute harness, tighten shoulder harness and safety belts, and lock inertia reels. Pilot maintains 50° 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 ditching is imminent, do not extend the landing gear.

NOTE

The crew member 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.

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 may 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 at airspeeds below 250 KIAS 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.

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.

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.

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 spoilers, 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

The loss of an engine at any time is considered an emergency, regardless of the amount of thrust still available, since some emergency procedure must be executed. The unsymmetrical thrust capabilities for this airplane are shown in the Appendix, T.O. 1C-135(E)C-1-1. Flight minimum control speed is that speed required to provide sufficient control to enable the airplane to fly a straight path over the ground when an outboard engine has failed. Critical field length chart distances are based on takeoff rated thrust. Flight minimum control speed should always be compared with approach speed. If flight minimum control speed is greater, increase approach speed to equal flight minimum control speed. The ability of the airplane to maintain level flight or climb will depend upon the airplane gross weight. Charts in Part 3 of the Appendix, T.O. 1C-135(E)C-1-1, show the rates of climb possible with three engines operating. Maximum endurance settings for three and two engines are shown in Part 6 of the Appendix.

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(E)C-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(E)C-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 wing 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 crew member is scanning the engine area from the cargo compartment, he will maintain interphone liaison with the pilot.

If a fire becomes uncontrollable, immediately increase airspeed to the maximum allowable IAS or Mach and initiate a shallow descent, if conditions permit. Descending will allow increased acceleration to maximum speed with resultant decrease in the angle of attack which will help keep fire from the wing until fire is extinguished or controlled.

WARNING

- If fire appears to be burning into the wing, abandon the airplane or effect an immediate landing.
- 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 RGA/AP/ARR pushbutton 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 FUEL JETTISONING, this section.

WARNING

Do not operate the forward A/R pumps and landing gear simultaneously. Slow operation of the gear with reduced climbout performance will result. Do not operate the aft A/R pumps and wing flaps simultaneously. Slow operation of the powered rudder with reduced rudder effectiveness will result.

6. Generator Control Switch - TRIP, if applicable (CP)

CAUTION

Move the applicable generator control switch to the TRIP position if engine No. 1, 2, or 4 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.

NOTE

If the fire switch has been pulled, the generator failure light will not illuminate but the generator control has been tripped.

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 a practice engine shutdown. Practice starts should be made in the area shown by the air start envelope, figure 3-3. Practice starts will 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 auto-pilot 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 CUTOFF.
- 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. Affected Generator Switch - TRIP (P)
3. Throttle - CUT-OFF (P)

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

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 flight minimum directional 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 cut off are not recommended except for demonstrations, and then only with one engine out on a side. 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.

For practice maneuvers simulating failure of one or two engines, 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 maintain 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.

NOTE

When engines 3 and 4 are inoperative, place the emergency hydraulic crossover valve lever to the left system.

ENGINE AIR STARTING

If an engine has been shut down because of a serious malfunction, do not attempt a restart unless a greater emergency exists. Refer to AIR START ENVELOPE, figure 3-3, for proper rpm relationship for existing altitude and airspeed. If rpm disagrees considerably with the air start envelope, indicating possible internal engine damage, do not attempt a restart. Air starts have been successfully demonstrated at all points within air start envelope.

CAUTION

- 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.
- An engine air start after an emergency shutdown should not be attempted unless it is determined 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 1 minute waiting period with throttle in CUT-OFF should be observed before attempting a second or subsequent start. This will allow adequate fuel drainage from the rear cowling, thus preventing a possible cowl fire.
- 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.

air start envelope

DATE: OCTOBER 1964

DATA BASIS: FLIGHT TEST

NOTE

ROTOR SPEEDS SHOWN ARE FOR NO. 1, 2 & 4 ENGINES WITH 120 KVA GENERATOR DRIVE CONNECTED. NO. 3 ENGINE SPEEDS WILL BE APPROXIMATELY 2% HIGHER

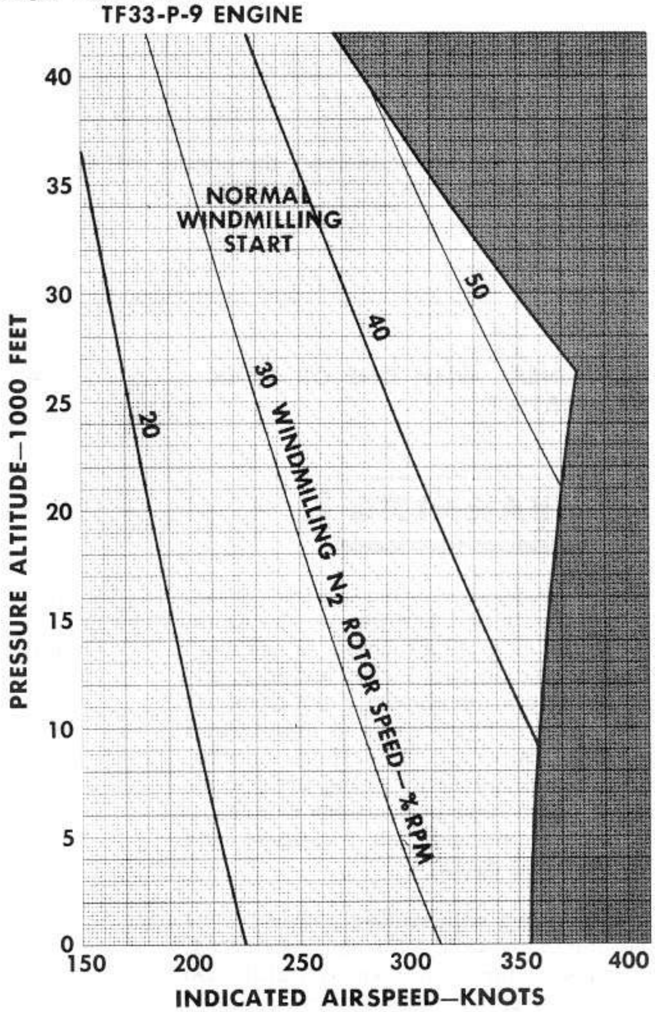


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Figure 3-3

ENGINE AIR STARTING (CP reads)

1. Engine Anti-Icing Switch - OFF (CP)

   Turn off the engine anti-icing system and 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. Oil Pressure Gage - Checked (P)
6. Starter Switch - FLIGHT START (P)
7. Throttle - START (P)
8. Engine Instruments - Checked (P)

   Leave throttle at START until engine instrument readings have stabilized as follows:

   a. Tachometer - 60 to 85% rpm

   b. EGT - Approximately 250° 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 START, and the engine fails to accelerate to idle within approximately 1 to 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.

9. Throttle - Advance as desired (P)
10. Starter Switch - OFF (P)
11. Generator 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 procedure. 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 will don oxygen masks and breathe 100% oxygen. The crewmember designated to combat the fire will don the firefighter's mask, connect the mask to a source of 100% oxygen, and don the fire-fighter's gloves. Portable oxygen bottles may have to be used by the crewmembers engaged in fire-fighting procedures.

2. Fire - Combat (N, BO)

   Boom operator and/or navigator will institute fire fighting procedures. One crew member will 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 bromochloro-methane (CB) is used on hot metal or open fire. CB is an anethetic 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.

3. Airspeed - Adjust (P)

   As soon as possible, take the necessary action to adjust airspeed to within the desirable range for bailout. (See 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 firefight-er's mask with the MA-1 portable oxygen system. (See figure 4-36.) The A-21 regulator must be set to the NORM position when used in conjunction with the firefighter'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, open the applicable circuit breakers and continue the flight without operating the overheated equipment. In the event 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 crew members 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.

3. Source and Cause - Locate (ALL)

FROM ELECTRICAL SYSTEM

1. Electrical Equipment - Off (if fuel fumes are present)
2. Applicable Circuit Breakers - Open

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 source of smoke and fumes from the ACM, an individual engine, or from 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.

SMOKE AND FUME ELIMINATION (Cont)

Determination and Isolation of Source

AIR CYCLE MACHINE

1. Air Conditioning Master Switch - OFF (CP)
2. Temperature and Alternate Pressure Control - MANUAL, WARMER (approximately 10 seconds), check for smoke and fumes (CP, BO, N)

   Boom operator or navigator will check air conditioning ducts for smoke and fumes.

   a. If smoke and fumes do not recur, the source was the ACM.

      Ventilate as necessary and continue mission, cycling the temperature and alternate pressure control valve for heat/pressurization as required.

   b. If smoke and fumes continue or recur, proceed to next step.

ENGINE THROUGH A BLEED VALVE

3. Temperature and Alternate Pressure Control - MANUAL, COOLER (approximately 10 seconds) (CP)

   Close temperature and alternate pressure control valve.

4. Engine Bleed Switches - CLOSED (CP)
5. Air Conditioning Master Switch - COND AIR (CP)
6. 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 the mission. If unable to determine source, smoke and fumes continuing, proceed to the next step.

EITHER SOURCE COMBINED WITH SYSTEM VALVE(S) FAILURE

7. Air Conditioning Crossover Switch - CLOSED (CP)
8. 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.

9. Air Conditioning Master Switch - OFF (CP)
10. Temperature and Alternate Pressure Control - MANUAL, WARMER (approximately 10 seconds), 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 temperature and alternate pressure control 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.

NOTE

> If the airplane interior becomes too hot during heating and pressurization with the temperature and alternate pressure control valve, cooling and ventilation may be obtained using ram air.

ENGINE BLEED VALVE ISOLATION

Engine Bleed Valve(s) Inoperative

Isolating an engine bleed system with an engine bleed valve which has failed in the open position requires that the one way check valve in the engine bleed line be closed. The only way the check valve can be closed is to increase back pressure on the valve to a value exceeding the bleed air pressure of that engine. By retarding the throttle on the suspected engine (not below IDLE) and increasing thrust on other engines (not above NRT) until a difference in EPR reading of 0.50 exists, the check valve in the engine bleed line will be closed. Consideration should be given to shutting down the offending engine if its thrust is not needed to maintain flight. During descent, it will probably be necessary to shut down the offending engine to maintain the 0.50 EPR differential required to prevent smoke and fumes from reentering the cabin. After the offending engine(s) is found, if thrust requirements are critical, the EPR differential may be slowly reduced while closely monitoring the air conditioning outlets for smoke and fumes. If smoke and fumes recur, increase EPR differential until smoke and fumes disappear. Maintain that minimum EPR differential. The following procedure should be used to isolate an engine bleed system from the air conditioning system.

1. A/C Crossover Switch - Checked CLOSED (CP)

2. Engine Oil Pressure Gages - Checked (P, CP)

   Erratic or abnormal oil pressure indications may indicate oil leakage.

3. Throttle on Suspected Engine - Retarded to 0.50 EPR differential (not less than IDLE) (P)

   If thrust requirements are not critical the corresponding engine on the other side may be retarded to reduce the yawing moment.

4. Thrust on Remaining Engines - Increased, if necessary (not above NRT) (P)

   Increase thrust as necessary to give 0.50 EPR differential.

5. Smoke and Fumes - Checked (3 minutes) (CP, BO)

   If the air conditioning shutoff valve and temperature and alternate pressure control valve have been closed, open the air conditioning shutoff valve if engine 3 or 4 has been retarded; open the temperature and alternate pressure control valve if engine 1 or 2 has been retarded.

   a. If smoke and fumes do not recur, continue mission with offending engine retarded or shut down if its thrust is not required. Ventilate as required.

   b. If smoke and fumes exist, repeat steps 3, 4, and 5 for remaining engines.

SMOKE AND FUMES DUE TO ENGINE ANTI-ICING

If smoke and fumes enter the cabin following actuation of the engine anti-icing system, it is probably due to oil entering the high pressure compressor and then being vented back into the engine inlet via the anti-icing system.

1. Engine Bleed Valve Switches 1 and 4 - CLOSED (CP)

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.

SMOKE AND FUME ELIMINATION (Cont)

a. If the smoke and fumes cease, open the closed bleed valve switches one at a time to determine the offending engine. Once it is found, operate that engine with the engine bleed valve closed and all others open.

b. If the smoke and fumes continue, proceed to next step.

2. Engine Bleed Switches 1 and 4 - OPEN (CP)

3. Engine Bleed Switches 2 and 3 - CLOSED (CP)

a. If the smoke and fumes cease, open the closed bleed valve switches one at a time to determine the offending engine. Once it is found, operate that engine with the engine bleed valve closed and all others open.

b. If the smoke and fumes continue, attempt to isolate the smoke and fumes by using the air conditioning crossover valve in conjunction with the air conditioning master switch, temperature, and alternate pressurization control switch.

VENTILATION

After the source of the smoke and fumes is determined and isolated, ventilation may be necessary to eliminate the smoke and fumes from the airplane. The ventilation rate may be increased by setting the cabin altitude above airplane altitude and rotating the cabin rate of change knob towards MAX. More rapid ventilation rates can be achieved by slowly rotating the cabin manual pressure control knob out of the INCREASE & OFF position CCW towards DECREASE until manual cabin pressure control is gained. After cabin manual pressure control is gained, rotate the cabin manual pressure control knob CCW in 5 to 10 degree increments until desired cabin altitude is obtained. Maximum ventilation rates can be achieved by rotating the cabin manual pressure control knob full CCW to DECREASE (this action will depressurize the cabin in approximately 27 seconds).

WARNING

Do not open the aft emergency exit hatch for ventilation during flight because fuel fumes may be drawn in from the fuel vent system.

ADDITIONAL PROCEDURE FOR SMOKE AND FUMES

If the preceding procedures do not eliminate the smoke or fumes, it may be desirable to depressurize the airplane. To depressurize, use the following procedure.

1. Engine Bleed Switches - CLOSED (CP)
2. Cabin Manual Pressure Control - Full DECREASE (CP)

   This action will depressurize the cabin in approximately 27 seconds.

3. Air Conditioning Master Switch - RAM AIR (CP)
4. Oxygen - NORMAL OXYGEN (ALL)

   After cabin is clear of smoke or fumes, move regulator diluter lever on oxygen regulator panel from 100% OXYGEN to NORMAL OXYGEN. The oxygen supply is limited and the pilot should decide whether to continue the mission or descend to an altitude requiring less oxygen.

WARNING

Do not open the aft emergency exit hatch for ventilation during flight because fuel fumes may be drawn in from the fuel vent system.

EX[illegible]

Excessive heat in the control cabin will probably be due to the temperature and alternate pressure control valve failing open; in the main cabin it will probably be due to the hot side of the hot air bypass valve failing open.

1. Temp & Alternate Press Cont Knob - COOLER (CP, BO)

   If the temperature cannot be controlled with the main cabin temperature control, the copilot will move the temperature and alternate pressure control knob to maximum cooler and the boom operator will check that the airflow from the control cabin air conditioning duct decreases and becomes cooler (similar to that in main cabin). If the airflow does not decrease, proceed to step 2.

2. Air Conditioning Crossover Valve Switch - CLOSED (CP)

EXCESSIVE HEAT ELIMINATION (Cont)

3. Engine Bleed Switches (Engines 1 and 2) - CLOSED (CP, BO)

CAUTION

If the flight is continued with the air conditioning crossover valve closed and engines 1 and 2 bleed valves 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.

After the copilot closes the bleed air valves, the boom operator will check the control cabin air conditioning duct for decreasing and cooler airflow. (Allow 5 to 10 minutes for a cooling change.) If airflow from the control cabin or main cabin air conditioning duct remains excessively hot, the problem is most likely caused by a failed hot air bypass valve. Continue to **step 4.**

4. Oxygen - 100% (ALL)

All personnel shall don oxygen masks and breathe 100% oxygen.

5. Air Conditioning Master Switch - OFF (CP)
6. Air Conditioning Crossover Valve Switch - OPEN (CP)
7. Engine Bleed Switches - OPEN (CP)
8. Temperature and Alternate Press Cont Knob - Adjust as required to maintain pressurization and temperature

If an appropriate cabin altitude cannot be maintained without excessive cabin temperature, the flight should be continued using RAM AIR. Refer to AIRPLANE DEPRESSURIZATION, Section IV.

EMERGENCY JETTISONING

FUEL DUMPING

If at any time the airplane requires an immediate gross weight reduction, while carrying a heavy fuel load, fuel should be dumped in the following manner:

WARNING

Do not operate the forward A/R pumps and landing gear simultaneously. Slow operation of the gear with reduced climbout performance will result. Do not operate the aft A/R pumps and wing flaps simultaneously. Slow operation of the powered rudder with reduced rudder effectiveness will result.

NOTE

Time and conditions permitting, fuel dumping procedures will be completed prior to initiating subsequent checklists.

1. A/R To Engine Manifold Valve Switch - CLOSED (CP)
2. Line Valve - OPEN (CP)

3. Fuel Dump Switch - FUEL DUMP (CP)

4. A/R Pump Switches - ON (CP)

NOTE

To prevent excessive fuel pressure surges, at completion of fuel dumping, it is recommended that A/R pump switches be positioned OFF prior to placing fuel dump switch in NORMAL.

5. Fuel Panel - Reset (CP)

For a description of operations brought about by actuation of the fuel dump switch, refer to FUEL DUMP SWITCH, Section I. To dump fuel it is not necessary to have the boom out of the stowed position. Electrical power for fuel dumping is normally 28 volt DC, T-R power. However, fuel dumping may be initiated with only battery power on the airplane, as power for the operation is taken from the switched DC bus circuit breaker panel. In this instance the battery power switch (20, figure 1-15) must be in the EMERGENCY position. If it is desired to dump airplane fuel system fuel in addition to the fuel in the body tanks, it is only necessary to open the wing to aft tank valves and the center wing to forward body tank valves, at any time during the fuel dumping operation.

NOTE

With four A/R pumps operating, fuel can be dumped at a minimum rate of 6500 pounds per minute.

EPR increase – loss of radome

GIVEN:
Loss of airspeed indication due to loss of radome
Maintain .78 mach number
Altitude = 33,000 feet
Gross weight = 250,000 Lb

FIND:
EPR setting

SOLUTION:
Enter TARGET THRUST SETTINGS chart in the Appendix and read EPR = 1.63

EPR to compensate for additional drag = .16 (from Figure 3-4)

EPR setting = 1.79

REMARKS:
LEVEL FLIGHT WITH 4 ENGINES
CLEAN CONFIGURATION EXCEPT RADOME LOST
EPR SETTING DEFINED AS SUM OF EPR INCREASE AND EPR AS DETERMINED FROM TARGET THRUST SETTINGS CHART, FULL THROTTLE OR EGT LIMIT WHICHEVER COMES FIRST

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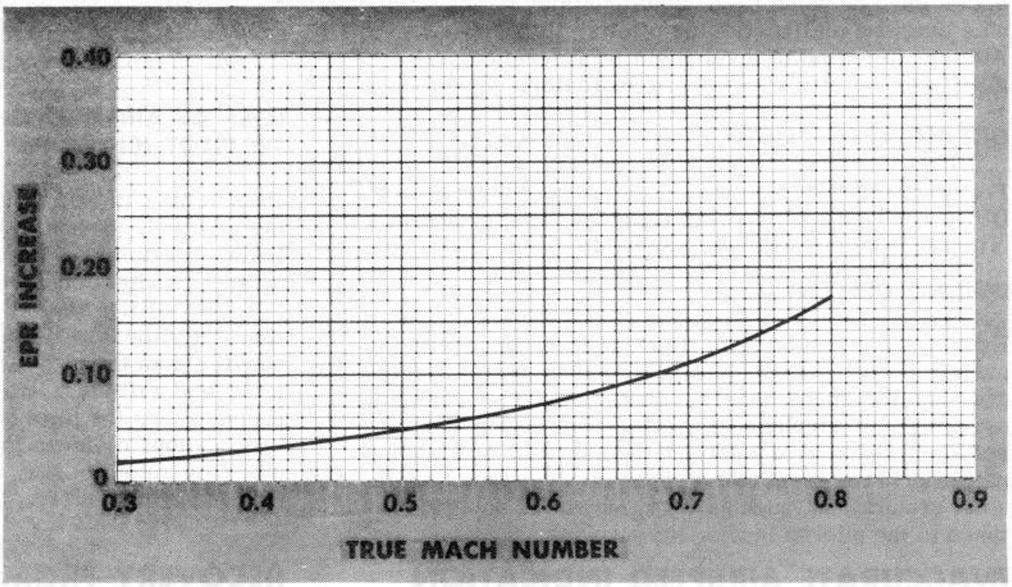

Figure 3-4

LOSS OF RADOME

A complete separation of the nose radome from the airplane will result in inaccurate indications of airspeed, mach number, altitude and vertical velocity. In addition, the noise level will be sharply increased and probably buffeting will occur.

NOTE

- Separation of the radome will not impose any new structural or aerodynamic limitations on the performance envelope of the airplane. However, the possibility of exceeding structural or aerodynamic limitations exists due to the lack of reliable airspeed indications. Therefore, operation in the area of any limitation should be avoided.
- The disturbed local airflow will also render the angle of attack system unreliable.
- In all cases, the pilot's evaluation of the specific emergency should determine the course of action to be followed.

If pressurization of radar is not lost after radome separation, the navigator's ground speed indicator is reliable to within 300 to 500 feet of the surface. This figure, corrected for wind, will give airplane airspeed. Attempt to obtain the immediate services of a pacer airplane to provide accurate airspeed checks.

WARNING

Because of the magnitude of inter-related aerodynamic effects, flying two airplanes in close vertical proximity is not safe. The pacer airplane should fly wing formation only.

DURING CLIMB

Continue the climb by maintaining 8 degrees on the attitude indicator for gross weights up to 225,000 pounds, or 6 degrees for higher gross weights. Advance throttles to obtain NRT. Continue the climb until reaching VFR conditions or until an estimated altitude of 20,000 to 25,000 feet is reached to provide for safe terrain clearance under night or IFR conditions. The radio altimeter may be used to confirm altitude. Determine a level flight EPR setting from the TARGET THRUST SETTINGS chart, in Part 5 of the Appendix, T.O. 1C-135(E)C-1-1. To compensate for the added drag as a result of losing the radome, obtain from figure 3-4 an increment of EPR for the desired Mach number and add this increment to the EPR setting derived from the TARGET

THRUST SETTINGS chart. The resulting EPR setting will maintain the desired speed in level flight for the gross weight and altitude of the airplane. The autopilot may be used with the exception that the altitude hold and Mach No. hold function should not be used because these functions may be unreliable due to a malfunctioning pitot-static system. Attempt to maintain level flight by reference primarily to the attitude director indicator.

DURING LEVEL FLIGHT

Follow the procedures given in the preceding paragraph, DURING CLIMB. If terrain clearance is a problem, a climb to a higher altitude may be desirable.

DURING DESCENT

Establish a climb or level flight in accordance with the paragraph titled DURING CLIMB, after retracting the gear and the speed brakes. Land as soon as possible using a pacer airplane (if available) to obtain accurate speed checks, and to establish the approach and landing pattern. In the event that a pacer airplane is not available, ground aids, such as GCA, may be of some assistance to the pilot in landing the airplane.

INACCURATE AIRSPEED INDICATION

When inaccurate airspeed indications are apparent or suspected, attempt to obtain the services of a pacer airplane to provide accurate airspeed checks.

DISPARITY BETWEEN AIRSPEED INDICATORS

If there is a disparity between airspeed indicators, the speed deviation indicators may be used to determine which airspeed indicators are most accurate. The aircraft should be flown with wings level (0° bank) so that the speed deviation pointer indicates "ON SPEED" (0.6 AOA) and the airspeed readings at 0.6 AOA should be compared with the corresponding airspeed for the aircraft weight and configuration obtained from the Pattern/Approach Speed Chart in T.O. 1C-135(E)C-1-1. If during climb, one or more airspeed indicators are accurate, continue mission using the accurate indicator. If all airspeed indicators are determined to be inaccurate, continue climb at NRT and maintain 8 degrees pitch on the ADI for gross weights up to 225,000 pounds. Maintain 6 degrees for higher gross weights. Continue climb to cruise altitude, adjust EPR as necessary to maintain the desired reference (maximum range or maximum endurance) on the angle-of-attack indicator and head for the nearest suitable landing field with VFR conditions. The autopilot may be used with the exception that the altitude hold and Mach No. hold function should not be used because these functions may be unreliable due to a malfunctioning pitot-static system. The airspeed required to maintain a 0.6 AOA may be used with the Pattern/Approach Speed Chart in T.O. 1C-135(E)C-1-1 to determine approximate gross weight (within ±10,000 pounds) in the event of a fuel gage malfunction.

NOTE

If the angle-of-attack and/or the speed deviation indicating system is inoperative and weather conditions permit, the airplane may be flown to a safe altitude and placed in initial buffet. By referring to figure 6-1 or 6-2 as applicable, and using gross weight, altitude and the 0 degree bank angle curve, the initial buffet chart speed may be obtained to check against the airspeed indicators to determine which of the airspeed indicators is accurate.

LOSS OF AIRSPEED INDICATION DUE TO PITOT ICING

Pitot icing can be encountered during any portion of the mission. See also PITOT ICING under ICE AND RAIN, Section IX. For climb and cruise with loss of airspeed indications due to pitot icing, see DISPARITY BETWEEN AIRSPEED INDICATORS, this section. If pitot icing is caused by icing conditions heavier than the pitot heater can handle, the blocked pitot tube will clear after VFR conditions are reached. If, however, the pitot heater is inoperative, it may take an hour or more for sublimation of the ice build-up. The autopilot may be used with the exception of the Mach No. hold function.

RECOVERY FROM UNUSUAL ATTITUDES

For unusual attitudes, recovery procedures prescribed by the appropriate USAF Instrument Manual should be employed.

WARNING

During the recovery from a high speed unusual attitude, if the landing gear is lowered, a pitch-up condition results. If the pilot is already applying positive load factor by trying to pull out of a dive, the additional pitch-up caused by the gear lowering may be enough to exceed the acceleration limits. (During gear drop tests at high speeds, the results revealed that considerable forward stick pressure is required to stay within acceleration limits.)

RAPID PITCH OSCILLATIONS

Pitch oscillations can occur from a lightening of control forces at elevator deflections of 10 to 12 degrees due to incorrect elevator balance seal gap. This condition has been experienced during climbout after takeoff and usually occurred between 250 and 285 KIAS. The control column oscillated with considerable movement. Avoid the use of abrupt and large elevator deflections by keeping the airplane in a trimmed condition; such action will preclude the occurrence of rapid pitch oscillations. If the airplane enters into rapid pitch oscillations, perform the following actions:

A. Hold control column in a firm grip and maintain as near centered as possible. Keep movement to a minimum.

B. Reduce airspeed five knots or more until oscillations stop.

rudder available with rudder power inoperative

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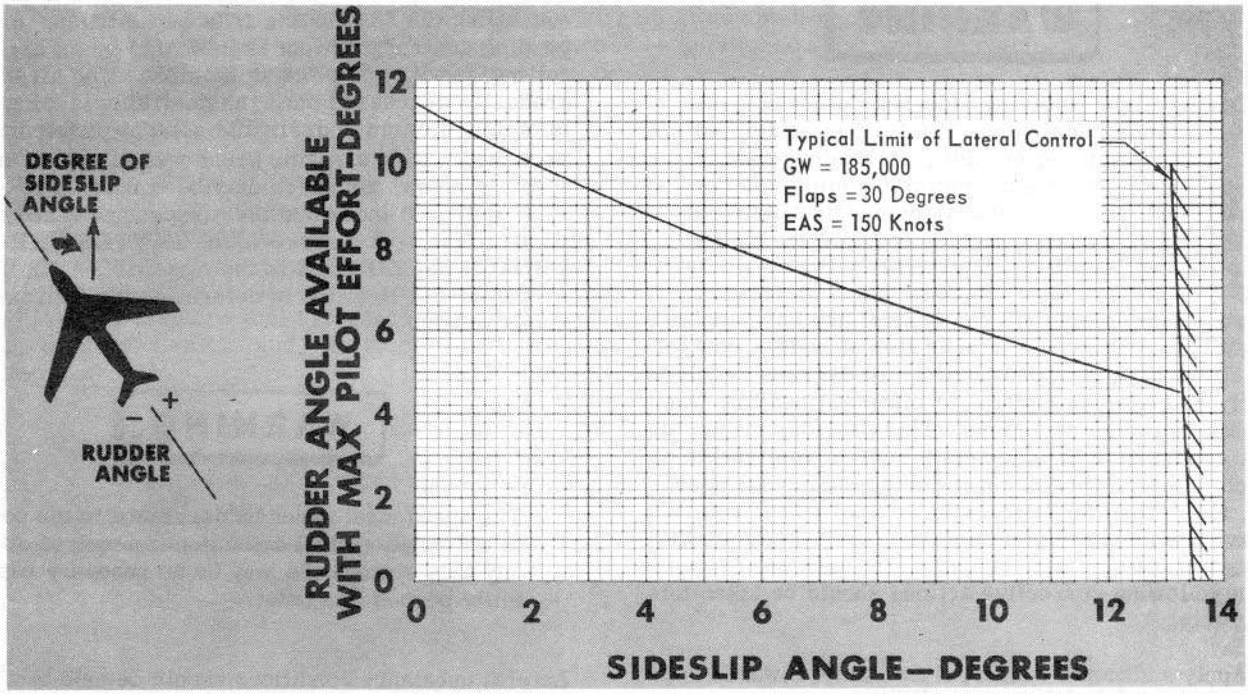

Figure 3-5

C. Trim stabilizer to eliminate sustained stick forces. Keep trim forces at or near zero, if possible.

D. Land as soon as possible.

Refer also to LATERAL AND DIRECTIONAL CONTROL DIFFICULTY DURING TAKEOFF in this Section.

FLIGHT WITH RUDDER POWER INOPERATIVE

The rudder characteristics of this airplane are such that without rudder power the rudder angle available will decrease as sideslip angle increases. When sideslip angles are encountered it is important to apply rudder and correct the asymmetrical thrust condition before extreme sideslip angles develop. See figure 3-5 for rudder angles vs sideslip. When the chart values of sideslip are exceeded, the rudder effectiveness deteriorates quite rapidly with a resultant loss of directional control.

WARNING

- With rudder power off or inoperative, the pilot should be prepared to apply as much as 180 pounds force to the rudder pedals to obtain required rudder deflection.
- If full rudder deflection is required, the seat back should be in the full vertical position or the pilot will slide up the seat back when heavy rudder pedal force is applied. The seat and rudder pedals should be adjusted so that the knee can be locked at full rudder pedal travel with allowance for compression of clothing, parachute and seat cushion.
- Airspeed indicator errors exist during sideslip. An actual airspeed 7 knots lower than indicated will exist at 10 degrees of sideslip.

An extreme sideslip condition in which the rudder must operate is one of maintaining directional control during a go-around after an outboard engine failure. Asymmetrical thrust produces a constant turning moment which is independent of speed; however the rudder effect becomes greater as speed increases. The force opposing the constant turning moment produced by asymmetrical thrust can be increased by application of full rudder, banking the airplane to keep the dead engines high, and increasing airspeed. In order to minimize the probability of attaining large sideslip angles during flight with asymmetrical thrust, maintain directional control with the rudder and maintain this rudder if turns are made. Any decrease of rudder during turns will increase the sideslip angle.

WARNING

During flight involving sideslip, do not release any rudder pedal force if a turn is attempted into the dead engine side. Releasing rudder pedal force and reapplying the same force results in a reduction of maximum effective rudder angle obtainable, thereby reducing the ability to maintain directional control.

Do not use excessive aileron control and bank angle to maintain directional control in lieu of rudder control. Sideslip angles of approximately 10 degrees result in nearly full aileron control to maintain heading when inadequate rudder is applied. This provides means for pilot recognition of inadequate rudder application or effectiveness. Therefore, if during engine out operation, more than 30 degrees of control wheel rotation toward the operating engines is required to maintain straight flight or steady turning flight, then one or more of the following corrective actions should be taken immediately:

A. Apply additional rudder, if available, towards "operating engines."

B. Increase airspeed.

C. Decrease thrust on the "operating engines" side.

NOTE

There is a noticeable stiffening of rudder pedal forces during the last 2 or 3 degrees of rudder deflection. Therefore, in any maneuver requiring full rudder deflection, the pilot should be certain to depress the rudder pedal fully.

CONTROLLABILITY CHECK

A controllability check is conducted to determine the minimum safe airspeed to maintain during approach and landing following inflight structural damage, fuel unbalance, or differential airspeed readings. Ordinarily the check should be conducted in the landing configuration at approximately 12,000 feet altitude. Minimum airspeed obtained at higher altitudes will be excessive because of compressibility effects. Care should be exercised in progressing to the landing configuration. All speed and configuration changes should be made slowly taking note of any excessive control requirements produced. With the airplane in the desired configuration, the airspeed is gradually decreased while evaluating the control and trim capabilities. Any impending control problem is indicated by an excessive rolling, yawing, or pitching moment. The airspeed is gradually decreased until the desirable landing speed is obtained or an undesirable control problem is approached. If an airplane gross weight approximation is being made, the check may be conducted to .6 AOA approach index and the airspeed obtained compared to the speed shown in the PATTERN/APPROACH SPEED chart in the Appendix, T.O. 1C-135(E)C-1-1 in order to determine the approximate gross weight.

WARNING

The speed must never be decreased to the point at which full control deflection is required about any axis since there may be no recovery capability beyond this point.

Lateral unbalance conditions should be held to a maximum bank angle of 5 degrees for adequate ground clearance during landing. Longitudinal unbalance may reduce the landing flare capability by requiring excessive elevator angles if the unbalance condition cannot be trimmed for zero elevator force. The landing flare requirements can be decreased by making a low flat landing approach. (See STABILIZER TRIM EMERGENCY OPERATION this Section.) The speed must never be allowed to decrease below the minimum safe speed as determined from the check.

PRESSURIZATION EMERGENCIES

RAPID DECOMPRESSION

When a rapid decompression occurs, the cabin pressure is reduced to the outside pressure very rapidly. Any rapid decompression affects all crew members and can be extremely dangerous at high altitudes. If a rapid decompression occurs the pilot should descend immediately, direct the crew to go on 100% oxygen, try to ascertain the cause of the trouble and if it cannot be fixed in flight, he should decide whether to continue his mission or land as soon as possible.

PRESSURIZATION WITH CRACKED WINDOW

If a crack appears in a window during pressurized flight, immediately cut off power to all windows if it is an electrically heated window. Determine position of the crack; if in outer pane, normal pressurization schedules can be maintained. However, since it may not be possible to determine if the crack is confined to the outside pane it is not advisable to continue the mission unless the importance of the mission dictates. If the crack is found on inner pane, reduce airplane altitude to minimum required to safely proceed to a selected recovery airfield and increase the cabin altitude as high as humanly safe. Both actions result in a reduced cabin differential pressure and relieve pressure load on the windows. Figure 4-2 shows the cabin altitude obtainable with any cabin differential pressure up to the maximum. It is not recommended that the mission be continued with a cracked inner pane because of the possibility of failure of the plastic interlayer between panes which is capable of sustaining pressurization loads only if in good condition. Use of the following procedure is recommended if a window fails.

A. Window Heat Switches - OFF

B. Locate Window Crack

(1) If window crack is in outer pane of electrically heated window - Open circuit breaker for affected window.

With circuit breaker opened for affected window, normal pressurization schedule can be maintained.

NOTE

It may not be possible to determine if the crack is confined to the outside pane; therefore, it is not advisable to continue the mission unless the importance of the mission dictates.

(2) If window crack is in any inner pane or if unable to determine if window crack is confined to any outer pane - Reduce cabin pressure differential as necessary to prevent further cracking.

Accomplish this by resetting cabin selector knob to higher altitude if using automatic control. Rotate manual pressure control toward DECREASE if using manual pressure control. Decrease airplane altitude as necessary. Open circuit breaker for cracked window if it is an electrically heated window.

C. Window Heat Switches - NORMAL or as required

Location of a crack, whether in the inner or outer pane, can be determined by the use of parallax, by placing a finger or smudge mark at the crack and moving the line of sight parallel with the window surface at right angles to direction of crack. If the outer pane has failed, the crack will appear to move with the line of sight. If the crack is in the inner pane, the crack will not appear to move. A crack in the inner pane can also be determined by scraping a fingernail lightly across the window. Failure of both inner and outer panes can be easily recognized. The inner pane will be completely shattered and there will be a definite outward bulge in the window.

The depth of this bulge will depend upon the size of the window, temperature of the vinyl core, and differential between cabin and ambient air pressure. Cracking of the electrically heated windows without any other apparent malfunction can be attributed to one or more of the following conditions:

A. Uneven heating or thermal gradient across the glass pane or between heated and unheated areas.

B. Residual stresses due to warpage of the glass panes and installation stresses induced by application of torque on the window fasteners.

C. Stresses concentrated in a window by deflection of the airframe structure under load.

D. Overheat condition on pilot and copilot's No. 2 sliding windows when windows are open and window heat is ON. Other malfunctions of the heated windows may be visually observed. These are:

(1) Delamination of the glass pane from the vinyl core indicated by a thin, clear bubble often relatively large in area. Delamination is believed to be caused by differential expansion rates of glass and vinyl through temperature extremes, locally overheated areas, initial warpage of the glass plies, or faulty bonding procedure.

(2) Arcing at the connection of the braid to the bus bar or along the bus bar, and arcing between the bus bar and airplane structure. Arcing may be caused by differential of expansion between the glass and vinyl resulting in an interrupted circuit in the window or formation of a conductive path through insulating material.

(3) Chipping or flaking of the glass surface in areas bonded to the vinyl core. This is caused by stresses induced in the glass pane in areas where the adhesive strength of the bond is apparently greater than the surface strength of the glass.

(4) A milky or cloudy appearance anywhere around the edge of either the inner or outer pane. This is an indication of actual or imminent delamination as a result of moisture penetration.

BAILOUT

WARNING

- Under level flight conditions, bail out at least 2000 feet above the terrain whenever possible. Accident statistics show that chances for successful bailout decrease as altitude decreases below 2000 feet above the terrain.
- For all bailouts at 14,000 feet or above, pull the automatic ripcord release as soon as well clear of the airplane. If it becomes obvious that the automatic mechanism has failed or the altitude is uncertain, pull the parachute ripcord T-handle.
- For all bailouts below 14,000 feet, pull the parachute ripcord T-handle as soon as well clear of the airplane.

IMMEDIATE BAILOUT

An immediate bailout is defined as one in which the emergency is such that insufficient time is available to prepare for a bailout. This may occur at low altitude, high altitude, over land or over water. In the event an immediate bailout is required, the pilot will place the alarm bell switch ON and announce on the interphone "Bail out, Bail out, Bail out." The pilot will depressurize the airplane, then the boom operator or navigator will pull the chinning bar and raise the floor grille. All personnel will immediately evacuate the airplane.

CONTROLLED BAILOUT

If bailout is decided upon, the following procedure is recommended when crew members only are aboard. Try to plan the bailout before the last minute. The pilot must warn the crew as soon as bailout is decided upon. See figure 3-7 for bailout exits and methods of egress.

WARNING

- If passengers are aboard, it may be necessary to open the aft emergency exit hatch to permit a faster bailout. See WARNING, figure 3-7. If the emergency is such that the boom operator and extra crew members cannot reach the control cabin, it will be necessary to open the aft emergency exit hatch to bail out. It is possible to open the aft emergency exit hatch safely at speeds greater than 200 KIAS; however, bailing out of the aft hatch at speeds in excess of 200 KIAS is not recommended.
- Bailout through the overwing hatches is not recommended and should only be attempted as a last resort because of the possibility of striking the airplane.

The boom should be stowed (if applicable) and the landing gear retracted to avoid any possible interference. Under most circumstances, the airspeed should be reduced to the approach speed (.6 AOA) for the maximum flap setting that can be safely obtained. This will increase the clearance with the airplane, reduce the possibility of striking the fore and aft sides of the escape chute because of nose high deck angles at slower speeds, and will decrease the effect of tumbling. The minimum recommended altitude for controlled bailout is 2000 feet above the terrain; however, if the airplane is not controllable, do not delay bailout. The appointed jumpmaster will bail out after all crewmembers and passengers, except the pilot and copilot, have been evacuated. After the jumpmaster has evacuated other personnel, he will notify the pilot and then bail out followed by the copilot and pilot. The autopilot will be engaged by the pilot just before leaving. The oxygen mask will be discarded immediately after checking the parachute canopy and raising the helmet visor.

Low Altitude Bailout

Low altitude bailouts involve definite hazards; therefore, several considerations must always be kept in mind. At low altitudes, parachute opening must not be delayed unnecessarily, yet a minimum delay of one second is needed to assure clearing the airplane. The actual safe minimum altitude for bailout is very difficult to determine. Because of the number of variables that have an effect, such as airspeed, airplane attitude, directional controllability and even the individual himself, flight tests may be inconclusive in determining this value. The minimum altitude will vary with airplane attitude and airspeed. During any low altitude bailout, the chances of success are improved if the airplane is in a positive climb. This would impart to a crew member an initial upward component of velocity, thereby providing more time for parachute deployment than in straight and level flight. The opposite is true of bailout from an airplane in a descent or dive. If a bailout at low altitude is necessary, the airplane should be in either level flight or a climb.

Airspeed affects the minimum bailout altitude. From the standpoint of deployment of the parachute, extremely slow airspeed is not desirable at low altitudes. Increasing airspeed can decrease the minimum altitude from which safe bailout may be expected. A parachute canopy inflates in a given distance, regardless of the speed or altitude at which it is deployed. See figure 3-6. The trajectory of a falling body is a curve when it has an initial compo-

bailout considerations

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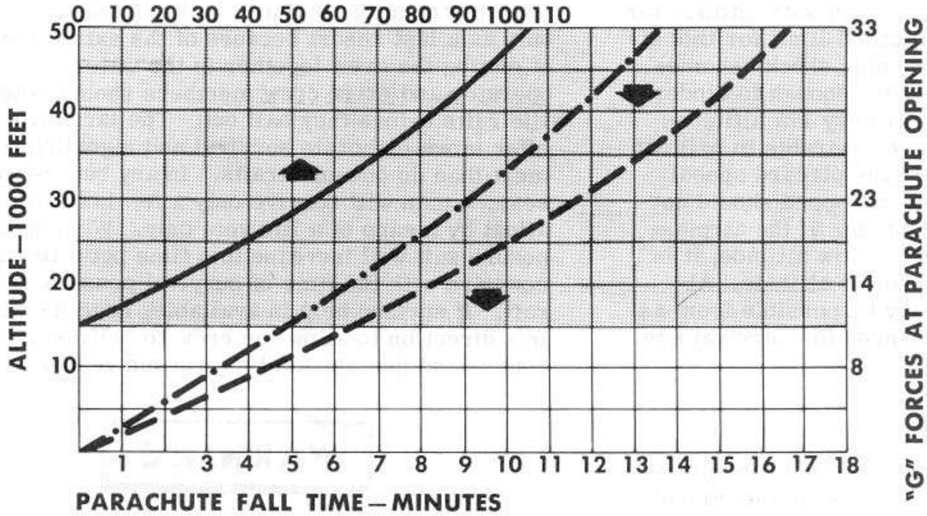


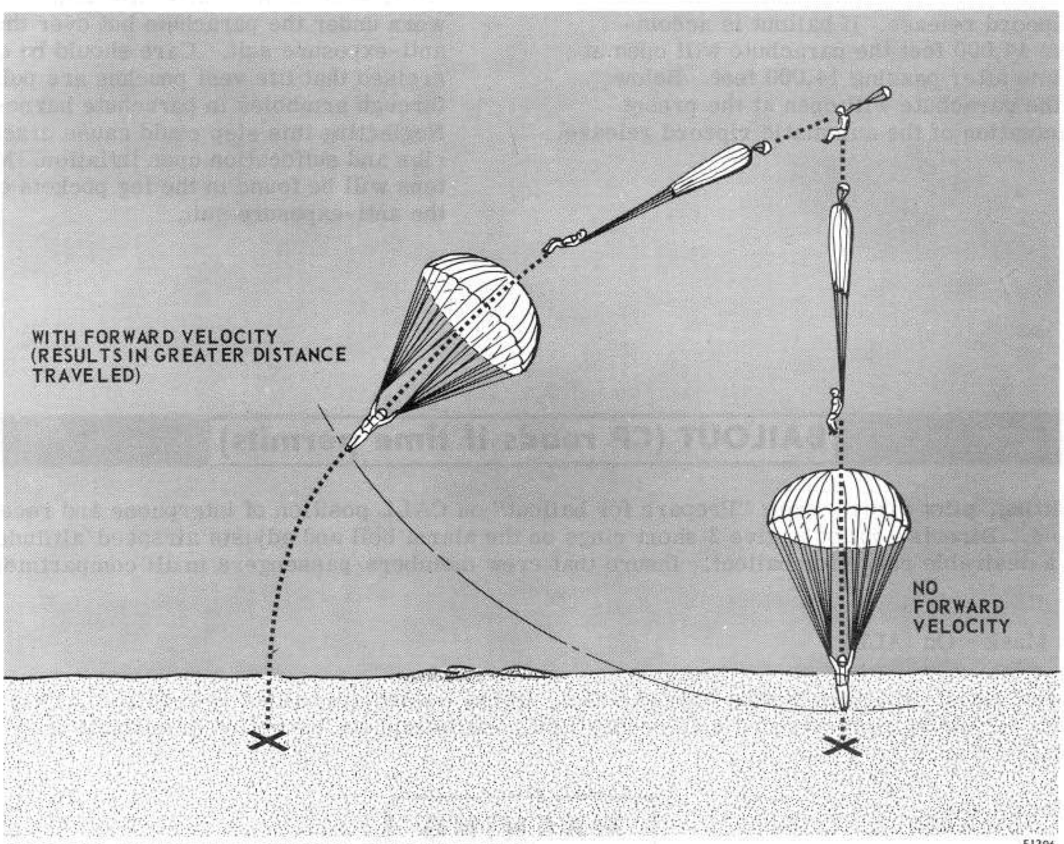
NOTE

The faster you fall to 15,000 ft. the better.

WARNING

Do not open parachute above 15,000 feet unless you are losing consciousness.

BAILOUT DESCENT TIME



AIRSPEED EFFECT ON BAILOUT DESCENT PATH

Figure 3-6

nent of velocity in the horizontal direction. Thus, the actual distance traveled through the air is greater than the vertical distance dropped. Applying this effect to a parachute, a canopy with an initial horizontal velocity will inflate in a shorter vertical distance than one without. Therefore, it can be expected that as airspeed increases, the minimum safe altitude for bailout becomes lower. A practical limit for this effect occurs when parachute opening shock becomes intolerable, or tumbling is severe enough to hinder rapid pulling of the ripcord. At very low altitudes, it is, therefore, generally more desirable to bail out at a high airspeed (within airplane placard speed) than a low airspeed. However, airspeed should not be sought at the expense of altitude. If the airplane is controllable, at high speed and low altitude, it is usually better to trade airspeed for altitude. Although a successful bailout may be possible from as low as 400 or 500 feet, the chances for survival are best when above 2000 feet.

High Altitude Bailout

Bailout at high altitudes introduces the problems of lack of oxygen, low temperature, and high parachute opening shock. To minimize these problems, it is necessary to free fall to lower altitudes. Descent time and opening shock can be determined from figure 3-6. The parachute is equipped with automatic opening features which are armed by pulling the automatic ripcord release. If bailout is accomplished above 14,000 feet the parachute will open at the preset time after passing 14,000 feet. Below 14,000 feet the parachute will open at the preset time after actuation of the automatic ripcord release.

Over Water Bailout

Successful over water bailouts require additional consideration and preparation time. When over water, bailout is not recommended unless visual contact is made with adequate surface help. If no rescue vessels are in the vicinity, bailout should be used only as a last resort because of the extreme difficulty of getting the crew together in the water. The boom operator and extra crew members should release the life rafts before they bail out. The large life rafts offer more elaborate survival and signaling equipment than do one-man rafts. In any but the warmest seas, a man will survive only a few hours if kept afloat by means of a life vest only. Wearing an exposure suit will increase this time but still cannot compare with the time of survival possible in a life raft. If surface help is available, head the airplane in a direction to allow the crew to drift onto the course and just ahead of the rescue vessel.

WARNING

For over water bailout, anti-exposure suits available in the airplane should be put on if time permits. Anti-exposure suits should be put on over flying suits. A life vest is imperative and must be worn under the parachute but over the anti-exposure suit. Care should be exercised that life vest pouches are pulled through armholes in parachute harness. Neglecting this step could cause cracked ribs and suffocation upon inflation. Mittens will be found in the leg pockets of the anti-exposure suit.

BAILOUT (CP reads if time permits)

Time permitting, pilot directs crew "Prepare for bailout" on CALL position of interphone and receives acknowledgment. Directs copilot to give 3 short rings on the alarm bell and adjusts airspeed/altitude, time permitting, to a desirable range for bailout. Insure that crew members/passengers in all compartments are notified.

1. Oxygen Mask - On (ALL)

Don oxygen mask and attach bailout oxygen bottle, unless immediate bailout is required. Excessive cockpit noise with escape spoiler extended may render radio and interphone reception impossible if the helmet and mask are not worn.

WARNING

When the "Prepare for bailout" signal is given, each man will recheck his parachute harness for proper fit.

2. Landing Gear - UP (if applicable) (CP)

WARNING

- With the gear or gear doors extended, egress from the airplane through the crew entry chute may be extremely hazardous and only as a last resort should bailout through the crew entry chute be attempted. In the event that gear or gear doors are extended, use the aft emergency exit hatch for bailout, if possible.
- The boom should be stowed if possible to prevent a chance contact with the boom during bailout.

3. Cabin Pressure - RELEASE (P)

Pilot will pull cabin pressure emergency release handle.

NOTE

Each man should make sure his individual life raft pack (survival kit) is snapped onto the parachute harness. Crew members should check each other to see that all straps and packs are properly adjusted. For over-water bailout boom operator and extra crew members stand by to open the aft hatch, then the left overwing hatch and release life raft. Navigator should stand by to actuate chinning bar when directed by pilot.

4. Crew - Bailout (ALL)

Pilot gives the bailout order and directs copilot "Alarm bell on." The boom operator or the navigator will pull the chinning bar down, lift the crew entry chute floor grille, and bail out as shown in figure 3-7.

When over water, the boom operator and extra crew members will release life rafts. If time permits, they should immediately proceed to control cabin and out through the crew entry chute; if time does not permit, they will go out the aft hatch.

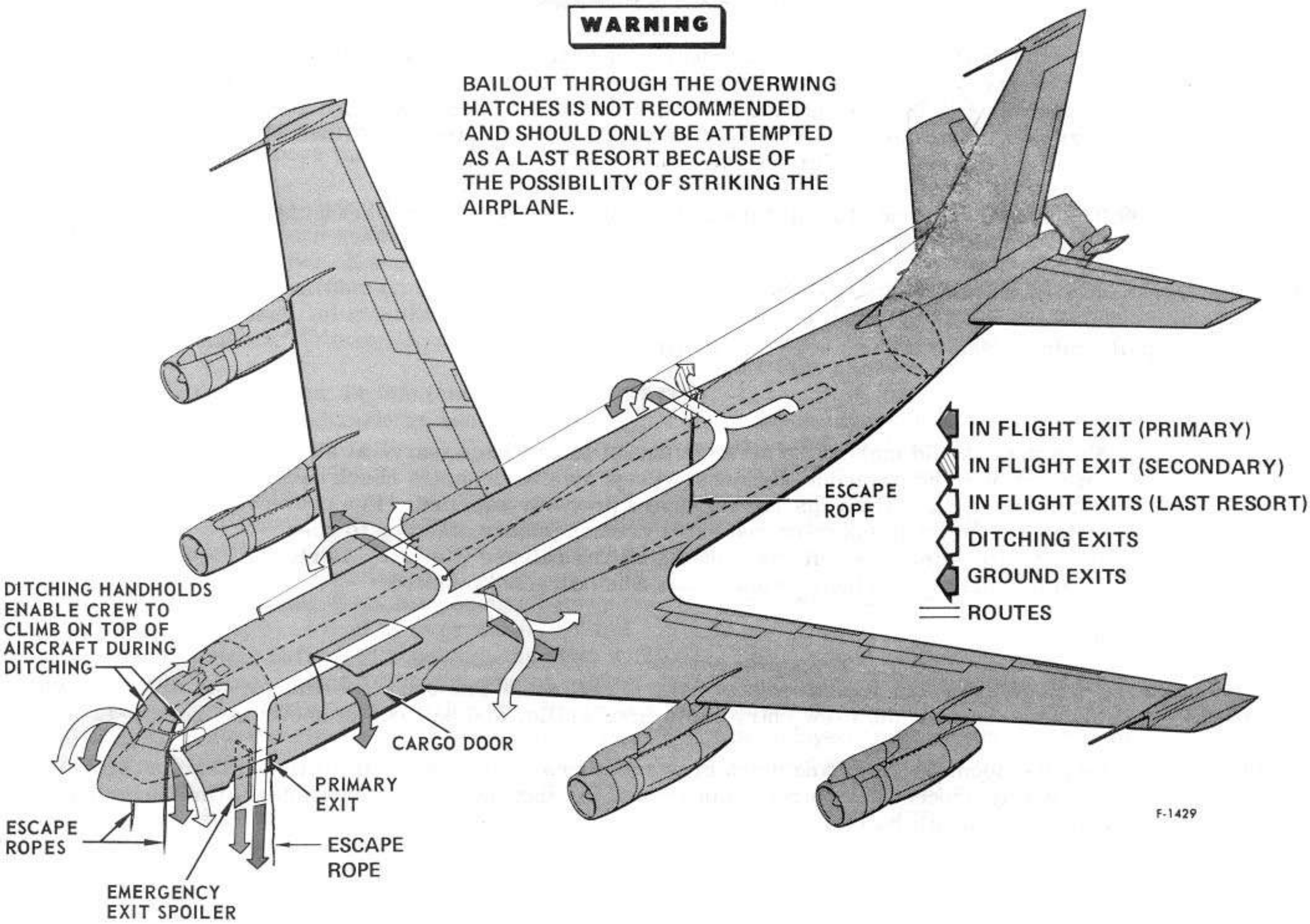
EMERGENCY DESCENT

The following procedure will result in maximum descent rates within the structural limits of the airplane. Due regard to the nature of the emergency should be given and descent modified accordingly. For instance, if a hatch has blown out and struck the tail the seriousness of the situation may be compounded by attempting a maximum rate descent.

1. Throttles - IDLE (P)
2. Landing Gear - DOWN (P, CP)
3. Speed Brakes - 60° (P)
4. Descend at Airplane Placard Speed (P)

For practice, observe maximum allowable airspeed for landing gear. See Section V.

emergency escape routes & exits



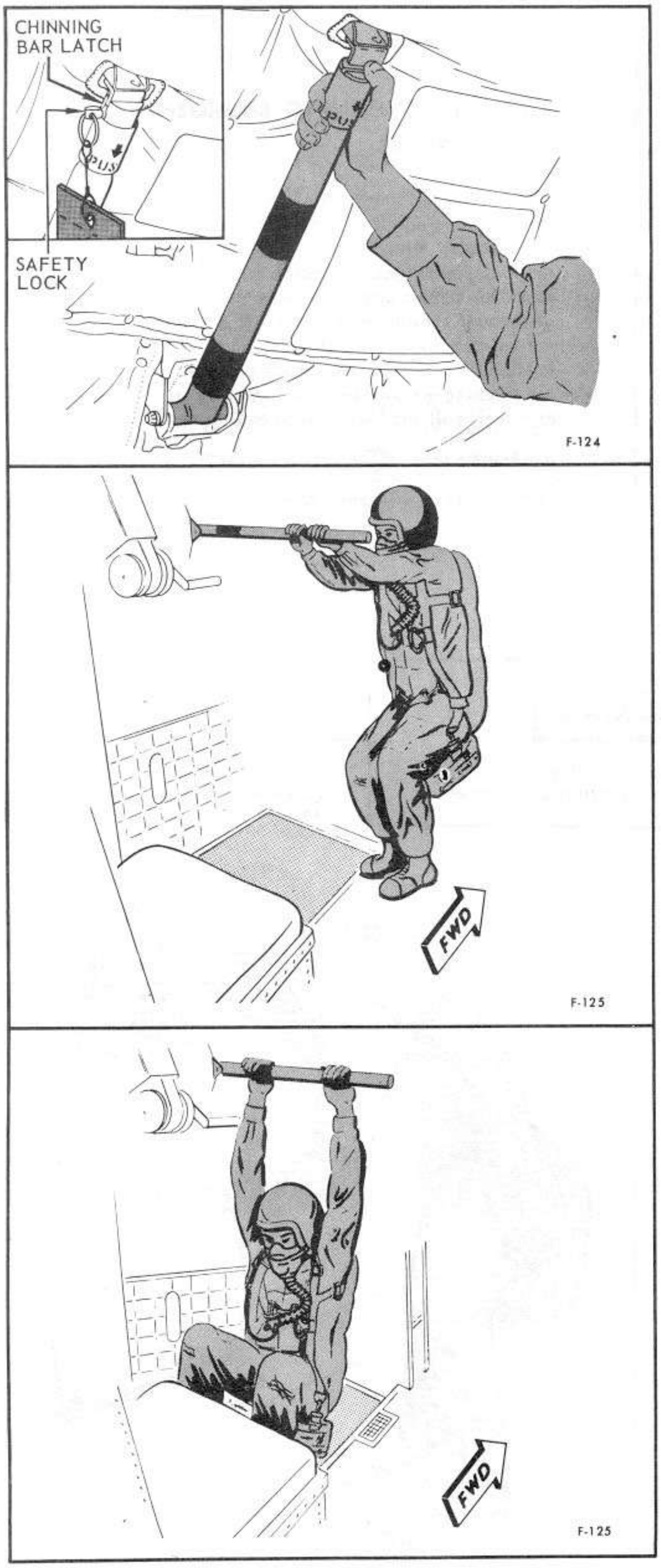
WARNING

- If a main cabin hatch should come out during flight, a pressure differential may cause the cargo door pressure plates to open and the cargo door warning light to come on. If this situation should occur during takeoff, smoke from the nose wheel compartment may enter the cockpit.
- Emergency exit hatches should not be removed unless absolutely necessary. Reduce airspeed as low as practical, preferably below 150 KIAS, before opening either of the overwing hatches or the aft emergency hatch. However, it is possible to open the aft emergency exit hatch safely at speeds greater than 200 KIAS. If both the overwing hatches and the aft emergency hatch are to be opened, the aft emergency hatch should be opened first to minimize the forces acting to push the hatch inward. All hatches may be expected to open with considerable inward force if the crew entry door has been jettisoned and the emergency exit spoiler extended.

NOTE

- In the event emergency exit is required on the ground due to a crash landing, collapsed landing gear, or other ground emergency, each crewmember should remove his parachute prior to abandoning the airplane. Egress from the airplane will be expedited if the parachute is not worn. However, if the site is other than an active airfield, consideration should be given to the need for the parachute for survival, in which case the parachute should be hand-carried or thrown out of the airplane.
- Before opening emergency exit hatches in flight, the fuselage must be depressurized. Crewmember opening hatch should stand at approximately the forward edge of the hatch, facing aft; be prepared for the aft edge of the hatch to rotate inboard as a result of inflowing slipstream. Open overwing emergency exit hatch by pulling lock handle at right of hatch and holding fixed handle at top. Open aft hatch by turning lockhandle at right.

Figure 3-7 (Sheet 1 of 7)



CREW ENTRY CHUTE (PRIMARY INFLIGHT EXIT)

A. Don oxygen masks and bail-out oxygen bottles if altitude requires and depressurize aircraft.

B. Remove chinning bar safety lock if installed.

C. Press chinning bar plunger at top of bar into the chinning bar sleeve to disengage the latch and pull the bar down to the horizontal position. This will release the crew entry door and extend the entry chute spoiler.

D. Raise and latch floor grille.

E. Grasp chinning bar centrally over the chute area facing aft and drop feet into chute.

F. When body position stabilizes, tuck knees up and let go both hands simultaneously. As soon as possible move hands down and across the chest and grasp the parachute harness; this prevents the elbows from contacting the sides of the chute and the hands and arms from contacting the spoiler when the body rotates as it enters the slipstream.

G. Delay pulling ripcord and/or automatic ripcord release mechanism until well clear of the airplane if altitude permits.

WARNING

- It is recommended that crash helmets be worn during bail-out to prevent injuries if head should strike entry chute.
- It is also advisable to retract the main landing gear and stow the boom if possible to prevent chance of being blown against an extended gear or boom.

Figure 3-7 (Sheet 2 of 7)

emergency escape routes & exits (cont)

F-118

OPENING OVERWING EMERGENCY EXIT HATCHES

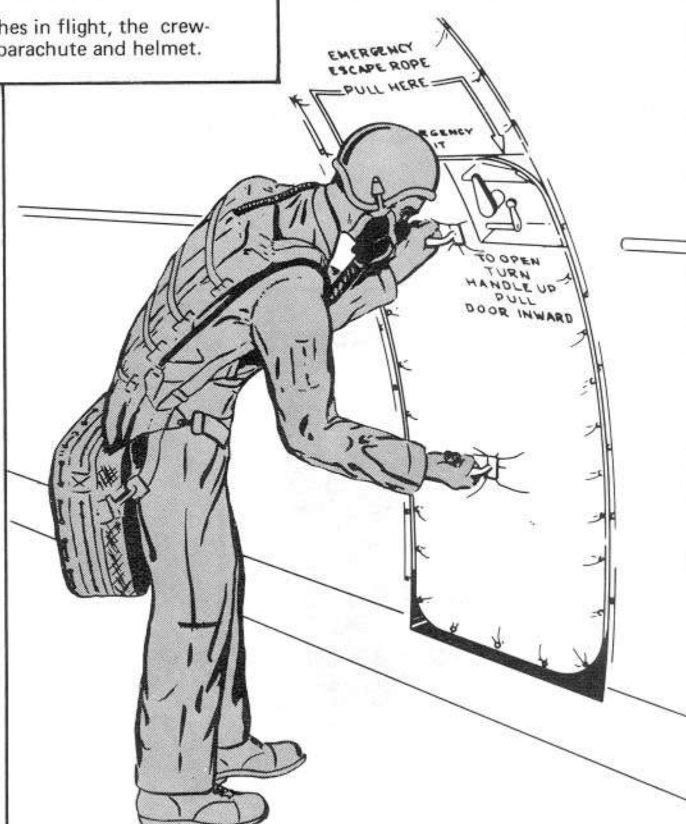
Stand at approximately the forward edge of the hatch facing aft. Place left hand on door handle. With the other hand pull down the lock handle and pull hatch in. Be prepared for sudden opening of hatch if emergency exit spoiler is extended. If this does not unlatch the exit hatch, push on the hatch with a shoulder to reduce pressure on the latching mechanism, and with a finger or a tool, pull the hatch over-center lock mechanism (see **7** of figure 1-62) inboard. This will unlatch the hatch.

WARNING

When removing hatches in flight, the crewmember will wear a parachute and helmet.

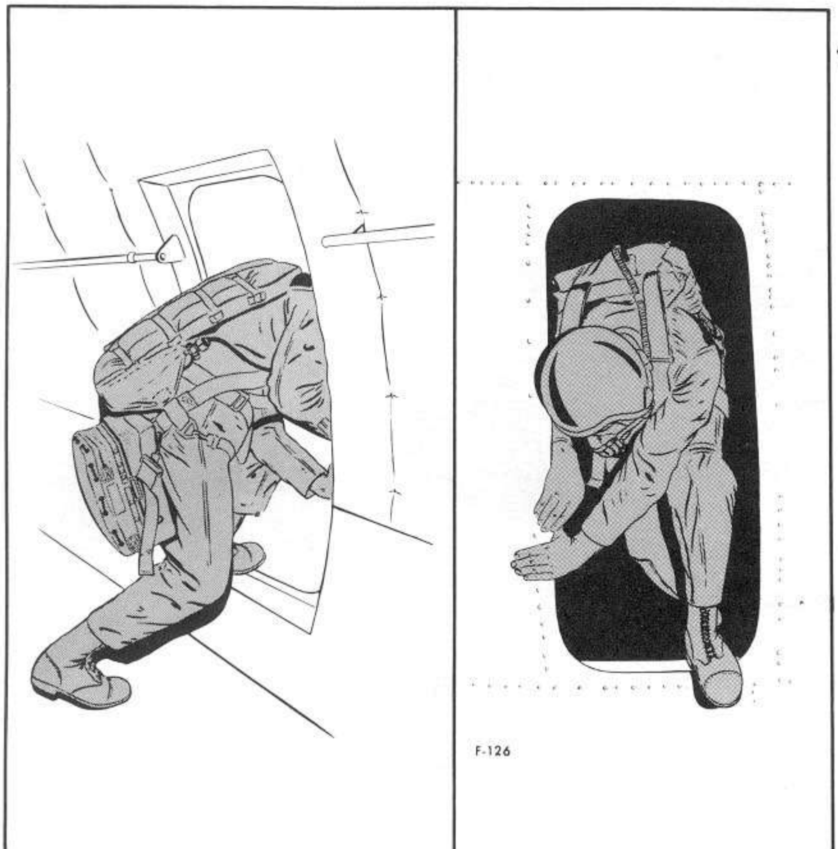
OPENING AFT EMERGENCY EXIT HATCH

Stand at approximately the forward edge of the hatch facing aft. Place left hand on upper door handle and reach across with the right hand and raise lock handle to the vertical position. Quickly move right hand to lower door handle and pull inboard. Be prepared for sudden opening of hatch if emergency exit spoiler is extended.



F-119

Figure 3-7 (Sheet 3 of 7)



AFT EMERGENCY EXIT HATCH (USE ONLY IF GEAR OR GEAR DOORS ARE EXTENDED OR IF CREW ENTRY CHUTE CANNOT BE REACHED)

1. Approach hatch from forward side.
2. Grasp aft edge of hatch frame.

WARNING

Be prepared for inflow of air across aft edge of hatch frame that approaches airplane speed in velocity.

3. With shoulder against aft edge of hatch frame, place left foot at forward corner of hatch and roll into slipstream.
4. Using hands and feet, push away from side of airplane if possible.
5. Delay pulling ripcord and/or automatic ripcord release mechanism until well clear of airplane if altitude permits.

OVERWING EMERGENCY EXIT HATCH (USE ONLY IF OTHER ESCAPE EXITS CANNOT BE REACHED)

1. Approach hatch from forward side.
2. Grasp aft edge of hatch frame and step out on wing with one foot.

WARNING

Be prepared for strong inflow of air.

3. Move head and shoulders through hatch and roll into slipstream.
4. Using hands and feet, push away from side of airplane, if possible.
5. Delay pulling ripcord and/or automatic ripcord release mechanism until well clear of airplane if altitude permits.

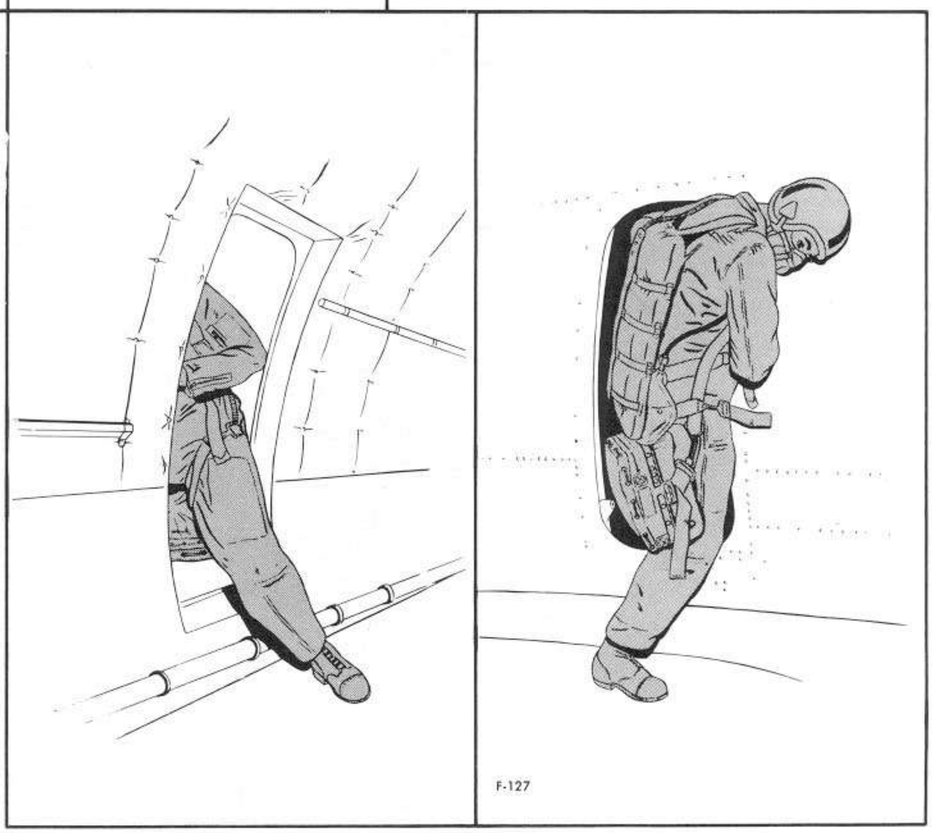


Figure 3-7 (Sheet 4 of 7)

emergency escape routes & exits (cont)

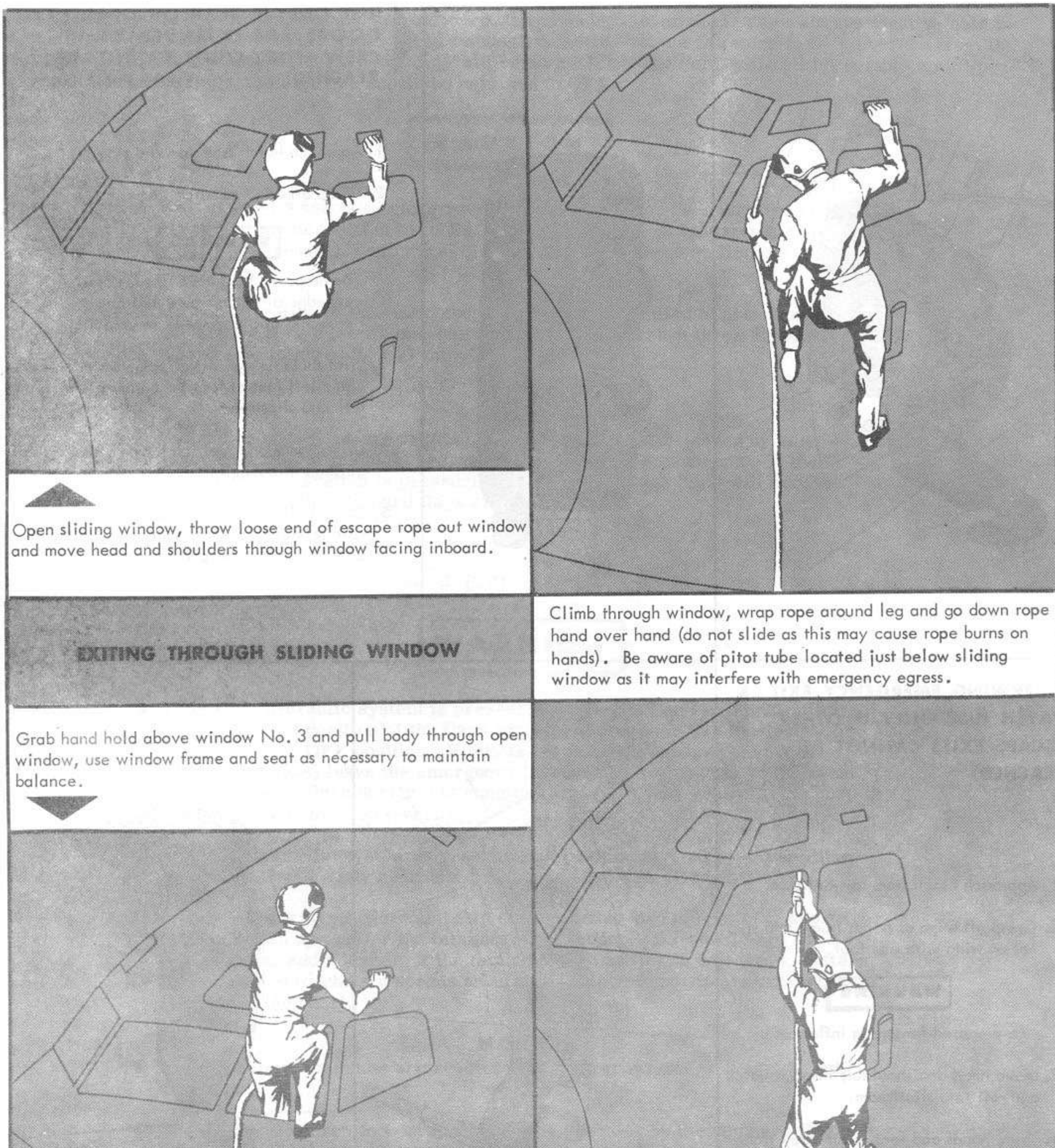


Figure 3-7 (Sheet 5 of 7)

GROUND EXIT THROUGH CREW ENTRY CHUTE

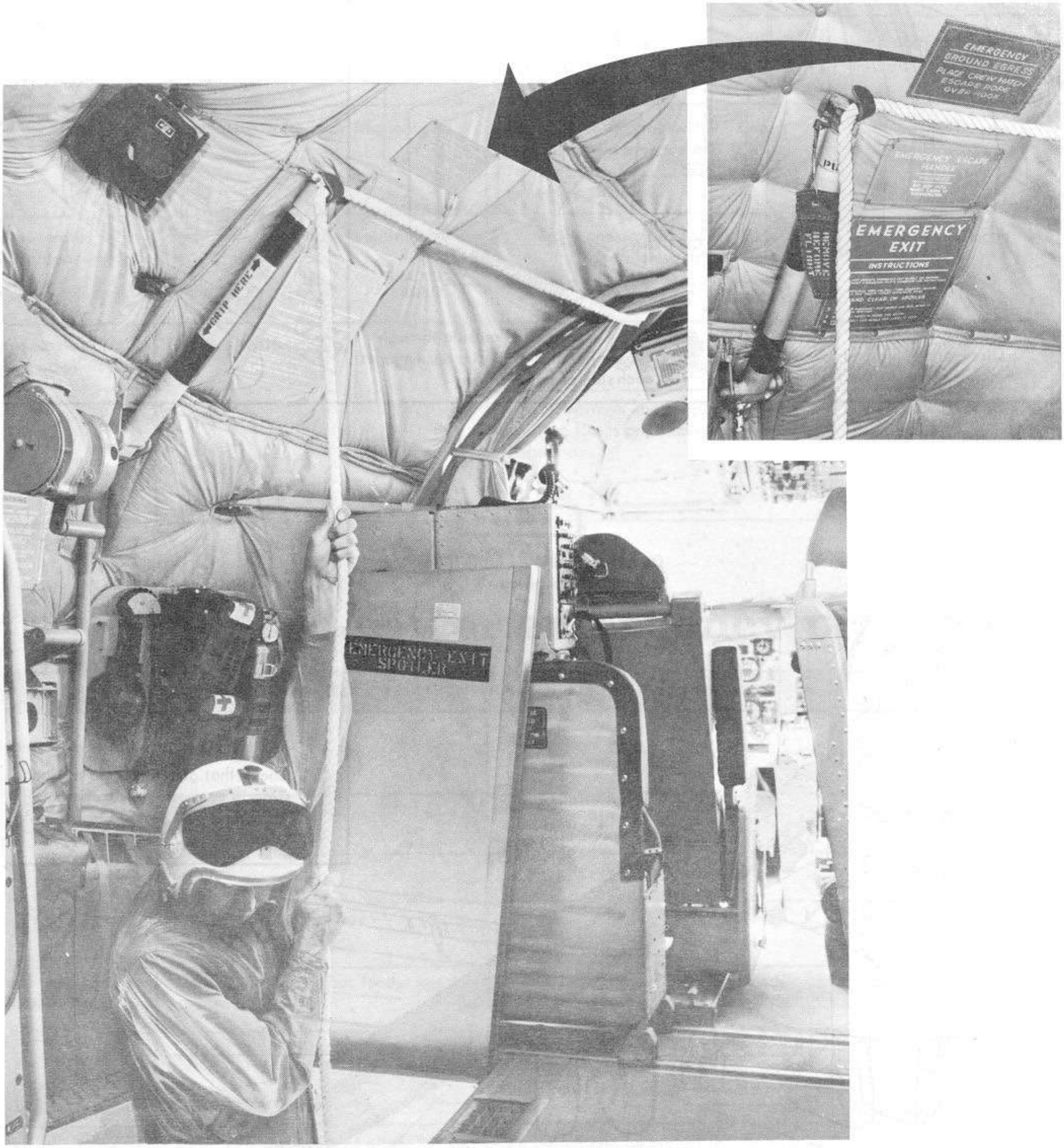
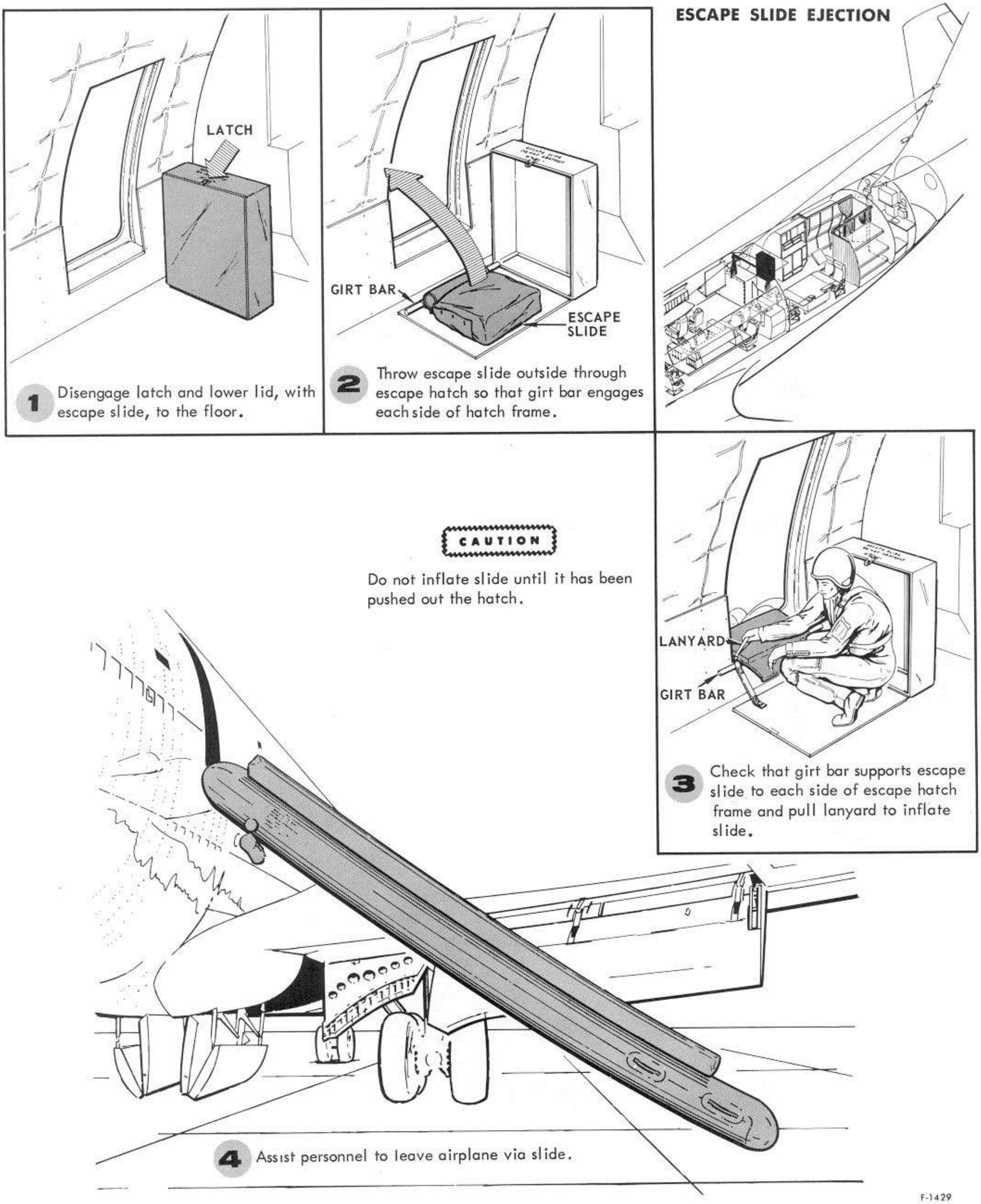


***Figure 3-7** (Sheet 6 of 7)*

emergency escape routes & exits (cont)



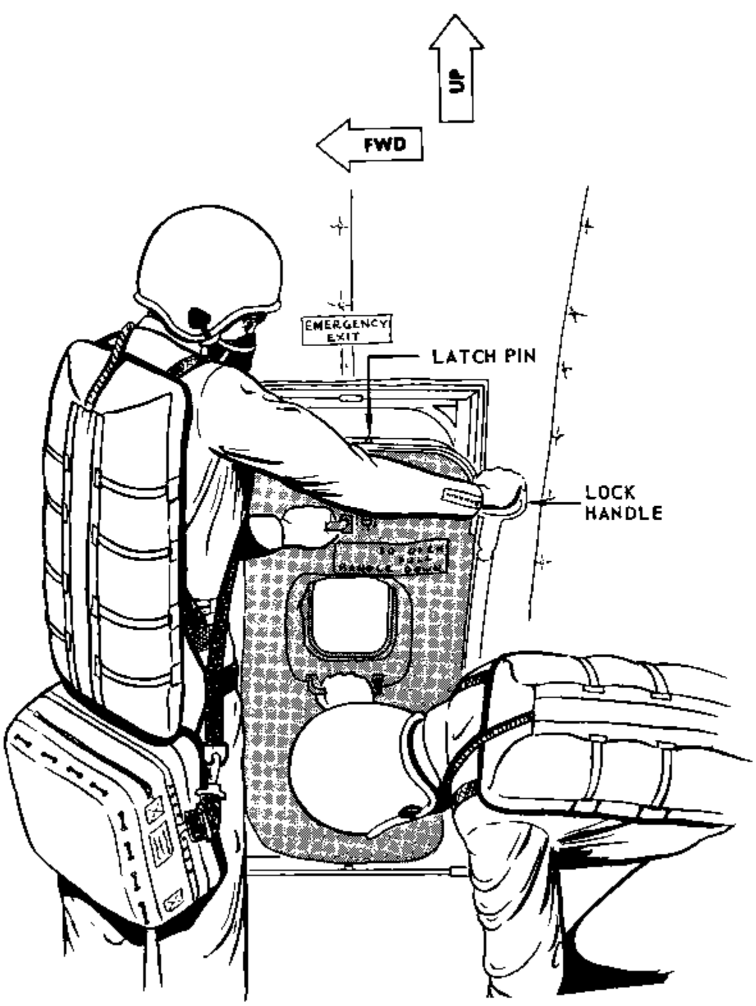
1. Disengage latch and lower lid, with escape slide, to the floor.
2. Throw escape slide outside through escape hatch so that girt bar engages each side of hatch frame.
3. Check that girt bar supports escape slide to each side of escape hatch frame and pull lanyard to inflate slide.
4. Assist personnel to leave airplane via slide.

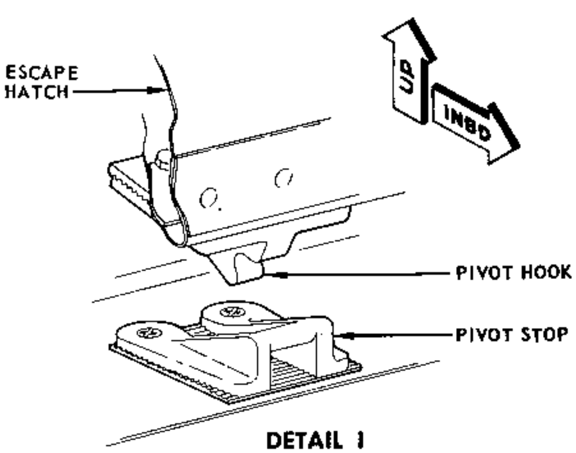
CAUTION

Do not inflate slide until it has been pushed out the hatch.

Figure 3-7 (Sheet 7 of 7)

reinstallation of hatches in flight





DETAIL 1

Figure 3-8

REPLACING EMERGENCY EXIT HATCH IN FLIGHT

Inflight installation of the emergency hatches is not normally recommended. Should it become absolutely necessary to install them, two men are required. The forward hatches must be installed first. To install a hatch:

WARNING

- Installation of emergency hatches becomes extremely hazardous above 150 KIAS.
- When checking or reinstalling hatches in flight, the crewmember shall wear a parachute and helmet.

1. Make sure that the external handle is flush.
2. Both men hold the hatch by its handles and approach the opening from the forward side as shown above. (One man holds the hatch by the upper fixed handle with one hand and the lock handle with the other hand. The lock handle is held so that the latch pin is fully retracted. The second man holds the hatch by the lower fixed handle.)
3. The hatch is positioned in the opening with the top of the hatch inboard. The man holding the lower handle visually guides the pivot hook into the pivot stop and pulls the hatch inboard to keep the hook tight against the stop.
4. Push the upper end of the hatch outward and lock the hatch. To lock a forward hatch, push the lock handle all the way up. The aft hatch is locked by turning the lock handle down (CW).

NOTE

The force required to place the handle to the locked position increases as the lock is applied and relieves slightly as the lock goes over center.

5. Inspect the lock linkage. This linkage must be in a definite outboard overcenter position. See figure 1-62.
6. Inspect pivot hook and pivot stop for proper engagement. It is possible for hook to be out of engagement even though the hatch feels secure.

LANDING EMERGENCIES

WARNING

Removal of emergency exit hatches in preparation for a possible crash landing or ditching is not recommended. Inflight removal is accompanied by a certain amount of hazard to the crewmember, and open hatches subject occupants to fumes, debris, and high velocity airflow. Studies indicate that structural shock great enough to jam hatches closed on impact will provide a fuselage break for egress. Closed hatches increase the protection afforded occupants from fire, fuel, or water inflow. Selective opening of hatches after impact provides safe egress passages and prevents flooding if the fuselage does not float evenly after a ditching.

LANDING WITH ONE ENGINE INOPERATIVE

Landing with an engine failure can be accomplished by following the normal landing procedure with the addition that, as thrust is decreased, trim will have to be decreased to compensate for reduction of the unequal thrust. Under any approach conditions involving reduced power, the necessity of early anticipation of additional power requirements cannot be overemphasized. Use the normal landing pattern, except as follows:

A. 50 degree flap approaches will not be flown with less than four engines operating. The positioning of flaps to 50 degrees should be delayed until the landing is assured. Consideration should also be given to extending the final approach under conditions of high gross weight.

B. If maintaining altitude is a problem, retract and/or delay lowering of the landing gear until there is no doubt that the runway can be reached.

WARNING

Maintain prescribed traffic pattern speeds consistent with flap setting, gross weight, and flight minimum directional control speeds.

LANDING WITH TWO ENGINES INOPERATIVE

Landing with two engines inoperative can be accomplished safely provided that it is properly planned. Follow the normal landing procedure except fly the downwind leg, base leg, and final approach with 20 degrees flaps at 20 degree flap pattern/approach speed or V_{MCA}, whichever is higher. If maintaining altitude is a problem, retract and/or delay lowering the landing gear until there is no doubt that the runway can be reached. Do not lower more than 20 degrees flaps until the landing is assured, but not before reaching 300 feet above the runway. Then lower final flaps and complete the landing.

WARNING

For inflight minimum control speeds with two engines inoperative (powered rudder operative) refer to Part 9 of the Appendix, T.O. 1C-135(E)C-1-1.

GO-AROUND WITH ONE OR MORE ENGINES INOPERATIVE

The decision to go-around should be made as early as possible. This decision becomes most important with one or more engines inoperative since reduced thrust available and limited directional control under some circumstances may make a go-around impossible near the ground. See Parts 3 and 9 of the Appendix, T.O. 1C-135(E)C-1-1 and GO-AROUND in Section II, this manual.

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.

ONE ENGINE INOPERATIVE

If one outboard engine becomes inoperative and a go-around becomes necessary, the airplane should be trimmed out using a maximum of rudder trim and a minimum of lateral control trim in order to avoid loss of performance due to spoiler deflection. Sufficient rudder should be applied to avoid excessive sideslip angles. By applying rudder as well as appropriate lateral control, straight ahead directional control can be maintained. Steady flight conditions can only be established with the thrust deficient wing a few degrees high. See also FLIGHT AND LANDING WITH RUDDER POWER INOPERATIVE in this Section.

TWO ENGINES INOPERATIVE

A go-around with two engines inoperative on the same side is possible provided the gross weight is low enough to permit climb (for climb capability with two engines inoperative refer to Part 9 of the Appendix, T.O. 1C-135(E)C-1-1). If performance is critical, dump fuel as necessary. Flight minimum control speeds shown in Part 9 of the Appendix, T.O. 1C-135(E)C-1-1 must be increased by 26%. The pilot must apply full rudder and sufficient lateral control as power is applied to the remaining operating engines. Any go-around which must be made with two engines inoperative on the same side should be accomplished with caution. Directional and lateral control must be promptly applied as soon as the throttles are moved forward. It is recommended that the throttles be moved forward slowly until the pilot has determined his capabilities for handling such an emergency. Leave flaps at 20° and raise landing gear as soon as possible. Many different combinations of engine failure are possible and go-around techniques will vary slightly with each. The most critical conditions are those go-arounds which occur when two engines on the same side have failed, since directional control is the limiting condition.

WARNING

- Airspeed indicator error exists during sideslip. An actual airspeed 7 knots lower than indicated will exist at 10 degrees of sideslip.
- A successful go-around with two engines inoperative on one side and rudder power inoperative cannot be assured using full throttle thrust on the two good engines. Pedal forces from 250 to 375 pounds are required to obtain full rudder deflection at minimum control speed. Full rudder deflection is the basis for the Inflight Minimum Control speed charts The pilot should not hesitate to request copilot assistance in applying and maintaining required rudder pressure.

LANDING WITH GEAR FAILURE (CP reads)

In general, landing with as much of the gear extended as possible provides the maximum protection for personnel and for airplane structure. If the gear problem is associated with the failure of either or both hydraulic systems, the pilot should consider those affected items (brakes, rudder power, spoilers and nose wheel steering) which will apply to the control problem during the ground roll. All excess fuel should be dumped prior to landing. Fuel dump should be completed at least 2 minutes prior to touchdown. Approximately 2000 pounds in each of the main wing tanks is recommended at touchdown assuming a normal cg. The forward and aft body tanks should be empty. At low fuel levels, abrupt maneuvers, accelerations and steep pitch attitudes should be avoided. Accomplish a normal approach. The use of foam on the runway is recommended except when landing with one main gear retracted. The foaming operation should be completed to coincide with the landing of the airplane to prevent foam from dissipating before landing. If freezing conditions are present, foam should be applied to the runway in sufficient time for freezing to occur because of better sliding characteristices. An additional layer of foam can then be applied just prior to landing. When landing with the nose gear retracted and both main gear extended a narrow strip of foam not more than 15 feet wide will protect the nose without affecting main wheel braking. The foam strip should be started approximately 4000 to 4500 feet from the approach end of the runway and should be continued for 5000 feet or to the far end of the runway. When landing with only the nose gear extended a foam strip at least 130 feet wide should be started 1500 feet from the approach end of the runway and should be continued for 4000 to 5000 feet or to the far end. For all emergency landings where time and or foam quantity is limited the stopping end of the ground roll is considered most important. Sufficient foam should be retained to extinguish any fire that might develop. After the airplane stops, the upper wing surface should not be foamed unless necessary since it may interfere with evacuation of personnel through the overwing hatches.

PREPARATION FOR GEAR UP LANDING, ALL CONFIGURATIONS

1. Crew - Alert (P)

   Pilot directs crew to "Prepare for crash landing" on CALL position of interphone and receives acknowledgement. Directs copilot to give six short rings on alarm bell.

2. Fuel - Dump as required (CP)

   Refer to EMERGENCY JETTISONING, this Section.

3. Airplane - Depressurize (CP)

4. Aft Emergency Exit Hatch - Remove (if required) (N, BO)

   See figure 3-7. Remove the aft emergency exit hatch only if it is required for jettisoning or for non-essential personnel to bail out.

LANDING WITH GEAR FAILURE (Cont)

5. Loose Gear - Jettison or stow (N, BO)

CAUTION

Before jettisoning, lower full flaps and reduce airspeed to slowest practical speed. Jettison cargo through aft hatch to avoid damaging the upper wing surface.

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 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°.

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 SHUT-OFF circuit breakers for the two 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 - Accomplish (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)

    Pilot warns crew to brace for crash landing on CALL position.

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.

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. 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 contact 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 pulled. 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 WITH GEAR FAILURE (Cont)

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 slightly high, followed by lowering the nose wheel gently to the runway. 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. 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)

    To preclude leaking hydraulic fluid from starting or feeding a fire, and if time and circumstances permit, close the ENGINE HYDRAULIC OIL FIRE SHUTOFF circuit breakers previously pulled.

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 reads)

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. The ANTI-SKID INBOARD and OUTBOARD circuit breakers should be pulled if the left hydraulic system is depleted. 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 must be manually lowered and the main flaps electrically lowered with the leading edge flaps remaining in the retracted position. Hydraulic leakage 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 1-52. 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 electrically. See MAIN FLAP EMERGENCY OPERATION, this Section.

6. Antiskid Circuit Breakers - Pull (BO or N)

   Pulling the antiskid circuit breakers will prevent rapid depletion of reserve brake accumulator pressure.

7. Control Cabin Windows - Open (P, CP)

8. Safety Belt and Shoulder Harness - Lock (ALL)

LANDING WITHOUT NORMAL BRAKE SYSTEM PRESSURE (Cont)

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

    It is possible to replenish reserve brake pressure by holding down the reserve brake switch 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 - Notified (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 weights, unsymmetrical power, high altitude fields, etc.

LANDING WITH EMERGENCY FLAP CONTROL ONLY

When landing with only emergency control of the flaps it will be necessary to start lowering the flaps well before the final approach is reached. Because of the time element involved (approximately 3 minutes from full up to full down) full flaps may not be able to be lowered before touchdown. See LANDING WITH 30 DEGREES FLAPS OR LESS, this Section. At least 23 degrees of outboard flaps must be down before the full outboard ailerons become available. 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(E)C-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(E)C-1-1.

WARNING

- For landing with less than 2800 psi rudder hydraulic pressure, apply performance data for rudder power inoperative. If rudder hydraulic pressure is less than high range (2800 psi minimum), 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(E)C-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 TIRES

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 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. With flaps up, this airplane can remain airborne on a single-engine at weights up to 200,000 lbs. (The two-engine maximum endurance speed should be used.) Since fuel flow under these conditions is approximately 9500 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.

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 to 300 foot per minute rate of descent at 50° flap 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.

Figure 3-9 and all data on pages 3-49 and 3-50 (Deleted)

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° flaps should be used. The use of more than 20° 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 sufficient 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° with windmilling engines.

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.

DITCHING PREPARATION (Cont)

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)

   See figure 3-7. Remove aft emergency exit hatch only if loose gear to be jettisoned.

7. Loose Gear - Jettison or stow (N, BO)

8. Aft Emergency Exit Hatch - Re-install (N, BO)

   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)

    Pilot warns crew to brace for impact on CALL position of interphone.

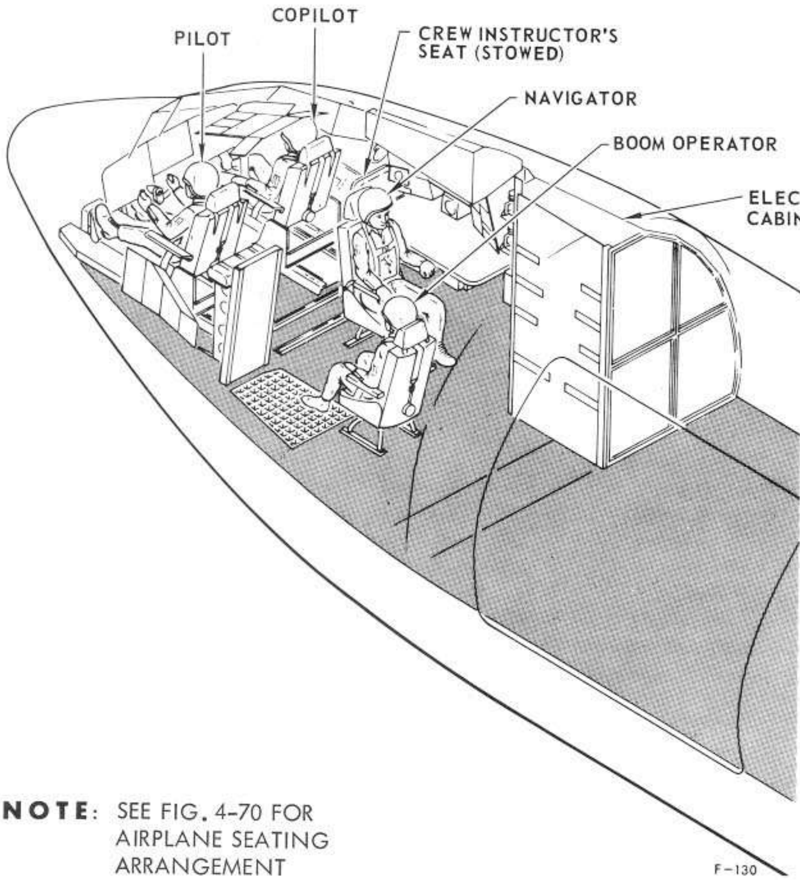
WARNING

Do not release safety belt or shoulder harness until airplane comes to a complete stop.

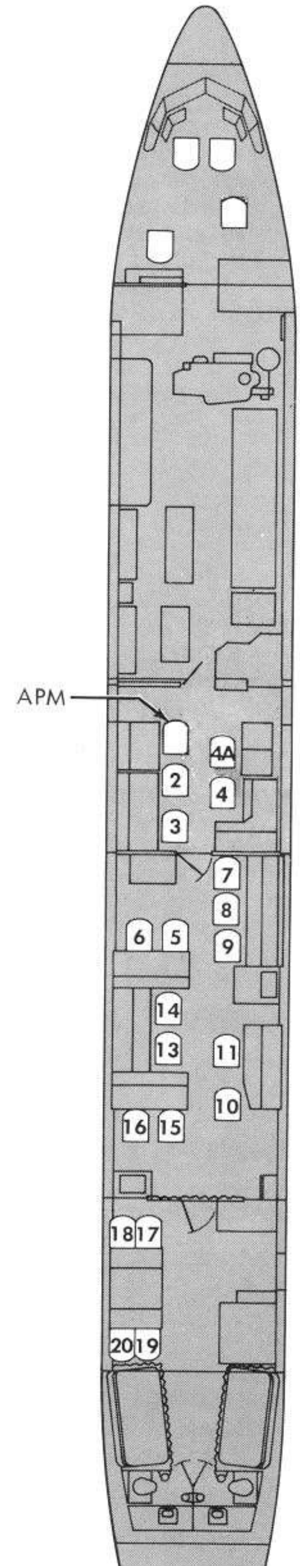
13. Alarm Bell - One long sustained ring (CP)

14. Airspeed - Reduce to slowest safe speed (P)

ditching & crash landing positions



NOTE: SEE FIG. 4-70 FOR AIRPLANE SEATING ARRANGEMENT



WARNING

- DURING DITCHING, IT IS RECOMMENDED THAT PERSONNEL NOT BE SEATED AFT OF THE RIGHT AFT ESCAPE HATCH SINCE EXTENSIVE FUSELAGE DAMAGE, INCLUDING FUSELAGE SEPARATION, MAY OCCUR IN THE AREA AFT OF THAT POINT.
- DO NOT OCCUPY SEATS 19 AND 20 DURING CRASH LANDING UNLESS THE SEATS ARE EQUIPPED WITH THE WIDE MD-2 TYPE SAFETY BELTS. EACH OCCUPANT MUST REST HIS HEAD AND UPPER BODY ON THE TABLE DURING THE EMERGENCY.
- DO NOT OCCUPY THE BUNKS DURING TAKEOFF, LANDING, DITCHING AND CRASH LANDING.

Figure 3-10

ditching chart

	DUTY	PROVIDE	POSITION	EXIT
PILOT	Warn crew over loudspeaker and six short rings on alarm bell to prepare for ditching. Don exposure suit if time permits. Request position from navigator. Check landing gear up, flaps down. Check life vest, safety belt, shoulder harness and inertia reel locked. Approximately 5 seconds before impact, give "brace-for-ditching" warning on interphone and one long ring on alarm bell. Before impact, retard throttles. Don helmet.	Parachute, flashlight, survival kit, exposure suit if not already on	Pilot's seat	Left overwing hatch or sliding window
COPILOT	Dump fuel. If at night, check external lights on. Check emergency exit lights ON. Don exposure suit if time permits. Check life vest, safety belt, shoulder harness and inertia reel locked. Assist pilot in any way. Transmit emergency on UHF. Don helmet.	Parachute, flashlight, exposure suit if not already on	Copilot's seat	Right overwing hatch or sliding window
NAVIGATOR	Upon pilot's ditching warning, transmit position report in accordance with FLIP Enroute Supplement. If time permits, furnish radio operator with position report information for retransmission. SIF/IFF - Set. Place IFF master switch in EMER position. Don antiexposure suit if time permits. Check life vest, safety belt, shoulder harness and inertia reel locked. Don helmet.	Parachute, navigation kit, flashlight, water, and exposure suit if not already on	Navigator's seat	Left overwing hatch
BOOM OPERATOR	Check overwing emergency exit lights ON and boarding lights ON. Check life vest, safety belt, shoulder harness and inertia reel locked. After ditching assist in launching raft. Don helmet. Don antiexposure suit if time permits.	Life raft, parachute, first aid kits, flashlight, and exposure suit if not already on	Boom operator's seat	Left overwing hatch
RADIO OPERATOR 1	Upon pilot's ditching warning obtain position report from navigator and send emergency distress signals (SOS) giving position, flight time, course speed, altitude, nature of distress and intentions of pilot. Don helmet. Don antiexposure suit if time permits.	Parachute, flashlight and exposure suit if not already on	Radio operator's seat facing aft	Right overwing hatch
RADIO OPERATOR 2	Turn forward main cabin lights ON. Assist navigator and boom operator as required. Instruct and assist staff members in ditching procedures. Don helmet. Don antiexposure suit if time permits.	Life raft, survival gear, parachute and exposure suit if not already on	Radio operator's seat facing aft	Left overwing hatch
RADIO MAINTENANCE TECHNICIAN	Assist navigator and boom operator as required. Instruct and assist staff members in ditching procedures. Don helmet. Don antiexposure suit if time permits.	Parachute, flashlight and exposure suit if not already on	RM seat or rest area seat	Left overwing hatch

Figure 3-11 (Sheet 1 of 2)

		PROVIDE	POSITION	EXIT
STAFF MEMBERS	Upon pilot's ditching warning check life vests and don exposure suit if time permits, turn swivel chairs to face aft wherever practicable. After ditching, staff members on right side of airplane go to right overwing hatch; staff members on left side of airplane go to left overwing hatch. Don helmet. Don antiexposure suit if time permits.	Exposure suit if not already on	Assigned seats facing aft	Staff members on right side of airplane, right overwing hatch; staff members on left side of airplane, left overwing hatch.
CRYPTO OPERATOR	Assist RO 1 in sending emergency distress signals. Time permitting, assist navigator and boom operator as required. Don helmet. Don antiexposure suit if time permits.	Life raft survival gear, parachute and exposure suit if not already on	Crypto operator's seat facing aft	Right overwing hatch
FLIGHT TRAFFIC SPECIALIST	Assist RO2 in instructing and assisting staff members in ditching procedures. Don helmet. Don antiexposure suit if time permits.	Life raft, survival gear, parachute and exposure suit if not already on	Flight traffic specialist's seat facing aft	Left overwing hatch or aft hatch if necessary

WARNING

Do not inflate life rafts in the airplane as they will not then pass through the exits.

NOTE

- If time permits antiexposure suits will be donned over flight clothing. Life vest will then be put on.
- When additional rafts are carried a minimum of one crew member will be assigned to each raft to take command.
- Rafts should be launched over the leading edge of the wing thus preventing damage to rafts by possible torn wing flaps resulting from ditching impact. Rafts are equipped with ropes to attach to the airplane structure to prevent the raft from being blown away before it can be boarded.
- Remain in the vicinity of the airplane as long as possible.

Figure 3-11 (Sheet 2 of 2)

SYSTEMS EMERGENCY OPERATION

ELECTRICAL SYSTEM EMERGENCY OPERATION

The electrical power system has been designed to automatically clear system faults and shut down malfunctioning generator systems. When a generator fails during normal (parallel) operation, its loads are automatically redistributed. During parallel operation, the load of a failed generator receives power from the bus tie. If a generator fails to trip off automatically when an abnormal operating condition is indicated on the electrical control panel, the generator should be isolated or turned off, depending upon the situation. When operating with one generator isolated and that generator fails, its load will be automatically placed on the central bus tie. If the load is not automatically placed on the central bus tie, the failed generator load may be placed on the central bus tie by placing the respective generator switch to TRIP position and checking that the bus tie circuit breaker closes.

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 generator drive oil system on this airplane is designed to withstand negative accelerations.

If a generator drive malfunction is indicated by a generator drive overheat light, the generator drive shaft should be disconnected from the engine shaft by use of the disconnect switch. The generator switch should be placed to TRIP as a backup to the underspeed switch to assure the bus tie breaker closes. If the drive fails to disconnect or the drive overheat light reilluminates after attempted disconnect, the engine should be shut down as soon as possible and 25% windmilling rpm obtained to minimize generator drive component damage.

NOTE

The overheat light should go out immediately when the CSD disconnect switch is placed to DISC if the temperature is between 350 (±15°)F and 4602 (±25°)F. If the temperature is allowed to exceed 460° (±25°)F prior to switching to DISC, the drive will disconnect but the light will remain illuminated until drive temperature cools off to below 365° (±25°)F. If it is positively determined that drive disconnect has occurred, an illuminated overheat light is not reason to shut down the engine. In this case, the light should go out when the drive temperature drops below 365° (±25°)F.

LOSS OF ONE OR TWO GENERATORS

CAUTION

Do not attempt to takeoff, practice multiple full stop landings, touch-and-go landings or multiple low approaches on a normal or training mission with a known generator failure. The torque applied to generator drive systems during throttle advancement to high power settings can produce rapid deterioration of generator drive components if a generator failure exists. Inflight fires can result. The condition should be corrected prior to flight.

One generator will supply normal load requirements for a 5 min. period. If more than one generator is lost the ammeter should be checked to ensure that the remaining generator is not overloaded. Electrical loads must be kept at a minimum and the flight ended as soon as the situation permits. All unneeded load should be dropped off the line by turning their respective switches off. For further information on loads, see ELECTRICAL EQUIPMENT LOADS, figure 7-8.

GENERATOR TRIP-OFF WITH NO DRIVE OVERHEAT LIGHT

If AC electrical power is lost to a particular bus at time of generator trip-off, wait at least 15 seconds before attempting to reset the generator to allow a time delay feature to complete its cycle and the power to restore itself.

A. Attempt to reset generator by placing generator switch to CLOSE. A total of five resets may be attempted at approximately 15-second intervals.

B. If generator will not reset, place generator switch momentarily to TRIP.

C. Continue mission with all engines even if generator reset is impossible.

GENERATOR DRIVE OVERHEAT LIGHT ILLUMINATES

A. Place the voltmeter and frequency meter selector switch to the affected generator position and check for presence of voltage and/or frequency.

B. Place affected CSD disconnect switch to DISC and hold for 1 to 2 seconds. Release to MON position. The overheat light should go out.

C. Check generator drive disconnected by noting generator circuit breaker open light illuminates and generator voltage and frequency drop.

D. If generator drive disconnected, place generator switch to TRIP, check bus tie circuit breaker open light out, and continue mission with all engines operating.

E. If generator drive did not disconnect or if the overheat light reilluminates, shut down generator and engine as given in GENERATOR SHUTDOWN AFTER CSD DISCONNECT FAILURE.

GENERATOR SHUTDOWN AFTER CSD DISCONNECT FAILURE

A. Place the affected generator switch momentarily to TRIP.

B. Shut down engine. After engine shutdown, establish 25 percent or less windmill rpm as soon as possible (figure 3-3).

CAUTION

- Continued operation at higher windmill rpm may result in extensive damage to generator drive and adjacent components.
- The generator drive overheat light should go out if the generator drive cools off to below the overheat temperature. However, this does not mean that the generator drive is again satisfactory for continuing the mission.

AC POWER LOSS DUE TO ENGINE SHUTDOWN

Shutdown of engines 1, 2 or 4 will be accompanied by the loss of electrical power from the generator geared to that engine. Although an engine at idling speed will transmit enough energy to the generator drive to maintain full AC power output, a windmilling engine will not. The generator on the dead engine should be taken off the line. Pulling the fire shutoff switch in the course of engine shutdown will open the generator circuit breaker taking the generator off the line. If the fire shutoff switch is not pulled, the generator switch may be used placing it to the TRIP position.

LOSS OF ALL GENERATORS

A. Move battery power switch to EMERGENCY.

NOTE

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. Push bus tie isolate switch and hold in while momentarily moving generator switch to CLOSE position. Place frequency and voltage selector switch in applicable GEN position and check voltage and frequency. If readings exceed caution limits move generator switch momentarily to TRIP.

CAUTION

Prior to restoring electrical power to the No. 4 bus, the autopilot should be disengaged. Restoring AC power to the autopilot bypasses the three minute warm-up cycle. If the control switches are engaged the autopilot can apply very erratic control inputs. This could cause unusual attitudes or overstressing of the airplane.

C. Repeat steps A and B for remaining two generators.

D. Do not attempt to reclose bus tie breakers. For further information concerning restoration of full system operation, see Figure 3-12.

NOTE

If all generators remain inoperative, to conserve battery power, pull the circuit breakers on the SWITCHED DC BUS marked COMM CTR AC CONT and FUEL FLOWMETER POWER SUPPLY.

E. Move battery switch to NORMAL.

LOSS OF TRANSFORMER-RECTIFIERS NO.1 AND NO.2

Illumination of the switched DC bus failure light indicates that DC power to the SWITCHED DC BUS has failed. Moving the battery power switch to the EMERGENCY position energizes the SWITCHED DC BUS with battery power. See Section VII for load requirements and equipment which can be operated by battery power. All circuit breakers for T-R No. 1 and T-R No. 2 on the Main Circuit Breaker Panel should be checked IN. If the trouble is not corrected by the above power for T-R BUS NO. 1 and T-R BUS NO. 2 can then be supplied by T-R NO. 3 and T-R NO. 4 if the following is performed:

A. Turn off one of the UHF Command (AN/ARC-34) radios (preferably UHF 2 Command). UHF 1 is powered by the SWITCHED DC bus.

B. Turn off all nonessential equipment supplied by T-R BUS NO. 1 and T-R BUS NO. 2.

C. Total and record the load supplied by T-R NO. 3 and T-R NO. 4 using the loadmeter on the electrical control panel.

D. Place the pilot's DC system tie switch to the ON position.

NOTE

Each 0.1 division on the DC loadmeter is equivalent to 10 amperes.

E. Check the battery power switch in the EMERGENCY position and observe that the switched DC bus failure light does not illuminate. SWITCHED DC BUS will now be supplied from the battery and battery charger, and T-R 1 and T-R 2 busses will be supplied from T-R 3 and T-R 4 within the limits of the load capability of the latter through the DC tie circuit.

CAUTION

When utilizing the battery charging T-R to power the switched DC bus, limit the load to 12.5 amps (20 amps is permissable for short periods of time). 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. The battery charging T-R has a maximum continuous output of approximately 25 amps and exceeding this may cause the T-R unit to fail. 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 in Section VII). The hours of battery life can be predicted by dividing the amps discharge reading on the battery charging ammeter into the amp-hrs of energy remaining in the battery (a fully charged battery has 22 amp-hrs of energy). For 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 4.5 amps = 3.66 hours (3 hours and 40 minutes).

F. Turn on, one at a time, desired equipment turned off in step B, except UHF Command radio turned off in step A, making certain that the total load supplied by T-R NO. 3 and T-R NO. 4 does not exceed the load recorded in step C by more than 0.5 (50 amperes).

G. Continue to monitor T-R NO. 3 and T-R NO. 4 loads.

ac power emergency procedure

INDICATION OF TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION	RESULT
	FAULTS EVIDENT ON START-UP		
Failure of external power breaker to close	External power phase reversed or one phase open	None	External power cannot be applied to airplane with existing ground power cart
	No DC power available from ground cart	None	
Generator voltage high	Voltage sensing lead circuit breaker open	Reclose circuit breaker on Main AC Power Panel	Normal operation
	Voltage regulator fault	None	Generator not usable
Generator will not parallel	Voltage regulator or generator drive fault	Check voltage and frequency of affected generator:	
		1. If outside caution limits, TRIP affected generator	Generator not usable
	Auto-paralleling control fault	2. If voltage and frequency normal, momentarily push bus tie isolate switch	Normal operation
		a. If generator circuit breaker open light for affected generator extinguishes, parallel remaining generators →	Generator operates isolated
		b. If generator circuit breaker open light on affected generator remains illuminated, TRIP generator, and CLOSE remaining generator switches →	Generator not usable
Generator parallels but bus tie breaker trips	Abnormal voltage Generator overheat Faulty equalizing loop	Check voltage or frequency on affected generator:	
		1. If normal, or within caution limits CLOSE generator	Normal operation
		2. If bus tie breaker light illuminates - no further action	Generator operates isolated
		3. If voltage and frequency on affected generator exceed caution limits, TRIP generator	Generator not usable
Generator circuit breaker trips	Abnormal generator voltage	CLOSE affected generator	
		If load fluctuates or is abnormally high TRIP generator	Generator not usable
	Drive under or over speed. Differential fault	If generator circuit breaker trips, move generator switch to TRIP	Generator not usable
One bus tie breaker tripped	Abnormal voltage on affected generator	Check voltage and frequency on affected generator	
		If within caution limits CLOSE generator switch	Normal operation
	Generator overheat	If bus tie breaker trips, no further action should be taken	Operate affected generator isolated
		If voltage or frequency fluctuate, or exceed caution limits, or if load is abnormally high or fluctuating - TRIP generator	Load carried by remaining generators

Figure 3-12 (Sheet 1 of 3)

ac power emergency procedure (cont)

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
All bus tie breakers tripped	System fault	Check voltage, frequency and load on each generator	
		If normal, CLOSE generator switch If bus tie breaker trips, operate all generators isolated	Generators operate isolated
		If load excessive, or voltage or frequency exceed caution limits, TRIP affected generator	Load carried by remaining generators
Abnormally unbalanced ammeter readings	Load division fault	Push bus tie isolate switch. Check voltage and frequency	
		If caution limits are exceeded, CLOSE normal operating generator switches and TRIP faulty generator switch.	Load carried by remaining generators
		If voltage and frequency within caution limits, operate faulty generator isolated, CLOSE remaining generator switches	Generator operated isolated
Bus voltage low	Voltage regulator loop open	Push bus tie isolate switch if voltage is less than 190 volts	Operate generators isolated
Bus frequency low	Frequency control loop open	Push bus tie isolate switch if frequency is less than 390 cycles	Operate generators isolated
Generator drive overheat light illuminates	Drive overheated	Place disconnect switch to DISC. Check drive disconnected. If drive disconnected, place generator switch to TRIP. If drive did not disconnect, shut down engine and obtain 25% windmilling rpm as soon as possible.	Load carried by remaining generators
Two bus tie breakers tripped	Load division fault	Check voltage and frequency	
		If within caution limits CLOSE generator switches	Normal operation
		If bus tie breakers do not stay closed operate generators isolated	Generator isolated
		If voltage and frequency exceed caution limits TRIP affected generator	Load carried by remaining generators
Multiple generator circuit breaker and bus tie breaker trip	System fault	Push bus tie isolate switch and hold while tripped generator switch is CLOSED	Operate isolated
		If generator circuit breaker remains tripped move generator switch to TRIP position	Operate with dead bus

Figure 3-12 (Sheet 2 of 3)

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
No ammeter reading	Generator being motored	Push bus tie isolate switch momentarily and CLOSE generator switch for normal generators	Faulty generator operated isolated
		Check voltage and frequency of affected generator - if readings exceed caution limits TRIP generator	Load carried by remaining generators
Load oscillations	Fluctuating voltage or frequency	Push bus tie isolate switch. Check voltage and frequency and TRIP affected generator. CLOSE remaining generator switches	Load carried by remaining generators
Two generator circuit breakers tripped	System fault or multiple malfunctions	Turn off nonessential loads. CLOSE affected generator switch - if generator circuit breaker reopens, move switch to TRIP position	Load carried by one generator
All generator circuit breakers open	Multiple malfunctions	Push bus tie isolate switch and hold while generator switches are CLOSED	Operator generators isolated
		Check voltage and frequency - if caution limits are exceeded TRIP generator	Operate with dead bus

Figure 3-12 (Sheet 3 of 3)

dc power emergency procedure

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
Ammeter reads zero on T-R No. 1 (Same for T-R No. 2)	Faulty T-R unit	No action ❶	System operating on T-R No. 2 (or 1)
	Circuit breakers open	Close	Normal operation
	If breaker opens →	No action →	Operate without indication
	AC circuit breakers open	If circuit breakers do not hold ❶	System operating on T-R No. 2 (or 1)
One T-R ammeter or voltmeter reads zero	Faulted T-R bus or bus feeder has opened all limiters	No immediate action will remedy	Operate on one T-R
	Circuit breakers open	Close →	Normal operation
		If circuit breakers do not hold →	Operate without indication

❶ At the discretion of pilot, DC system tie switch can be moved to ON to draw power from T-R No. 3 and T-R No. 4 if T-R No. 2 is not capable of supplying the required load. The added load from T-R No. 3 and T-R No. 4 must be limited to 50 amps.

❷ When using the battery charging T-R to power the switched DC bus, limit the load requirement to approximately 20 amps. Refer to LOSS OF TRANSFORMER-RECTIFIERS, this Section.

Figure 3-13 (Sheet 1 of 2)

dc power emergency procedure (cont)

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
Switched bus failure light illuminated	Faulted T-R bus No. 2	Battery power switch to EMERGENCY	Switched DC bus on battery power ❷
	Faulted SWITCHED DC BUS feeders	Close feeder circuit breakers → If circuit breakers won't hold, switch to EMERGENCY →	Normal operation Switched DC bus on battery power ❷
	Faulted SWITCHED DC BUS	Close circuit breakers → If circuit breakers won't hold →	Normal operation Operate with dead SWITCHED DC BUS
	SW BUS FAIL LT circuit breaker open	Close circuit breaker → If breaker opens →	Normal operation Operate with light on
Battery bus voltage zero	Faulted voltmeter line	Close circuit breaker → If circuit breaker won't hold →	Normal operation No voltage indication
	Fault on battery bus	No action	One or both battery busses dead
T-R3 voltmeter or ammeter reads zero (Same for T-R4)	Circuit breaker open	Close → If circuit breakers do not hold →	Normal operation Operate without indication
Copilot's and comm center ammeter for T-R3 reads zero T-R4 OK (Same for T-R4)	T-R3 faulted	No action	Operate on one T-R
	Feeder fault from T-R power relay	No action	Operate comm center on one T-R
	AC circuit breakers open	No action	Comm center operator can close circuit breakers. If circuit breakers do not hold, operate on one T-R
Copilot and comm center ammeter and voltmeter for T-R3 and T-R4 read zero or	Feeder fault from T-R3 or T-R4 to comm center T-R bus	See Loss of T-R3 and T-R4 this Section If comm center load is not energized - open DC tie switch	Operate comm center from T-R1 and T-R2 Operate with T-R3 and T-R4 bus dead
Copilot ammeter and voltmeter for T-R1 and T-R2 read zero	Feeder fault from T-R1 or T-R2 to T-R bus	See Loss of T-R1 and T-R2 this Section	Operate T-R1 and T-R2 bus from T-R3 and T-R4
Battery/Battery charge T-R over heat or fire	Faulted radio noise filters in battery charge control panel	Pull the 3 battery charge circuit breakers (5 amp) on MCBP and 1 battery charge circuit breaker (50 amp) on battery CBP	Battery recharge capability lost. Battery charge T-R to SBCBP capability lost.

Figure 3-13 (Sheet 2 of 2)

copilot's instrument power system emergency procedure

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
Copilot's instrument power off light illuminates	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

LOSS OF TRANSFORMER-RECTIFIERS NO. 3 AND NO. 4

When it is determined that T-R NO. 3 and T-R NO. 4 have failed, DC power for the communications center can be supplied by T-R NO. 1 and T-R NO. 2 if the following is performed.

A. Turn off, or pull the applicable circuit breaker, for every piece of equipment supplied by the Communications Center DC circuit breaker panel (CCBP PL-25).

B. Total and record the load supplied by T-R NO. 1 and T-R NO. 2 using the loadmeter on the electrical control panel.

C. Place the pilot's DC system tie switch to the ON position.

NOTE

Each 0.1 division on the DC loadmeter is equivalent to 10 amperes.

D. Turn on, one at a time, desired equipment turned off in step A making certain that the total load supplied by T-R NO. 1 and T-R NO. 2 does not exceed the load recorded in step B by more than 0.5 (50 amperes).

E. Continue to monitor T-R NO. 1 and T-R NO. 2 loads.

FLAP EMERGENCY OPERATION

MAIN FLAP EMERGENCY OPERATION (CP reads)

If the right hydraulic system is inoperative place the copilot's instrument power switch to EMERGENCY. If use of the crossover system is impractical, refer to FLIGHT AND LANDING WITH RUDDER POWER INOPERATIVE, this Section.

1. Emergency Flap Master Switch - ON (CP)

   This switch must be on to operate the hydraulic bypass valves and to apply power to the INBD and OUTBD flap drive switches.

2. Flap Lever - 50 Degrees (CP)

NOTE

The flap lever should always be positioned to a setting greater than actual flap extension. The flaps are then operated, extended or retracted, by the emergency flap drive motors while monitoring the flap position indicators. This is necessary to reduce brake force at the hydraulic motor.

MAIN FLAP EMERGENCY OPERATION (Cont)

3. INBD and OUTBD Flap Drive Switches - Actuate, as required (CP)

By actuating these switches, inboard and outboard flaps should be available. The switches must be held in the DOWN position to extend the flaps. The switches are spring-loaded to return to OFF position from the DOWN position. If placed to UP, the switches will remain UP and the flaps will retract completely. Upon retraction of the flaps, the switches should be returned to OFF.

CAUTION

- Wait at least 6 seconds before reversing flap travel or returning the emergency flap master switch to OFF. Damage to electrical emergency flap motors will result if centrifugal clutches are not allowed sufficient time to disengage.
- Ground operation of the emergency flap system is limited to nine minutes cumulative time during a one-half hour period or through three 50 degree movements followed by a 27 minute cooling period.

NOTE

No leading edge flaps are available when the flaps are extended by emergency operation if the right hydraulic system is not pressurized. If the right hydraulic system is pressurized, the leading edge flaps will function normally when the outboard flaps are extended.

4. Flap Lever - Actual flap position (CP)
5. Emergency Flap Master Switch - As required (CP)

WARNING

- If the right hydraulic system is pressurized inflight, flap lever shall always be at the actual position of the flaps when the emergency flap master switch is placed in the OFF position. If this is not possible (such as during use of differential flaps) leave the emergency flap master switch ON. In the event of T-R power failure during this condition, the flaps may return to the position selected by the flap lever.
- If the left hydraulic system is pressurized, positioning the crossover valve handle to LH will apply hydraulic pressure to the wing flap system.
- 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 0 degrees, pattern, approach, and touchdown speeds should not be increased as this correction is included in the chart.

NOTE

- Approximately 3 minutes are required for 50 degrees of flap travel in either direction.
- The outboard aileron lockout mechanism is operated by the outboard flap drive. 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(E)C-1-1, for factors to be applied to landing distances 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(E)C-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 handles for the A/R line valve, the ARR manifold valves and the main ARR valve. See figure 4-50 and 4-63.

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 the 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 used).

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.

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 cause fuel transfer. It is also possible to experience fuel transfer from the A/R manifold to the aft body tank through the manifold valves (see figure 4-63). If the manifold valves remain in an intermediate position (both valves partially open), fuel can flow from either the wing single point refueling manifold or the A/R manifold into the aft body tank. 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. 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.

If a fuel level control valve switch is OPEN and the master refuel switch is in the ON position, inadvertent fuel transfer could occur if the A/R manifold or wing single point refueling manifold is pressurized.

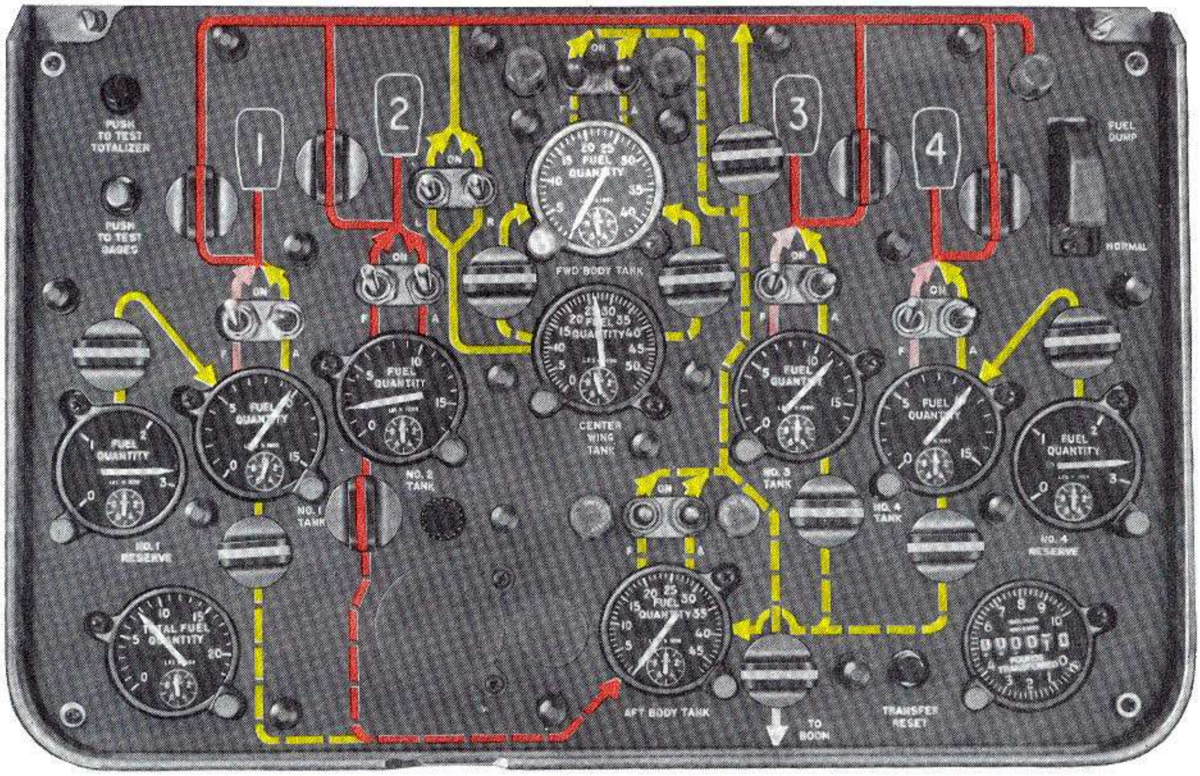
WARNING

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.

CAUTION

It is possible to transfer fuel inflight between the forward and aft body tanks and from the body tanks to the reserve, main and center wing tanks by pressurizing the A/R manifold and opening the appropriate fuel level control valve. However, inflight internal transfer of fuel by use of an A/R pump is considered an emergency procedure and should be avoided whenever possible.

fuel system emergency operation



NOTE: 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

F-1463

Figure 3-15

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 so that ample pressure will be available 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 and aft body 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 inflight. Speed brakes may be used after landing.

H. Land as soon as possible.

WARNING

To avoid a flameout when operating all engines from a single main tank, use extreme care 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 manner similar 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 receiver, or crossfed to the engines in the manner described in BODY TANKS TO ENGINES in Section VII.

FUEL QUANTITY INDICATOR, FAILURE

A malfunction of any fuel quantity indicator may indicate a possible failure that would, with proper sequence of events, allow the introduction of high voltage electrical power into the associated fuel tank.

WARNING

If any fuel quantity indicator is inoperative or a malfunction occurs, open the associated 115 volt AC fuel quantity indicator circuit breaker on the generator No. 1 MCBP. 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 thrust settings during takeoff and at high altitude will reduce thrust and continued operation will damage engine fuel 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.

EMERGENCY FUEL TRANSFER BETWEEN TANKS

In an emergency, fuel may be transferred between body tanks or from body tanks to the main, center wing or reserve tanks by use of an A/R pump. Fuel transfer can result in a large change in airplane center of gravity location. The cg must, therefore, be closely monitored and the fuel quantity gages must be checked frequently to insure proper fuel distribution.

WARNING

- The main ARR (IFR) valve must be in the CLOSED position before operating the A/R fuel pumps because fuel pressure surges could cause rupture of the ARR manifold in the cockpit area.
- When transferring fuel, only one A/R pump shall be operated at a time. This will preclude the possibility of overpressurizing a fuel tank if a fuel level control valve fails in the open position.
- Monitor the fuel quantity gages to avoid exceeding airplane cg limits. Maintain symmetrical fuel quantities in the wing tanks to prevent lateral unbalance.

Fuel transfer may be accomplished as follows:

INFLIGHT EMERGENCY FUEL TRANSFER

Fuel Panel

1. Main Wing Tank Boost Pump Switches - ON
2. All tank to Engine Manifold Valve Switches - CLOSED
3. A/R to Engine Manifold Valve Switch - OPEN

ARR Panel

4. Master Refuel Switch - ON
5. Manifold Valves Switch - WING REFUEL (REFUEL)

   Check that the amber NOT IN FLIGHT light is on.

6. Fuel Level Control Valve Switches - OPEN

   Open the fuel level control valve switch(es) for the tank(s) to which fuel is being transferred.

Fuel Panel

7. A/R Fuel Pump Switch - ON

   Turn on one A/R fuel pump in the tank from which fuel is being transferred.

WARNING

- The main ARR (IFR) valve must be in the CLOSED position before operating the A/R fuel pumps because fuel pressure surges could cause rupture of the ARR manifold in the cockpit area.
- Only one A/R fuel pump shall be operated at a time. This will preclude the possibility of overpressurizing a fuel tank if a fuel level control valve fails in the open position.

CAUTION

- Do not allow the tanks to fill to a level exceeding those specified in AIR REFUELING FUEL MANAGEMENT in Section IV.
- Monitor center of gravity to avoid exceeding limits.

INFLIGHT EMERGENCY FUEL TRANSFER (Cont)

AFTER EMERGENCY FUEL TRANSFER IS COMPLETE:

Fuel Panel

1. A/R Fuel Pump Switch - OFF

NOTE

To terminate any fuel transfer, turn the A/R fuel pump switch off prior to closing the tank level control valves.

ARR Panel

2. Fuel Level Control Valve Switches - CLOSED
3. Manifold Valves Switch - FLIGHT
4. Master Refuel Switch - OFF

Fuel Panel

5. Tank to Engine Manifold Valve Switches - As required
6. Main Wing Tank Boost Pump Switches - As required
7. A/R Manifold to Engine Manifold Valve Switch - CLOSED

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 (and alternate slipway door control valve), normally operated by the left hydraulic system. Placing the emergency crossover valve lever to RH connects the landing gear (and alternate slipway door control valve) to the right hydraulic system; moving the lever down to LH connects the powered rudder, flaps, low frequency antenna reel 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.

HYDRAULIC PUMP ISOLATION

The hydraulic pumps are isolated by closing the respective hydraulic supply shutoff valve. This may be accomplished by using the engine fire switch without shutting down the engine; however, the generator will be tripped off the line.

A. Pull the fuel valve circuit breaker marked FUEL VALVES, FIRE SHUTOFF on the SBCBP.

B. Pull the fire switch. The hydraulic shutoff valve should close within one second and the generator will trip off the line.

C. Pull the circuit breaker marked ENGINE HYDRAULIC OIL FIRE SHUTOFF on the SBCBP.

D. Reset the fire switch by pushing the switch back in.

E. Reset the fuel valve circuit breaker.

F. Close the generator switch.

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.

hydraulic system emergency procedure

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
Illumination of hydraulic pump inoperative light (no fluid loss)	Failure of engine-driven hydraulic pump	1. Momentarily depressurize affected system. 2. Repressurize system - If pump inoperative light remains on, pump is inoperative. 3. Isolate indicated pump.	Operation of the affected system on the remaining pump
Illumination of hydraulic pump inoperative light (fluid loss)	Failure of engine-driven pump or connecting lines allowing fluid loss through the pump	Immediately isolate indicated pump.	Affected system is operating on the remaining pump
Sustained system pressure indication in excess of 3400 psi	Engine-driven hydraulic pump malfunction	Immediately depressurize affected system by placing the system hydraulic pressure switch to the OFF position.	Continue with the system depressurized and repressurize system by placing the system hydraulic pressure switch to the ON position only for short periods as required
Loss of quantity occuring with no other indications	Hydraulic supply or subsystem leakage	1. Immediately depressurize affected system	
		2. If fluid loss stops or is extremely slow after depressurization →	Continue with system depressurized and repressurize only for short period as required to complete mission or land the aircraft
		3. If fluid loss continues, isolate the inboard pump. If loss of fluid stops repressurize the system →	Continue with the system operating on the remaining pump
		NOTE After fluid loss below the 2 gal quantity level, isolate the outboard pump to reduce tendency to introduce air into system.	
		4. If fluid loss continues, restore the inboard pump and isolate the outboard pump. If loss of fluid stops, repressurize the system →	Continue with the system operating on the remaining pump
		5. If fluid loss continues, attempt to isolate the leak by placing the rudder power switch to the OFF position and/or placing the spoiler switches to the CUT-OFF position and/or placing the alternate and normal slipway door switches to the CLOSED position and/or placing the	

(Continued)

Figure 3-16 (Sheet 1 of 2)

INDICATION OF TROUBLE	POSSIBLE CAUSE	CREW ACTION	RESULT
		body fuel pump switches to OFF and/or placing copilot's instrument power switch to EMERGENCY position. If fluid loss stops	Continue with the affected portion of the system isolated
		6. If fluid loss continues, isolate the inboard pump	Continue with both pumps isolated and system depressurized. Restore both pumps and repressurize the system as required for landing. Land the airplane as soon as practicable
Low hydraulic pressure with no other indications	Low accumulator preload.	1. Depressurize affected hydraulic system. 2. Check for proper accumulator preload. (See figure 1-66.) 3. If preload is low repressurize and check other gauges in affected system for true system pressure. If normal	Gauge is inaccurate continue with system pressurized
		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 pressure gauge by placing the power rudder in the high range or on the pressure gauge for the boom system accumulator in the boom pod. ● 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 250 KIAS.	
	Hydraulic pump malfunction or system internal leak	4. If accumulator preload is normal, repressurize system	Continue with system pressurized and expect slow slow operation of equipment in affected system

Figure 3-16 (Sheet 2 of 2)

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, powered rudder, or LF antenna reel 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, alternate ARR, trailing wire antenna system 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.

LANDING GEAR EMERGENCY OPERATION

EMERGENCY RETRACTION OF LANDING GEAR

When Landing Gear Lever Will Not Move To The Up Position

If time permits, prior to actuation of the override trigger, check the nose and main gear for correct position.

CAUTION

Wheel well damage can result from emergency retraction if the landing gear is not in correct position. The override trigger bypasses the nose gear centering switch, truck leveling switches, and oleo extension switches.

WARNING

In the event of engine loss or other takeoff emergency wherein immediate gear retraction is a vital necessity, it is unnecessary to accomplish items 1 through 4.

1. Nose Gear Steering Wheel - Check Centering (P)

   The alignment arrow on the steering wheel must align with arrow on sidewall decal. If they are not aligned, turn wheel to align. Attempt to move landing gear lever to UP position. If this is not possible, proceed to next step.

EMERGENCY RETRACTION OF LANDING GEAR (Cont)

2. Nose Gear Wheels - Check Centering (P, BO or N)

   When viewed through the inspection window, if not centered, turn steering wheel until wheels point straight forward. Attempt to move landing gear lever to UP position. If this is not possible, proceed to next step.

3. Main Gear Leveling Cylinder and Snubber Cylinder - Check attachment (P, BO or N)

   If one end of centering cylinder or snubber is loose and swinging free, do not retract gear. Make a normal landing. If leveling cylinder and snubber are normal, proceed with next step.

4. 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 1-48). Yellow mark on torsion link bolt must fall entirely within yellow zone on the torsion link for proper oleo extension (2, figure 1-48).

CAUTION

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

   If a truck is not level or an oleo is not fully extended, do not retract gear. Make a normal landing. (If one oleo is not fully extended, airplane will lean toward that side during landing. Be prepared to correct steering as necessary.) If oleo extension and truck level is normal, proceed to next step.

NOTE

> Even if the truck level and oleo extension indicators appear to be normal, consideration should be given to leaving the gear down unless aircraft performance is critical or the nature of the mission warrants the risk.

5. Landing Gear Override Trigger - Pull trigger aft and move landing gear lever to UP position (P, CP)

When Gear Indicators Indicate Gear Is Not Up And Locked

Make a visual inspection.

1. Lock Safety Stripes - Check Alignment (P, BO or N)

   Check lock safety stripes for the gear which has the unlocked indication.

   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 1-48).

   If main 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 (8, figure 1-48).

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.

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)

   Manual extension procedures are given under BOOM OPERATOR'S AND NAVIGATOR'S EMERGENCY PROCEDURES, this Section.

WARNING

Application of hydraulic pressure to the <u>main gear</u> 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. Refer to HYDRAULIC SYSTEM EMERGENCY OPERATION, this Section.

6. Gear Indicators - Recheck for safe indication (CP, BO or N)

When <u>Nose Gear</u> 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 <u>6a</u> is completed.

LANDING GEAR EMERGENCY EXTENSION (Cont)

b. Nose Gear Ground Down Lock and Release Handle - Insert handle with striker pointer 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.

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. Refer to 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 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 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 Indicators - Check alignment of stripes (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 for 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 down lock 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 down lock prior to window removal to prevent loss of the down lock 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, Isolate The Hydraulic Pumps and 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 Pumps - Isolate (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 - Accomplished (P)

   Manual extension procedures are given under section titled BOOM OPERATOR'S AND NAVIGATOR'S EMERGENCY PROCEDURES.

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 EMERGENCY BRAKE OPERATION in this Section.

LANDING GEAR EMERGENCY EXTENSION (Cont)

When Landing Gear Becomes Jammed Due To Inadvertent Manual 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 Safety 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 emergency extension system as described earlier in this section (see figure 1-47).

CAUTION

If the nose gear landing gear position indicator does not indicate down and locked, the pilot's anti-skid system may be inoperative. Refer to ANTI-SKID INOPERATIVE in Section VII.

When Landing Gear Lever Warning Light Only Stays On After Gear Is Extented:

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 Near The Idle Range

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

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. Monitoring of oil temperature on a windmilling engine should provide warning of engine seizure. 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 the affected engine.

C. If gross weight is high, dump fuel to reduce thrust requirements.

D. Avoid all abrupt maneuvers causing high "g" forces; this will prevent unnecessary bearing loads.

E. After the critical thrust condition is past, immediately shut down the affected engine. 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 60 psi. Blown oil system seals and/or loss of lubrication can result. The condition should be corrected before flight.

When engine oil pressure goes to between 60 and 70 psi (steady or transient) in flight, the procedure outline 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 60 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 the 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 engine oil pressure exceeds 70 psi (steady or transient) in flight immediately shut the engine down 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 60 psi, monitor the engine and continue normal operation until pressure drops to 35 psi or rises to 60 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 60 psi or the mean is no lower than 35 psi, continue normal operation monitoring the engine closely and make a Form 781 entry.

OIL TEMPERATURE HIGH

Oil temperature will increase with an oil system malfunction. With each engine equipped for immediate identification of oil temperature, engine seizure due to excessive temperatures is unlikely to occur. Advancing the throttles for an engine with high oil temperature will usually reduce the oil temperature by increasing fuel flow through the fuel-oil cooler. With the engines stabilized at cruise flight condition, the engine oil temperature should be monitored at convenient intervals for any temperatures above 132°C or for any significant temperature variations between engines. By monitoring the engine oil systems, excessive temperatures may be detected in time to accomplish engine shutdown and prevent an oil system emergency condition.

NOTE

If oil temperature exceeds 132°C for more than 10 minutes, or exceeds 143°C at any time, the engine should be shut down unless its thrust is necessary to maintain flight.

RUDDER EMERGENCY OPERATION

Move the rudder power switch to OFF immediately in the event of unscheduled rudder deflection during powered rudder operation. Actuation of the rudder power switch 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 deflection, 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 as necessary. Reduce power on the upwing 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 0 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 control 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 CW 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 malfunctions during approach, a go-around should be initiated immediately 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 control 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 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 STAB TRIM 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 malfunction trim switch, pull both control circuit breakers marked PILOT and COPILOT on the T-R BUS NO. 1 section of the MCBP (figure 1-33, sheet 1). 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 STAB TRIM CUTOUT position and pull the operating power circuit breakers marked STABILIZER TRIM in the GENERATOR NO. 2 section of the MCBP (figure 1-33, sheet 2). Use manual trim for the remainder of the flight.

NOTE

Except during emergency, air refueling will not be accomplished when electrical trim is inoperative.

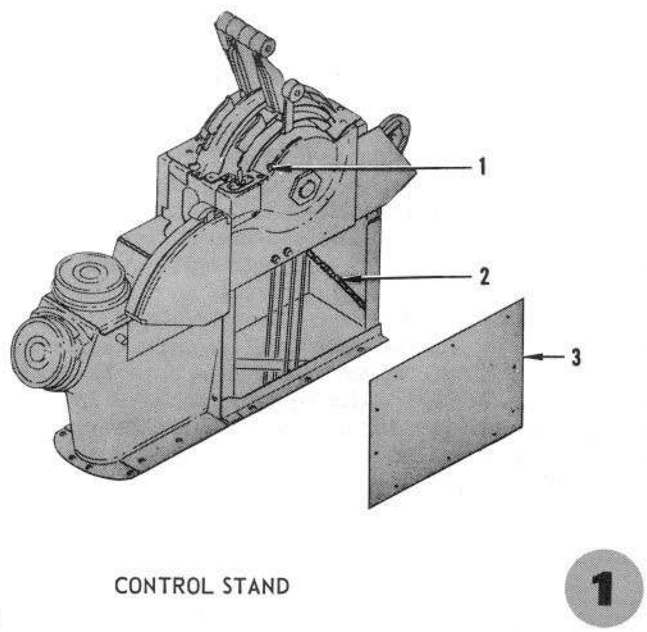
AUTOPILOT TRIM MALFUNCTIONS

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.

MECHANICAL TRIM MALFUNCTION

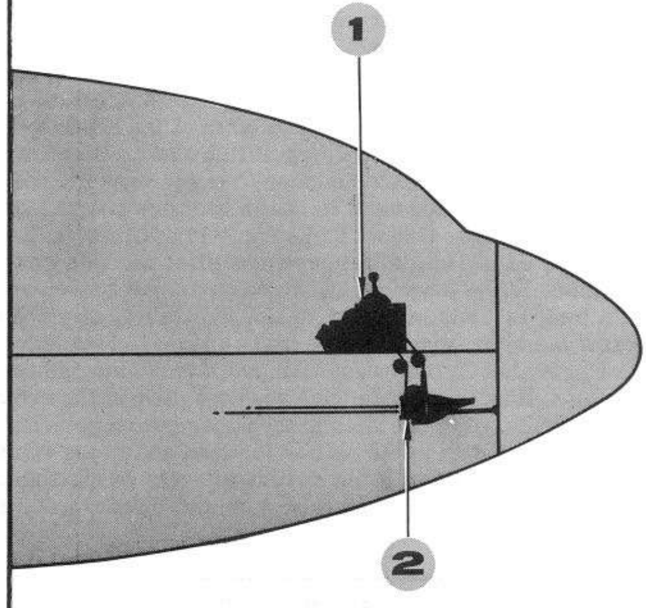
Should it be determined that electrical trim is ineffective due to mechanical trim malfunction, discontinue use of electrical trim and attempt manual trimming. (See also EMERGENCY TRIM OPERATION, this Section.) If the stabilizer is found to be jammed, it may be freed by applying a moderately high force 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

stabilizer manual trim mechanism

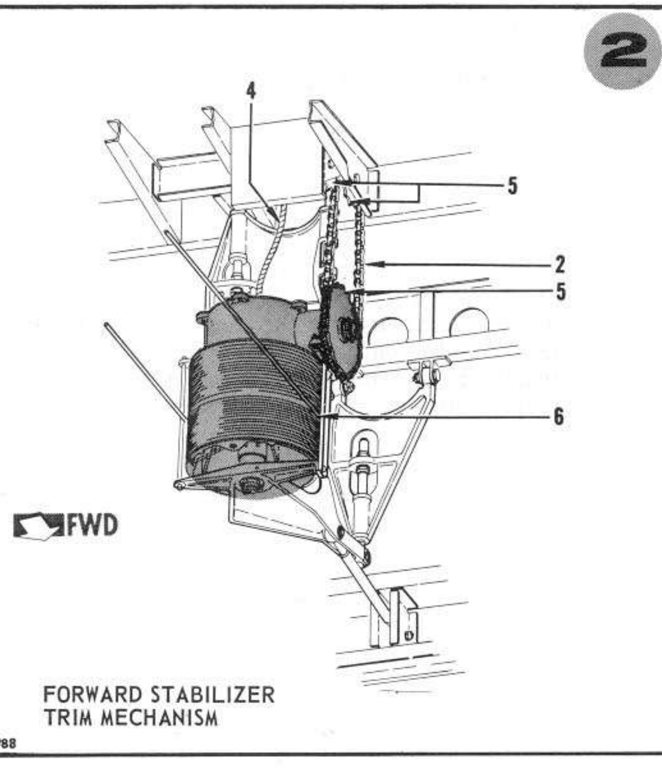


CONTROL STAND

F-986



F-987



FORWARD STABILIZER
TRIM MECHANISM

F-988

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

Figure 3-17

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 STAB TRIM CUTOUT position before working on the lower mechanism. Inadvertent actuation of the electrical trim could result in injury to the crew member from the turning spocket 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 1-33, sheet 2). 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.

NOTE

If the outboard spoiler switch is placed in CUT-OFF for landing the leading edge flaps will remain up regardless of main flap position.

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 pilot's emergency procedures also appear in T.O. 1C-135(E)C-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 fire-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 - 100%

   Don oxygen mask and breathe 100% oxygen.

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 1-48). Yellow mark on torsion link bolt must fall entirely within yellow zone on the torsion link for proper oleo extension (2, figure 1-48).

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 Safety Stripes - Check alignment (P, BO, or N)

   Check lock safety stripes for the gear which has the unlocked indication and advise the pilot of their position.

   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.

   If main gear 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.

LANDING WITH GEAR FAILURE

1. Crash Landing Signal - Acknowledge (BO, N, P)
2. Aft Exit Hatch - Remove (when directed) (BO, N)

   See figure 3-7.
3. Loose Gear - Jettison or stow (BO, N)
4. Non-essential Personnel - Bail out
5. Aft Exit Hatch - Re-install
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 (BO or N, P)

LANDING WITHOUT NORMAL BRAKE SYSTEM PRESSURE

1. Crash Landing Signal - Acknowledge (BO, N, P)
2. Antiskid Circuit Breakers - Pull (P, BO or N)
3. Crash Landing Position - Assume

   Don helmet, fasten shoulder harness and safety belt. Lock inertia reel.

MAIN LANDING GEAR EMERGENCY EXTENSION

FAILURE OF LEFT HYDRAULIC SYSTEM. When cleared by the pilot the boom operator or the navigator will insert main gear and flap emergency crank in gear receptacle and complete the MAIN LANDING GEAR EMERGENCY EXTENSION checklist. The crew member not actually engaged in lowering the gear will observe the gear lowering sequence through the main gear inspection window located in the main cabin. Prior to beginning the gear lowering sequence the Boom Operator and Navigator will establish interphone contact and coordinate the gear lowering procedure on interphone.

1. Emergency Crank - Rotate 1-1/2 turns CCW (BO or N)
2. Wheel Well Doors - Check open (BO, N)

   Visually check wheel well doors open before performing step 3. If the doors have not opened, open them by pulling up on the upper cable under the emergency wheel well door access. (See figure 1-50.)

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, 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.

6. Stripe Alignment - Check (BO, 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 (CP or N reads)

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.

2. Nose Gear Handle - 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. Nose Gear Handle - 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.

NOSE GEAR EMERGENCY EXTENSION (Cont)

5. Gear Lock Indicators - Check (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 NOSE GEAR FAILS TO EXTEND MANUALLY:

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 Cover - Pull up and forward (BO or N)

   Hold open until step 9 is completed.

7. Nose Gear 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.

8. Crossover Valve Lever NORMAL and LH System Pressure Switch ON - Check (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 nearly aligned.

10. Nose Gear 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 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 and safe indication (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.

NOTE

If the nose gear has extended but an unsafe gear down condition is determined, it may be possible to insert the nose gear external down lock 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 down lock prior to window removal to prevent loss of the down lock 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

[redacted]

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 Switch - Closed (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.

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)

[redacted]

Consideration should be given to landing with the boom in trail any time the boom hoist cable breaks with more than 5 feet of cable attached to the boom. The distance between the boom hoist cable attaching joint and the ruddevators (approximately 8 feet) can be used to gage the length of cable 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)

[redacted]

1. Boom Telescope Lever - RETRACT (BO)
2. Line Valve Switch - Closed (BO, CP)
3. Fuel Dump Switch - FUEL DUMP (BO, CP)
4. Fuel Dump Switch - NORMAL (BO, CP)
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, (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.

[redacted]

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 pilot

   When directed by the pilot to open hatches, the boom operator will open aft hatch first then 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)

[redacted]

1. Ditching Signal - Acknowledge (BO, P)

2. Boom - Stow

3. Unnecessary Electrical Equipment - Off

4. Main Cabin Lights - On

5. Aft Emergency Exit Hatch - Remove (when directed) (BO, N)

   When directed by pilot, remove aft emergency exit hatch. See figure 3-7.

6. Loose Gear - Jettison or stow (BO, N)

7. Aft Exit Hatch - Re-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, parachute, first aid kits, flashlight, and anti-exposure suit if not already on

11. Exit - Left overwing hatch

NOTE

The boom operator's emergency procedures also appear in T.O. 1C-135(E)C-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

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.

Three Short Rings on the Alarm Bell

1. Prepare to Bailout Signal - Acknowledge (N, P)
2. Over Water - (a) Anti-Exposure Suit - Don (if time permits)

   (b) Life Vest - Don
3. Parachute - Don and check
4. Helmet and Oxygen Mask - Don and attach bailout bottle
5. Survival Kit - Attach
6. IFF - EMER

   Place IFF master switch to EMER.
7. 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

8. Chinning Bar - Pull down (N or BO)
9. Crew Entry Chute Floor Grille - Raise (N or BO)
10. Bail Out Through Entry Chute

1. Ditching Signal - Acknowledge (N, P)

2. IFF - EMER

   Place IFF master switch to EMER.

3. Position Report - Transmit (if required)

   Transmit airplane position report in accordance with FLIP Enroute Supplement.

4. Aft Emergency Exit Hatch - Remove (when directed) (N, BO)

   When directed by the pilot, remove aft emergency exit hatch

5. Loose Gear - Jettison or stow (N, BO)

6. Aft Exit Hatch - Re-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 for altitude determination 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(E)C-1CL-2, which is an abbreviated checklist. The abbreviated checklist has each numbered step of the normal, alert, and emergency procedures in shortened form.

RADIO & CRYPTO OPERATORS' AND RADIO MAINTENANCE TECHNICIAN'S EMERGENCY PROCEDURES

1. **PILOT — NOTIFY**

   If fire, smoke, or fumes are detected, notify pilot on CALL position of interphone.

2. **OXYGEN—100%**

3. Electrical Equipment - OFF (if fuel fumes present)

4. Fire fighting procedures - Assist N or BO if required

[redacted]

Three Short Rings on the Alarm Bell

1. Prepare to Bailout Signal - Acknowledge (RO-1, RO-2, RM, Crypto, P)

2. Over Water - (a) Anti-Exposure Suit - Don (if time permits)

   (b) Life Vest - Don

3. Parachute - Don and check

4. Helmet and Oxygen Mask - Don and attach bailout bottle

5. Survival Kit - Attach

   Assist staff members by checking parachute harness and survival kit properly fitted.

6. Position Report - Transmit (if required) (RO-1, RO-2, Crypto, N)

   Transmit airplane position if known. The navigator can supply position information if time permits.

One Long Ring on the Alarm Bell

7. Over Land - (a) Proceed to control cabin
   (b) Bailout crew entry chute

   Bailout the crew entry chute in turn, as directed by the jumpmaster.

   Over Water - (a) Assist in releasing life raft
   (b) Bail out crew entry chute or aft emergency exit hatch

[redacted]

Six Short Rings on the Alarm Bell

1. Crash Landing Signal - Acknowledge (RO-1, RO-2, RM, Crypto, P)

2. Loose Gear - Secure or Jettison (time permitting)

3. Position Report - Transmit (if required) (RO-1, RO-2, Crypto, N)

   Transmit airplane position if known and required. The navigator can supply position information if time permits.

4. Electrical Equipment - OFF, if requested

5. Crash Landing Position - Assume

   Don helmet, fasten shoulder harness and safety belt. Lock inertia reel.

Six Short Rings on the Alarm Bell

1. Ditching Signal - Acknowledge (RO-1, RO-2, RM, Crypto, P)

2. Loose Gear - Secure or jettison (time permitting)

3. Position Report - Transmit (if required) (RO-1, RO-2, Crypto, N)

   Transmit airplane position if known and required. The navigator can supply position information if time permits.

4. Electrical Equipment - OFF, if requested

5. Antiexposure Suit - Don

5A. Life Vest - Don

6. Ditching Position - Assume

   Don helmet, fasten shoulder harness and safety belt. Lock inertia reel.

7. Provide - Life raft, survival gear, parachute and exposure suit if not already on

8. Exit - RO-1 - Right overwing hatch
   RO-2 - Left overwing hatch
   RM - Left overwing hatch
   Crypto - Right overwing hatch

NOTE

The radio operators' emergency procedures also appear in T.O. 1C-135(E)C-1-2CL-1, the crypto operator's emergency procedures also appear in T.O. 1C-135(E)C-1-2CL-2 and the radio maintenance technician's emergency procedures also appear in T.O. 1C-135(E)C-1-2CL-5, which are abbreviated checklists. The abbreviated checklists have each numbered step of the normal, alert, and emergency procedures in shortened form.

STAFF PERSONNEL AND FLIGHT TRAFFIC SPECIALIST'S EMERGENCY PROCEDURES

1. **PILOT — NOTIFY**

   If fire, smoke or fumes are detected, notify pilot on CALL position of interphone.

2. **OXYGEN — 100%**

   If possible, prior to initiating firefighting procedures, don the firefighter's mask, connect the mask to a source of 100% oxygen and don the firefighter's gloves.

3. Electrical Equipment - OFF (if fuel fumes present)

4. Firefighting Procedures - Assist N or BO if required

EXCESSIVE HEAT ELIMINATION

When directed by the pilot:

1. Oxygen - 100%

   Don oxygen mask and breathe 100% oxygen.

Three Short Rings on the Alarm Bell

1. Prepare to Bailout Signal - Acknowledge (OPS, FTS, RO-1, RO-2, RM, CRYPTO, P)
2. Over Water - (a) Anti-Exposure Suit - Don (if time permits)

   (b) Life Vest - Don
3. Parachute - Don and check
4. Helmet and Oxygen Mask - Don and attach bailout bottle
5. Survival Kit - Attach
6. Over Land - (a) Proceed to control cabin
   (b) Bail out crew entry chute

   Over Water - (a) Assist in releasing life raft
   (b) Bail out crew entry chute or aft emergency exit hatch

Six Short Rings on the Alarm Bell

1. Crash Landing Signal - Acknowledge (OPS, FTS, RO-1, RO-2, RM, CRYPTO, P)
2. Loose Gear - Secure or jettison (time permitting)
3. Electrical Equipment - OFF (if requested)
4. Crash Landing Position - Assume

Six Short Rings on the Alarm Bell

1. Ditching Signal - Acknowledge (OPS, FTS, RO-1, RO-2, RM, CRYPTO, P)

2. Loose Gear - Secure or jettison (time permitting)

3. Electrical Equipment - OFF (if requested)

4. Anti-Exposure Suit - Don

4A. Life Vest - Don

5. Ditching Position - Assume

6. Provide - Life raft, survival gear, parachute and exposure suit if not already on

7. Exit - FTS - Left overwing hatch or aft hatch if necessary
   - Staff members on right side, right overwing hatch
   - Staff members on left side, left overwing hatch

NOTE

The flight traffic specialists emergency procedures also appear in T.O. 1C-135(E)C-1-2CL-4 and the staff personnel emergency procedures appear in T.O. 1C-135(E)C-1-2CL-3 which is an abbreviated checklist. The abbreviated checklists have each numbered step of the normal alert and emergency procedures in shortened form.

TWA EMERGENCY PROCEDURES

In an airplane emergency, the trailing wire antenna shall be retracted as quickly as possible if time permits. If time does not permit retracting the antenna, and the nature of the emergency will seriously jeopardize the airplane and crew, the antenna will be jettisoned. When operation of the trailing wire antenna system results in a failure or malfunction of equipment which prevents nesting of the drogue, the antenna cable will be jettisoned. Prior to jettisoning the cable, every possible method of retracting the cable should be attempted.

TRAILING WIRE ANTENNA JETTISON PROCEDURE (TWAO reads)

WARNING

Do not jettison the trailing wire antenna outside of authorized areas unless withholding of such action would seriously jeopardize the airplane and crew.

NOTE

Calculated data indicates a jettisoned antenna will follow a trajectory parallel to the line of flight, with wind direction and velocity affecting its trajectory path. The point of impact is determined by altitude and true airspeed at time of jettisoning, and at 30,000 ft may impact at a maximum distance of 55 miles from the point of jettisoning. Refer to figure 3-18 for jettison impact area.

1. Crew - Notify (P)

When it has been determined that it is necessary to jettison the trailing wire antenna, the pilot will notify the TWA operator and other crewmembers. The pilot will designate a crewmember other than the TWA operator to proceed to the boom operator's station to observe the cable jettisoning.

NOTE

The antenna cable may be jettisoned from either the pilot's, copilot's or TWA operator stations. Under controlled conditions the copilot will perform the jettison procedure using the wire cutter control cut switch.

2. Proceed to Jettison Area (time permitting) (P)

While copilot and TWA operator are arming the TWA system, the airplane will be flown to the jettison area.

3. Air Traffic Control - Notify (if required) (CP)

The appropriate traffic control agency will be notified of the intent to jettison the antenna.

4. TWA Electric Power Switch - Check ON (TWAO, CP)

The TWA operator will ensure the ELEC PWR switch on the trailing wire antenna control indicator panel is ON and notify copilot that electric power is available for jettisoning.

5. Brakes Switch - ON (TWAO)

TWA operator will ensure antenna is stopped and brakes are applied.

6. Notify Pilot - "Ready for cut" (TWAO, P)

TWA operator will notify pilot "ready to cut" when antenna is stopped and brakes applied.

7. Wire Cutter Control Arm Switch - ON (CP)

ARMED light should illuminate to indicate power is available to the CUT switch.

TRAILING WIRE ANTENNA JETTISON PROCEDURE (Cont)

8. Wire Cutter Control Cut Switch - "CUT" (P) "CUT" (CP)

   Pilot will direct copilot to "CUT." Copilot will repeat "CUT" after positioning switch to CUT and will check with observer at boom operator's station and TWA operator to ensure cable is jettisoned. TWA operator should observe tension meter drops to zero. If cable was not jettisoned, TWA operator will notify the pilot. Attempt to cut cable using pilot's or TWA operator's wire cutter control, if time permits. Proceed to MANUAL JETTISON if cable does not jettison using wire cutter control panel cut switch.

Repeat steps 5 thru 8 with Pilot's, then TWAO's wire cutter control if necessary.

9. TWA System - Shutdown (TWAO)

   TWA operator will reset length counters to zero and position hydraulic and electric control switches OFF after antenna cable is jettisoned.

10. Notify Pilot - "TWA system shutdown" (TWAO, P)

    TWA operator will notify pilot that the antenna wire is jettisoned and the system shut down.

11. Air Traffic Control - Notify (CP)

    After jettisoning the trailing wire antenna the air traffic control agency will be notified in accordance with appropriate regulations.

antenna impact radius

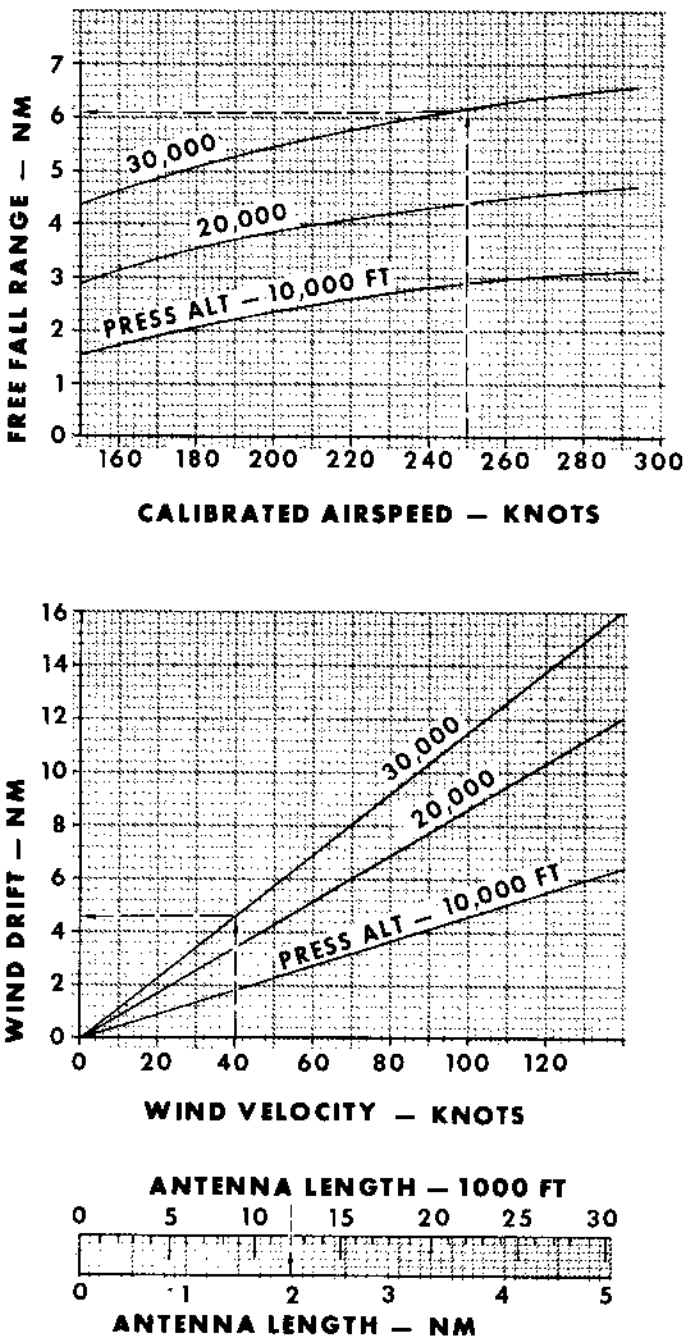


Figure 3-18.

REMARKS:

Impact radius equals free fall range plus wind drift plus antenna length.

Impact radius is the radius about the aircraft at the time of cable separation within which the cable/drogue will impact.

Use the maximum wind velocity the falling antenna will encounter. Normally, this will be the wind at cruising altitude.

Data estimated.

EXAMPLE:
GIVEN:

Altitude: — 30,000 ft
CAS — 250 knots
Wind velocity — 40 knots
Antenna length — 12,000 ft

FIND:

Impact radius

SOLUTION:

Impact radius equals 6.2 plus 4.7 plus 2.0 equals 12.9 NM.

TRAILING WIRE ANTENNA MANUAL JETTISON PROCEDURES

In the event the antenna cable cannot be cut using a wire cutter control cut switch, the TWA operator will manually jettison the antenna cable with the emergency antenna wire cutter control (T-handle).

1. Notify TWAO - "Perform manual jettison" (P, TWAO)

   Pilot will direct TWA operator to perform manual jettison.

2. Notify Pilot - "Ready to cut" (TWAO, P)

3. Notify TWAO - "Cut" (P, TWAO)

   When over jettison area, pilot will notify TWA operator to cut cable.

4. Emergency Wire Cutter Control Handle - Rotate 90° and pull (TWAO)

   TWA operator will rotate T-handle left or right 90°, pull slowly to remove slack and then sever antenna cable with a firm pull. Check tension meter for zero indication.

   NOTE

   If antenna cable failed to jettison as indicated by the tension meter, TWA operator will notify pilot. Pilot will check with observer to confirm that antenna has not jettisoned.

   Proceed to EMERGENCY AIRSPEED JETTISON if manual jettison procedure fails to jettison antenna cable.

5. TWA System - Shutdown (TWAO)

   TWA operator will reset length counters to zero and position hydraulic and electric power switches OFF after antenna cable is jettisoned.

6. Notify Pilot - "TWA system shutdown" (TWAO)

   TWA operator will notify the pilot that the antenna wire is jettisoned and the system shut down.

7. Air Traffic Control - Notify (if required) (CP)

   After jettisoning the trailing wire antenna the air traffic control agency will be notified in accordance with appropriate regulations.

[redacted]

CAUTION

This procedure is to be used only after all other methods of jettisoning the antenna cable have failed.

1. Crew - Notify (P)

   Pilot will notify the TWA operator and other crewmembers of the intent to jettison the antenna by use of high airspeed. Pilot will ensure that an observer is stationed at the boom operator's observation window to observe and report when the antenna cable is jettisoned.

2. Brakes Switch - ON (TWAO)

3. Hydraulic Power Switch - OFF (TWAO)

4. Notify Pilot - "Ready for emergency airspeed jettison" (TWAO, P)

   TWA operator will notify pilot when system is set for jettison.

5. Emergency Airspeed Jettison - Perform (P, TWAO)

   Pilot will increase airspeed until cable tension causes cable to break. TWA operator will notify pilot when the tension increases above 2080 pounds.

   NOTE

   The antenna cable minimum breaking strength is 2200 pounds (average 2800 pounds).

   Observer at boom operator's station will report when cable servers. TWA operator checks tension meter zero and confirms observer's report.

6. TWA System - Shutdown (TWAO)

   TWA operator resets length counters to zero and turns electric power switch OFF after antenna cable is jettisoned.

7. Notify Pilot - "TWA system shutdown" (TWAO)

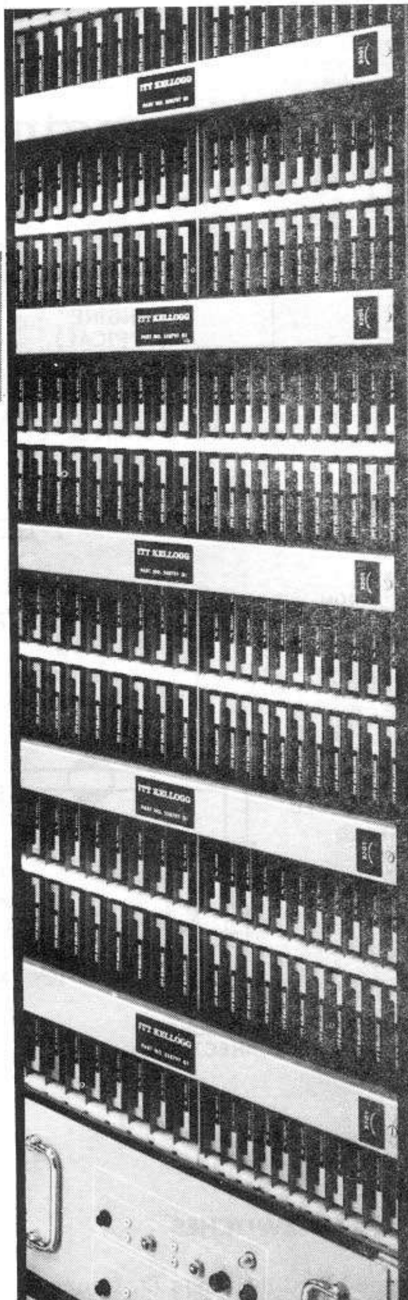
   TWA operator will notify pilot TWA system is shut down.

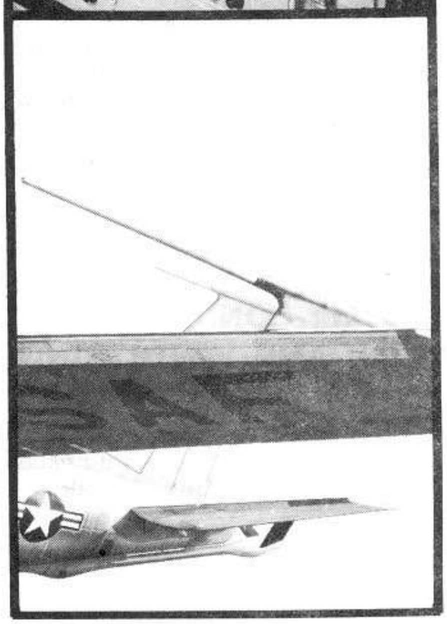
8. Air Traffic Control - Notify (if required) (CP)

   After jettisoning the trailing wire antenna the air traffic control agency will be notified in accordance with appropriate regulations.

NOTE

The trailing wire antenna operator's emergency procedures also appear in T.O. 1C-135(E)C-1-2CL-6 which is an abbreviated checklist. The abbreviated checklists have each numbered step of the normal and emergency procedures in shortened form.





section IV

AUXILIARY EQUIPMENT

TABLE OF CONTENTS

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, air conditioning, and window defrosting. 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 pressurize each generator drive oil system, for nacelle and engine anti-icing and ground air ejector for the generator drive 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 Appendix, T.O. 1C-135(E)C-1-1, for effect on engine thrust. A ground air connection is on the lower left side of the fuselage near the wing leading edge for ground operation of low pressure systems when engine bleed air is not available.

low pressure engine air bleed system

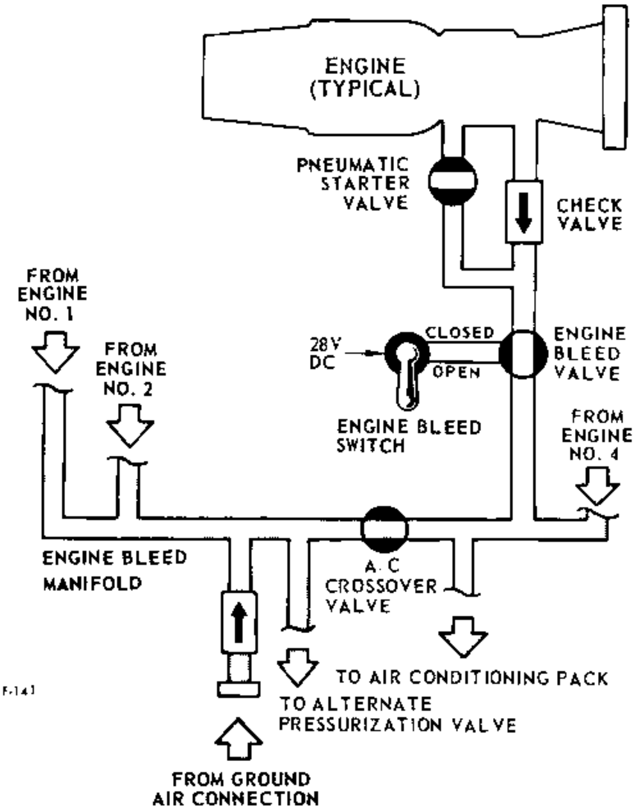


Figure 4-1

ENGINE BLEED SWITCHES

Four engine bleed switches (3, figure 4-5) with OPEN--CLOSE positions are on the air conditioning control panel. Each engine bleed switch will open or close its respective engine bleed valve. The engine bleed switches should remain in the OPEN position at all times except when necessary to close them 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 1-33, sheet 4).

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.

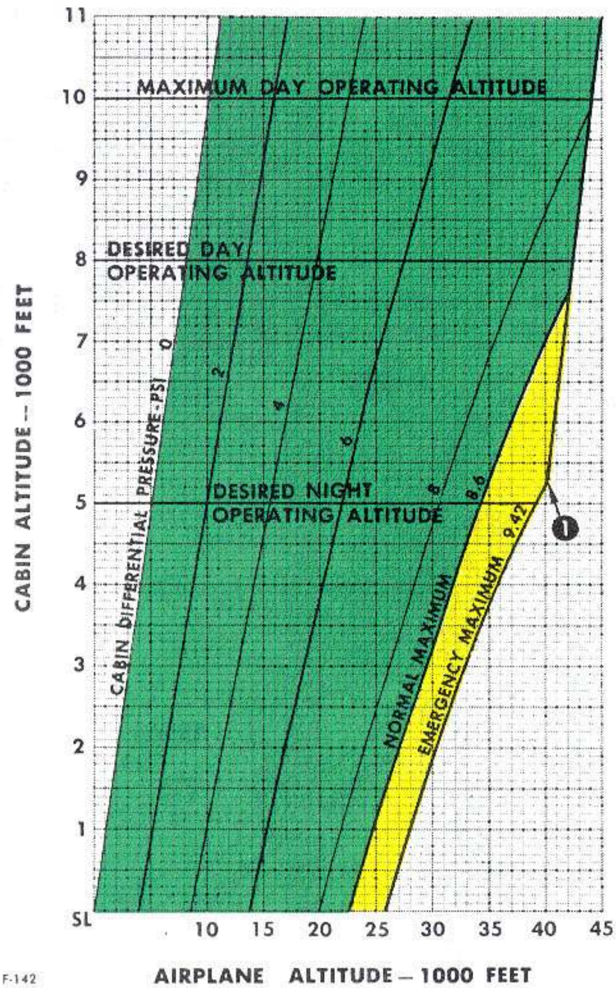
A portion of the cabin air conditioning ducting is jointly shared with an auxiliary cooling system used for cooling certain electronic equipment and requires coordination of use of the airflow controls jointly used.

AIR CONDITIONING SYSTEM

The air conditioning system (figure 4-3 and 4-4) has an 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 and more heat is extracted as it passes through 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 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 temperature in the water separator drops to approximately 33° F and will be closed when it 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 conditioned air is discharged into the main cabin compartments through conditioned air outlets in the

cabin altitude schedule

DATE: FEBRUARY 1964
DATA BASIS: ESTIMATED



F-142

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 (green)
DIFFERENTIAL CABIN ALTITUDE (yellow)

Figure 4-2

overhead duct and 12, foot level, side wall outlets. The overhead duct air outlets are easily located. Refer to figure 4-3 for location of the side wall air outlets. The overhead air conditioning distribution duct is protected from overpressurization by blowout 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 airflow through the air conditioning system is limited by the airflow 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 airflow control valve is open and the airflow rate falls below a minimum rate for ventilation, the air cycle machine bypass valve will open and bypass enough air to maintain a minimum airflow for ventilation. A ground air ejector moves ambient air through the heat exchangers for cooling during ground operation. Refer to Part 2 of the Appendix, T.O. 1C-135(E)C-1-1, for the air conditioning system effect on engine thrust.

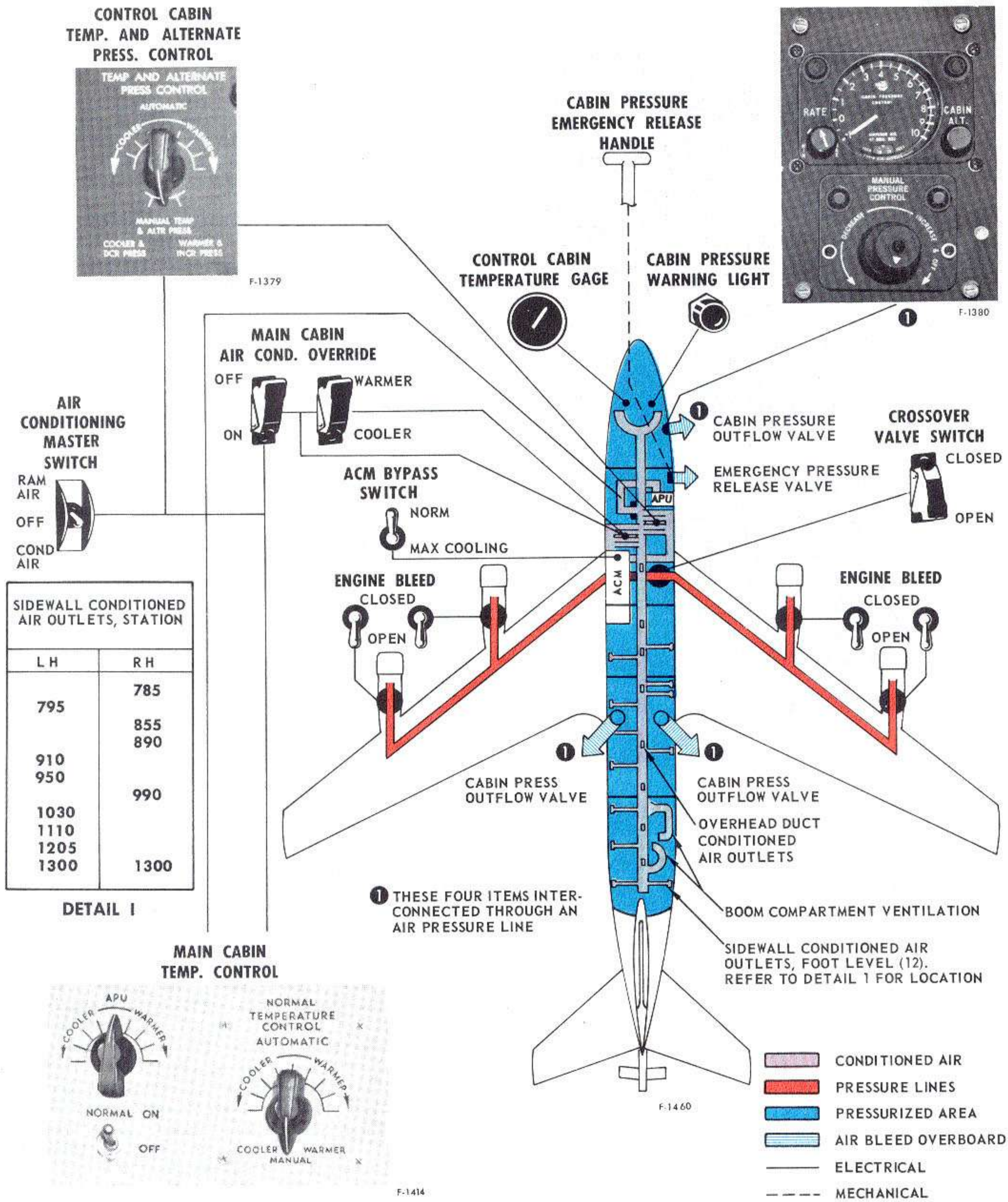
Engine Bleed Switches

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 and auxiliary heat 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 and auxiliary heat 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 for the air conditioning master switch and equipment operated through it is 28 volts DC with circuit protection for the A/C shutoff valve through a circuit breaker marked AIR COND SHUTOFF on the SBCBP; the ground air ejector valve through a circuit breaker marked GROUND AIR EJECT on the SBCBP; the ram air valve through a circuit breaker marked RAM AIR on the SBCBP; the

air conditioning & pressurization



SIDEWALL CONDITIONED AIR OUTLETS, STATION

LH	RH
	785
795	
	855
	890
910	
950	
	990
1030	
1110	
1205	
1300	1300

DETAIL I

Figure 4-3

alternate pressurization and auxiliary heat valve through a circuit breaker marked ALT PRESSURIZATION & AUX HEAT on SBCBP (figure 1-33, sheet 4). Control power for control cabin A/C temperature control is 28 volts DC through the A/C master switch and a circuit breaker marked A/C CONT CABIN on T-R BUS NO. 2 of the MCBP (figure 1-33, sheet 1). The control power for main cabin A/C temperature control is 28 volts DC through the ON-OFF switch on the main cabin A/C control panel (5, figure 4-6) and a circuit breaker marked MAIN CABIN AIR COND on T-R BUS NO. 1 of the MCBP (figure 1-33, sheet 1).

Control Cabin Temperature Control

The temperature and alternate pressurization control (control cabin temperature control, item 1, figure 4-5) is a rotary switch and dial on the overhead air conditioning control panel. The control is operative only when the air conditioning master switch is in the OFF or COND AIR position. The upper half of the dial has AUTOMATIC, COOLER--WARMER positions and the lower half of the dial has MANUAL, COOLER & DCR PRESS--WARMER & INCR PRESS. positions. The selector is spring-loaded when in the MANUAL range from the COOLER & DCR PRESS. and WARMER & INCR PRESS. 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 temperature and alternate pressure control valve to increase the flow of warm air to the control cabin; the COOLER position will decrease the flow of warm air into the cabin. Operating power for the valve is 28 volts DC through the cabin temperature control from a circuit breaker marked ALT PRESS. & AUX HEAT on the SBCBP (figure 1-33, sheet 4). Operating power for the control cabin temperature controls is 115 volts AC through a circuit breaker marked CONTROL CABIN TEMP CONTROL on the ENG 1 GEN of the MCBP (figure 1-33, sheet 2). Control power for the control cabin temperature control is 28 volts DC through the A/C master switch and a circuit breaker marked A/C CONT CABIN on T-R BUS NO. 2 of the MCBP (figure 1-33, sheet 1).

Main Cabin Temperature Control Switch

This switch (5, figure 4-6) on the main cabin temperature control panel has NORMAL ON--OFF positions. The NORMAL ON position supplies power to position the hot air bypass valve to maintain main cabin temperature as set on the main cabin temperature selector. The OFF position removes power from all main cabin A/C control panel components except the APU temperature control. Operating power is 115 volts AC through a circuit breaker marked MAIN CABIN A/C CONT on ENG 2 GEN of the MCBP (figure 1-33, sheet 2).

Main Cabin Temperature Control

The main cabin temperature control is a rotary switch and dial located on the main cabin temperature control panel and marked NORMAL TEMPERATURE CONTROL (4, figure 4-6). This control is operative only when the main cabin temperature control switch (5, figure 4-6) is in the NORMAL ON position, the main cabin A/C override switch (7, figure 4-5) is in the OFF position and 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 positions. The selector is spring-loaded when in the MANUAL range from the COOLER and WARMER positions to the neutral position. With the selector in the AUTOMATIC range the air conditioning pack is automatically controlled to provide a satisfactory temperature in the main cabin. This temperature is determined by personnel comfort because there is no temperature gage. However, the approximate temperature range of this control is 20 to 100° F. When the selector is placed in the MANUAL range the automatic control is inoperative and the main 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 into the main cabin; the COOLER position will increase the flow of cool air and decrease the flow of warm air into the main cabin. Operating power is 115 volts AC through a circuit breaker marked MAIN CABIN A/C CONT on ENG 2 GEN of the MCBP (figure 1-33, sheet 2). Control power is 28 volts DC through the main cabin A/C master switch from a circuit breaker marked MAIN CABIN AIR COND on T-R BUS NO. 1 of the MCBP (figure 1-33, sheet 1).

Boom Operator's Compartment Temperature Control

The boom operator's compartment receives conditioned air from the overhead duct and from above the main cabin lowered ceiling. Air is ducted from above the lowered ceiling down the sidewall and through a fan in the boom operator's compartment. Circulating the air above the lowered ceiling pro-

air conditioning system

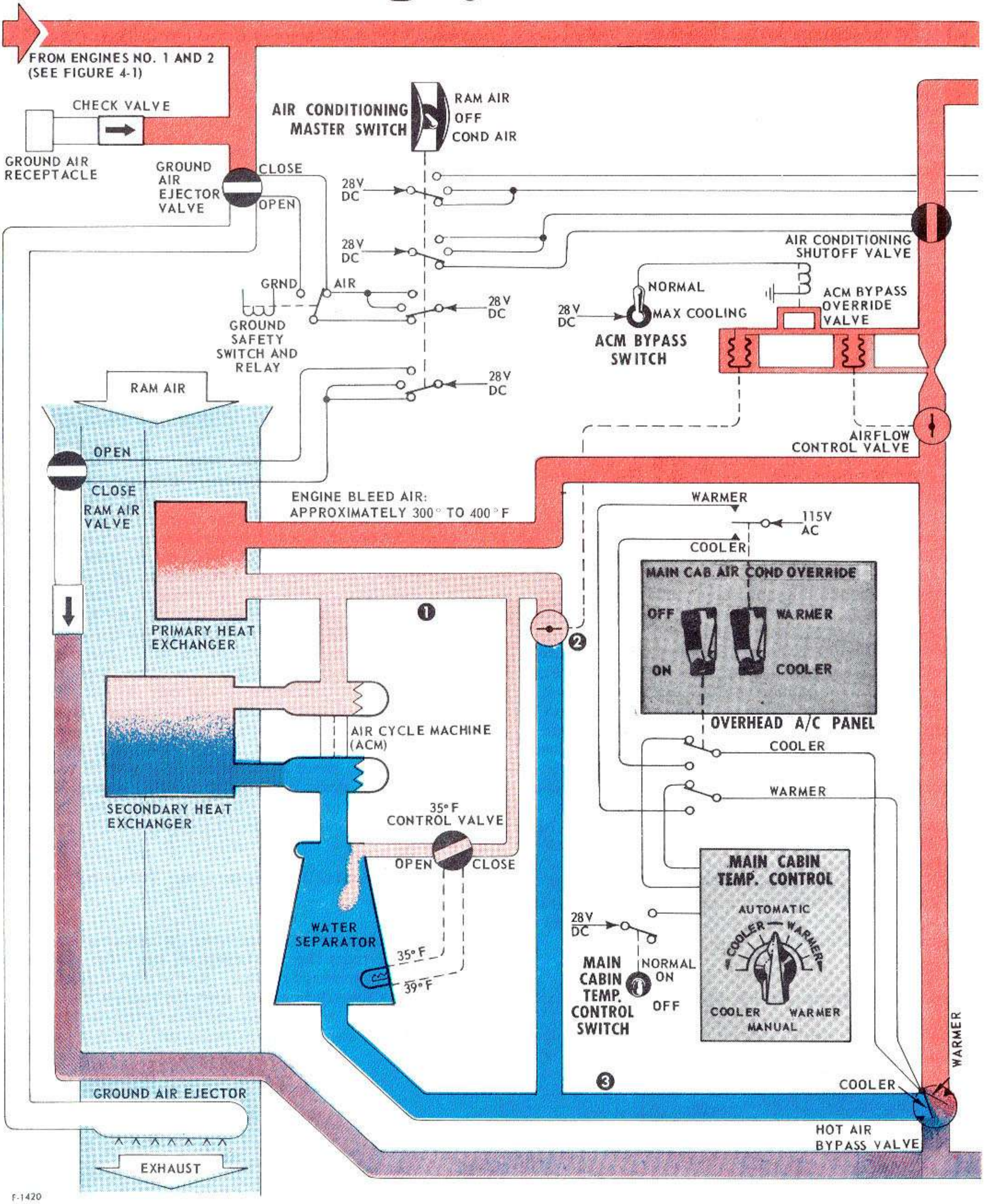


Figure 4-4 (Sheet 1 of 2)

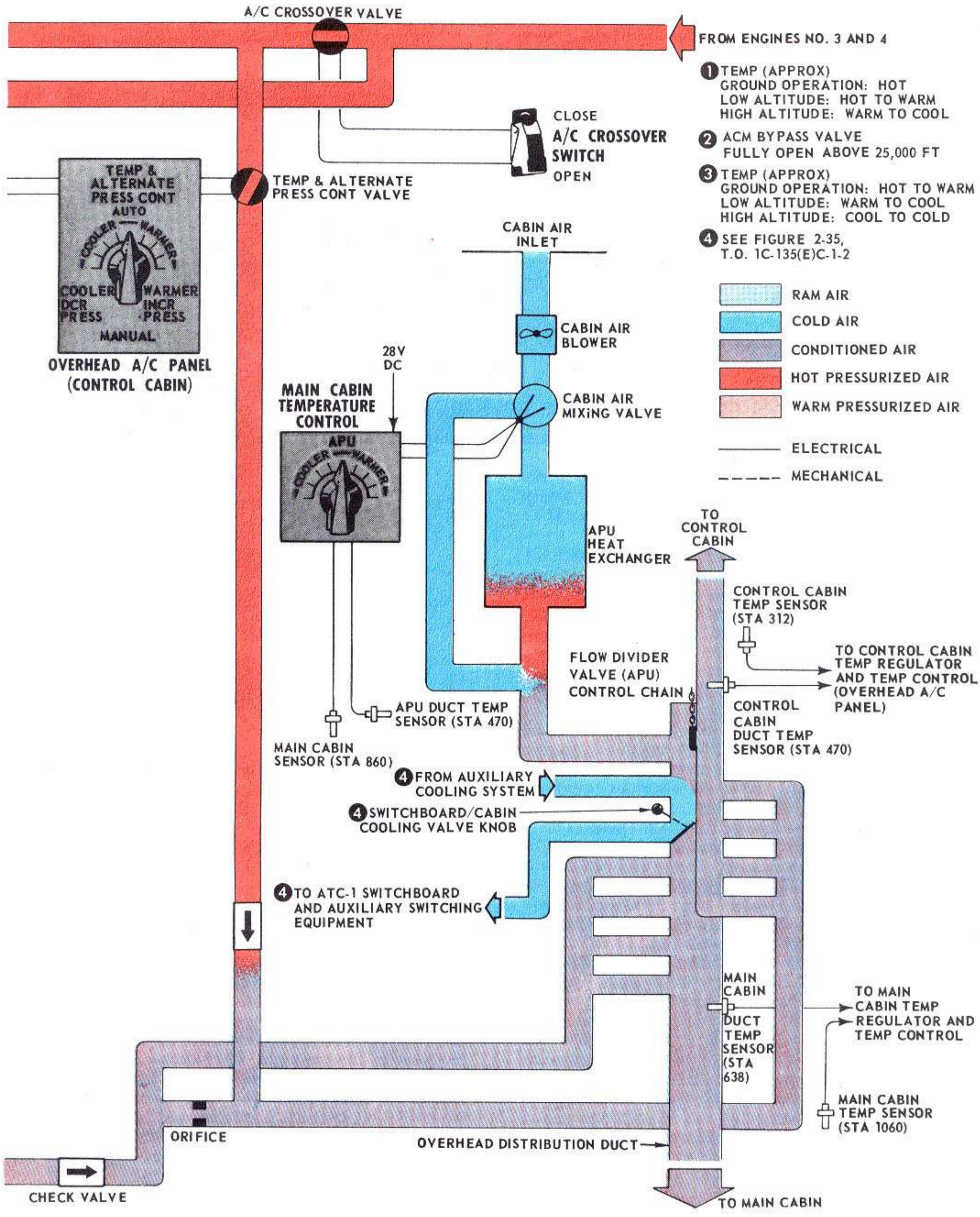
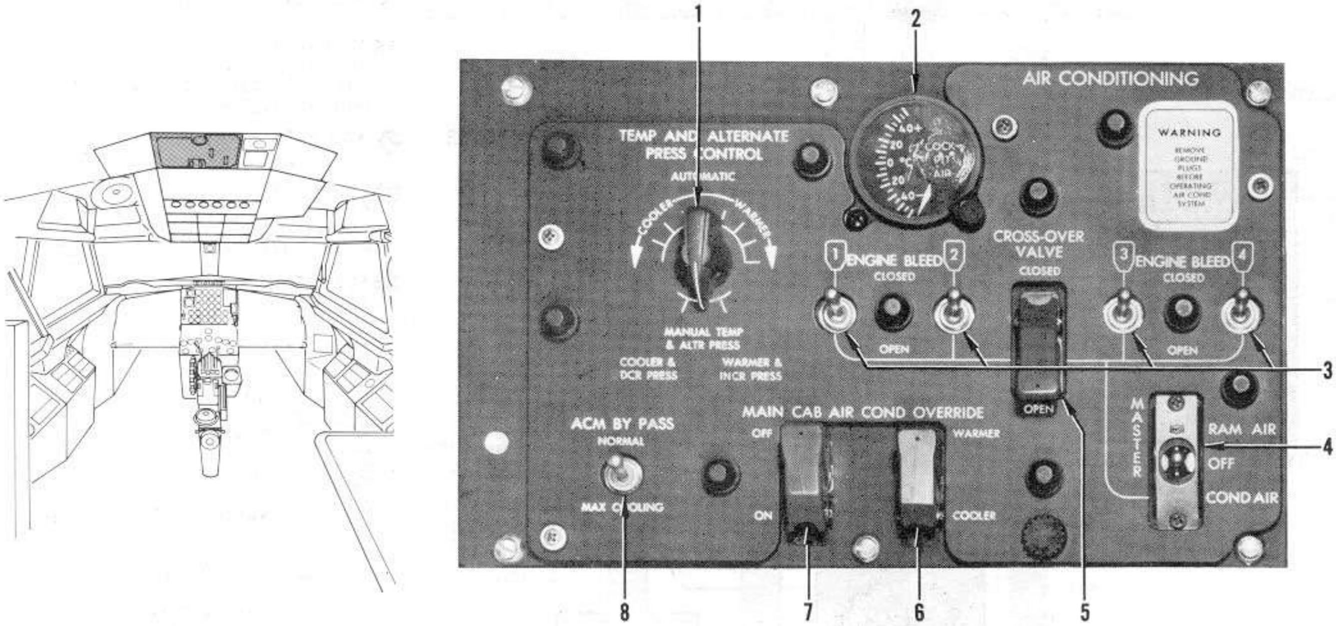


Figure 4-4 (Sheet 2 of 2)

air conditioning panel



1 CONTROL CABIN TEMPERATURE CONTROL
2 CONTROL CABIN TEMPERATURE GAGE
3 ENGINE BLEED SWITCHES
4 AIR CONDITIONING MASTER SWITCH
5 A/C CROSSOVER SWITCH
6 MAIN CABIN TEMPERATURE CONTROL OVERRIDE SWITCH
7 MAIN CABIN AIR CONDITION OVERRIDE SWITCH
8 ACM BYPASS SWITCH

Figure 4-5

vides additional cooling for the main cabin compartment No. 4 by removing warm air when the galley and compartment lighting are operating. Two switches control the fan; one switch, in the boom operator's compartment, is located overhead near the boom operator instructor's instrument panel. The second fan switch is located on the flight traffic specialist's console. The fan switch on the console also has an indicator light. When the light is on, the fan is operating. Operating power for the fan is 115V AC through a circuit breaker marked BOOM OPERATOR'S FAN on ENG 2 GEN of the CCP-PL25 (figure 1-33, sheet 9).

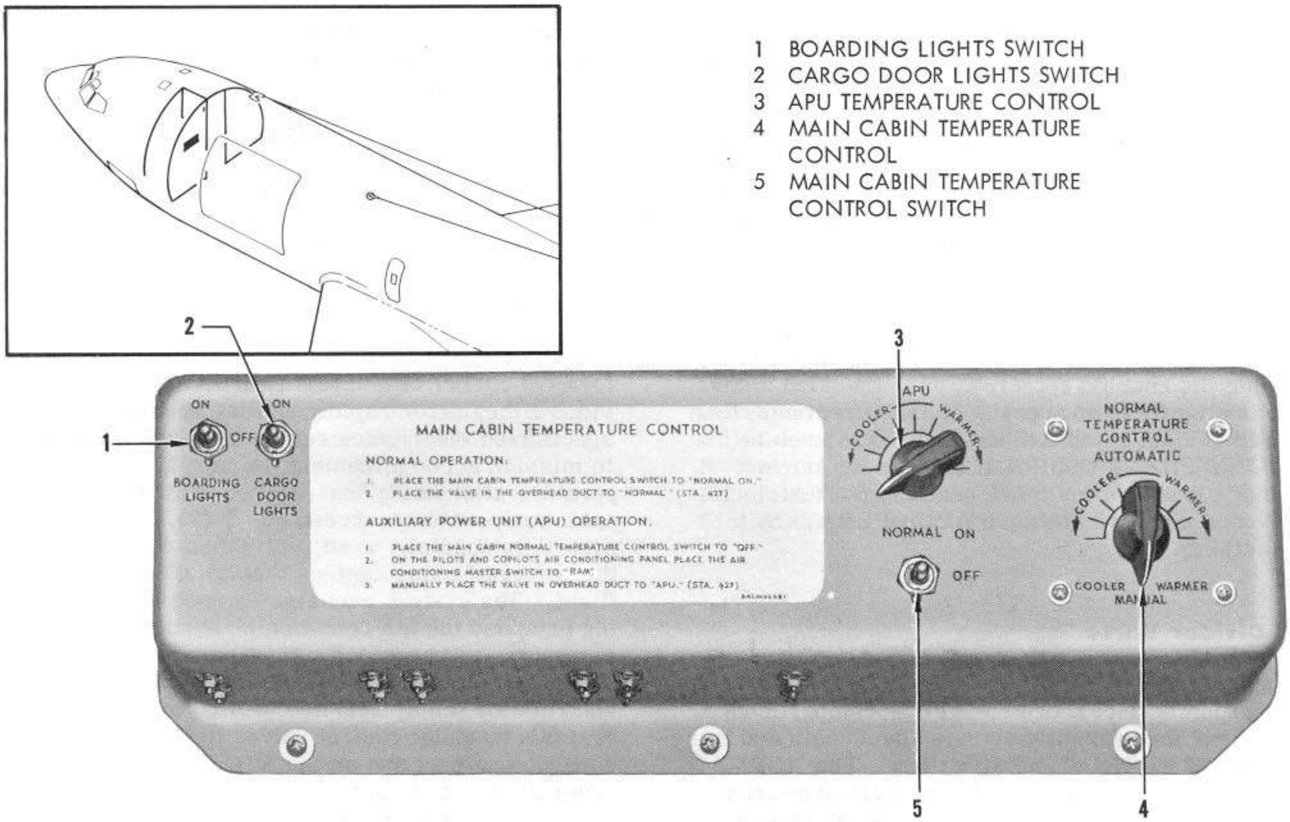
NOTE

The boom operator's fan permits heating of the boom operator's compartment before the boom operator enters. The fan can be turned off while the compartment is occupied.

Main Cabin Air Conditioning Override Switches

The main cabin air conditioning override switches, located on the overhead air conditioning panel (6 and 7, figure 4-5), permit overriding the main cabin temperature control system. The left main cabin air conditioning override switch has ON--OFF positions and is guarded to the OFF position. When the left main cabin air conditioning override switch is in the OFF position and the air conditioning master switch is in the COND AIR position, signals from the main cabin temperature regulator will modulate the hot air bypass valve to maintain the main cabin temperature selected on the main cabin temperature control. The ON position of the switch bypasses the main cabin regulator and allows the pilot to use the right override switch to manually regulate the hot air bypass valve for temperature control of the main cabin. The right override switch has WARMER--COOLER positions and is spring loaded and guarded to the neutral or off position. The hot air bypass valve requires approximately 40 seconds for

main cabin temperature control panel (typical)



1 BOARDING LIGHTS SWITCH
2 CARGO DOOR LIGHTS SWITCH
3 APU TEMPERATURE CONTROL
4 MAIN CABIN TEMPERATURE CONTROL
5 MAIN CABIN TEMPERATURE CONTROL SWITCH

Figure 4-6

F-1476

one cycle of operation, full hot to full cold, or the reverse. The hot air bypass valve operating power is 115 volts AC through both override switches and a circuit breaker marked MAIN CABIN A/C CONT on ENG 2 GEN of the MCBP (figure 1-33, sheet 2).

A/C Crossover Switch

The A/C crossover switch (5, figure 4-5) on the overhead 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 temperature and alternate pressure control 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 volts DC through a circuit breaker marked AIR CONDITIONING VALVES, CROSSOVER on the SBCBP (figure 1-33, sheet 4).

ACM Bypass Switch

The ACM bypass switch (8, figure 4-5) is on the air conditioning panel and has NORM--MAX COOLING positions. With the switch in the NORM position the ACM bypass valve will operate normally, that is, the valve will open to increase airflow to the pressurized area of the airplane when airflow falls below a certain ventilation rate. The ACM bypass valve, as it is normally controlled, will open at high altitudes and at low engine thrust settings regardless of altitude. During descent and holding at low altitudes when the ACM bypass valve is open, more cooling can be provided by placing the ACM bypass switch in the MAX COOLING position; this directs bleed pressure directly to the ACM bypass valve actuator and closes the valve, thus directing all of the air through the ACM for cooling. During cruise, with the ACM bypass switch in MAX COOLING, an increase in cabin altitude may be required to maintain airflow for maximum cooling. At very low airflow rates the bleed pressure becomes too low to actuate the ACM bypass valve even with the ACM bypass switch in MAX COOLING. Operating power is 28 volt DC through a circuit breaker marked MAIN CABIN AIR CONDITIONING on the T-R BUS NO. 1 section of the MCBP (figure 1-33, sheet 1).

APU Temperature Control

This control knob (3, figure 4-6), on the main cabin temperature control panel adjusts the setting of an automatic temperature regulator to control a valve within the APU that directs the incoming air directly within 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. The main cabin 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 breaker panel (figure 1-33, sheet 11). Should this control malfunction, a temperature control manual override (figure 4-47) 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. Refer to APU OPERATION in this Section.

Flow Divider Valve

The flow divider valve (figure 4-4) is in the overhead air conditioning duct above the APU in compartment 1. The valve is mechanically actuated by a chain and has NORMAL--APU HEATING positions. The NORMAL position distributes APU conditioned air primarily to the main cabin distribution duct and a smaller amount, due to an orifice, to the control cabin distribution duct. The APU position distributes an increased amount of APU conditioned air or auxiliary cooling system air to the control cabin via the flow divider gate valve in the common duct wall dividing the main cabin and control cabin air conditioning distribution ducts.

CAUTION

Flow divider valve should be in normal position when air conditioning system is in operation to prevent possible damage to auxiliary cooling system.

Control Cabin Air Temperature Gage

One air temperature gage has been installed in the airplane. This gage is located on the overhead air conditioning panel (2, figure 4-5) and indicates the control cabin air temperature in degrees centigrade. Operating power is 28 volt DC through a circuit breaker marked CABIN TEMPERATURE INDICATOR on T-R BUS NO. 2 of the MCBP (figure 1-33, sheet 1).

AUXILIARY COOLING SYSTEM

The auxiliary cooling system compressor is designed to operate normally up to 24,000 feet altitude. If operated above 24,000 feet, the compressor may fall off the line or unseat circuit breakers. If the compressor "falls off," it may not reset until airplane altitude is reduced to several thousand feet below the 24,000 foot level.

NOTE

If airflow through the ATC-1 switchboard is insufficient with the auxiliary cooling system OFF, the evaporator fans may be operated with the ATC-1 switchboard cooling doors open to augment the switchboard blowers.

The auxiliary cooling system is installed in the left forward corner of compartment 1. The system provides a means for rapidly cooling several items of specialized electronics equipment, which are critical to mission accomplishment, to normal operating temperature after being heat-soaked prior to flight when cabin temperatures exceed 85° F (29.4° C). The system is normally used, only when required, during the before starting engines through climb phases of flight. The system may also be used for cabin cooling provided the air conditioning system is not in operation, and provided its entire output is not required for electronics equipment cooling. Operating controls for the system are located on the radio operator's console; control valves in the overhead air conditioning duct and on the ATC-1 switchboard. Several modes of operation of the auxiliary cooling system in conjunction with the air conditioning system are possible. These modes of operation, and the various control settings required for each are shown in figure 4-7A. For additional information on the auxiliary cooling system see T.O. 1C-135(E)C-1-2.

Switchboard/Cabin Cooling Valve

The switchboard/cabin cooling valve (figure 4-4) is in the overhead air conditioning duct aft of the APU in compartment 1. The valve is mechanically actuated by a push-pull knob, and may be locked in any position by a thumbscrew. In SWITCHBOARD COOLING (knob full in) position, the valve directs all of the output air from the auxiliary cooling system into electronics equipment for cooling, provided the flow divider valve is in NORMAL position. In CABIN AIRFLOW (knob full out) position, all of the output air from the auxiliary cooling system is directed into the cabin air conditioning system overhead duct for cooling the main cabin, and the control cabin provided the flow divider valve is in APU HEATING position. In intermediate positions the valve directs portions, dependent on valve position, of the auxiliary

air conditioning system operating modes

	FLOW DIVIDER VALVE	SWITCHBOARD/ CABIN COOLING VALVE	APU HEAT CONTROLS	AIR CONDITIONING SYSTEM	AUXILIARY COOLING SYSTEM	ATC-1 SWITCH-BOARD COOLING DOORS
CABIN HEATING (Ground Only)	APU-Heating	Cabin-Airflow	On	Off	Off	Open
CABIN COOLING	APU-Heating	Cabin-Airflow	Off	Off	On	Open
CABIN COOLING/ ATC-1 SWITCH-BOARD COOLING	APU-Heating	Intermediate	Off	Off	On	Closed
ATC-1 SWITCHBOARD COOLING	Normal	Switchboard Cooling	Off	Any Condition	On	Closed
AIR CON-DITIONING SYSTEM ONLY	Normal	Switchboard Cooling	Off	On	Off	Open

Figure 4-7A

cooling system output air into the air conditioning system overhead duct and into the electronics equipment.

CAUTION

- Switchboard/cabin cooling valve should be in SWITCHBOARD COOLING position and locked when air conditioning system is in operation to prevent possible damage to auxiliary cooling system.
- Switchboard/cabin cooling valve should be in CABIN AIRFLOW position when APU is being operated to furnish cabin heat to prevent possible damage to electronics equipment.

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 4-7) 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 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 4-7), at the lower right of the dial (2, figure 4-7) and connected to the dial pointer (3, figure 4-7) provides a means of selecting cabin altitude. The maximum airplane altitude window (5, figure 4-7) will show the maximum airplane altitude for the cabin altitude as selected by the dial pointer.

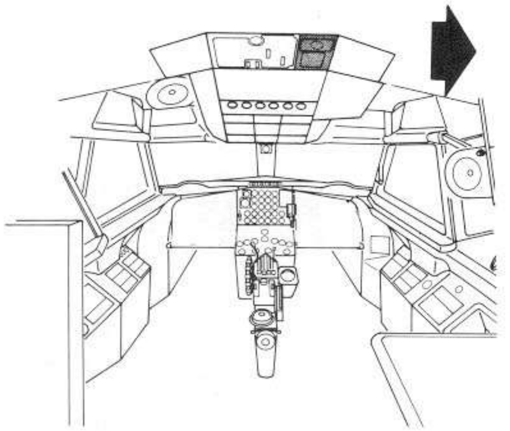
NOTE

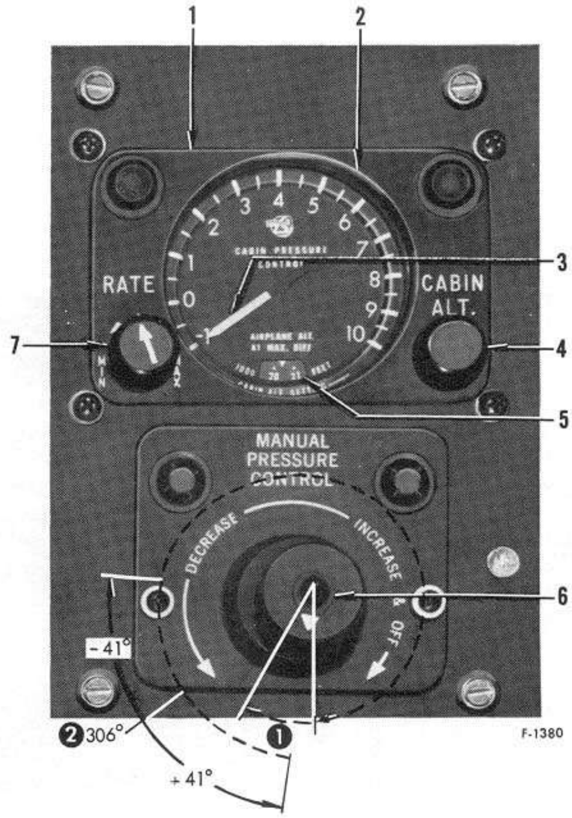
- Two types of cabin pressure controllers may be installed in the airplane and the only difference between the controllers is in the rotation of the dial pointer. One controller has a dial pointer that can be rotated approximately 1-1/2 revolutions from the lower mechanical stop to the upper mechanical 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 4-7), 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

Figure 4-7

Cabin Manual Pressure Control

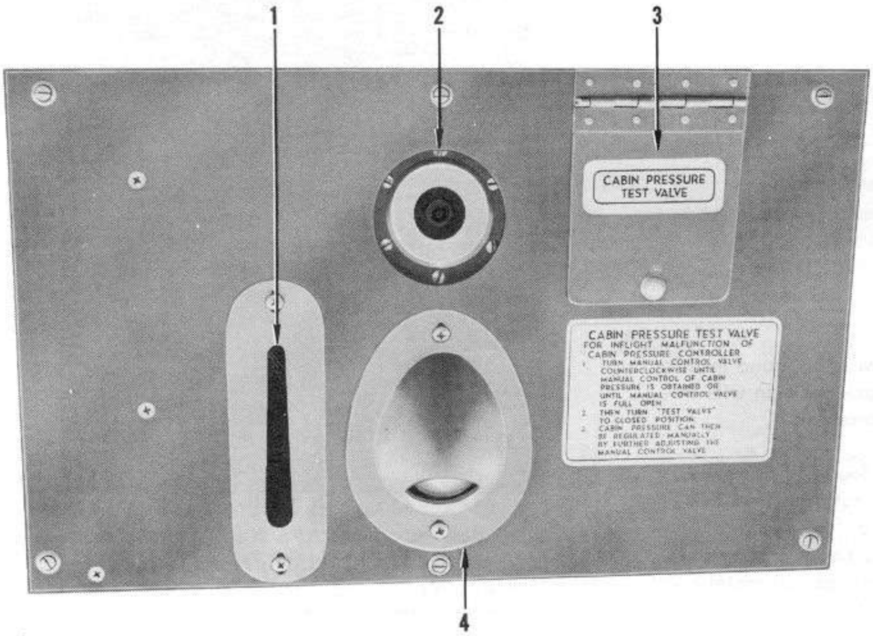
The cabin manual pressure control (6, figure 4-7) on the overhead panel has DECREASE--INCREASE & OFF indicating arrows. The normal position of the cabin manual pressure control is the OFF position attained by rotating the control fully clockwise. This position allows the cabin pressure controller to 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. 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 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 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 4-7) and the cabin manual pressure control (6, figure 4-7) 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).

auxiliary overhead panel

1 SPOTLIGHT APERTURE
2 WARNING HORN
3 CABIN PRESSURE TEST VALVE HANDLE (SEE DETAIL)
4 PANEL SPOTLIGHT



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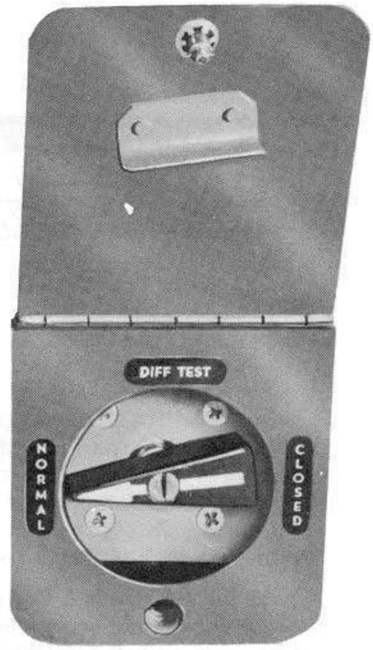


F-153

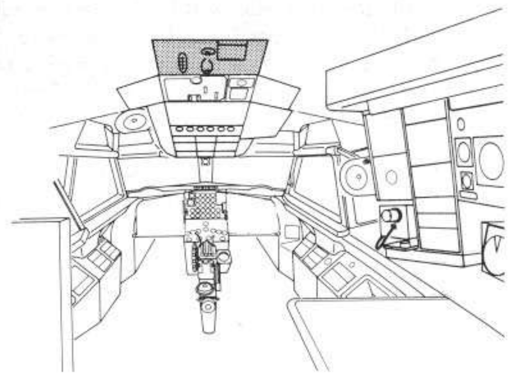


Figure 4-8

Cabin Pressure Test Valve Handle

The cabin pressure test valve handle (3, figure 4-8) 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.

CAUTION

The door covering the valve handle can be forced closed when the handle is not in the NORMAL position; however, this action will bend the door guide bracket. The pressure test valve handle must be positioned to NORMAL before closing the door. Refer to figure 4-8.

cabin pressure leakage check points

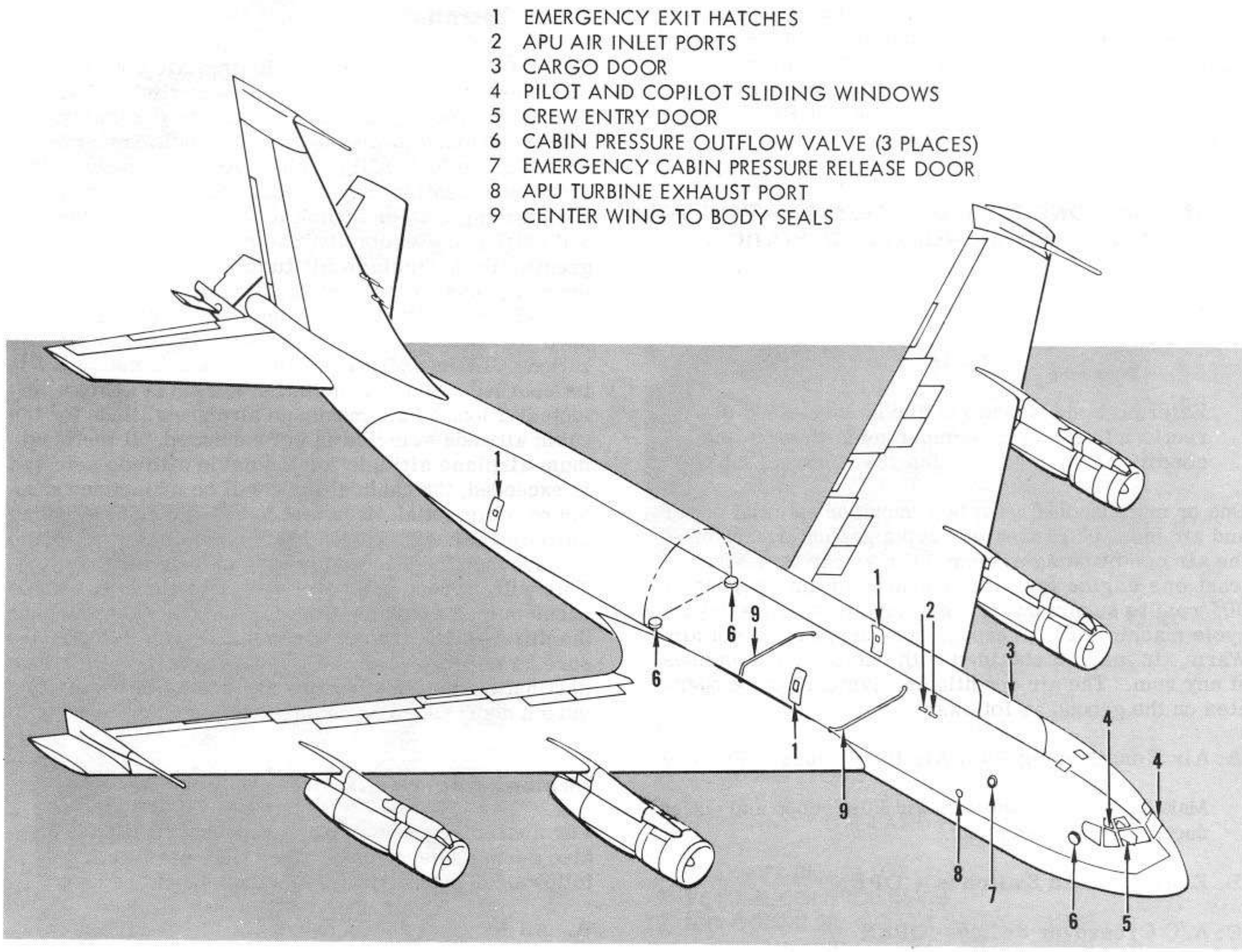


Figure 4-9

Cabin Pressure Emergency Release Handle

This handle (17, figure 1-15) is on the pilots' center instrument panel and controls the cabin pressure emergency release door (7, figure 4-9) 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) (16, figure 1-17) 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 1-17) on the copilot's flight instrument panel is connected to a pressure switch which turns the light on when the cabin pressure goes above 12,000 feet ± 1000 feet. When the light is on, it 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 volts DC through a circuit breaker marked CABIN PRESS WARN on the SBCBP (figure 1-33, sheet 4).

CABIN AIR CONDITIONING, PRESSURIZATION AND VENTILATING SYSTEMS NORMAL OPERATION

Ground Operation

NOTE

External conditioned air can be connected directly into the crew compartment through the conditioned air connection (34, figure 1-66).

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

C. A/C Crossover Switch - OPEN

CAUTION

If the A/C crossover valve is closed and engines No. 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. 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 non-emergency airplane depressurization and also during emergencies, when time permits, the following depressurization method should be used:

A. All Personnel - On oxygen (if required)

All personnel on board, time permitting, shall begin using oxygen prior to depressurization of the airplane under conditions which require use of oxygen.

B. Cabin Manual Pressure Control - Full DECREASE

Maximum cabin pressure bleed down, approximately 27 seconds, is achieved by rotating the cabin manual pressure control knob fully CCW to DECREASE.

C. Air Conditioning Master Switch - RAM AIR

Placing the air conditioning master switch in RAM AIR for approximately 20 seconds will close the alternate pressurization and auxiliary heat valve.

D. 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 left 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.

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 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. A bleed air operated ACM bypass valve in the air conditioning pack may be closed by placing the ACM bypass switch in the MAX COOLING position so that all air is directed through the ACM to provide maximum cooling. However, at very low power settings the bleed air pressure becomes too low to actuate the ACM bypass valve. (Refer to ACM Bypass Switch this Section.) 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, PRESSURIZATION 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 two routes, through the air conditioning shutoff valve and through the temperature and alternate pressure control valve. Failure of either the air conditioning shutoff valve or the airflow control valve in the closed position would prevent pressurizing the airplane through the air cycle machine. However, airflow could still be supplied through the temperature and alternate pressure control valve 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 wing to body junctions. 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).

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) Temperature and Alternate Pressure Control - MANUAL, INCR PRESS until sufficient airflow is obtained (CP).

Airflow from the temperature and alternate pressure control valve will be felt sooner at the air vents near the periscopic sextant mount.

(5) 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 aircraft is not pressurizing as desired:

(1) All Hatches and APU Ports - 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 in Section III 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 and auxiliary heat valve should be closed; this will reduce the amount of heat received by the control cabin. 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 and auxiliary heat 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. 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.

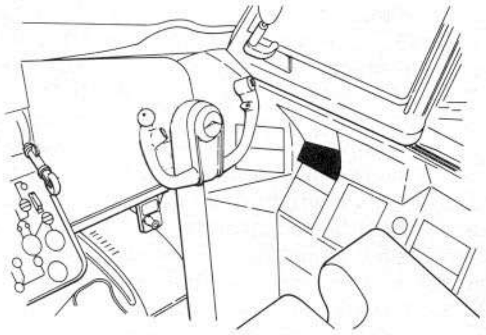
D. Cabin Manual Pressure Control - Adjust to desired cabin altitude.

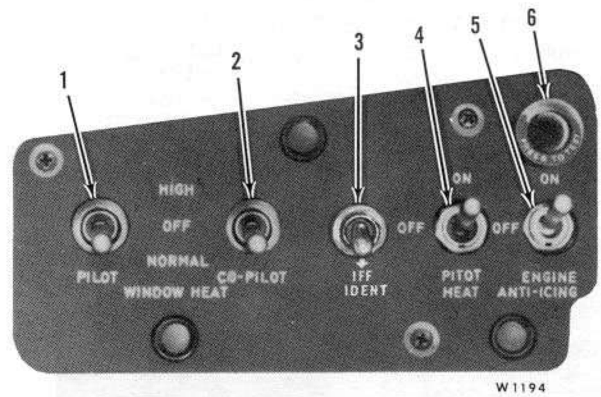
WARNING

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 stabi-

anti-icing panel





1 PILOT'S WINDOW HEAT SWITCH
2 COPILOT'S WINDOW HEAT SWITCH
3 IFF IDENT SWITCH
4 PITOT HEAT SWITCH
5 ENGINE ANTI-ICING SWITCH
6 ENGINE ANTI-ICE INDICATOR LIGHT

Figure 4-10

ize, 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 figure 4-7 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

An engine anti-icing system, using hot bleed air from the high pressure compressor engine bleed system, is provided to prevent ice formation on the nose cowl, EPR probe, generator drive oil cooler inlet, 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 the 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 into the engine inlet. Engine anti-icing air 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 hot air passing through the nose cowl anti-ice valve, located on top of the engine, is directed to the EPR probe, generator drive oil cooler inlet and the nose cowl. The probe and cooler inlet anti-icing air vents overboard. The nose cowl hot air is directed into the bottom of the nose cowl where it is mixed with ambient air drawn through a duct. 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 vented overboard.

CAUTION

To prevent deterioration of the foam-type rubber compound used in the inlet guide vanes to damp vibration, excessive use of anti-icing air at high ambient temperature should be avoided. Continuous use of the anti-icing system should be restricted to ambient temperatures below 50° F (10° C). At temperatures of 50° F (10° C) and above, limit use of system to 10 seconds if operating above 90% N_2 rpm, and limit to one minute if operating below 90% N_2 rpm.

Engine Anti-Icing Switch

The engine anti-icing switch (5, figure 4-10) on the anti-icing 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 engine anti-icing switch is moved to the OFF position. Operating power for the 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 1-33, sheet 1). Control power for the engine anti-icing system is 28 volt DC through a circuit breaker marked ANTI-ICE CONTROL, ENGINE on T-R BUS NO. 1 of the MCBP (figure 1-33, sheet 1).

control cabin heated windows

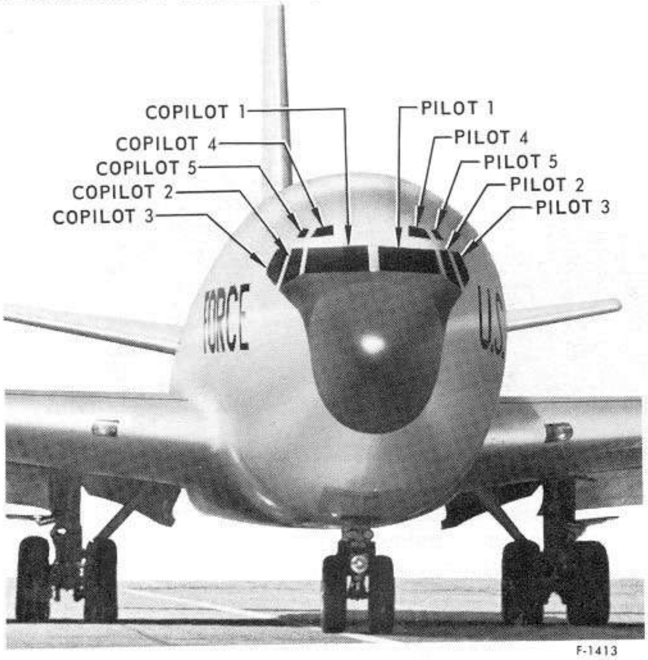


Figure 4-11

Engine Anti-Icing Indicator Light

The engine anti-icing indicator light (6, figure 4-10) on the anti-icing 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 1-33, sheet 1).

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 buildup 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 4-11. 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 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. Shutoff doors on the 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 (1, 2, figure 4-10) 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 ENG 1 GEN 1 and two circuit breakers marked WINDOW ANTI-ICE, NO. 3-4-5 COPILOT, PILOT NO. 2 COPILOT NO. 1 on ENG 4 GEN of the MCBP (figure 1-33, sheet 2). Control power for pilots' windows 3, 4 and 5 is 115 volt AC through a circuit breaker marked WINDOW ANTI-ICE, CONTROL on ENG 1 GEN and for copilot's windows 3, 4 and 5 through a circuit breaker marked WINDOW ANTI-ICE, CONTROL on ENG 4 GEN of the MCBP (figure 1-33, sheet 2). 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 1-33, sheet 1). The boom operator's window heat switch (1, figure 4-54) on the BOCBP has ON--OFF positions and controls the window heat for the boom operator's compartment. 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 1-33, sheet 10).

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 copilot window heat switches may be placed in the HIGH position without first warming up in the NORMAL position. Refer also to PRESSURIZATION WITH CRACKED WINDOW in 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 ENG 4 GENERATOR portion of the MCBP (figure 1-33, sheet 2) and the copilot's circuit receives power through a circuit breaker marked COPILOT PITOT STATIC ANTI-ICE on the ENG 1 GENERATOR portion of the MCBP (figure 1-33, sheet 2).

Pitot Heat Switch

A pitot heat switch (4, figure 4-10) 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. Accidental movement of the pitot heat switch is prevented by the switch design, which requires the operator to pull out on the toggle lever before it can be moved to either position.

ANGLE OF ATTACK TRANSMITTER ANTI-ICING SYSTEM

Ice formation on the angle of attack transmitter (50A, 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. 4 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 115V AC with circuit protection through a circuit breaker marked Q-INLET HEATER on the ENG 2 GEN section of the MCBP (figure 1-33, sheet 2). Power to the heater is controlled by the Q-inlet heat switch on the copilot's flight instrument panel (20, figure 1-17).

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 is on the copilots' flight instrument panel (19, figure 1-17), adjacent to the Q-inlet heat switch. Operating power for the light is 28V DC with circuit protection through a circuit breaker marked Q-INLET HEATER WARN on the T-R BUS NO. 2 section of the MCBP (figure 1-33, sheet 1).

Q-Inlet Heat Switch

The Q-inlet heat switch on the copilots' flight instrument panel (20, figure 1-17) 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 115V AC with circuit protection through a circuit breaker marked Q-INLET HEATER on the ENG 2 GEN section of the MCBP (figure 1-33, sheet 2).

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.

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 lose 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. This condition, during rudder power on operation, will result in reduced rudder pedal feel forces and can produce a tendency to overcontrol.

DRAIN LINE AND DRAIN MAST HEATERS

Drain lines and a drain mast are provided to drain water from the wash basins in the aft toilet compartments, condensate from the oxygen system converters, and waste water from the galleys. The heaters on the drain lines are automatically controlled by a thermal sensing switch. Operating power is 115 volt AC through a circuit breaker marked DRAIN LINE HEATER on the ENG 1 GEN section of the MCBP (figure 1-33, sheet 2). The drain mast heater is controlled by the L.H. oleo safety switch with circuit protection through a circuit breaker marked SAFETY SWITCH RELAY on T-R BUS NO. 2 of the MCBP (figure 1-33, sheet 1). When the airplane is on the ground, operating power is 28 volt AC through a circuit breaker marked DRAIN MAST HEATER on the 28 volt AC section of the MCBP (figure 1-33, sheet 2). When the airplane is airborne, operating power is 115 volt AC through a circuit breaker labeled DRAIN MAST HEATER on the ENG 1 GEN section of the MCBP (figure 1-33, sheet 2).

WARNING

To prevent injury from the hot surface, do not touch the drain mast if AC power is applied to the airplane.

CAUTION

If the oleo safety switches are bypassed in any manner (e.g. airplane on jacks) and AC power is to be applied to the airplane, pull the 115 volt AC circuit breaker marked DRAIN MAST HEATER, on the ENG 1 GEN section of the MCBP (figure 1-33, sheet 2), to prevent overheating of the element.

NOTE

During boom refueling operations (sighting door open) drain mast water may freeze on the boom operator's window. Therefore, water should not be poured into the water drain system (galley and lavatories) during boom air refueling.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

The electronic equipment used for air crew communications, navigation and identification is listed in figure 4-12. See T.O. 1C-135(E)C-1-2 for information pertaining to the Communications Center electronic equipment. 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, and radar beacon. The identification

communication & associated electronic equip.

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
INTERPHONE AN/AIC-18	Intraplane communication and use with other radio equipment	All crew and staff members, radio and crypto operators	Intraplane only except when used in conjunction with other equipment	All personnel 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 (2 SETS) (WITHOUT TCTO 1044) **AN/ARC-164 (2 SETS)** (WITH TCTO 1044)	Short range, two-way voice communication	Pilots and radio operator	Line-of-sight. Range varies with altitude in respect to receiving station	Overhead panel and radio operator's console	Do not operate both sets on or near the same frequency
UHF-ADF AN/ARA-25	Receives signals for directional bearing and homing, both air to air and ground to air	Pilots and radio operator	Line-of-sight. Range depends upon power of transmitting stations and conditions	ADF position on UHF command radio No. 1 control panel on overhead panel and radio operator's console	Used in conjunction with the UHF Command radio (COMM #1). Requires data from N-1 Compass
LIAISON RADIO AN/ARC-58 (LIA NO. 1 on RADIO OPERATOR'S CONSOLE)	Long range, two-way voice communication	Navigator, Pilots and radio operator	Range dependent upon mode selected, operating frequency and atmospheric conditions. 4000 NAM average	One on overhead panel, one on navigator's forward control console, and LIA No. 1 on radio operator's 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; and pilot's HSI pointer No. 1 and navigator's RMI pointer No. 2
GLIDE SLOPE RECEIVERS (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

Figure 4-12 (Sheet 1 of 3)

communication & associated electronic equip. (cont)

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
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-32	Receives marker beacon signals	Automatic		Beacon light located on both pilots' instrument panels	
RADAR NAVIGATION SET AN/APN-99	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 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 at Navigator's station and Copilot's station. Requires data from N-1 Compass
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
IFF AN/APX-64	Airplane Identification	Navigator	Line-of-sight	Navigator's Radar Control Console	

Figure 4-12 (Sheet 2 of 3)

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
RADIO ALTIMETER (HIGH RANGE) AN/APN-133	Indicates distance from airplane to surface	Navigator	0-50,000 feet	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 copilot'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	
COMMUNICATIONS CENTER ELECTRONICS		See T.O. 1C-135(E)C-1-2			
ALCC SYSTEM AN/ASW-28		See T.O. 21M-LGM30F-1-7			
VLF RADIO AN/ARC-96	Long Range very low frequency teletype and emergency hand key communications	See T.O. 1C-135(E)C-1-2			Emergency cable cutting capability at pilot and copilot station

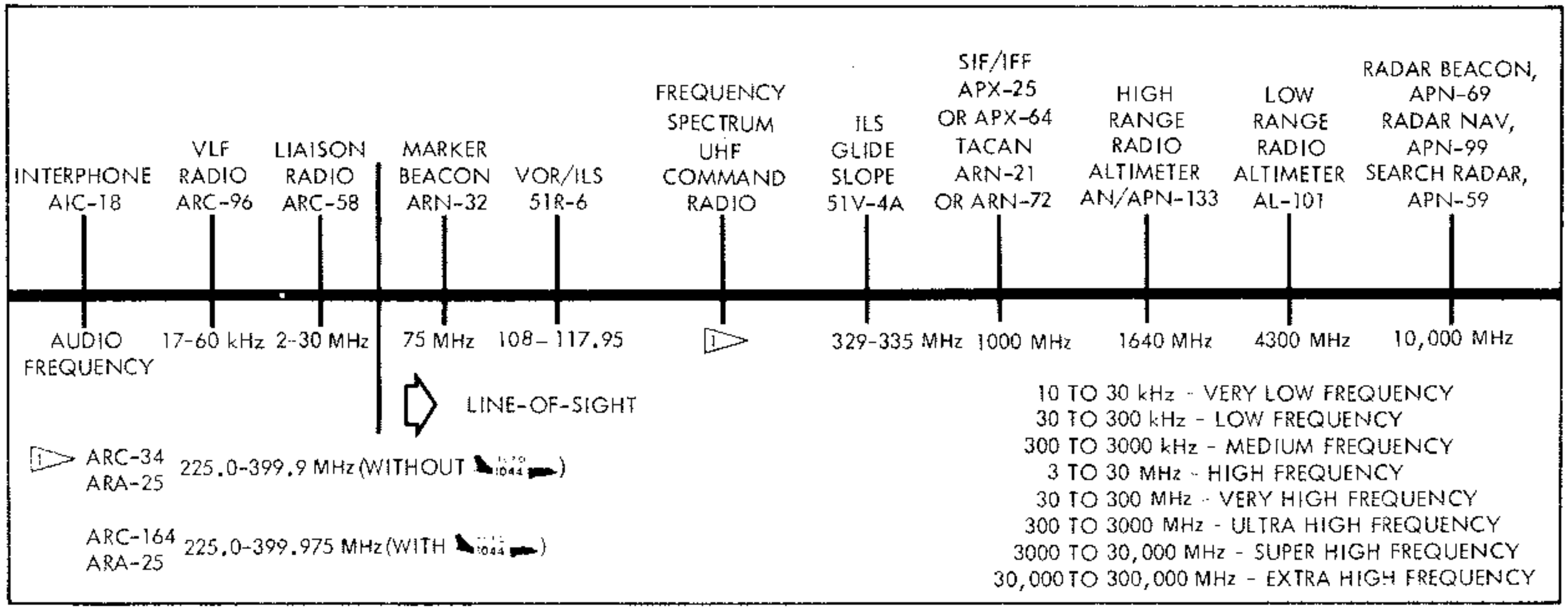
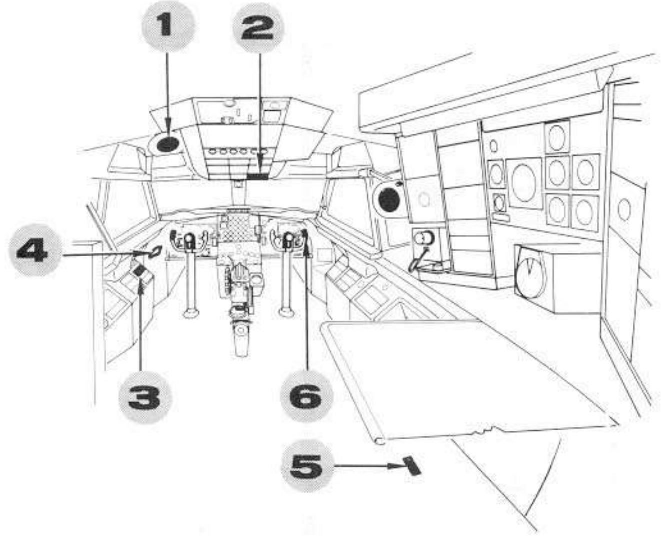


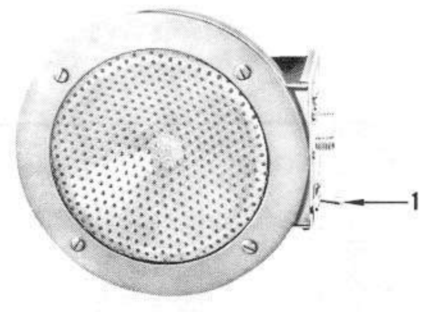
Figure 4-12 (Sheet 3 of 3)

interphone controls



1 LOUDSPEAKER SWITCH
2 COCKPIT LOUDSPEAKER CONTROL SWITCH
3 SWBD SEIZE LIGHT
4 SWBD SEIZE AND RELEASE SWITCH
5 SWBD CALL LIGHT
6 INTERPHONE SWITCH (2 PLACES)
7 FOOT MICROPHONE SWITCH
8 INTERPHONE-MIKE SWITCH
9 MICROPHONE SWITCH

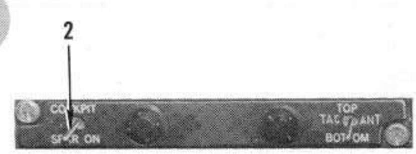
1



LOUDSPEAKER

F-164

2



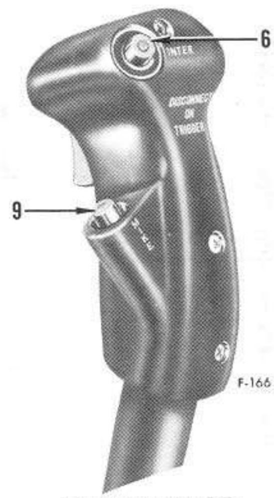
LOUDSPEAKER AND TACAN ANTENNA CONTROL PANEL

W1135

3

SWBD SEIZE AND CALL PANEL

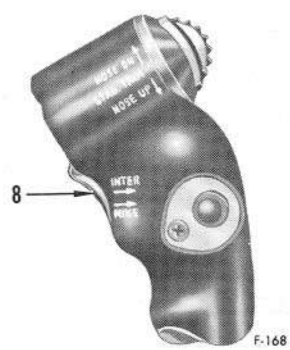
F-1482



RUDDEVATOR CONTROL STICK

LOCATED AT BOOM OPERATOR'S STATION ONLY

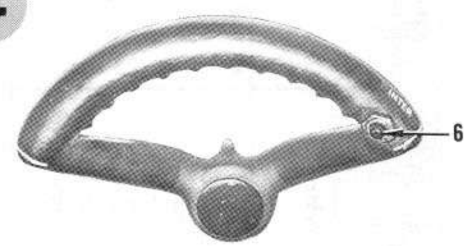
6



CONTROL WHEEL

LOCATED AT PILOTS' STATIONS

4



NOSE STEERING WHEEL

LOCATED AT PILOT'S STATION

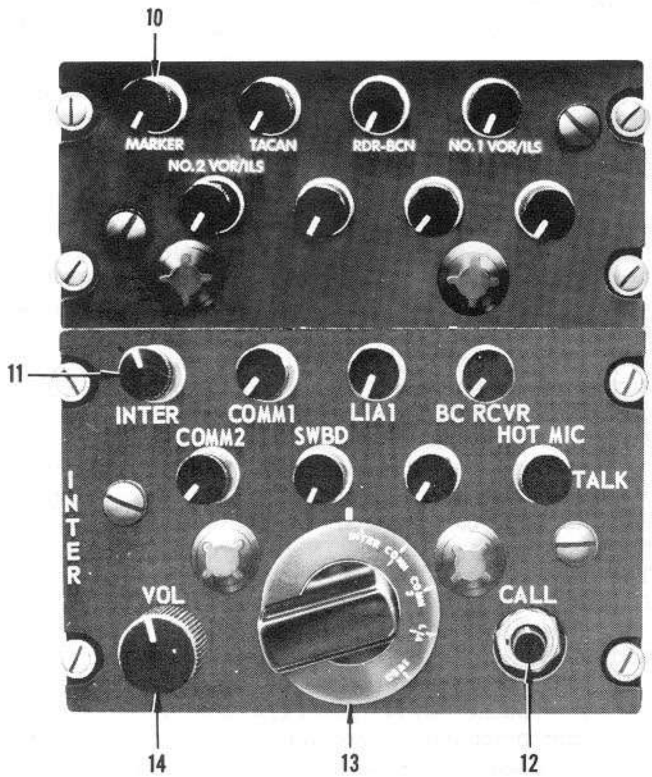
F-167

5

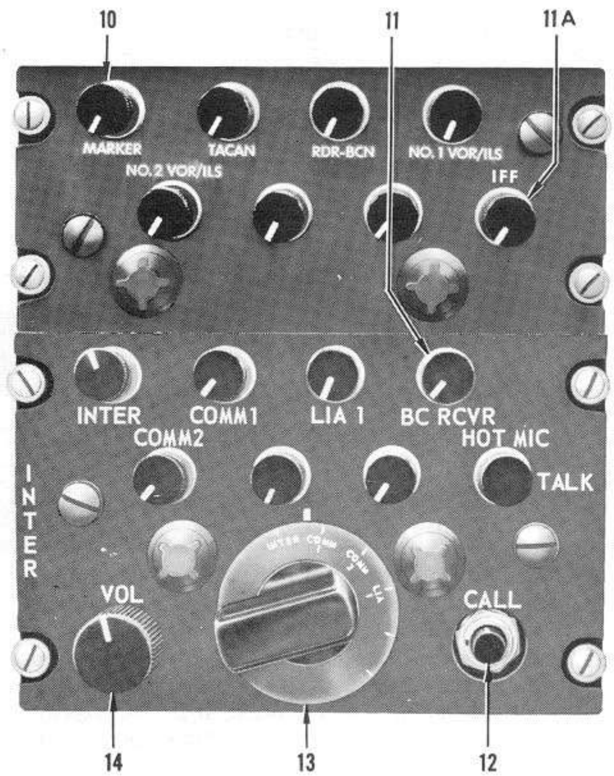
RADIO OPERATORS', CRYPTO OPERATOR'S AND NAVIGATOR'S STATION ONLY

F 169

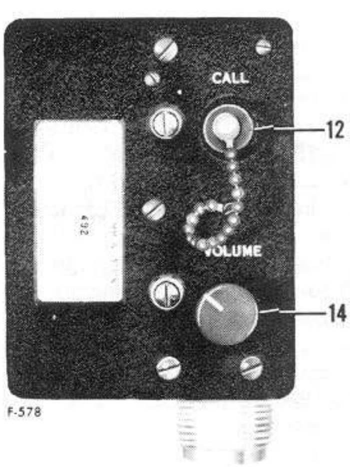
Figure 4-13 (Sheet 1 of 2)



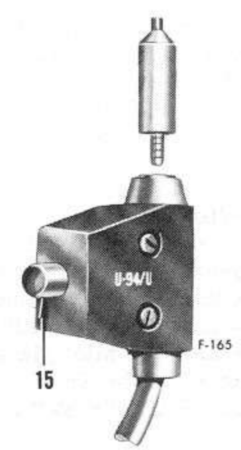
INTERPHONE CONTROL PANEL
(-2106 and C-2323A)
LOCATED AT PILOT'S STATION



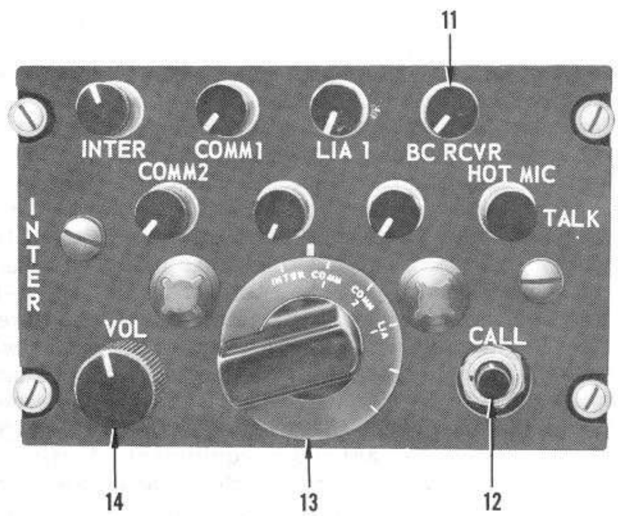
INTERPHONE CONTROL PANEL
(C-2106 and C-2323A)
LOCATED AT COPILOT'S, NAVIGATOR'S, AND CREW INSTRUCTOR'S STATION



INTERPHONE CONTROL PANEL (C-2105)
LOCATED AT AFT EXIT HATCH (AFT SCANNING)



U-94 PLUG CONNECTOR
LOCATED AT ALL CREW POSITIONS



INTERPHONE CONTROL PANEL
(C-2106)
LOCATED AT BOOM OPERATOR'S, BOOM INSTRUCTOR'S, AND AUXILIARY INTERPHONE STATIONS

10 INTERPHONE MIXER SWITCH (NAVIGATION) (2 PLACES)
11 INTERPHONE MIXER SWITCH (COMMUNICATION) (3 PLACES)
11A IFF MIXER SWITCH (NAVIGATOR ONLY)
12 CALL BUTTON (4 PLACES)
13 INTERPHONE SELECTOR SWITCH (3 PLACES)
14 VOLUME CONTROL KNOB (4 PLACES)
15 MICROPHONE SWITCH

Figure 4-13 (Sheet 2 of 2)

equipment includes the IFF and radar beacon for use during normal flight conditions. The emergency identification equipment includes one feature of the 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.) Each electronic unit which requires fuses has spare fuses in the equipment. Figure 4-28 shows the location of all antennas.

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 cut out during transmission, it is not possible to transmit and receive simultaneously on the selected radio.

INTERPHONE (AN/AIC-18)

The interphone is provided for intercommunication between the flight crew, crypto and radio operators, and staff. The interphone system is also integrated with the various communication and navigation facilities. Intercommunication between the flight crew and the operator is through the interphone tie switch at the radio operators' console. (See T.O. 1C-135(E)C-1-2 for staff and operator interphone.) The interphone consists of two groups of basic components: user equipment (headsets) and station equipment (control panels, loudspeakers, and amplifiers). The particular control panel or panels at each station (figure 4-13) determine the facilities available for talking and listening. Regular crew stations have control panels with switching arrangements that permit speech communication between crew members, transmission and reception on the liaison, 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 crew members. The location of all interphone equipment is shown in figure 4-14. The pilot, copilot, boom operator and navigator stations each have an interphone control panel with a selector knob, volume control, call button and eight push-pull mixer switches. These stations (except boom operator) also have a separate mixer panel with eight additional push-pull mixer switches for the navigation radios. The interphone operates on battery voltage. In the event of low battery voltage communication can be maintained on the interphone line by use of the call button for voltages as low as 12 volts. Circuit protection is through two circuit breakers labeled INPH on the battery circuit breaker panel (figure 1-33, sheet 3). One of the circuit breakers protects the following interphone stations: pilot, crew instructor, and boom instructor. The remaining crew stations receive power through the other circuit breaker. The interphone operates whenever the circuit breakers are set and power is on the battery bus.

Interphone Selector Switch

A rotary selector switch (13, figure 4-3) on the interphone control panel is for selecting one facility for both talking and listening. The pilot's station has INTER--COMM 1--COMM 2--LIA 1--SWBD positions on the selector switch. The copilot's, navigator's, crew instructor's, boom operator's, boom instructor's, and auxiliary interphone control panels have INTER--COMM 1--COMM 2--LIA 1 positions on the selector switch. Placing the switch on INTER permits listening on the interphone and talking when either the INTER or MIKE 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. The LIA 1 position allows the user to transmit and receive on the long range liaison radio No. 1. The SWBD position of the selector switch on the pilot's interphone control panel enables the pilot to receive and place calls through the communication center switchboard. The SWBD position of pilot's interphone selector switch is used in conjunction with the pilot's switchboard seize and call control panel.

Switchboard Seize and Call Panel

The switchboard seize and call panel (figure 4-13) is located on the pilot's side panel. The panel has a SEIZE light (3, figure 4-13) and a SEIZE and RELEASE switch (4, figure 4-13). The SWBD CALL light (19, figure 1-16) on the pilot's instrument panel illuminates when there is a communications center incoming call for the pilot. To receive the call, the pilot places the interphone selector switch to the SWBD position, and places the SEIZE and RELEASE switch to the SEIZE position. The SEIZE light will then illuminate indicating that the pilot's interphone control panel is connected to receive the incoming call. To place a call through the communications center, the pilot places the interphone selector switch to the SWBD position, and places the SEIZE and RELEASE switch to the SEIZE position. The SEIZE and CALL light will illuminate indicating that the pilot's interphone control panel is connected to the switchboard. The switchboard attendant (radio operator) will answer the call (in 10 seconds) when the attendant's bell chime rings indicating a switchboard incoming call. When the switchboard attendant answers the pilot's call, the pilot informs the attendant which party he wishes to call. The attendant then places the call for the pilot.

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 will be unable to transmit on a radio or talk on the interphone. With the interphone selector switch at the No. 1 (INTER) position or No. 6 (blank) position the user cannot transmit on HOT MIC.
- The external interphone receptacle in the nose wheel area is connected in parallel with the interphone control panel at the navigator's station, and the receptacle is connected to the interphone circuit regardless of the position of the navigator's interphone selector switch. The nose wheel external interphone volume is controlled at the navigator's interphone control panel.

Interphone Mixer Switches

Eight mixer switches (11, figure 4-13) are on the interphone control panel (communication facilities) and eight mixer switches (10, figure 4-13) are on the mixer panel (navigation facilities). These switches are push-pull for OFF--ON, and rotate for individual volume adjustment. Placing a mixer switch ON (pull) mixes the audio signal from the respective receiver simultaneously with the receiver selected by the interphone selector switch (13, figure 4-13). This allows the crew member to monitor incoming signals from various equipment without changing the selector switch position. The HOT MIC mixer switch permits communication between crew members without requiring use of push-to-talk buttons, and is available on crew control panels. For operation of the hot mic, the HOT MIC switch must be pulled out and the microphone selector knob placed in any position other than No. 1 (INTER) or No. 6 (blank). The base of each mixer switch will illuminate when ON, if the respective panel light switch is on, for easy night identification of switches in the ON position. Refer to figure 4-14) for the interphone configuration at each crew station.

NOTE

The various interphone and radio control panel volume knobs should be adjusted so that the white dot on the respective mixer switch is positioned at approximately 12 o'clock. If the mixer adjustment is positioned near either extreme, excessive crosstalk can be introduced.

Interphone Volume Control

The volume control (14, figure 4-13) 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.

NOTE

The external interphone receptacles (9, figure 4-14) are connected in parallel with interphone control panels inside the airplane. The forward receptacle is connected to the navigator's interphone control panel, the wheel well receptacle and the aft receptacle to the aft scanning station control panel. Volume at a receptacle is controlled by the respective interphone control panel. Markings are installed near the receptacle to indicate the location of the volume control.

Interphone Call Button

The CALL button (12, figure 4-13) on the interphone control panels is an emergency provision that enables a crew member to talk to the rest of the crew, operator's and staff on interphone regardless of switch positions on the control panels at the other stations. The call signal is a high volume signal which provides instant attention but does not interrupt other communications. Pressing the CALL button permits the user to talk to all stations on the airplane on the interphone regardless of the switch positions at other stations without using the press-to-talk switch.

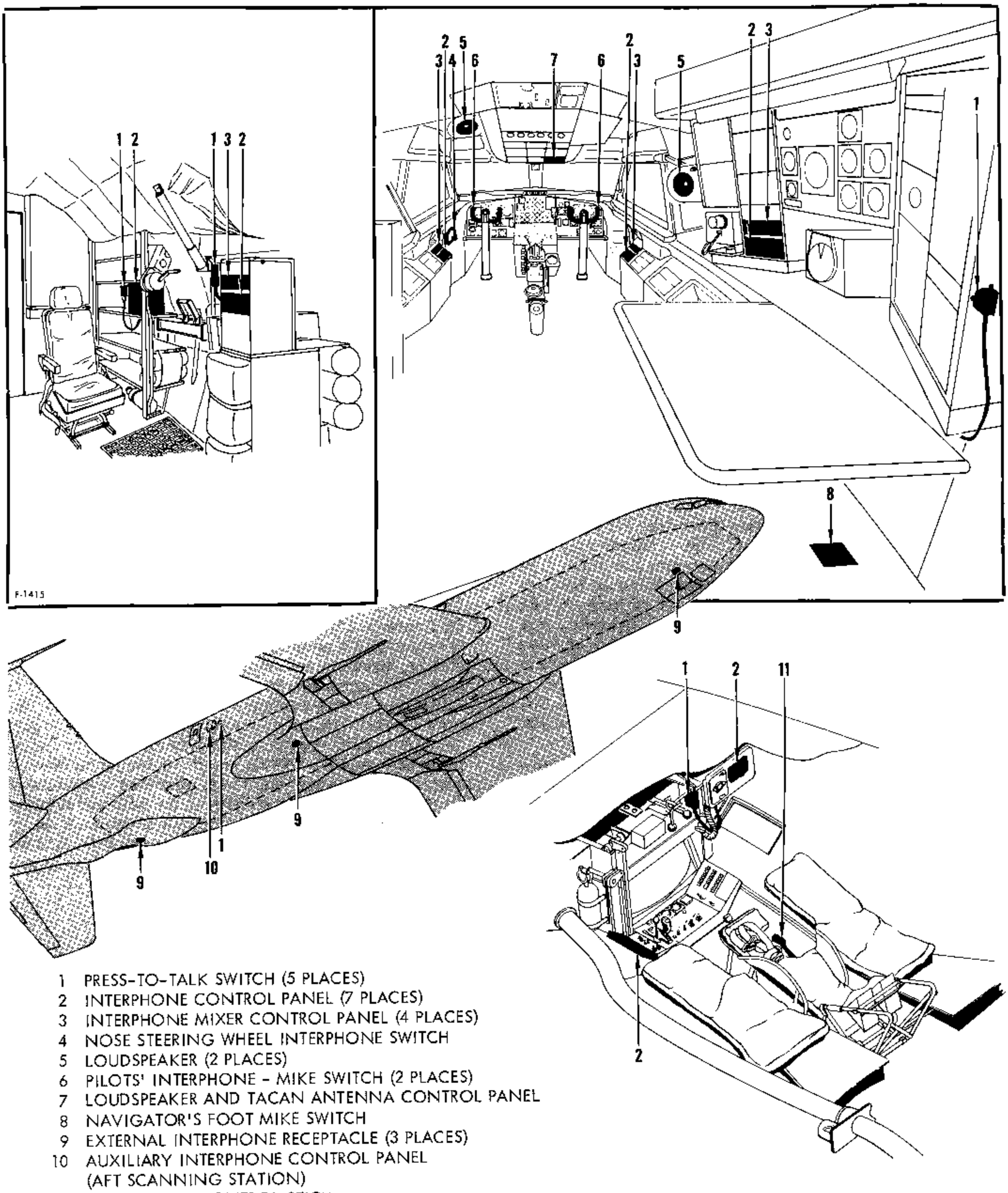
Interphone and Microphone Switches

There is a combined interphone-microphone switch (8, figure 4-13) on the pilots' control wheels, a foot operated MIKE switch (7, figure 4-13) at the navigator's station, and an interphone switch (6, figure 4-13) on the nose steering wheel. These switches, marked INTER or MIKE, are spring loaded press-to-talk switches. The press-to-talk switch on the interphone cord (15, figure 4-13) is a MIKE switch and can be used at any interphone station. The INTER switch, on the pilots' control wheels and nose steering wheel, provides transmission on interphone line regardless of the selected facility. The MIKE switches provide transmission only on the selected facility. The CALL button provides transmission on interphone regardless of selector switch positions.

Navigator's Foot Microphone Switch

A foot-operated microphone switch (7, figure 4-13) is on the floor beneath the navigator's table. The foot mike switch is in parallel with the press-to-talk switch (15, figure 4-13) on the navigator's interphone cord. Pressing either switch permits the navigator to talk on the facility indicated by the interphone selector switch (13, figure 4-13).

interphone equipment location



1 PRESS-TO-TALK SWITCH (5 PLACES)
2 INTERPHONE CONTROL PANEL (7 PLACES)
3 INTERPHONE MIXER CONTROL PANEL (4 PLACES)
4 NOSE STEERING WHEEL INTERPHONE SWITCH
5 LOUDSPEAKER (2 PLACES)
6 PILOTS' INTERPHONE - MIKE SWITCH (2 PLACES)
7 LOUDSPEAKER AND TACAN ANTENNA CONTROL PANEL
8 NAVIGATOR'S FOOT MIKE SWITCH
9 EXTERNAL INTERPHONE RECEPTACLE (3 PLACES)
10 AUXILIARY INTERPHONE CONTROL PANEL (AFT SCANNING STATION)
11 RUDDEVATOR CONTROL STICK

Figure 4-14

Mike Switch

The press-to-talk mike switch (15, figure 4-13) is a component of the interphone cord for all stations. By pressing this switch, the operator can talk on the facility selected at the station.

Loudspeakers (LS-184A/AIC)

There are two interphone loudspeakers in the control cabin (5, figure 4-14). Operation of the speakers is controlled by the loudspeaker switch (2, figure 4-13) on the loudspeaker and TACAN antenna control panel. The volume control knob (14, figure 4-13) on the pilot's interphone control panel regulates the volume of sound from the control cabin speakers.

Loudspeaker Switch

Each interphone loudspeaker has an ON--OFF switch (1, figure 4-13) at the base of the speaker that is not readily visible. When the loudspeaker switch (2, figure 4-13) is ON, the switch on the loudspeaker and TACAN antenna control panel turns the speaker on or off.

Interphone Adjustment

Crosstalk interference in the interphone system can be reduced to acceptable limits by properly adjusting volume controls of the various radio receivers "tied in" with the system. Before the pilot, copilot, or navigator adjusts the volume control of the receiver he should make the following adjustments on his interphone panel:

A. Pull appropriate mixer switch (10, 11, figure 4-13) out and rotate it to the mid-point position.

B. Turn volume control knob (14, figure 4-13) to the mid-point position.

C. Adjust receiver volume to a comfortable level.

Once the receiver volume is set correctly, individual interphone panel volume controls may be moved to any position desired by the listener without inducing crosstalk. This procedure should be followed each time a new receiver is tied into the interphone system.

UHF COMMAND RADIO (AN/ARC-34) (WITHOUT T.O. 1044)

The UHF command radio is a short range set for air to air or air to ground voice communications. The set includes an antenna (10, 19, figure 4-28), a transmitter, two receivers (guard and main), and a control panel (figure 4-15) on the overhead panel. The frequency range is 225.0 to 399.9 megahertz. There are 1750 frequencies available in steps of one-tenth of a megahertz. Twenty frequencies can be present in any order within the operating range of the equipment. Rotating the preset channel selector (6, figure 4-15) 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 4-15) on the control panel. There are two AN/ARC-34 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 (13 and 11, figure 4-13) 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 direction finding facility (ADF). The 28 volt DC power supply for COMM #1 is through a circuit breaker marked NO. 1 UHF COMMAND AND DIRECTION FINDER on the SBCBP (figure 1-33, sheet 4). The 28 volt DC power for COMM #2 comes through a circuit breaker marked UHF COMM NO. 2 on the MCBP T-R BUS NO. 1 (figure 1-33, sheet 1). Use of the UHF command radio in conjunction with the MIC mode of the SIF/IFF operation is covered under SIF (AN/APX-25A) or SIF/IFF TRANSPONDER SET (AN/APX-64) AIMS this section.

NOTE

- When a frequency below 225.0 megahertz 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 TACAN, UHF, and IFF. 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.

Command Radio (AN/ARC-34) Switching Panel

Command radio switching panels are located on the pilot's overhead panel (figure 4-15) and the radio operator's console. These panels have individual switching and indicating lights for control of either or both AN/ARC-34 radios. It is possible for the pilot or radio operator to take control of the COMM 1 or COMM 2 at any time. When the UHF indicating light is on, the other crew position has control of the radio set. The command radio switching panel power source is 28 volt DC from the UHF homing amplifier.

UHF Command Mode Selector Switch

The rotary selector switch (5, figure 4-15) 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 4-15) is for the selection of one of the three methods. In the MANUAL position, the frequency selector knobs (2, figure 4-15) 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 4-15), removes the cover from the channel indicator (8, figure 4-15), positions covers over the manual frequency indicators (1, figure 4-15), 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 4-15), 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 4-15) 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 4-15) indicates the operating frequency set up by the frequency selector knobs (2, figure 4-15) when the MANUAL--PRESET--GUARD switch (3, figure 4-15) is on MANUAL.

Tone Button Switch

Depressing the tone button (4, figure 4-15) when the UHF command radio is operating causes the set to transmit a continuous tone for direction finding purposes on the selected frequency.

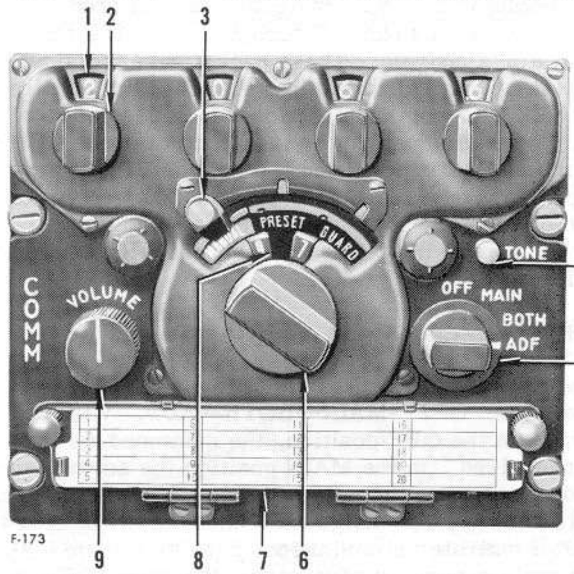
Preset Channel Selector

The preset channel selector (6, figure 4-15) is operative when the MANUAL--PRESET--GUARD switch (3, figure 4-15) 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.

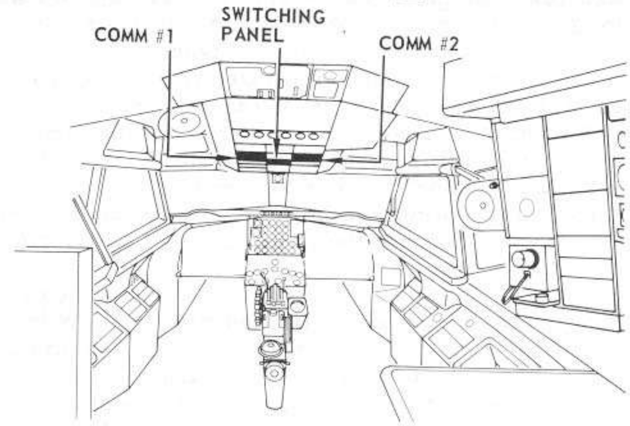
UHF Command Volume Control Knob

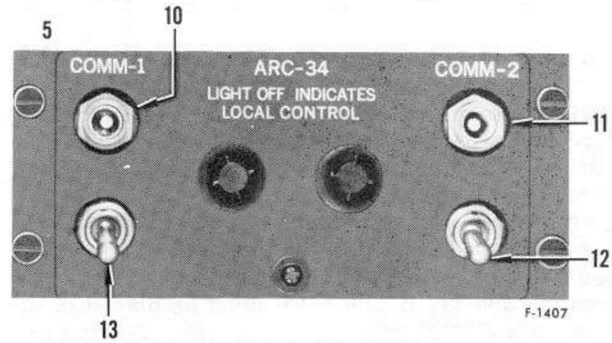
The volume control knob (9, figure 4-15) adjusts the strength of the signal that both receivers (guard and main) feed into the interphone system. The volume should be adjusted in conjunction with the interphone volume control (14, figure 4-13); however, the volume cannot be reduced below a fixed level.

UHF command radio control panels

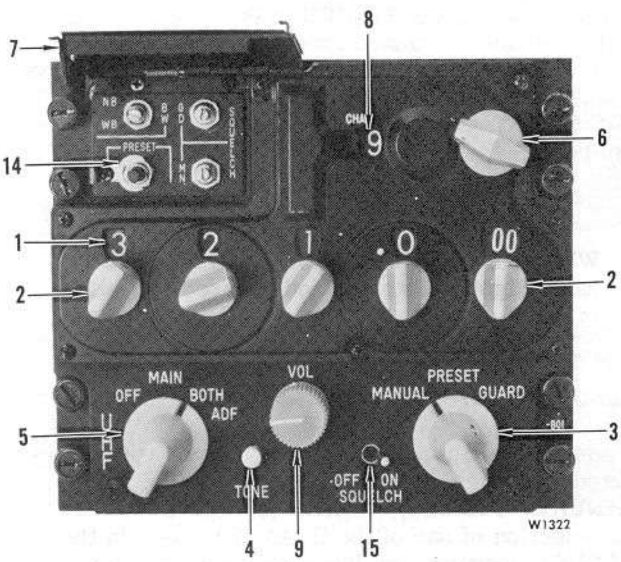


AN/ARC-34 CONTROL PANEL (WITHOUT TCTO 1044)





COMMAND RADIO (ARC-34/ARC-164) SWITCHING PANEL



AN/ARC-164 CONTROL PANEL (WITH TCTO 1044)

1. MANUAL FREQUENCY INDICATOR
2. MANUAL FREQUENCY SELECTOR KNOB
3. MANUAL-PRESET-GUARD SWITCH
4. TONE BUTTON SWITCH
5. MODE SELECTOR SWITCH
6. PRESET CHANNEL SELECTOR
7. PRESETTING COVER AND FREQUENCY CHART
8. CHANNEL INDICATOR
9. VOLUME CONTROL KNOB
10. UHF COMMAND NO. 1 CONTROL LIGHT
11. UHF COMMAND NO. 2 CONTROL LIGHT
12. UHF COMMAND NO. 2 CONTROL SWITCH
13. UHF COMMAND NO. 1 CONTROL SWITCH
14. PRESET BUTTON
15. SQUELCH SWITCH

Figure 4-15

Channel Indicator

The channel indicator (8, figure 4-15) indicates the preset channel is in use. The indicator is visible only when the MANUAL--PRESET--GUARD switch (3, figure 4-15) is in PRESET.

Presetting Drum Cover and Frequency Chart

This cover (7, figure 4-15) 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 4-15). Rotate the preset channel selector (6, figure 4-15) 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.

(UHF COMMAND RADIO (AN/ARC-164)(WITH 1010 1044)

The UHF command radio is a short range set for air to air or air to ground voice communications. The set includes an antenna (10, 19, figure 4-28), a transmitter, two receivers (guard and main), and a control panel (figure 4-15) on the overhead panel. The frequency range is 225.0 to 399.975 megahertz. There are 7000 frequencies available in steps of .025 of a megahertz. Twenty frequencies can be preset in any order within the operating range of the equipment. Rotating the preset channel selector (6, figure 4-15) to a channel number gives the desired frequency. Selection of any one of the 7000 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 4-15) on the control panel. There are two AN/ARC-164 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 (13 and 11, figure 4-13) 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 NO. 1 UHF COMMAND AND DIRECTION FINDER on the SBCBP (figure 1-33, sheet 4). The 28 volt DC power for COMM #2 comes through a circuit breaker marked UHF COMM NO. 2 on the MCBP T-R BUS NO. 1 (figure 1-33, sheet 1). Use of the UHF command radio in conjunction with the MIC mode of the SIF/IFF operation is covered under SIF (AN/APX-25A) or SIF/IFF TRANSPONDER SET (AN/APX-64) AIMS this section.

NOTE

- 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.
- 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 IFF. 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.

Command Radio Switching Panel

Command radio switching panels are located on the pilot's overhead panel (figure 4-15) and the radio operator's console. These panels have individual switching and indicating lights for control of either or both UHF command radios. It is possible for the pilot or radio operator to take control of the COMM 1 or COMM 2 at any time. When the UHF indicating light is on, the other crew position has control of the radio set. The command radio switching panel power source is 28 volt DC from the UHF homing amplifier.

UHF Command Mode Selector Switch

The rotary selector switch (5, figure 4-15) has four positions: OFF--MAIN--BOTH--ADF. With the switch in the OFF position, the command radio is deenergized. 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 labeled MANUAL--PRESET--GUARD (3, figure 4-15) is for the selection of one of the three methods. In the MANUAL position, the frequency selector knobs (2, figure 4-15) are used to quickly select an operating frequency without disturbing the preset frequencies. The manually selected frequency appears in the windows across the panel. Rotating the selector to PRESET shifts control of the frequency control to the preset channel selector (6, figure 4-15) and preset button (14, figure 4-15). In the GUARD position, the transmitter and main receiver operate on a fixed frequency and the guard receiver is inoperative. The fixed frequency cannot be changed in flight.

Manual Frequency Selector Knobs

Five knobs (2, figure 4-15) across the control panel are for selection of any frequency within the operating range of the equipment. The knobs are used to manually select frequencies when the Manual-Preset-Guard switch is in MANUAL, and to preset selected frequencies into memory when used in conjunction with the preset button (14, figure 4-15) with the Manual-Preset-Guard switch in PRESET.

Tone Button

Depressing the tone button (4, figure 4-15) when the UHF command radio is operating causes the set to transmit a continuous tone on the selected frequency for direction finding purposes.

Preset Channel Selector

The preset channel selector (6, figure 4-15) is operative when the MANUAL--PRESET--GUARD switch (3, figure 4-15) is in the PRESET position. To select one of the twenty preset frequencies, refer to the frequency chart at the upper left corner of the panel for the corresponding channel number, then rotate the selector knob until the channel number appears in the channel indicator (8, figure 4-15) adjacent to the selector.

Volume Control Knob

The volume control knob (9, figure 4-15) 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 (3, figure 4-12); however, the volume cannot be reduced below a fixed level.

Squelch Switch

The squelch switch (15, figure 4-15) controls squelch circuits in both main and guard receivers. In the ON position, the squelch circuits operate normally. In the OFF position, the squelch disable is actuated in the main receiver allowing receiver noise to be heard in absence of signal.

Frequency Chart

The cover (7, figure 4-15) conceals the preset button (14, figure 4-15) of the UHF command radio. The frequency chart on the cover is the record of the frequency of each preset channel.

Changing Preset Frequencies

A preset frequency can be changed by setting the mode selector (5, figure 4-15) to MAIN and the Manual-Preset-Guard selector (3, figure 4-15) to PRESET. Turn the preset channel knob (6, figure 4-15) to the desired channel number. Set the desired frequency on the manual frequency windows with the frequency select knobs (2, figure 4-15). Lift the frequency chart cover and press the preset button (14, figure 4-15). Record new preset frequency on the frequency chart adjacent to appropriate channel number.

LIAISON RADIO NO.1 (AN/ARC-58) (No.2,3 And 4; Radio Operators Only)

The AN/ARC-58 liaison radio can transmit and receive 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; however, frequencies below 4 megahertz are not usable on liaison radio No. 1 because it uses the probe antenna at the top of the vertical stabilizer. The radio can be operated from any one of 3 control panels but not from all 3 simultaneously. One control panel is on the overhead panel, one is on the navigator's forward control console and one is at the radio operator's 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 tranmissions 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. To transmit and receive on the liaison radio the mixer switch and interphone selector switch (11 and 13, figure 4-13) must be placed in the appropriate LIA 1 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 1-33, sheet 1) and 115/200 volt AC from ENG 2 GENERATOR of the MCBP (figure 1-33, sheet 2). Circuit breakers are marked LIAISON RADIO NO. 1.

CAUTION

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 anti-skid 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.

- 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 aircraft external skin surfaces or the boom. The HF antennas radiate a high voltage which may build up on these surfaces and shock anyone touching them.

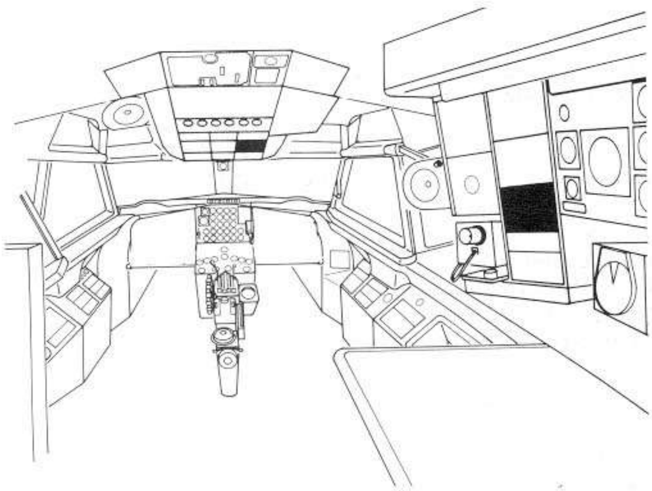
NOTE

- 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 KC knob (8, figure 4-16) momentarily to another frequency and return it to the desired frequency to get tuning.

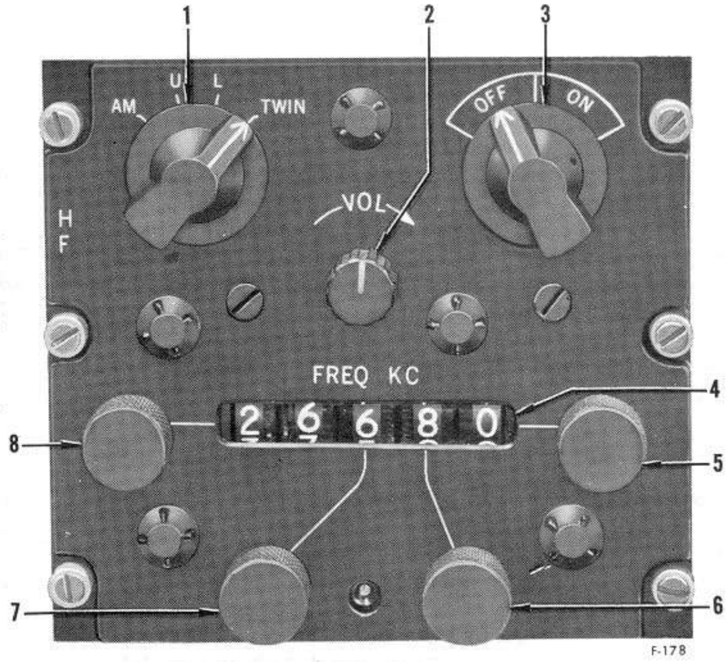
- The frequency for the liaison radio (AN/ARC-58) may not be stable immediately after the radio is turned on. To insure that the frequency is stable for operation of the radio, the following warm-up periods should be observed:

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

liaison radio control panel



1 MODE SELECTOR SWITCH
2 LIAISON RADIO VOLUME CONTROL
3 LIAISON RADIO CONTROL SWITCH
4 FREQUENCY INDICATOR
5 ONE KC KNOB
6 TEN KC KNOB
7 HUNDRED KC KNOB
8 THOUSAND KC (OR MEGACYCLE) KNOB
(5–8: FREQUENCY SELECTOR KNOBS)



PILOT'S NAVIGATOR'S AND RADIO OPERATOR'S LIAISON RADIO CONTROL PANEL

Figure 4-16

- 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 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 3.699MC, 3.7 to 7.699MC, 7.7 to 15.699MC, and 15.7 to 29.999MC) 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.
- The wire antenna for liaison radio No. 4 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.

Mode Selector Switch

The position of the mode selector switch (1, figure 4-16) 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 (5, 6, 7 and 8, figure 4-16). 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 (4, figure 4-16). 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 (2, figure 4-16) 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 (14, figure 4-13).

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 control switch (3, figure 4-16) on the pilot's and navigator's liaison 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 switches. Placing one control switch to the ON position causes the others 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 all 3 (pilot, navigator, and radio operator) switches OFF, the equipment is de-energized.

LOW FREQUENCY ANTENNA SYSTEM (AN/ARC-96)

These airplanes are equipped with the AN/ARC-96 low frequency transmitter-receiver and trailing wire antenna system. The set is a survivable low frequency communication system operating in the very low frequency range of 17 to 60 KHz. Controls for the system are installed at crypto operator's station. The trailing wire antenna is mounted externally in the right air conditioning bay, see figure 4-28. A drogue stabilizes the antenna during deployment. The antenna is extended and retracted by a reversible hydraulic motor up to the normal maximum antenna length of 27,000 feet and override capability up to 27,800 feet. Antenna length will be determined by the transmitting frequency. Performance limitations also exist due to the installation of the AN/ARC-96 communications system, see T.O. 1C-135(E)C-1-1. Emergency antenna cable cutting may be accomplished by hydraulic cutters from the pilot or copilot stations and hydraulic and manual cable cutting can be accomplished from the crypto operator's station. See T.O. 1C-135(E)C-1-2 for a complete description and operation of the AN/ARC-96 system.

Antenna Wire Cutter Panel

The antenna wire cutter panel contains the necessary controls for the pilot or copilot to cut the antenna if jettisoning the antenna becomes necessary.

WARNING

Do not jettison the trailing wire antenna outside of authorized areas unless withholding of such action would seriously jeopardize the aircraft and crew.

NOTE

Calculated data indicates a jettisoned antenna will follow a trajectory parallel to the line of flight, with wind direction and velocity affecting its trajectory path. The point of impact is determined by altitude and true airspeed at time of jettisoning, and at 30,000 ft may impact at a maximum distance of 55 miles from the point of jettisoning.

The antenna wire cutter arming switch, 22 figure 1-11, on the pilot's side panel, and 10C figure 1-12 on the copilot's side panel is a guarded switch with ON--OFF positions. The guarded OFF position is the normal position for the switch. Lifting the guard and moving the switch to the ON position applies electrical power to the cut switch and automatically applies brakes to stop the antenna from extending or retracting. The antenna wire cutter armed indicator, 21, figure 1-11 and 10B figure 1-12, will illuminate when the hydraulically powered wire cutters are armed. The antenna wire cut switch, 19 figure 1-11 and 10A figure 1-12, is a guarded switch with OFF--CUT positions and is normally safety wired in the OFF position. After breaking the safety wire, the guard may be lifted and the switch moved to the CUT position. With power available through the ON position of the arming switch the CUT position will actuate the hydraulic wire cutter to jettison the antenna cable. Control power for wire cutter is 28 volt DC through a circuit breaker marked LF ANTENNA CABLE CUTTER on the battery circuit breaker panel, sheet 3, figure 1-33.

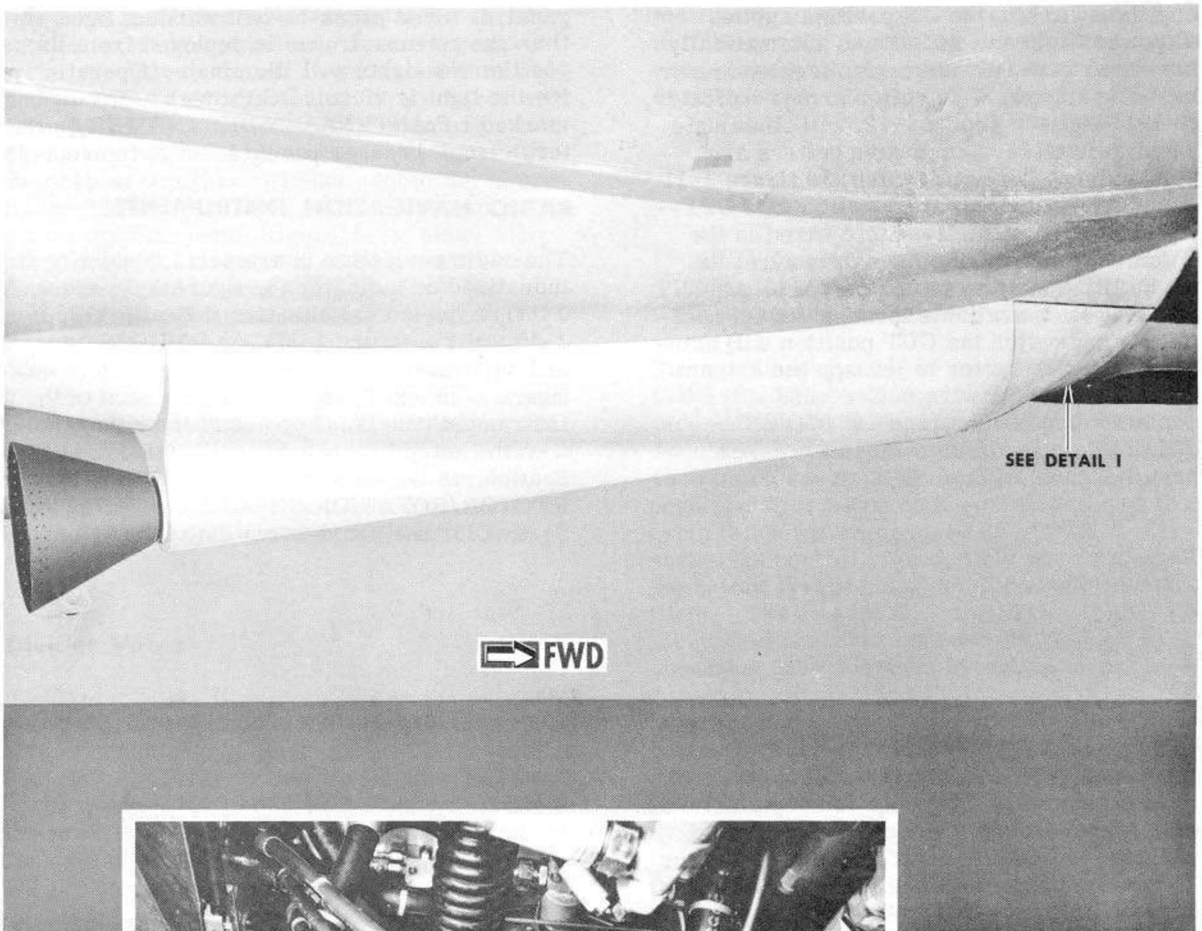
Drogue Deployed Light

The trailing wire antenna drogue deployed light, 23, figure 1-16 on the pilot's flight instrument panel and 12, figure 1-17 on the copilot's flight instrument panel, is a red press-to-test warning light. Any time the antenna drogue is deployed from its nested position the lights will illuminate. Operating power for the light is 28 volt DC through a circuit breaker marked LF ANTENNA CABLE CUTTER on the battery circuit breaker panel, sheet 3, figure 1-33.

RADIO NAVIGATION INSTRUMENTS

The radio navigation instruments consist of an attitude director indicator (8, figure 1-16 and 4, figure 1-17), a horizontal situation indicator (12, figure 1-16 and 27, figure 1-17), an RMI (21, figure 1-16 and 14, figure 1-17), and a TACAN select switch (7, figure 1-16 and 1, figure 1-17) 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.

TWA fairleads



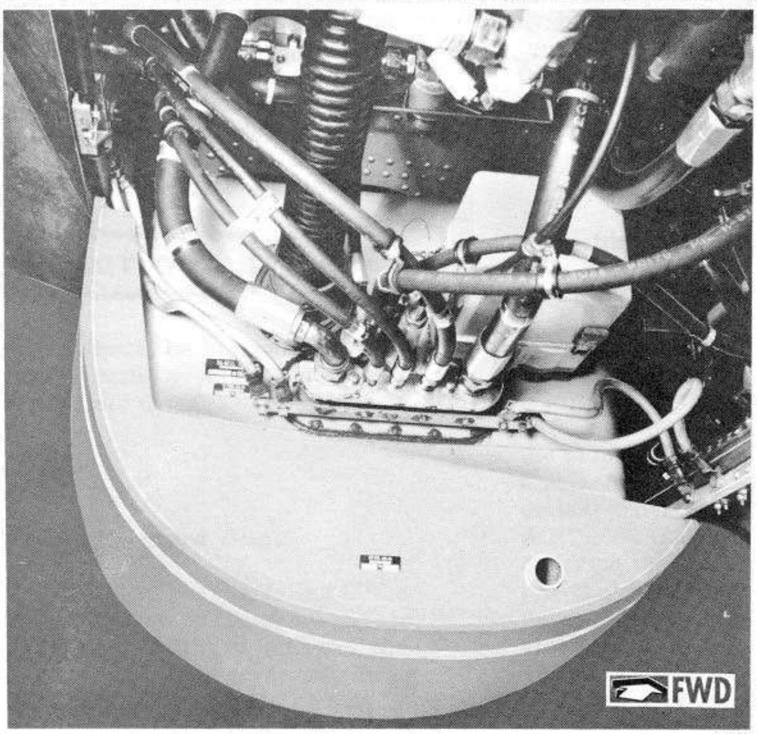


Figure 4-16A

Radio Magnetic Indicator (RMI) (ID-250A)

The RMI (figure 4-17) displays airplane heading and magnetic bearings to selected radio facilities. Each RMI has a rotating compass card (17, figure 4-17), a top index (14, figure 4-17), and two numbered bearing pointers (15, 16, figure 4-17). 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 4-17A. The navigator's RMI No. 2 pointer gives bearing information from VOR 2.

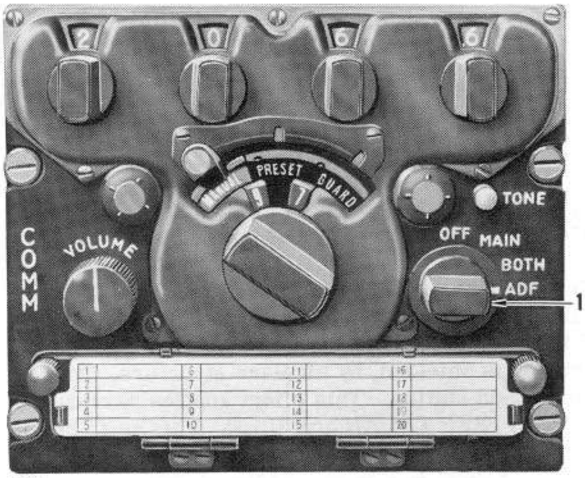
UHF DIRECTION FINDER (UHF-ADF) (AN/ARA-25)

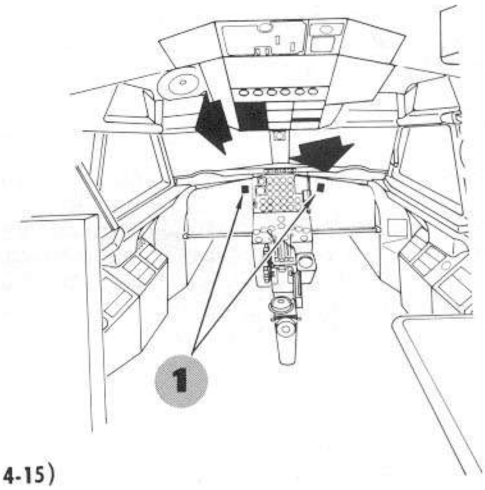
The UHF direction finder automatically determines the relative bearing of radio signals in the frequency range of 225.0 to 399.9 megahertz (without TC10 1044), or 225.0 to 399.975 megahertz (with TC10 1044). The signals are received by the COMM #1 UHF command radio, using the direction finder antenna. Operation of the direction finder is controlled from the UHF command radio control panel when the UHF command mode selector switch (5, figure 4-15) is on ADF (1, figure 4-17). Pointer No. 2 on each of the pilots' RMI's (figures 1-16, 1-17, and 4-17) 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 UHF HOMING on the T-R BUS NO. 2 section of the MCBP (figure 1-33, sheet 1). Operating power is from the command radio. An automatic antenna heater is installed to reduce moisture accumulation in the antenna housing. Operating power is 115 volt AC through a circuit breaker marked UHF ADF ANTENNA HEATER on the ENG 4 GENERATOR section of the MCBP (figure 1-33, sheet 2).

NOTE

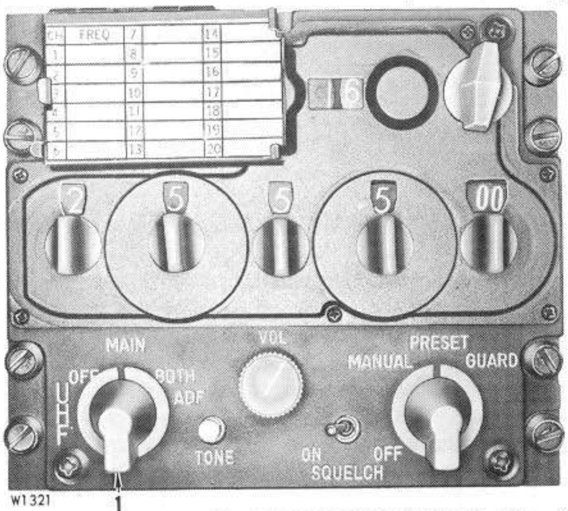
- Operation of the command radio transmitter (COMM #1) interrupts ADF operation.
- Certain line of sight communication and navigation systems may be impaired or inoperative if the attitude of the airplane is such that the antenna is shielded, by airplane structure, from the ground station. This effect applies particularly to IFF, 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.

navigation radios - controls and indicators

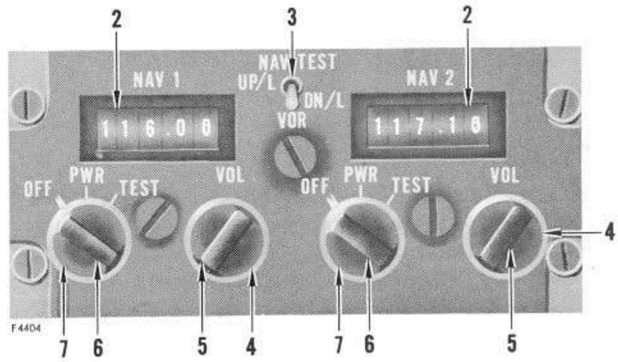




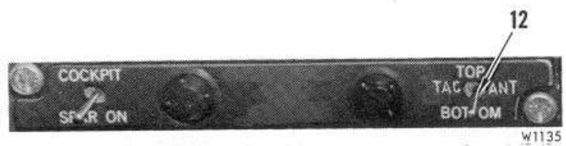
UHF COMMAND RADIO CONTROL PANEL (WITHOUT TCTO 1044) (SEE FIGURE 4-15)



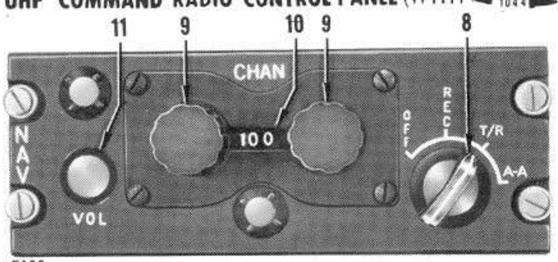
UHF COMMAND RADIO CONTROL PANEL (WITH TCTO 1044) (SEE FIGURE 4-15)



VOR/ILS (VHF-NAV) PANEL (51R-6)



LOUDSPEAKER AND TACAN ANTENNA CONTROL PANEL

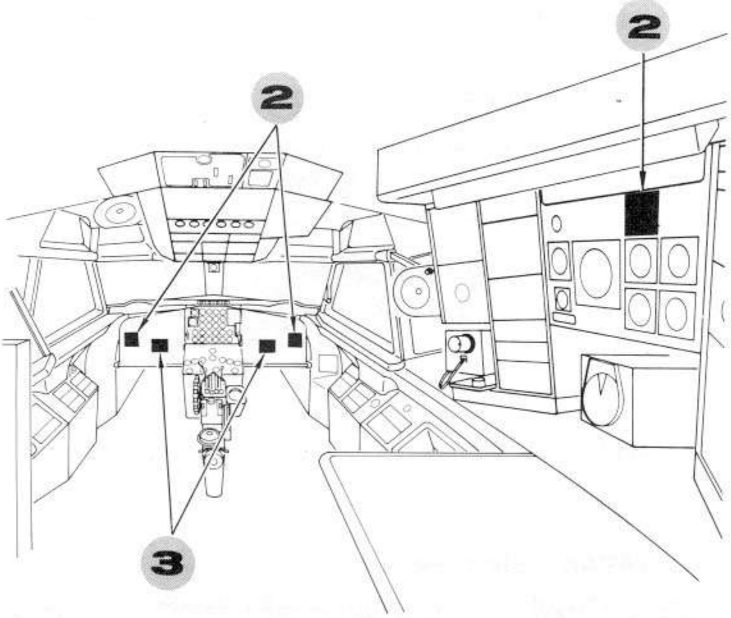


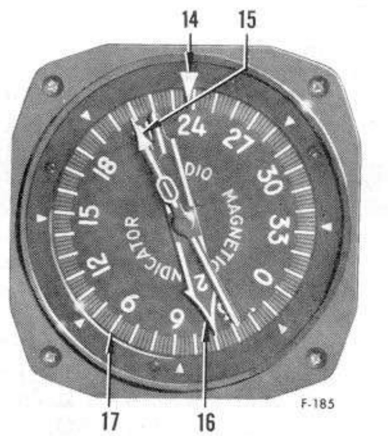
TACAN (UHF-NAV) RADIO CONTROL PANEL

1 TACAN SELECT SWITCH

1 UHF COMMAND MODE SELECTOR SWITCH
2 FREQUENCY WINDOW (2 PLACES)
3 NAV TEST SWITCH (INOPERATIVE)
4 VOLUME CONTROL (2 PLACES)
5 KILOCYCLE CONTROL (2 PLACES)
6 MEGACYCLE CONTROL (2 PLACES)
7 POWER SWITCH (2 PLACES)
8 FUNCTION SELECTOR SWITCH (2 PLACES)
9 CHANNEL SELECTOR KNOB (4 PLACES)
10 CHANNEL WINDOW (2 PLACES)
11 VOLUME CONTROL (2 PLACES)
12 TACAN ANTENNA SWITCH
13 TACAN SELECT SWITCH

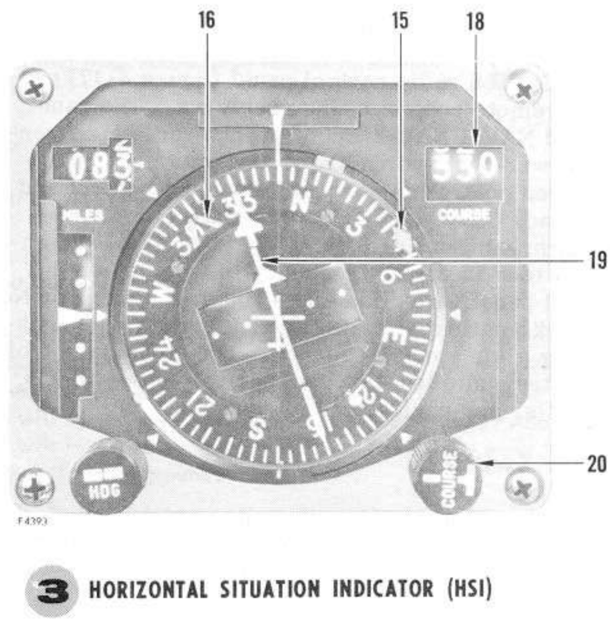
Figure 4-17 (Sheet 1 of 2)





2 RADIO MAGNETIC INDICATOR ID-250/ARN

14 TOP INDEX
15 NO. 1 BEARING POINTER (2 PLACES)
16 NO. 2 BEARING POINTER (2 PLACES)
17 COMPASS CARD (N-1/J-4 REPEATER)
18 COURSE COUNTER
19 COURSE DEVIATION INDICATOR
20 COURSE SET KNOB



3 HORIZONTAL SITUATION INDICATOR (HSI)

Figure 4-17 (Sheet 2 of 2)

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 (19, figure 1-18). The antennas (17, figure 4-28) 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 1-16 and 4, figure 1-17), pilot's and copilot's horizontal situation indicators (12, figure 1-16 and 27, figure 1-17), and the navigator's RMI. Power for operation and control of the No. 1 receiver is 28 volt DC through a circuit breaker marked VHF NAV No. 1 on T-R No. 2 section of the MCBP. On airplanes without TCTO 1007 power for the No. 2 receiver is through a circuit breaker marked VHF NAV No. 2 on T-R No. 1 section of the MCBP. For glide slope receiver No. 1, 28 volt DC power is through a circuit breaker marked G/S NO. 1 on T-R No. 2 section of the MCBP. On airplanes without TCTO 1007 power for glide slope receiver No. 2 is through a circuit breaker marked G/S NO. 2 on T-R No. 1 section of the MCBP. On airplanes with TCTO 1007 28 volt DC power to VHF NAV NO. 2 and G/S NO. 2 circuit breakers is through a circuit breaker marked F/D NO. 2 RELAY on T-R section No. 1 of the MCBP providing the F/D NO. 1 MASTER switch (4A, figure 4-29B) is ON, or through a circuit breaker marked F/D NO. 2 on CIPP if F/D NO. 1 MASTER switch is OFF (See figure 1-30, sheet 1).

VOR/ILS Radio Control Panel (51R-6)

The VOR/ILS radio control panel (figure 4-17) 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 (7, figure 4-17), 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 (6, figure 4-17), 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 (4, figure 4-17), varies the audio gain of the associated receiver.

Kilocycle Control

This control, operated by the center bar-shaped knob (5, figure 4-17), 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 (3, figure 4-17) is inoperative.

TACAN Select Switch

A TACAN select switch (13, figure 4-17) is provided for the pilot (7, figure 1-16) and copilot (1, figure 1-17). 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 (15, figure 4-17) and TACAN course deviation information on the respective CDI (19, figure 4-17). 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 (20, figure 4-17) to set his course counter (18, figure 4-17) 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 4-29D) and all RMI's (figure 4-17). Distance information is presented on the range indicators of the HSI's. An air to air mode provides an air to air (A/A) range capability only. 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. The loudspeaker and TACAN antenna control 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. 1 and ENG 1 GENERATOR sections of the MCBP (figure 1-33, sheets 1 and 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.

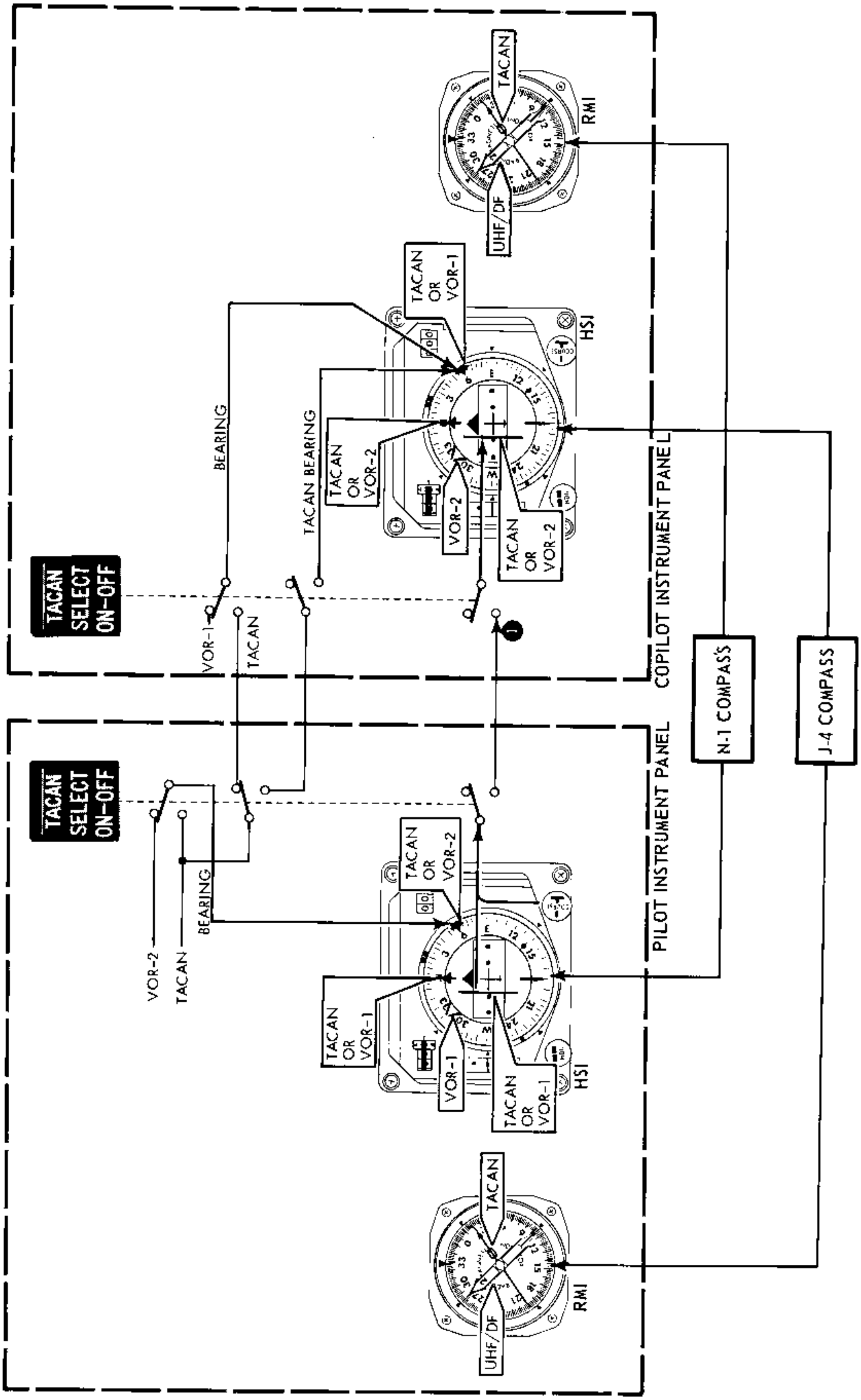
WARNING

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 IFF. 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.

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 4-17A

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 4-17) controls frequency selection and the type of operation. The panel has a function selector switch (8, figure 4-17), two channel selector knobs (9, figure 4-17), a channel window (10, figure 4-17) and a volume control knob (11, figure 4-17).

Function Selector Switch

This switch (8, figure 4-17) 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 five other sets. At the same time, it will receive replies to its own interrogations from all five 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 (9, figure 4-17) controls the tens and hundreds digit and the right knob controls the unit digit which appear in the channel selector window (10, figure 4-17).

Volume Control Knob

This knob (11, figure 4-17) marked VOL adjusts the audio level to the interphone system. The TACAN mixer switch (10, figure 4-13) must be ON to hear the signal on the interphone.

TACAN Range Counter

The TACAN range counter (1, figure 4-29D) is on each HSI and has an OFF bar. The 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 distance data, (2) when the set is awaiting a signal from the station, or (3) when the equipment is deenergized. 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 (12, figure 4-17) 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 is used to select the top or bottom antenna for optimum air to air range determination. Operating power is 28 volts DC through a circuit breaker marked TACAN ANT SEL on the T-R BUS NO. 2 section of the MCBP (figure 1-33, sheet 1).

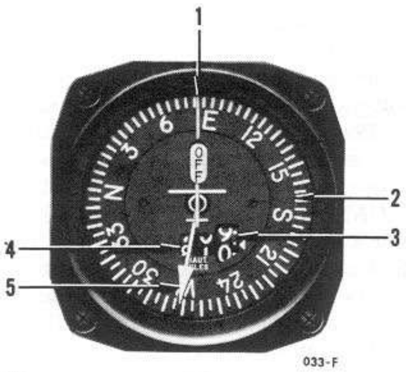
MARKER BEACON RECEIVER (AN/ARN-32)

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 MARKER mixer switch (10, figure 4-13) on. Visual identification is by means of the radio marker beacon light (9, figure 1-16 and 8, figure 1-17) 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 1-33, sheet 1). The circuit breaker is labeled MARKER BEACON.

RADAR NAVIGATION EQUIPMENT (AN/APN-99)

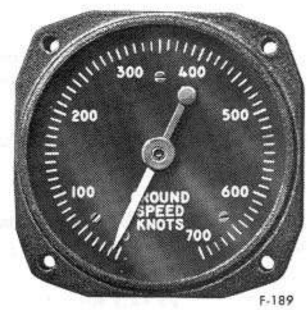
The radar navigation equipment consists of an auto-nav (doppler) radar (APN-81) and a destination computer (ASN-7A). The system gives continuous indication of

radar navigation equipment

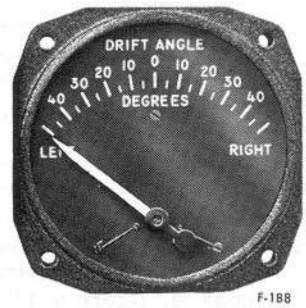


1 DESTINATION INDICATOR
ID-390A/ASN-7

2 GROUND SPEED INDICATOR
ID-341/APN-81



3 DRIFT ANGLE INDICATOR
ID-342/APN-81



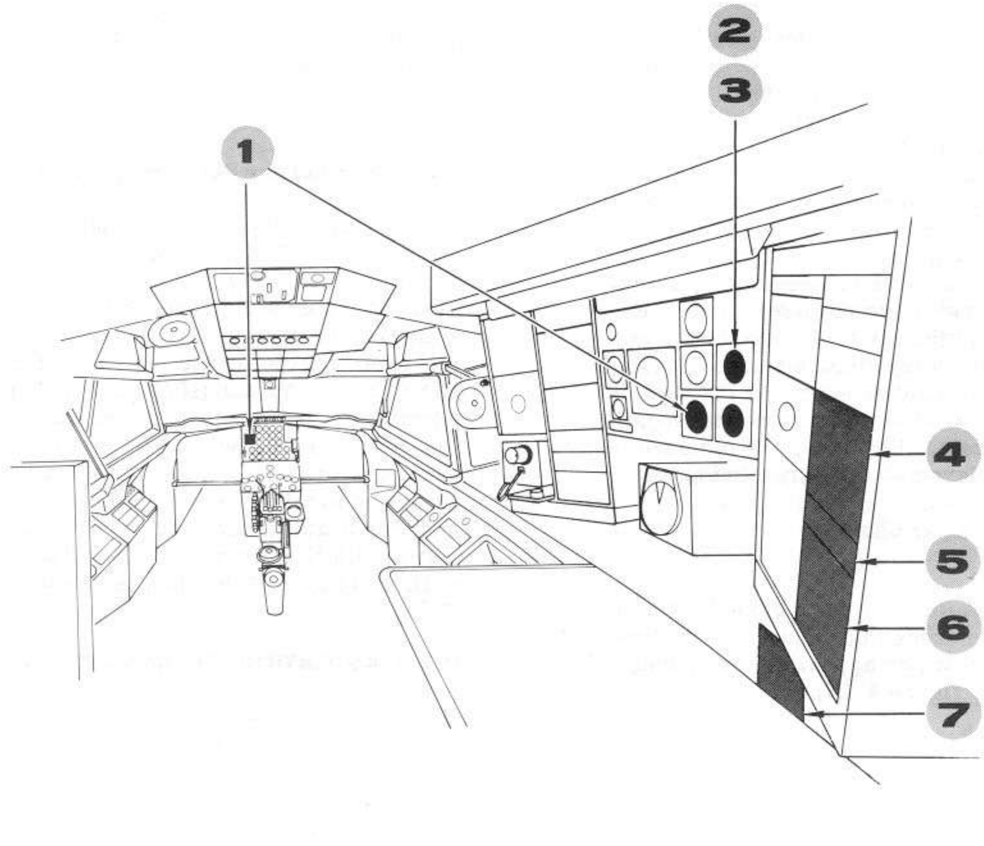
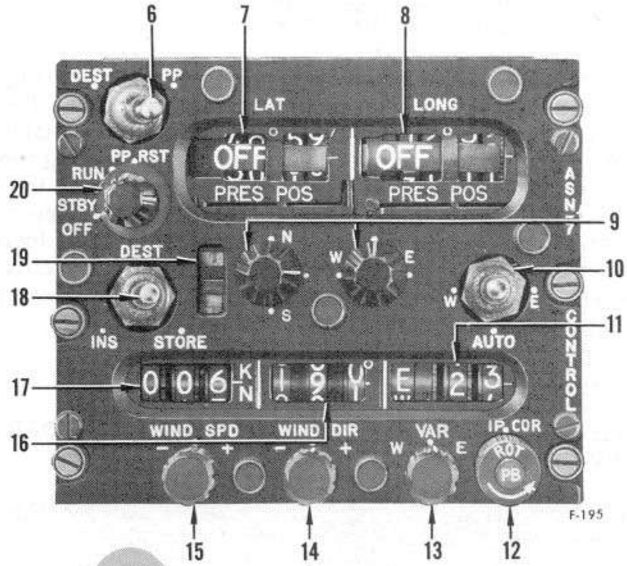


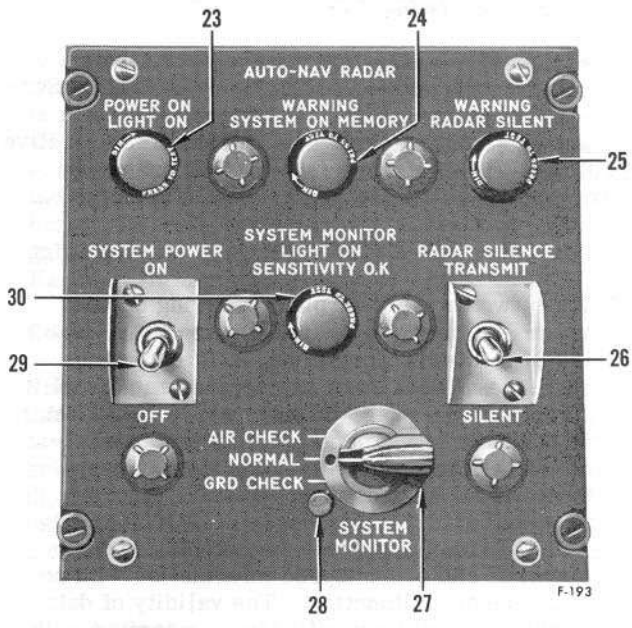
Figure 4-18 (Sheet 1 of 2)

1 TOP INDEX
2 ROTATING CARD
3 DISTANCE COUNTERS
4 OFF FLAG
5 COURSE-TO-DESTINATION POINTER
6 DISPLAY SWITCH
7 LATITUDE WINDOW
8 LONGITUDE WINDOW
9 LATITUDE, LONGITUDE SLEW SWITCHES
10 VARIATION SWITCH
11 VARIATION WINDOW
12 IP CORR BUTTON
13 VARIATION SLEW SWITCH
14 WIND DIRECTION SLEW SWITCH
15 WIND SPEED SLEW SWITCH
16 WIND DIRECTION WINDOW
17 WIND SPEED WINDOW
18 DESTINATION SWITCH
19 DESTINATION STORAGE WINDOWS
20 MODE SELECTOR SWITCH
21 DEPARTURE SWITCH
22 FUNCTION SWITCH
23 POWER-ON LIGHT
24 MEMORY LIGHT
25 RADAR SILENT LIGHT
26 RADAR SILENCE SWITCH
27 SYSTEM MONITOR SWITCH
28 LATCH
29 AUTO-NAV SYSTEM POWER SWITCH
30 SYSTEM MONITOR LIGHT
31 EMERGENCY OVERRIDE SWITCH
32 UNIT OFF OR INOPERATIVE LIGHT (3 PLACES)
33 FUSE FAILURE LIGHT (4 PLACES)

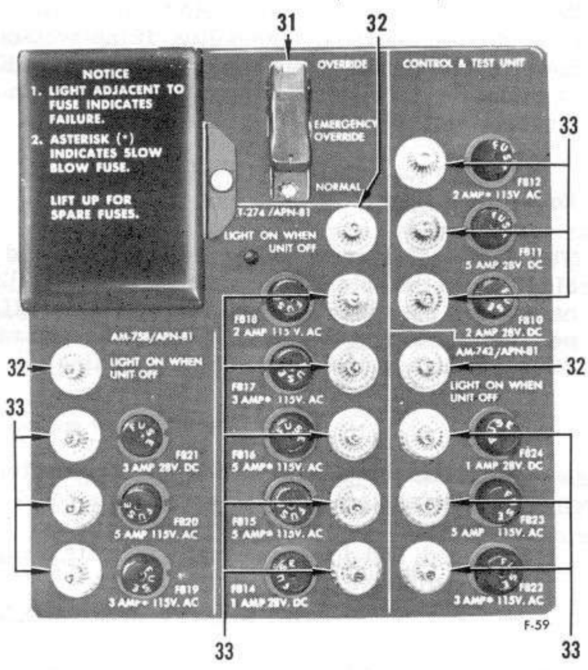


4 CONTROL PANEL C-1317( )/ASN-7

5 NAV-COMPUTER CONTROL PANEL C-1196/APN-99



6 AUTO-NAV RADAR CONTROL PANEL C-1416( )/APN-81



7 FUSE PANEL J-608/APN-81

Figure 4-18 (Sheet 2 of 2)

ground speed, drift angle, airplane position in latitude and longitude, and is independent of visibility and ground based navigational aids. The destination computer (ASN-7A) also continuously computes rhumb line course and distance to a selected destination (mercator sailing) and can automatically compute magnetic variation. The system 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 4-18); however, primary circuit protection is on the MCBP (figure 1-33, sheets 1 and 2). Circuit breaker markings are as follows:

LOCATION ON MCBP	MARKINGS
T-R BUS No. 2 Section (28V DC, 1 breaker)	DOPPLER RADAR
28V AC Section (1 breaker)	DOPPLER RADAR
ENG 2 GENERATOR Section (115/200V AC, 4 breakers)	DOPPLER RADAR
ENG 2 GENERATOR Section (115/200V AC, 3 breakers)	DOPPLER RADAR BLOWER
ENG 2 GENERATOR Section (115V AC, 1 breaker)	NAV COMPUTER

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 4-18, sheet 2 of 2).

NOTE

- When two or more airplanes, having doppler radar equipment in operation, are flying in close proximity (formation, A/R rendezvous, etc), the signals from one doppler radar (AN/APN-81) can cuase 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 groundspeed 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.

Auto-Nav System Power Switch

The system power switch (29, figure 4-18) on the auto-nav radar control panel has ON--OFF positions. This switch energizes the auto-nav radar.

Power-On Light

This light (23, figure 4-18) 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 (24, figure 4-18) on the auto-nav radar control panel is marked SYSTEM ON MEMORY. The light illuminates when the doppler radar 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 (26, figure 4-18) 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 (26, figure 4-18) 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 doppler radar operates in the memory mode.

Radar Silent Light

This light (25, figure 4-18), 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 (27, figure 4-18) on the auto-nav radar control panel has three positions:

AIR CHECK--NORMAL--GRD CHECK. This switch and the system monitor light (30, figure 4-18) 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 (30, figure 4-18) 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.

Fuse Panel J-608/APN-81

This panel (figure 4-18, sheet 2) houses all fuses for the APN-81 and is divided into three sections. Each section provides circuit protection for APN-81 units. Each unit has a unit failure light which will illuminate if the unit fails. All sections have fuses with lights adjacent to each fuse. If a fuse fails, the light adjacent to it will illuminate. Spare fuses are located in a box on the front of the J-608 fuse panel.

Emergency Override Switch

This switch (31, figure 4-18) 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 (32, figure 4-18) on the J-608 fuse panel become illuminated.

Drift Angle Indicator

This indicator (figure 4-18) indicates the drift angle output of the doppler 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 4-18) 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 4-18, sheet 2) 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 (Doppler) 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 (28, figure 4-18) 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 three minutes and twenty seconds 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-7A)

The ASN-7A nav-computer operates as an automatic navigation computer to give present position plus course and distance to destination. The control panels (figure 4-18, sheet 2) are on the navigator's radar control console and the associated destination indicator (11, figure 4-41) is on the navigator's instrument panel. An additional destination indicator is on the pilots' center instrument panel (18, figure 1-15). 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 (22, figure 4-18) 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. If the nav-computer is to be used, the function switch must be in the NORMAL position. This switch has a locking slide plate to prevent inadvertent actuation.

Display Switch

The display switch (6, figure 4-18) has two positions: PP--DEST. The switch is used to select the display in the latitude and longitude windows (7 and 8, figure 4-18). 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 (9, figure 4-18) only when the display switch is on PP and the mode selector switch is on STBY or PP RST. 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 (18, figure 4-18) 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 (9, figure 4-18) 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 (7, figure 4-18) 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 (8, figure 4-18). 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 (20, figure 4-18) is on OFF or RUN. Operation of the slew switches is also dependent upon the correct positioning of the display switch (6, figure 4-18) and the destination switch (18, figure 4-18). 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 (10, figure 4-18) 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 (11, figure 4-18). 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 (13, figure 4-18) 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 (13, figure 4-18), 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, changing values of W or E magnetic variation/grivation/convergence are inserted into the computer and are visible in the variation window (11, figure 4-18).

IP CORR Button

A push button with marked IP CORR position (12, figure 4-18) 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.

Wind Direction Slew Switch

This switch with -, NEUTRAL, and + positions (14, figure 4-18) is used to manually increase or decrease the value of the wind direction figure, visible in the wind direction window (16, figure 4-18). 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 (22, figure 4-18) is on NORMAL.

Wind Speed Slew Switch

Wind speed data can be manually placed into the equipment by use of the slew switch (15, figure 4-18). 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 (17, figure 4-18) and automatic drift information is supplied to the AN/APN-99 system by the doppler radar set. The function switch (22, figure 4-18) must be on NORMAL for the computer to receive the input from the AN/APN-81.

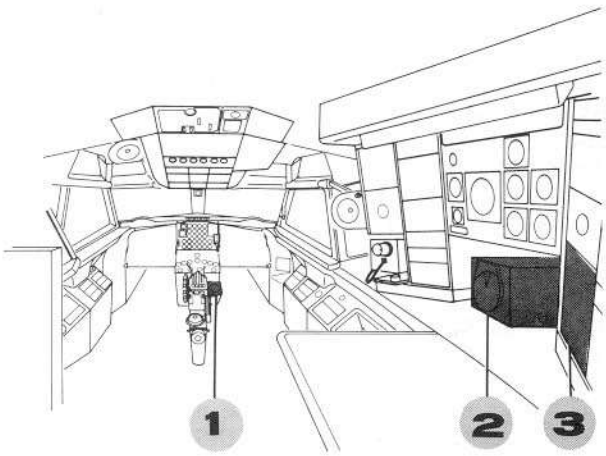
Destination Switch

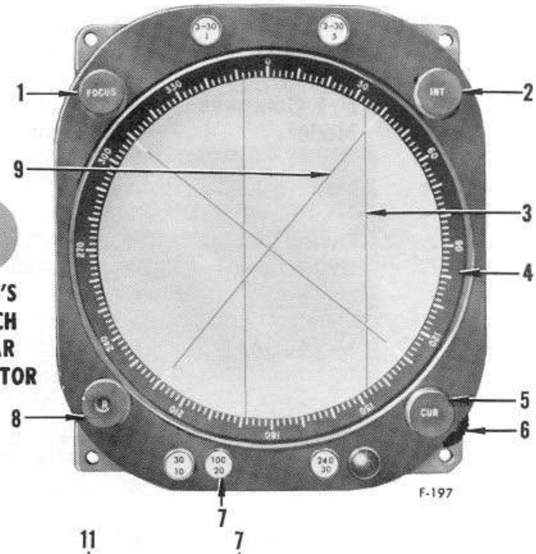
The switch marked DEST (18, figure 4-18) controls the insertion of destination data into the computer. The switch has two positions: INS--STORE. In the STORE position, destination coordinates can be placed into the storage machanism of the computer. The appearance of the LA and LO flags in the destination storage windows (19, figure 4-18) indicates that destination data is in storage. The coordinates of a destination can be selected with the latitude and longitude slew switches (9, figure 4-18) only when the destination switch is in STORE and the display switch (6, figure 4-18) 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

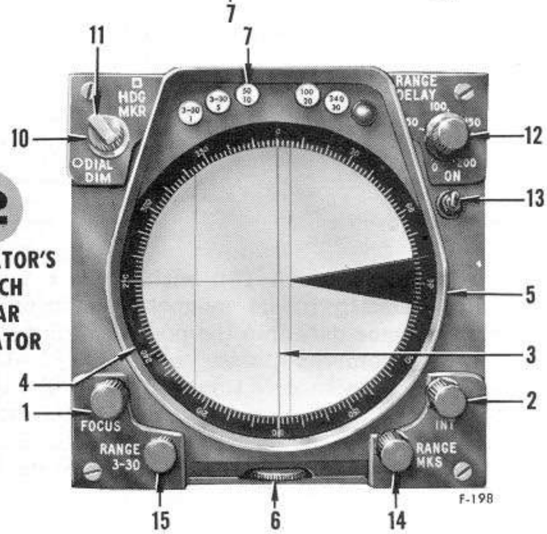
This switch (20, figure 4-18) has four positions: OFF--STBY--RUN--PP RST. When the switch is OFF and DC power is available, all power is removed from the nav-computer except for the panel lights. If AC power is available but no DC power, some computer circuits will be energized as long as the AC power is applied. Off flags appear in the latitude and longitude windows and over the distance counters (3, figure 4-18) 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,

search radar controls





PILOT'S 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

Figure 4-19

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 1-15 and 11, figure 4-41) 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 (2, figure 4-18) is positioned under the fixed top index (1, figure 4-18) to show the true ground track. True ground track is derived from variation, drift, and magnetic heading data. The course-to-destination pointer (5, figure 4-18) 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 (3, figure 4-18). 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. An off flag will appear when the Mode Selector Switch is in the OFF or PP RST position, and a LIMIT flag will be displayed if the distance limits of the computer are exceeded.

Nav-Computer Operation

The AN/APN-99 consists of the AN/APN-81 auto-nav (doppler) radar and the AN/ASN-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 or 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 4-19 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 (4, figure 1-20) and the navigator's indicator (11, figure 4-29) 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 4-19) on the search radar control panel. The control panel (7, figure 4-23) 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 1-33, sheet 1) and operating power is 115 volt AC from ENG 1 GENERATOR on the MCBP (figure 1-33, sheet 2). The circuit breakers are marked SEARCH RADAR.

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 4-19) 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 4-20.)

Gain Control

The GAIN control (20, figure 4-19) 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.

Range (NM) Switch

This switch (31, figure 4-19) 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 4-19) 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 4-19) 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 4-19) on the search radar control panel, marked HDG SEL, orients the PPI display when the bearing switch (27, figure 4-19) 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 4-19). 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 4-19) 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 4-19) 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 4-19) 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 4-19) 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

radiation hazard area

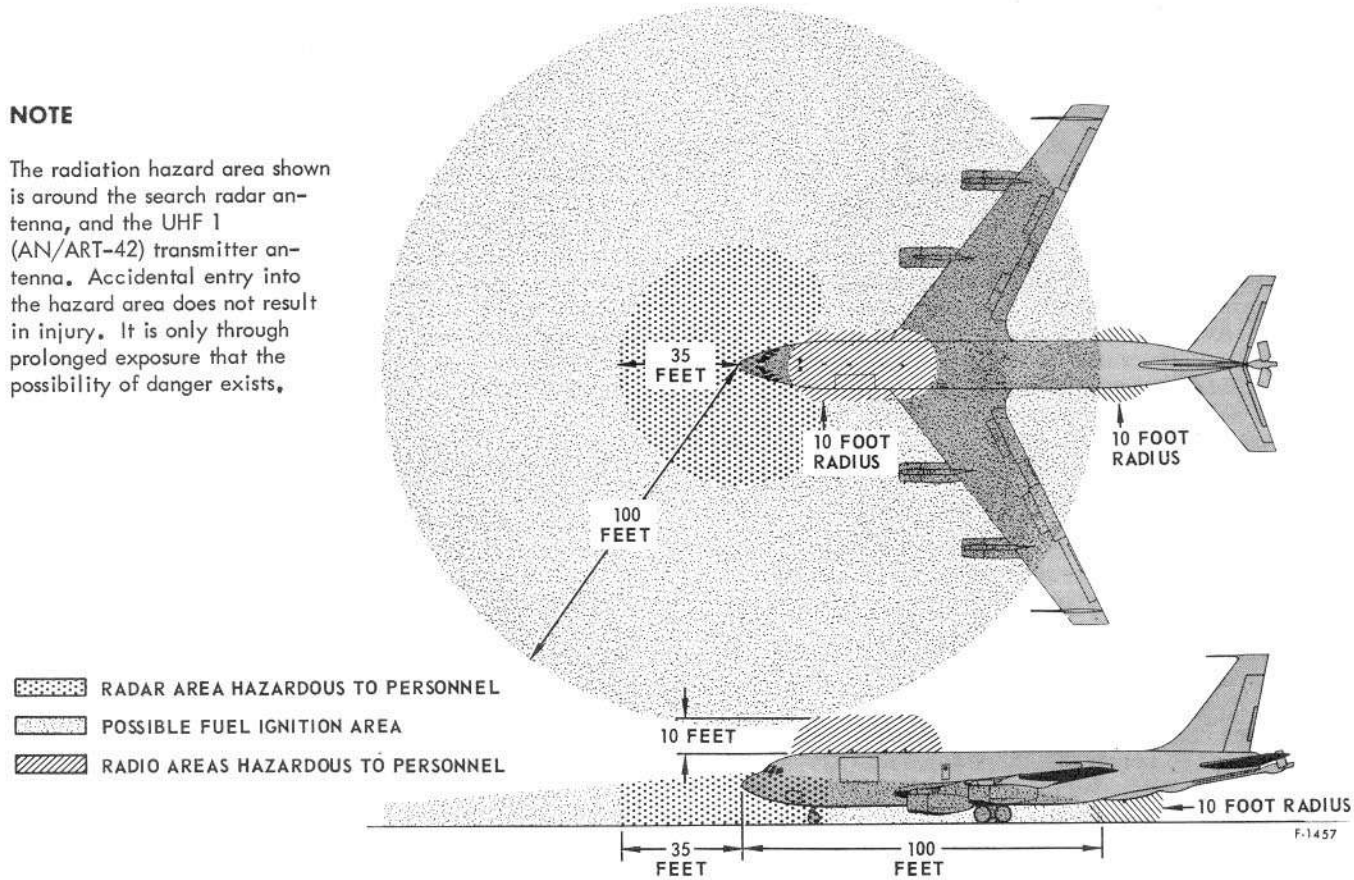


Figure 4-20

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 4-19) 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 4-19) 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 4-19) 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 4-19) 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 4-19) 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 4-19) 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 4-19) on the navigator's and pilot's search radar indicators is used to adjust intensity of PPI trace for best visibility and contrast.

Range Marks Control

This control (14, figure 4-19) 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 4-19) 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 4-19) on each search radar indicator moves the reticle sidewise.

Range 3-30 Control

This control (15, figure 4-19) 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 4-19) 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 4-19) on the pilot's search radar indicator is used to select slaved (S) or relative (R) 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 4-19) on the control panel provides readings of selected circuits for operating tests.

Cursor

The cursor (9, figure 4-19) 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 4-19) 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 4-19) on the navigator's and pilot's search radar indicators indicate range of PPI display.

Azimuth Ring

The azimuth ring (4, figure 4-19) on the navigator's and pilot's 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.

navigation equipment malfunctions chart

WARNING

Prior to changing fuse(s), turn off affected equipment, then open the applicable circuit breaker(s).

ACTION

	MALFUNCTION	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	■	■	■	■						
APN-81	WARNING SYSTEM ON - MEMORY LIGHT ON										
APN-81	WARNING SYSTEM ON - MEMORY LIGHT ON & WARNING RADAR SILENT LIGHT ON							■	■		■
APN-81	SYSTEM MONITOR LIGHT WILL NOT COME ON - SWITCH IN AIR OR GND CK		■					■			
APN-81	FUSE BLOWN LIGHT ILLUMINATED					■					
APN-81	RT-274 UNIT FAILURE LIGHT ILLUMINATED			■						■	
APN-81	AM-758 AND RT-274 UNIT FAILURE LIGHTS ILLUMINATED			■	■						
APN-81	AM-742, AM-758 AND RT-274 UNIT FAILURE LIGHTS ILLUMINATED			■	■					■	
ASN-7	GPI COUNTERS NOT MOVING					ITEM 19, 48					
ASN-7	LARGE POSITION ERRORS IN THE GPI			■		ITEM 19					
ASN-7	AUTOMATIC VARIATION INACCURATE OR OSCILLATING					ITEM 47					
ASN-7	DESTINATION LAT & LONG COUNTERS CAN BE SLEWED IN ONLY ONE DIRECTION										
ASN-7	LIMIT FLAG APPEARS ON ID-390										
ASN-7	LAT OR LONG FLAG CHATTERING										
ASN-7	LAT & LONG OFF FLAGS DO NOT DISAPPEAR AFTER NORM WARMUP TIME					ITEM 19					
ASN-7	OFF FLAG APPEARS ON ID-390										
ASN-7	ID-390 COMPASS CARD WILL NOT ROTATE AS N-1 COMPASS ROTATES					ITEM 48					
ASN-7	IP CORR BUTTON INOPERATIVE										
ASN-7	ABOVE ACTIONS DO NOT CORRECT PROBLEM(S)										

NOTE

- This chart includes the more common malfunctions encountered. Refer to applicable equipment Tech Orders for more comprehensive fuse protection and location.
- Reference to items in the chart correlate with the information contained in Figure 4-20B.

Figure 4-20A (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 4-20A (Sheet 2 of 4)

navigation equipment malfunctions chart (cont)

WARNING

Prior to changing fuse(s), turn off affected equipment, then open the applicable circuit breaker(s).

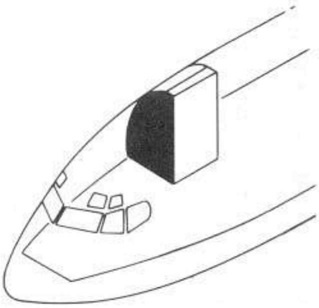
	MALFUNCTION	ACTION: CHECK AC POWER	PRESS TO TEST AND/OR REPLACE BULBS	RECYCLE CIRCUIT BREAKERS	CHECK CABLES FOR SECURITY	REPLACE FUSE(S)	AIR CHECK	RADAR SILENT SW TO TRANSMIT	HAVE PILOT REPEAT LAST MANEUVER	CHECK BLOWER FOR PROPER OPERATION	TURN POWER SW OFF & ON
APN-59	NO POWER TO APN-59	■		■							
	TESTMETER GIVES NO READING IN LINE POSITION	■		■							
	TESTMETER BELOW NORMAL IN LINE, FLUCTUATES IN MAG	■									
	NO SWEEP, TESTMETER READS NORMAL				■	F-103 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-2901 F-2902					
	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			■							

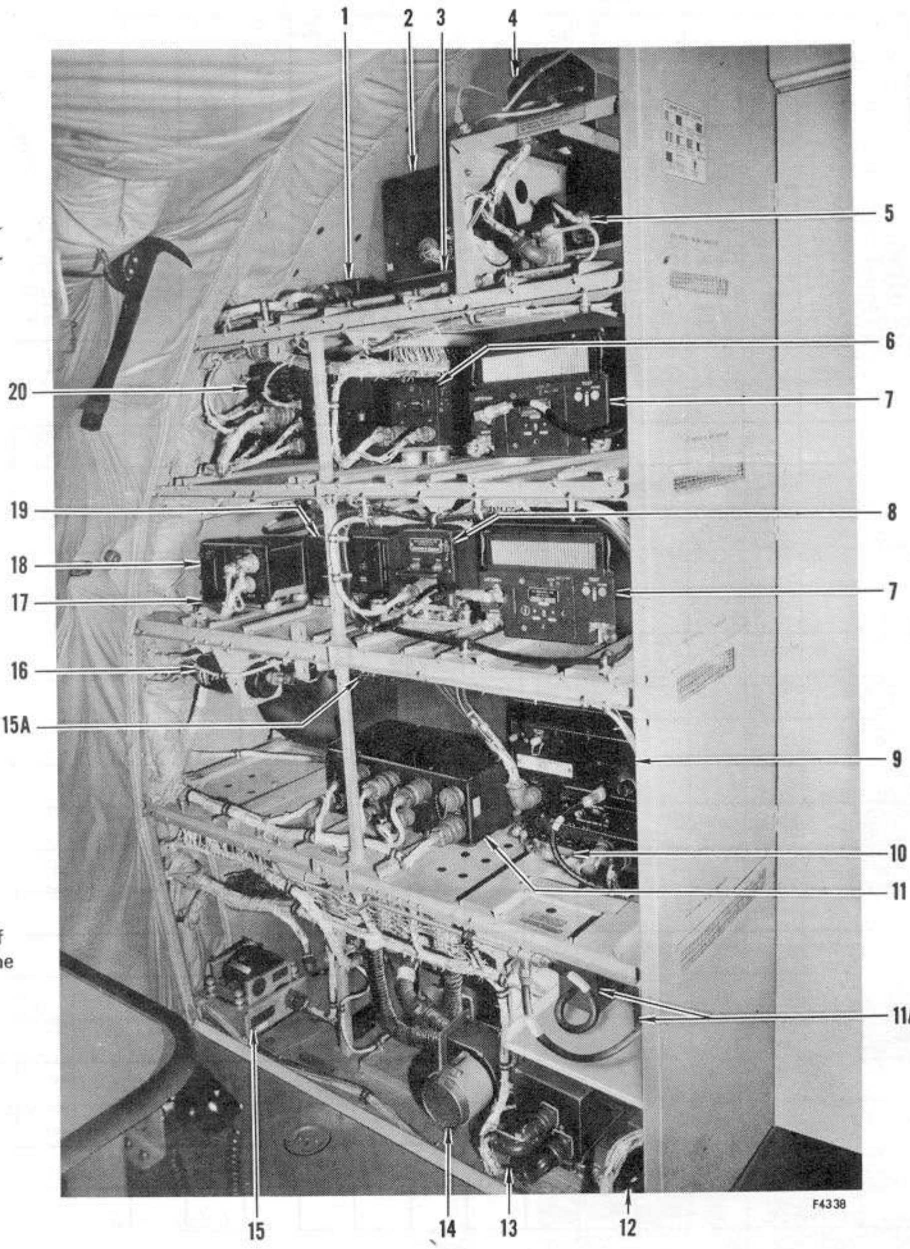
Figure 4-20A (Sheet 3 of 4)

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 4-20A (Sheet 4 of 4)

electronic cabinet equipment



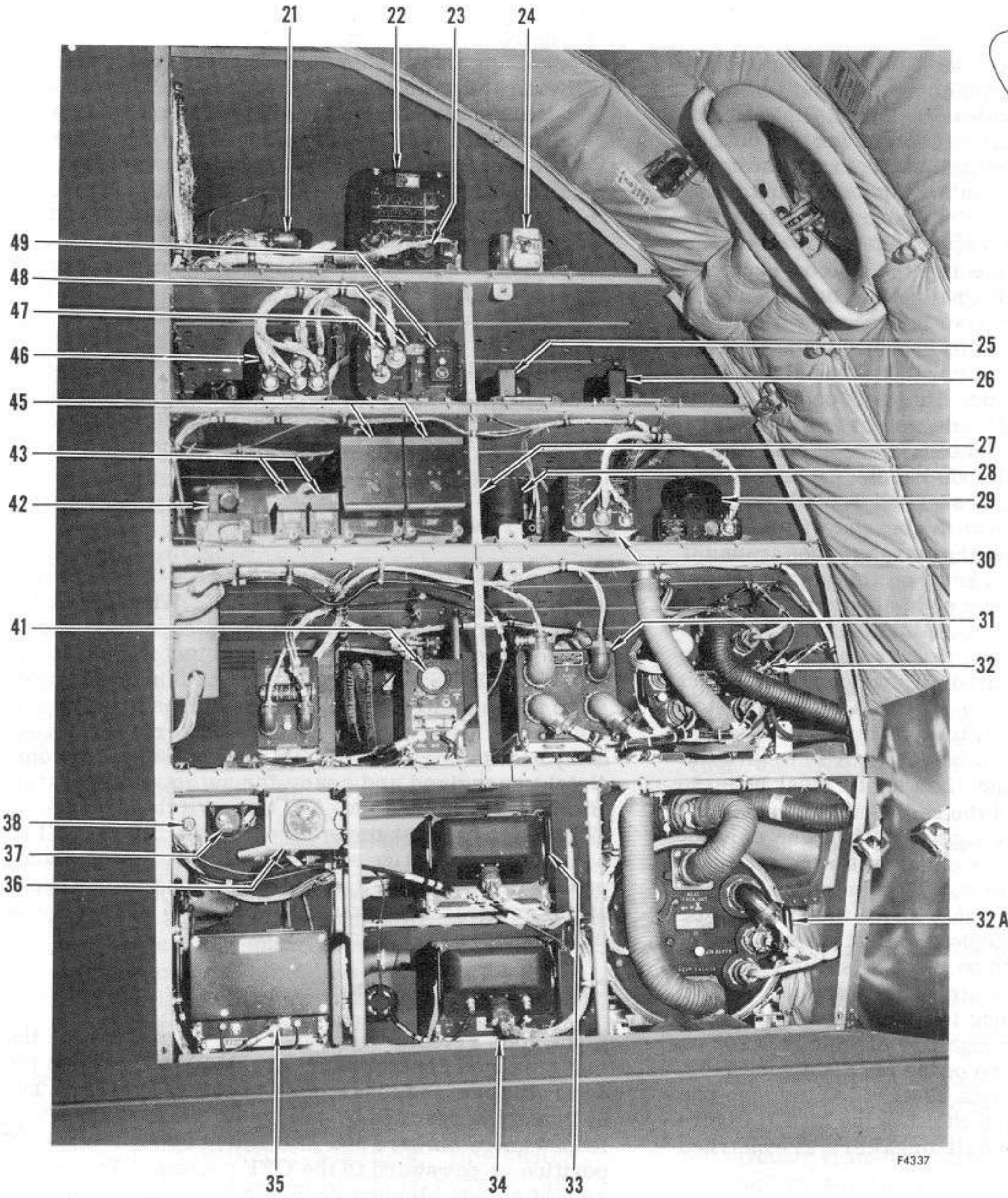


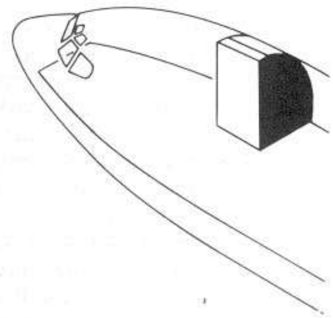
WARNING

Prior to changing fuse(s), turn off affected equipment, then open the applicable circuit breaker(s).

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 Without TCTO 1044, AN/ARC-164 With TCTO 1044) 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
15A RADAR NAVIGATION JUNCTION BOX (J-530)
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 4-20B (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 WIND MEMORY AMPLIFIER (AM-742) AN/APN-81
32A FREQUENCY TRACKER AMPLIFIER (AM-758) AN/APN-81
33 LIAISON RADIO TRANSMITTER
34 LIAISON RADIO RECEIVER
35 TACAN RECEIVER-TRANSMITTER
36 TACAN BEARING CONVERTER
37 TACAN PHASE ADAPTER
38 TEST EQUIPMENT POWER RECEPTACLE
39 (DELETED)
40 (DELETED)
41 LIAISON COUPLER CONTROL AN/ARC-58
42 MARKER BEACON RECEIVER 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 4-20B (Sheet 2 of 2)

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 navigator, crew instructor, pilot and copilot if the RDR-BCN interphone mixer switch is on. 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 4-21. (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 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 ENG 4 GENERATOR section of the MCBP (figure 1-33, sheet 2). Control power is 28 volt DC through one circuit breaker on T-R BUS NO. 1 of the MCBP (figure 1-33, sheet 1). The circuit breakers are marked RADAR BEACON.

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

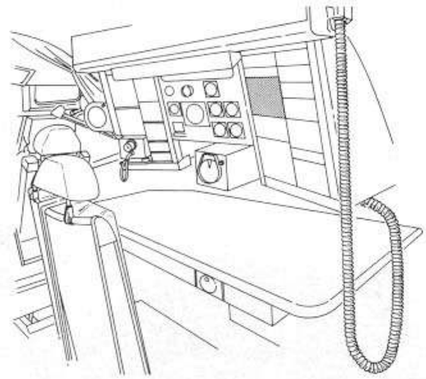
The master power switch (3, figure 4-21) has three positions: OFF--STDBY--OPERATE. When the switch is OFF, the beacon equipment is de-energized except for the panel lights and the code selector indicators. Refer to CODE SELECTOR INDICATORS in this Section. Placing the switch on STDBY energizes all circuits, 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 4-21) 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

beacon control panel

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
5 CODE SELECTOR SWITCHES
6 COMMON CODE SELECTOR
7 VOLUME KNOB



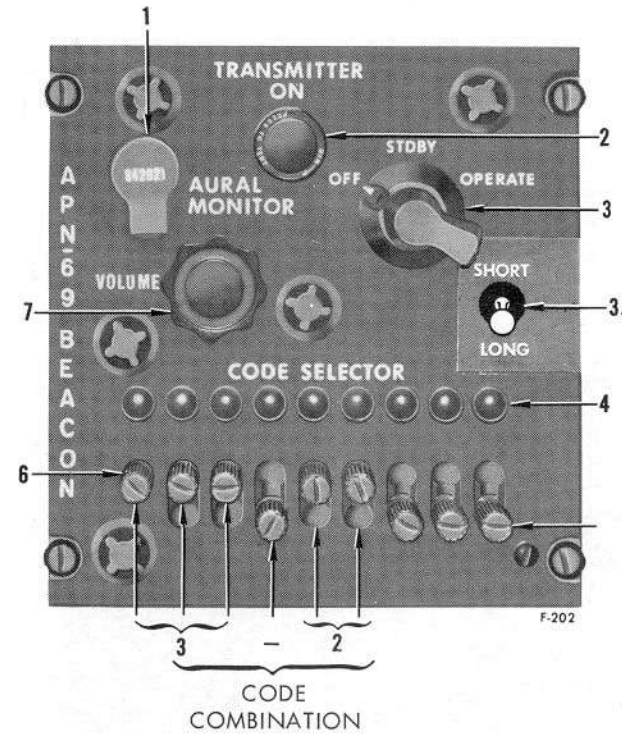


Figure 4-21

switch knob is down, the corresponding code element is absent from the transmitted code.

Pulse Width Switch

The pulse width switch (3A, figure 4-21), on the radar beacon panel has SHORT--LONG positions. Use of this switch allows the radar beacon to accept either of two different pulse width interrogation signals. The LONG position is the normal position for operation of the radar beacon. Placing the switch in the SHORT position enables the system to accept interrogation pulses from fighter airplanes.

Common Code Selector

A common code selector (6, figure 4-21) 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 4-21) 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 (14, figure 4-13).

Transmitter-On Indicator Light

A green indicator light (2, figure 4-21), marked TRANSMITTER ON, is on the radar beacon control panel. When the master power switch is turned to OPERATE, and a 3-minute warmup period has elapsed, the green press-to-test TRANSMITTER ON indicator light illuminates indicating that the radar beacon is ready for automatic operation. The navigator's panel lights (6, figure 4-41) control the brilliance of this indicator light.

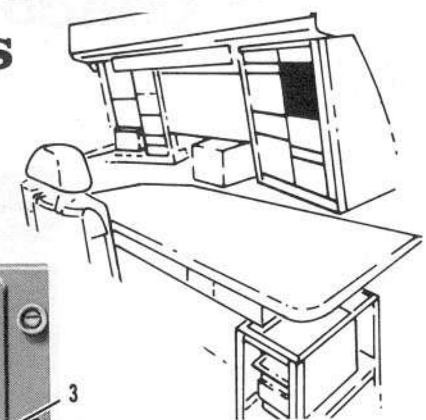
Code Selector Indicators

Nine code selector indicators (4, figure 4-21) are on the bottom of the radar beacon control panel. The navigator's panel lights (6, figure 4-41) control the brilliance of the indicators. Each code selector switch (5, figure 4-21) controls its respective indicator. The indicators, when illuminated, indicate the presence of a code element inserted in the beacon response.

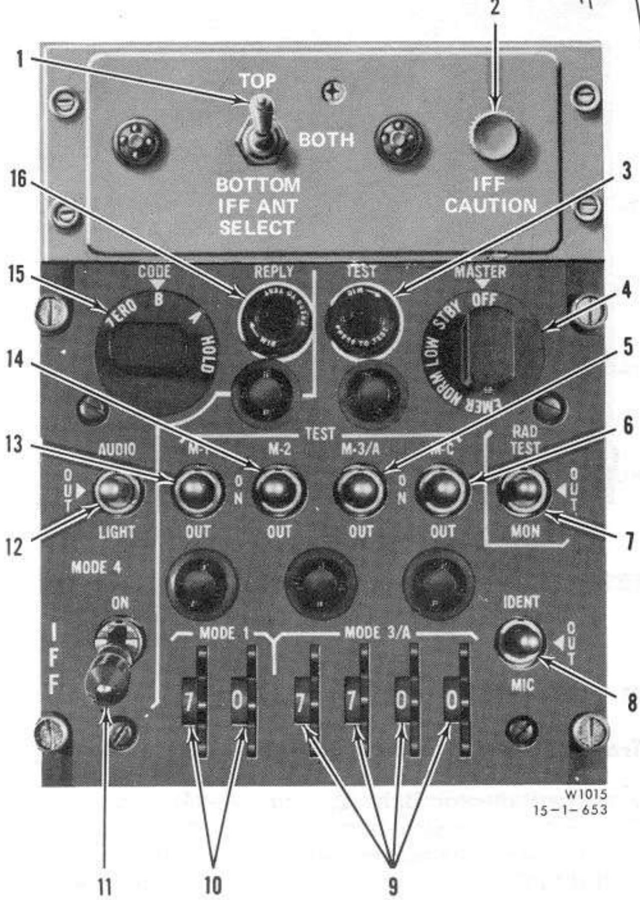
Aural Monitor Jack

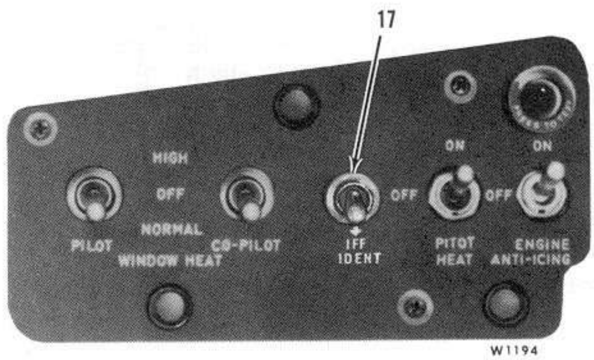
A jack (1, figure 4-21) on the radar beacon control panel is used for test purposes. The jack is not used by the flight crew.

AN/APX-64 IFF radar control panels



1. IFF ANTENNA SWITCH
2. IFF MODE 4 CAUTION 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. MODE 4 CODE SWITCH
16. MODE 4 REPLY LIGHT
17. COPILOT'S IFF IDENT SWITCH





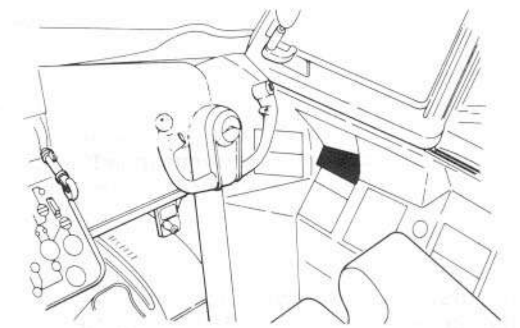


Figure 4-22

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-

All data on pages 4-55 and 4-56 (Deleted) 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 1-33, 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 4-22) 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. Warmup 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 switch is actuated 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 turning the master switch OFF or removal of electrical power from the airplane.

MODE ENABLING SWITCHES. Four mode enabling switches (13, 14, 5, and 6, figure 4-22) 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 4-22) 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 4-22) 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 4-22) 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 interphone mike switch is depressed for a crew member having control of the command radio 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 mike 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.

COPILOT'S IFF IDENT SWITCH. The IFF IDENT switch (17, figure 4-22) is provided so that the copilot can initiate the identification response instead of the navigator. This switch is spring-loaded from IFF IDENT to the center or off position, and has the same function as the IDENT position of the navigator's IDENT/MIC switch.

CODE SELECTORS. Mode 1 code selectors (10, figure 4-22) 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 4-22A) 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 4-22) 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 (15, figure 4-22) 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. Prior to flight and after encoding, the mode 4 code is retained indefinitely and system power can be cycled as many times as necessary without losing the code. Moving the code switch to ZERO or opening the computer door are the only means to zeroize the system. After landing, due to action of landing gear safety switches, both code settings will zeroize when system power is turned off. However, the code settings can be retained by momentarily placing the mode 4 code switch in the spring loaded HOLD position after the aircraft is on the ground. The HOLD function 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 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 4-22) 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 (16, figure 4-22) 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 (2, figure 4-22) 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 (1, figure 4-22) 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.
   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 with 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.
10. Copilot momentarily positions the IFF IDENT switch to IFF IDENT if identification is requested.
11. To turn off equipment, position master switch to OFF.

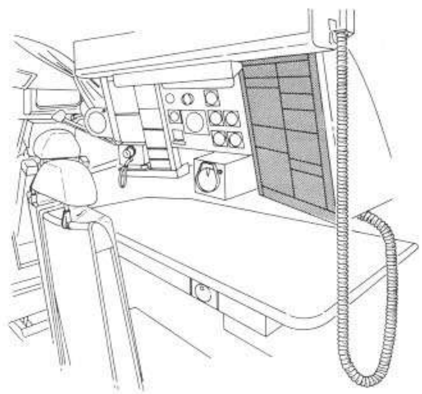
NOTE

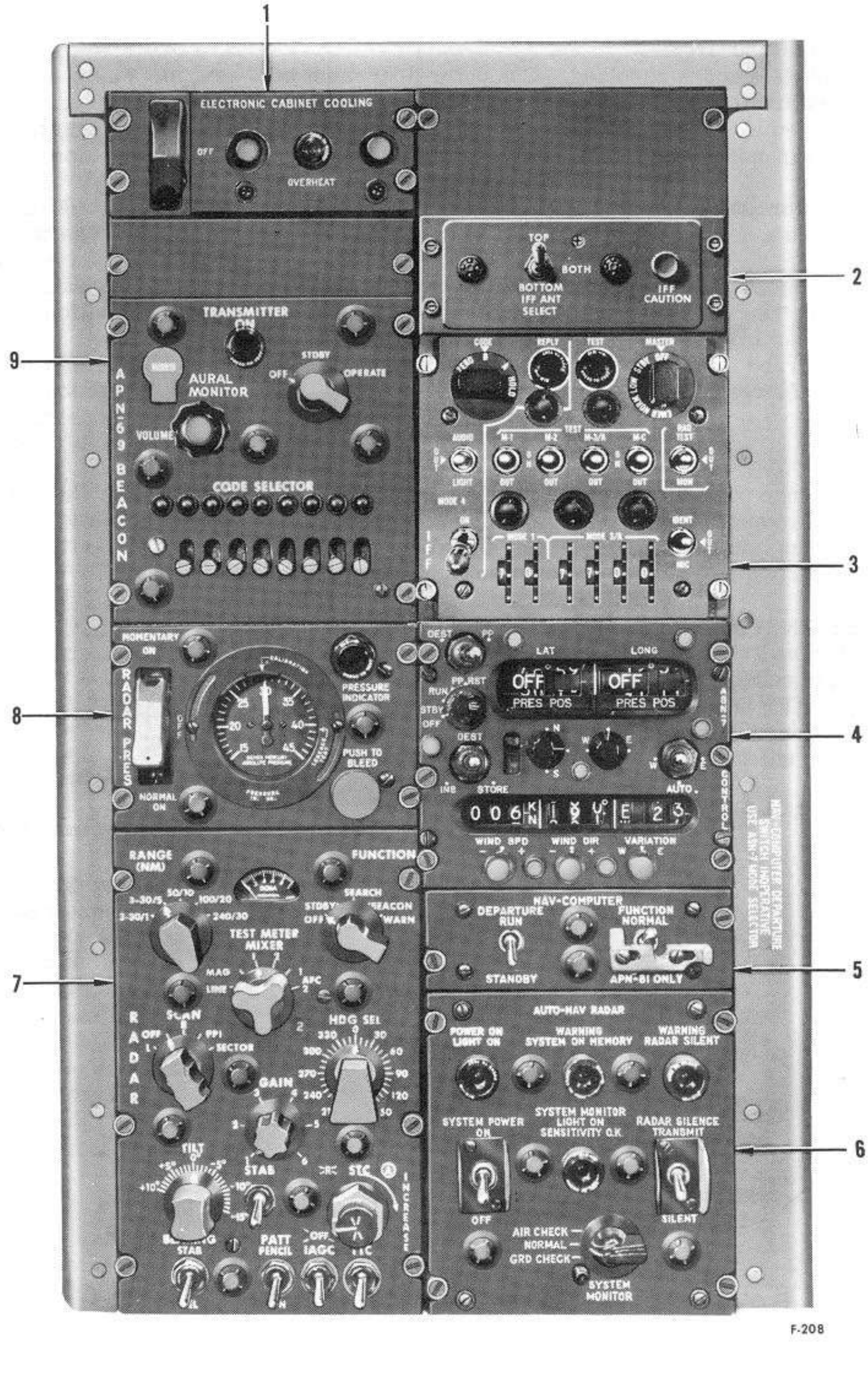
> If it is necessary to retain the mode 4 code after mission termination, momentarily place the mode 4 code switch to the HOLD position after the aircraft has landed.

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.

navigator's radar console

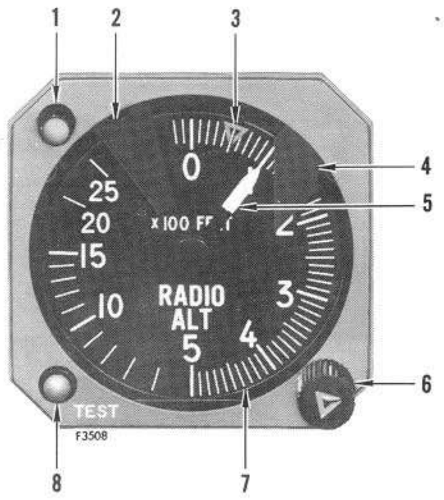


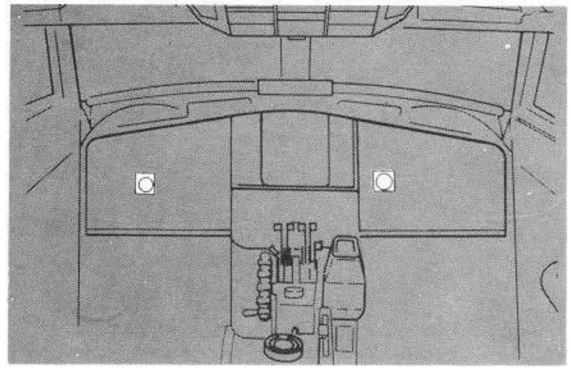


1. ELECTRONIC CABINET COOLING CONTROL PANEL (SEE FIGURE 4-27.)
2. IFF ANTENNA PANEL
3. IFF CONTROL PANEL (FIGURE 4-22.)
4. ASN-7 CONTROL PANEL (SEE FIGURE 4-18.)
5. NAV-COMPUTER CONTROL PANEL (SEE FIGURE 4-18.)
6. AUTO-NAV RADAR CONTROL PANEL (SEE FIGURE 4-18.)
7. SEARCH RADAR CONTROL PANEL (SEE FIGURE 4-19.)
8. RADAR PRESSURIZING CONTROL PANEL (SEE FIGURE 4-26.)
9. RADAR BEACON CONTROL PANEL (SEE FIGURE 4-21.)

Figure 4-23

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 minimum altitude 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 insure 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, while airborne below 2500 feet, the pointer will move to the appropriate airplane altitude. Above 2500 feet, the pointer will return to a maximum position behind the mask. Pointer should return to 0 if on the ground.

Figure 4-24

LOW RANGE RADIO ALTIMETER SYSTEM

Two low range radio altimeter systems (figure 4-24) 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 4-24) 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 4-24) and ADI (1, figure 4-29C). The minimum decision altitude, at which the MDA lights come on, is set by the minimum decision altitude control knob (6, figure 4-24) and indicated by the minimum decision altitude index (3, figure 4-24).

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).

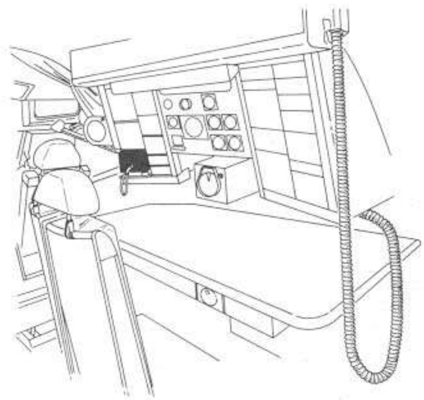
d. Furnishes altitude reference signals to the respective flight director system, which changes at 200 feet (radio altitude) the pitch signal gain to the command bars (8, figure 4-29C) during an ILS approach. This programmed gain decreases the pitch command deflection of the command bars as the glide slope beam narrows below 200 feet.

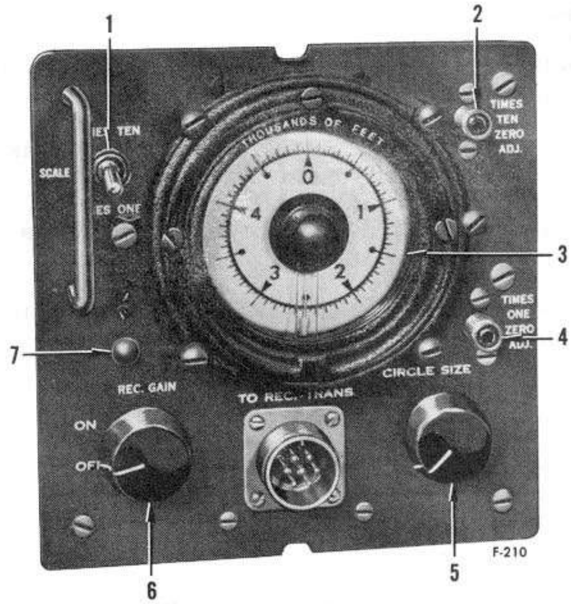
e. Performs continuous self-monitoring at all altitudes (4, figure 4-24) and has a pushbutton self-test feature (8, figure 4-24).

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 is on when the FD MASTER POWER switches are on. Operating power is 115 volt AC through circuit breakers marked RDO ALT on the FD/RGA circuit breaker panels (figure 1-33).

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

Figure 4-25

HIGH RANGE RADIO ALTIMETER (AN/APN-133)

The high range radio altimeter (figure 4-25) is used for determining height above terrain. The AN/APN-133 radio altimeter operates in the 1640 MC frequency band. The nominal range for the radio altimeter is 0 - 50,000 feet in an unpressurized cabin and up to 65,000 feet in a pressurized cabin. The maximum altitude 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. The altimeter (15, figure 4-29) is located above the navigator's table at the navigator's station. The set is turned on and off by the use of a REC GAIN knob (6, figure 4-25) on the altimeter. Operating power is 115 volt AC through one circuit breaker on ENG 1 GENERATOR section of the MCBP (figure 1-33, sheet 2), marked ALTIMETER.

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

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 4-25) on the face of the radio altimeter has TIMES TEN--TIMES ONE positions. in the TIMES TEN position, the lobe on the indicator travels one revolution for 50,000 feet. In the TIMES ONE position, the lobe travels one revolution for each 5000 feet.

Times-Ten Zero Adjustment Knob

This knob (2, figure 4-25) on the radio altimeter adjusts the zero lobe to zero when the SCALE switch is positioned to TIMES TEN.

Times-One Zero Adjustment Knob

This knob (4, figure 4-25) on the radio altimeter adjusts the zero lobe to zero when the SCALE switch is positioned to TIMES ONE.

Circle Size Knob

The CIRCLE SIZE knob (5, figure 4-25) on the radio altimeter adjusts the size of the circular trace.

Receiver Gain Knob

This knob (6, figure 4-25) 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 4-25) on the radio altimeter has a scale which ranges from 0 to 5, allowing altitude to be read up to 50,000 feet.

Pilot Light

A pilot light (7, figure 4-25) 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 doppler radar set (AN/APN-81), to provide satisfactory operation at high altitudes. The control panel of this equipment is shown in figure 4-26. The equipment is controlled by a switch on the radar pressurizing control panel (8, figure 4-23) 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 equipment switch is in the NORMAL ON position. A light on the pressurizing control panel illuminates when the pressurizing pump is operating. In the event that the pressure switch malfunctions and the equipment is overpressurized by a reading greater than 34 in. Hg, the system should be returned to normal pressure by depressing a PUSH TO BLEED button on the panel. In the event the reverse is true and the equipment is underpressurized as indicated by a pressure of less than 30 in. Hg, the pressure should be increased to the proper value by holding the equipment switch in the MOMENTARY ON position. Operating power is 115 volt AC through two circuit breakers on ENG 1 GENERATOR section of the MCBP (figure 1-33, sheet 2). The circuit breakers are marked PRESSURIZING KIT.

Control Switch

This switch (1, figure 4-26) 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.

Radar Pressure Gage

A radar pressure gage (2, figure 4-26) 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.

Pressure Indicator Light

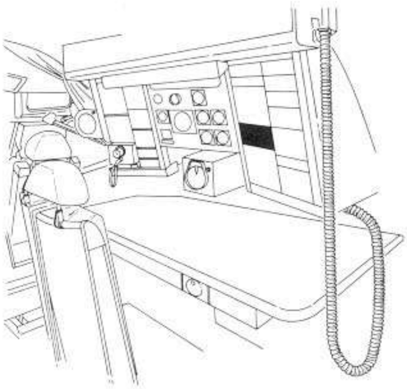
A green indicator light (3, figure 4-26) on the radar pressurizing control panel, when illuminated, indicates that the compressor is operating.

Bleed Valve Knob

A knob (4, figure 4-26) on the radar pressurizing control panel is marked PUSH TO BLEED. When the knob is pushed in, it mechanically actuates a valve to dis-

radar pressurizing control panel

1 CONTROL SWITCH
2 RADAR PRESSURE GAGE
3 PRESSURE INDICATOR LIGHT
4 BLEED VALVE KNOB



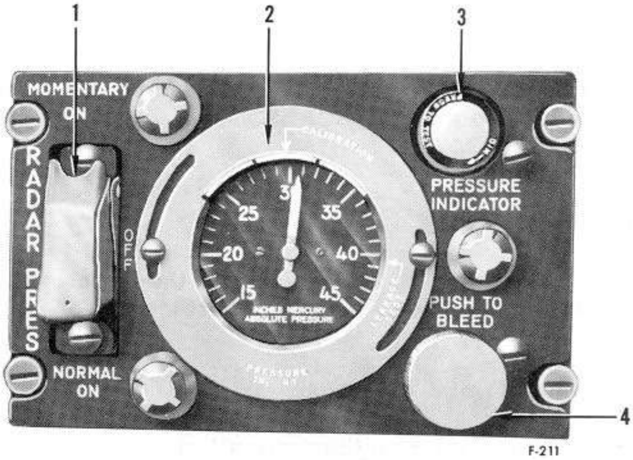


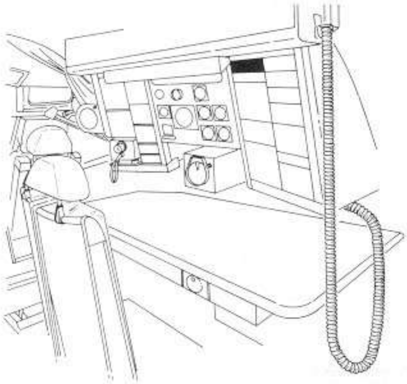
Figure 4-26

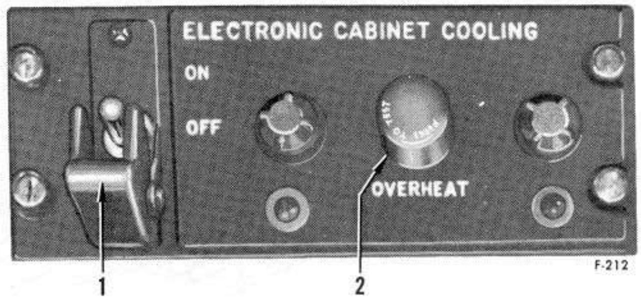
charge system compressed air into the cabin. The bleed valve knob is spring loaded to the extended (bleed valve closed) position.

ELECTRONIC CABINET NO. 1 COOLING SYSTEM

An electronic cabinet cooling system provides adequate cooling for electronic units mounted in the electronic cabinet (41, figure 1-3). The system is turned on and off by use of a switch (1, figure 4-27) on the electronic cabinet cooling control panel. The control panel for the system (1, figure 4-23) 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 ELEX CABINET 1 BLOWER IND on the MCBP (figure 1-33, sheet 2). Operating power is 115/200 volt AC through three circuit breakers, marked BLOWER CABINET COOLING NO. 1 on ENG 2 GENERATOR section of the MCBP (figure 1-33, sheet 2).

electronic cabinet cooling control panel





1 ELECTRONIC CABINET COOLING SWITCH
2 ELECTRONIC CABINET COOLING OVERHEAT WARNING LIGHT

Figure 4-27

Electronic Cabinet Cooling Switch

This switch (1, figure 4-27) 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 4-27) 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.

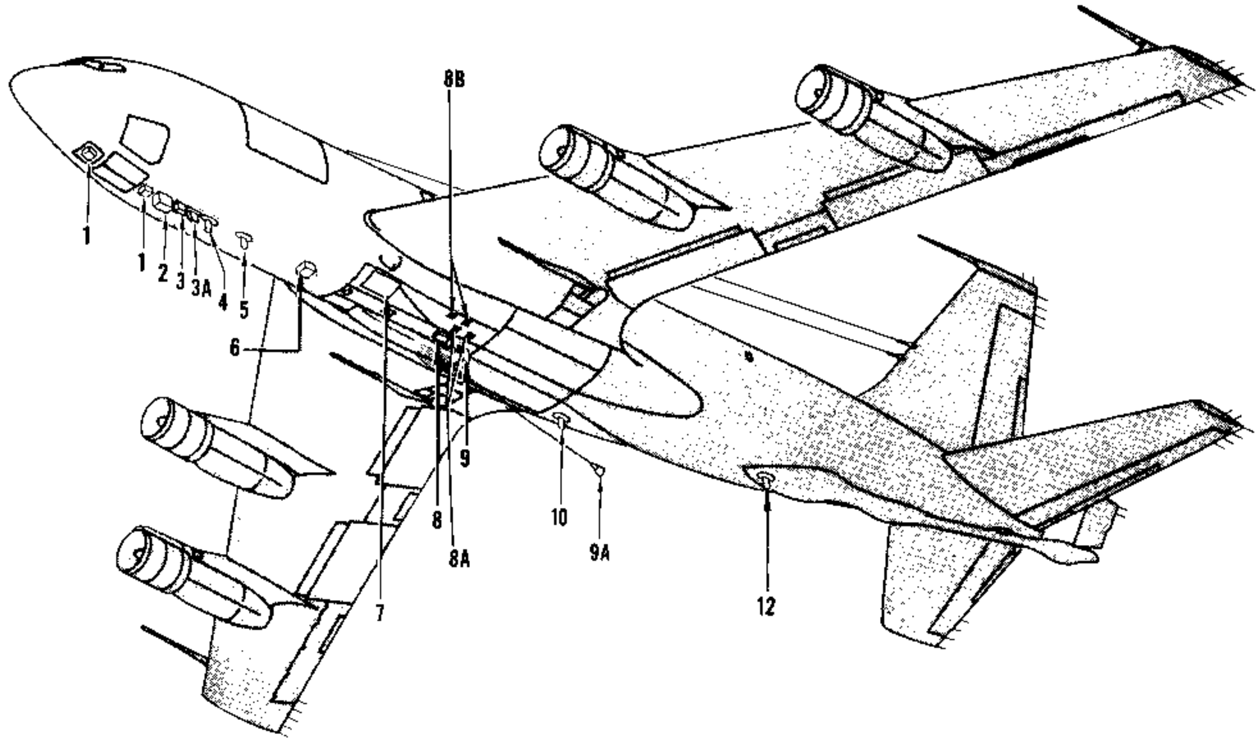
Electronic Cabinet Cooling Overheat Warning Light

This light (2, figure 4-27) on the control panel will illuminate if cooling air circulating in the electronic cabinet is inadequate or the blower is not operating.

CAUTION

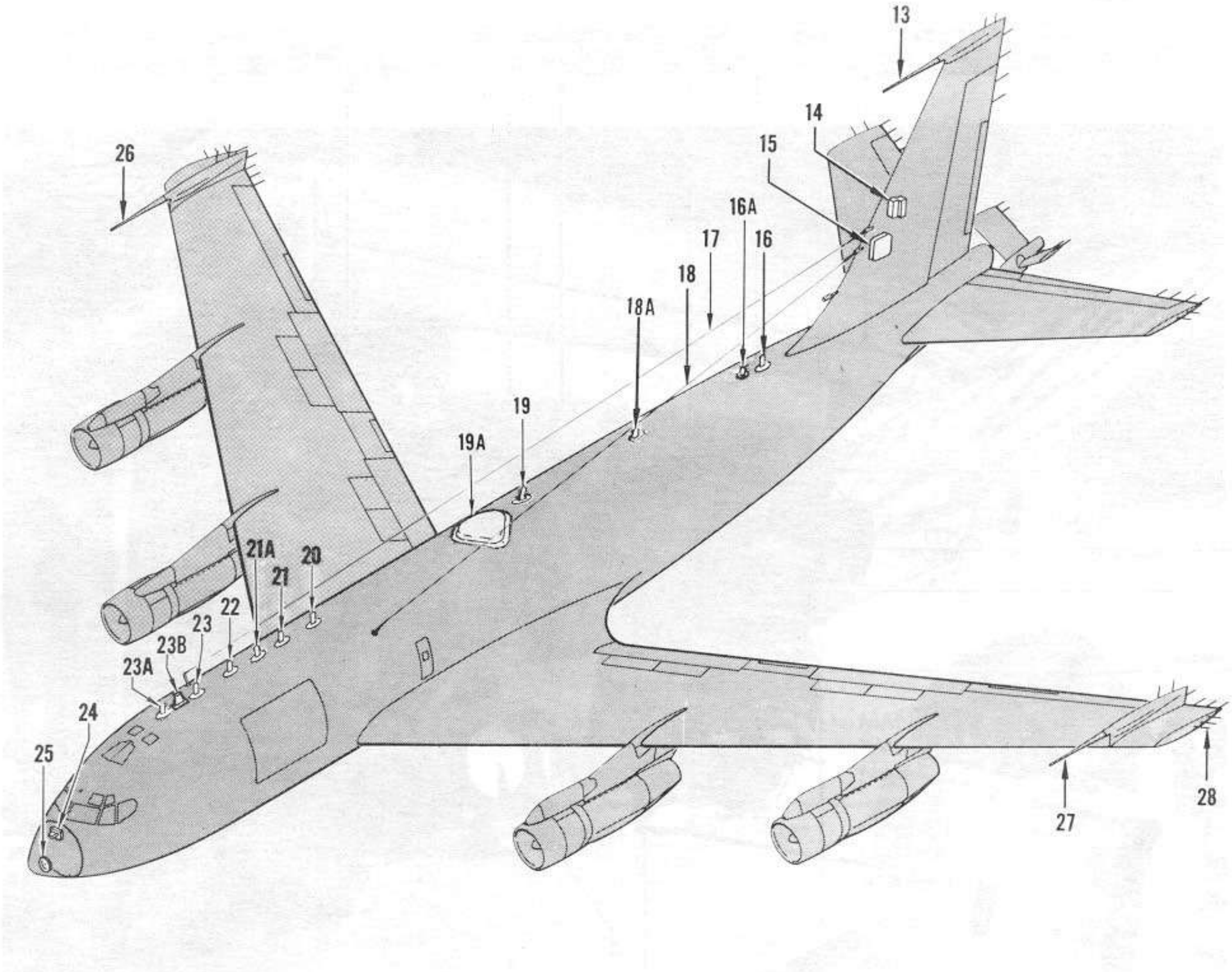
In the event an overheat condition (blower failure) of the electronic equipment exists, as determined by illumination of the electronic cabinet overheat warning light, serious damage to the equipment may occur. If this condition exists, the sets in question should be immediately turned OFF. Emergency cooling may be obtained by removing the cabinet doors. During this condition only critically needed electronic equipment should be operated.

antenna locations



1 RADIO ALTIMETER ANTENNA (APN/133) (2 PLACES)
2 NAVIGATION (DOPPLER) RADAR ANTENNA (APN/81)
3 TACAN ANTENNA (ARN/21)
3A IFF ANTENNA (BOTTOM)
4 UHF RECEIVERS NOS. 1 THRU 4 LOWER ANTENNA (ARR/68)
5 UHF RECEIVER NO. 5 ANTENNA (ARR/68)
6 UHF/ADF ANTENNA (ARA/25)
7 BROADCAST RECEIVER ANTENNA
8 MARKER BEACON ANTENNA (ARN/32)
8A COPILOT'S LOW RANGE RADIO ALTIMETER ANTENNAS
8B PILOT'S LOW RANGE RADIO ALTIMETER ANTENNAS
9 VHF FM TRANSCEIVER ANTENNA
9A ARC-96 TRANSMITTER DROGUE ANTENNA
10 UHF COMMAND RADIO NO. 2 ANTENNA
11 DELETED
12 UHF TRANSMITTER NO. 1 ANTENNA
13 LIAISON RADIO NO. 1 PROBE ANTENNA (ARC/58)
14 RADAR BEACON ANTENNA (APN/69)
15 VHF NAVIGATION (VOR) RADIO ANTENNA (ARN/14)

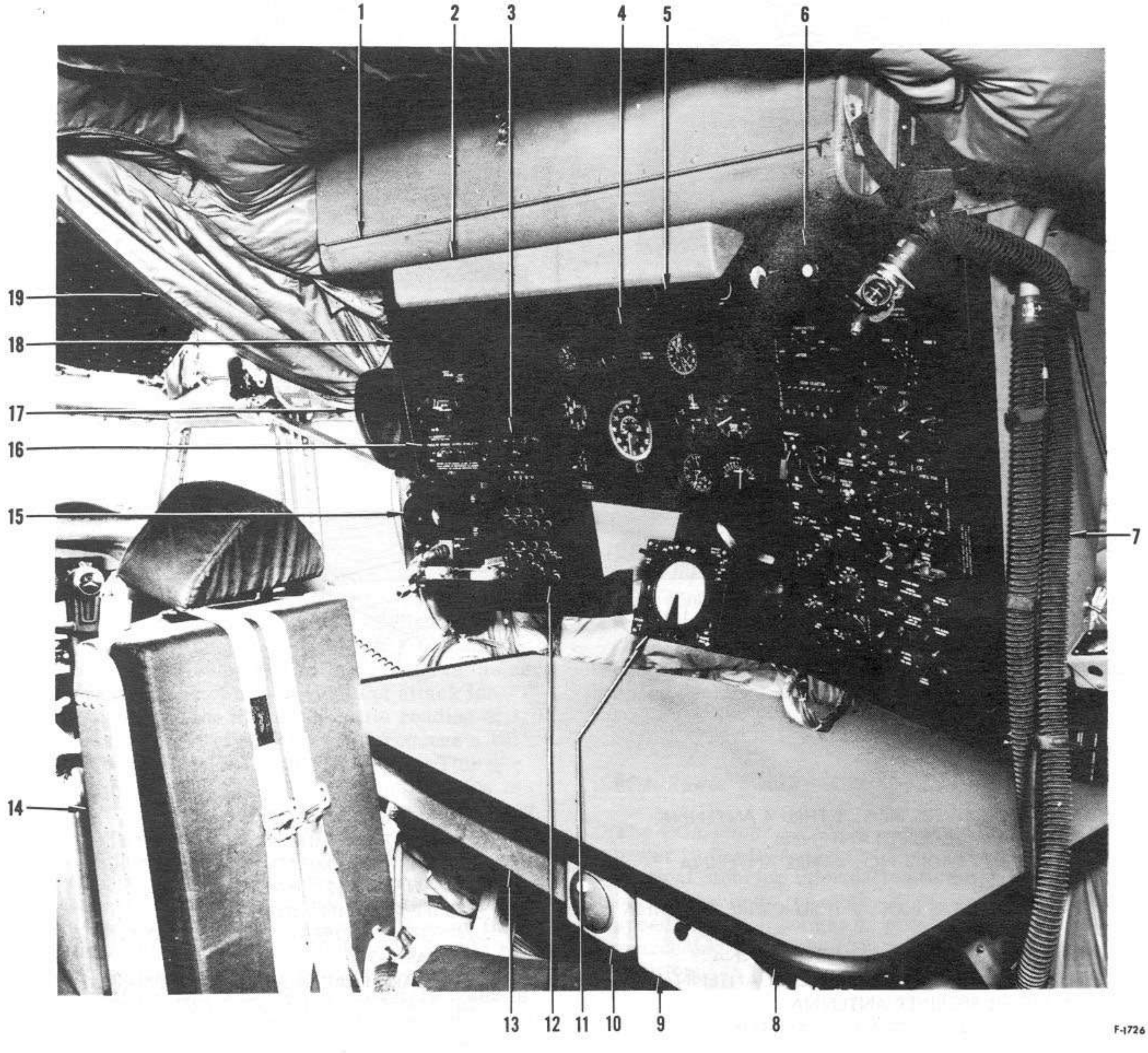
Figure 4-28 (Sheet 1 of 2)



16 UHF RECEIVERS NOS. 1 THRU 4 ANTENNA
16A SATCOM RECEIVER ANTENNA
17 LIAISON RADIO NO. 4 WIRE ANTENNA (ARC-58)
18 HF RECEIVERS NOS. 1 THRU 4 WIRE ANTENNA (ARC-58)
18A APM MONITOR RECEIVER ANTENNA
19 UHF COMMAND RADIO NO. 1 ANTENNA
19A ARC-96 RECEIVER ANTENNA
20 UHF TRANSMITTER NO. 4 ANTENNA
21 UHF TRANSMITTER NO. 3 ANTENNA
21A TACAN TOP ANTENNA
22 UHF TRANSMITTER NO. 2 ANTENNA
23 UHF TRANSMITTER NO. 5 ANTENNA
23A AN/ASQ-121 (HARDS) ANTENNA
23B IFF ANTENNA (TOP)
24 GLIDE SLOPE RECEIVER (ILS) ANTENNA (ARN-31)
25 SEARCH RADAR ANTENNA (APN-59)
26 LIAISON RADIO NO. 3 PROBE ANTENNA (ARC-58)
27 LIAISON RADIO NO. 2 PROBE ANTENNA (ARC-58)
28 STATIC DISCHARGERS (TYPICAL)

Figure 4-28 (Sheet 2 of 2)

navigator's station



1 NAVIGATOR'S STOWAGE CABINET
2 NAVIGATOR'S LIGHT SHIELD
3 NAVIGATOR'S LIAISON RADIO CONTROL PANEL (SEE FIGURE 4-16)
4 NAVIGATOR'S INSTRUMENT PANEL (SEE FIGURE 4-41)
5 NAVIGATOR'S LIGHT CONTROL PANEL
6 NAVIGATOR'S RADAR CONTROL CONSOLE (SEE FIGURE 4-23)
7 NAVIGATOR'S OXYGEN HOSE
8 NAVIGATOR'S TABLE
9 MAP BIN
10 ASH TRAY
11 SEARCH RADAR INDICATOR (SEE FIGURE 4-19)
12 NAVIGATOR'S INTERPHONE CONTROL PANEL (SEE FIGURE 4-13)
13 NAVIGATOR'S TABLE DRAWER
14 NAVIGATOR'S SEAT (SEE FIGURE 4-71)
15 HIGH RANGE RADIO ALTIMETER (SEE FIGURE 4-25)
16 NAVIGATOR'S OXYGEN REGULATOR PANEL (SEE FIGURE 4-35)
17 LOUDSPEAKER (SEE FIGURE 4-13)
18 NAVIGATOR'S FORWARD CONTROL CONSOLE
19 BLACKOUT CURTAIN

Figure 4-29

INTEGRATED DUAL FLIGHT DIRECTOR/ ROTATION GO-AROUND SYSTEM

The integrated dual flight director/rotation go-around (FD/RGA) system (figure 4-29A) 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 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 4-29B).

FD MASTER POWER SWITCHES

Two toggle switches (4A and 4B, figure 4-29B) 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

Two lights (21A, figure 1-16 and 12A, figure 1-17) 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

Without T.O. 1016

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 4-17A for radio navigation data flow.

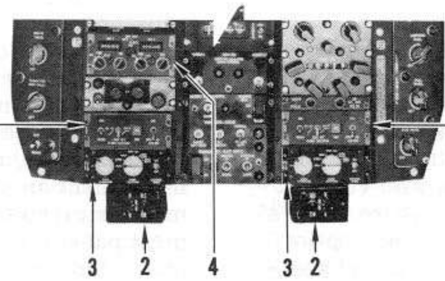
Attitude Director Indicator (ADI)

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.

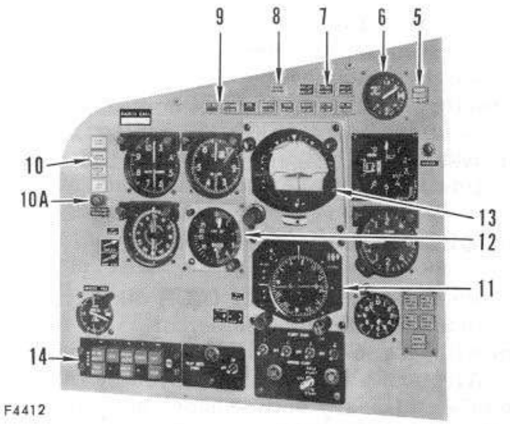
NOTE

- 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.

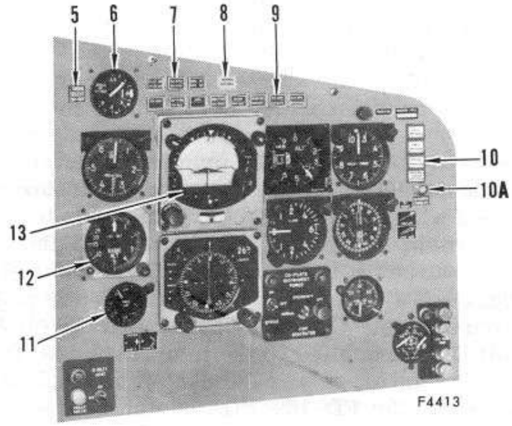
FD/RGA equipment location



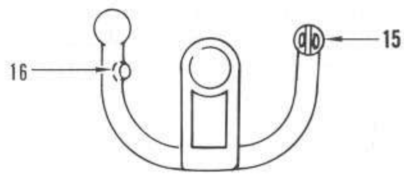
OVERHEAD PANEL



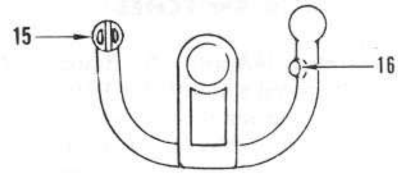
PILOT'S FLIGHT INSTRUMENT PANEL



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
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 (2 PLACES)
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/ARR 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

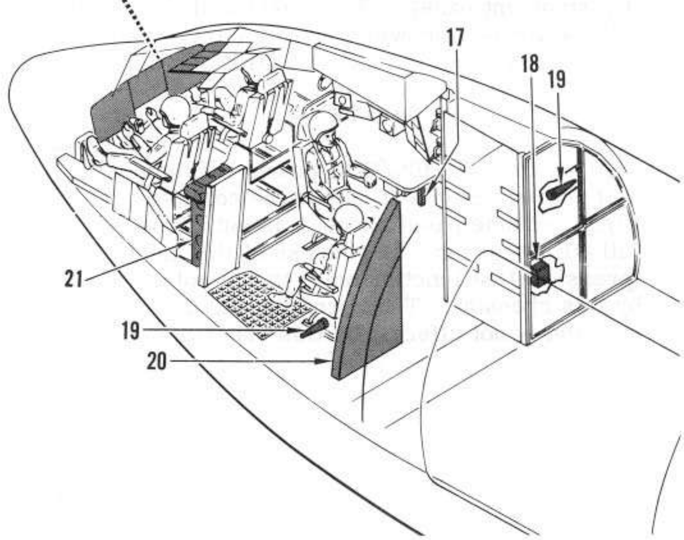
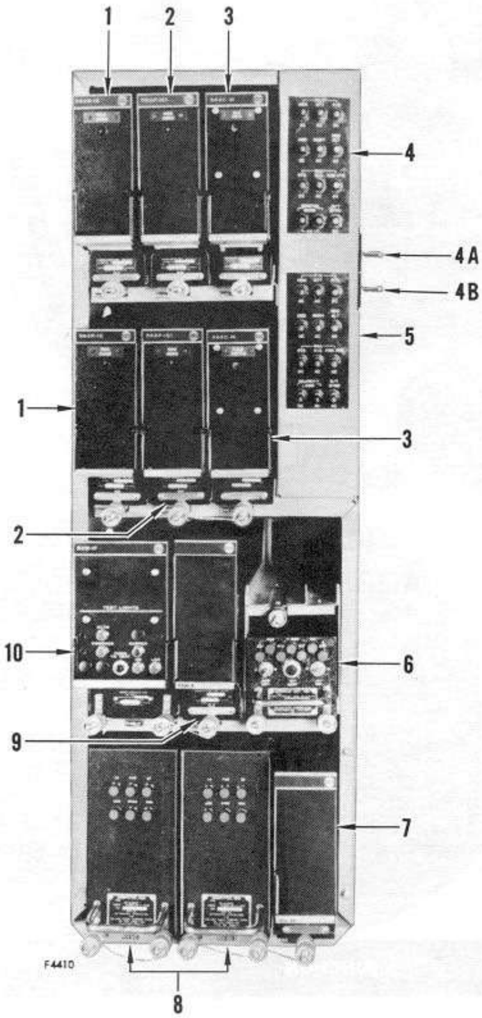
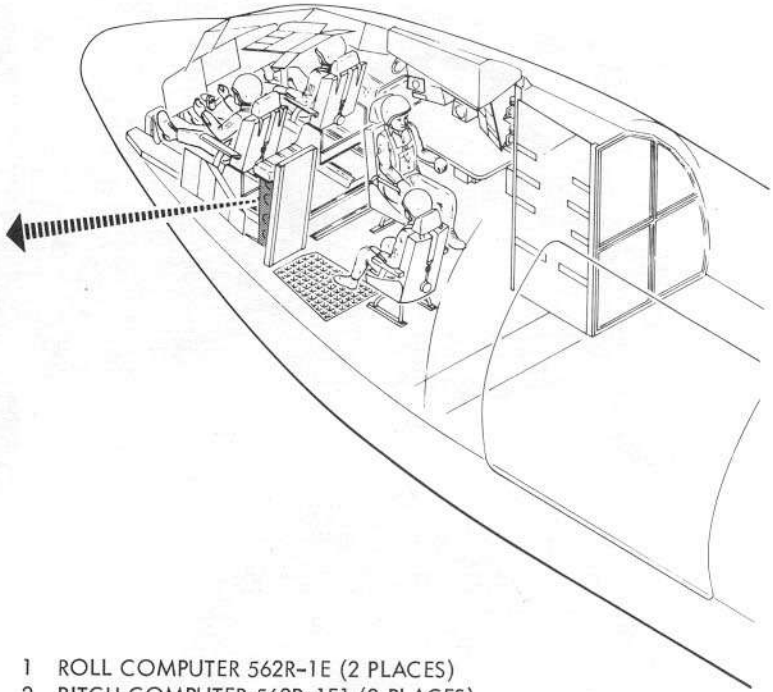


Figure 4-29A

FD-109/RGA equipment rack

(COVERS REMOVED)



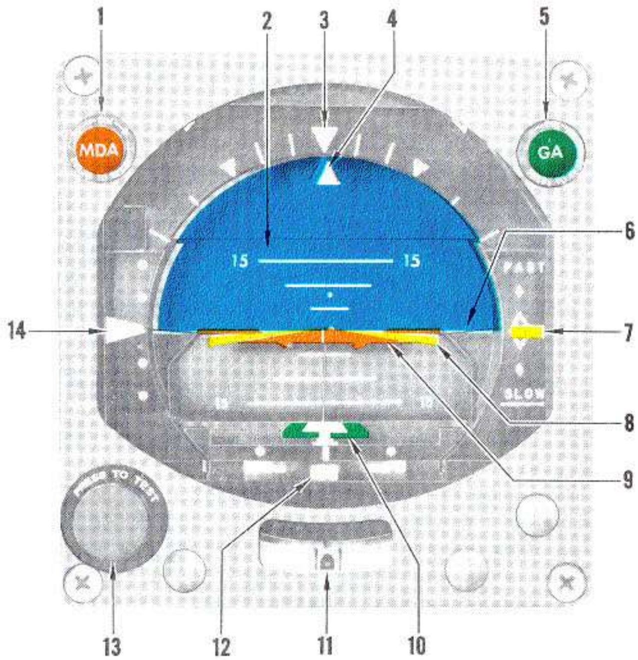


1 ROLL COMPUTER 562R-1E (2 PLACES)
2 PITCH COMPUTER 562P-1E1 (2 PLACES)
3 INSTRUMENT AMPLIFIER 344C-1K (2 PLACES)
4 PILOT'S FD/RGA CIRCUIT BREAKER PANEL (SEE FIGURE 1-33)
4A FD NO. 2 MASTER POWER SWITCH
4B FD NO. 1 MASTER POWER SWITCH
5 COPILOT'S FD/RGA CIRCUIT BREAKER PANEL (SEE FIGURE 1-33)
6 RGA INTERFACE UNIT 599K-1
7 REMOTE SLEW COUPLER 161E-7B
8 RGA COMPUTERS
9 MAJORITY LOGIC ATTITUDE COMPARATOR 54W-4
10 WARNING MONITOR 54W-1F

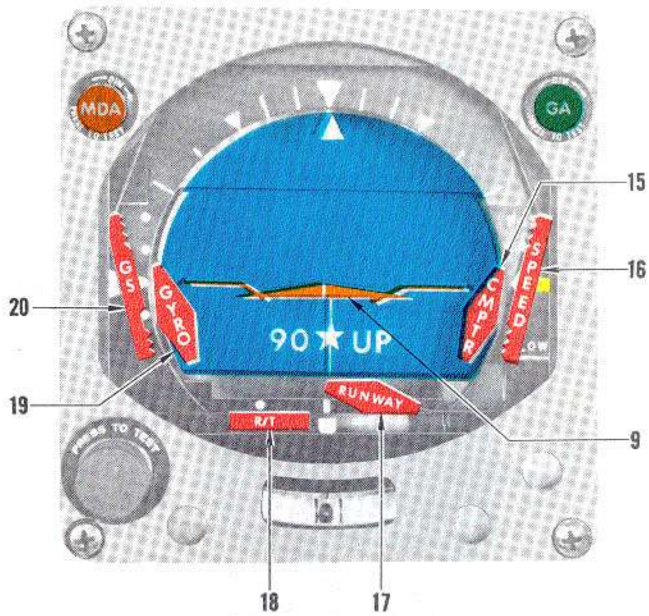
Figure 4-29B

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 4-29C for description and function of controls and indicators on the attitude director indicator.

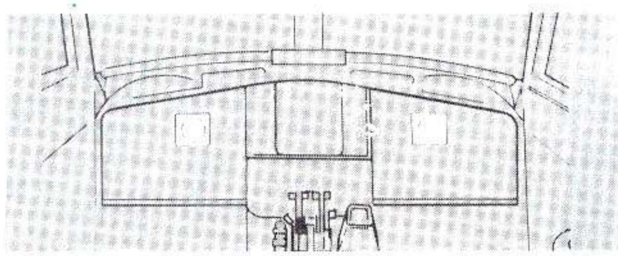
attitude director indicator



ATTITUDE DIRECTOR INDICATOR
WITHOUT FLAG DISPLAY



ATTITUDE DIRECTOR INDICATOR
WITH FLAG DISPLAY



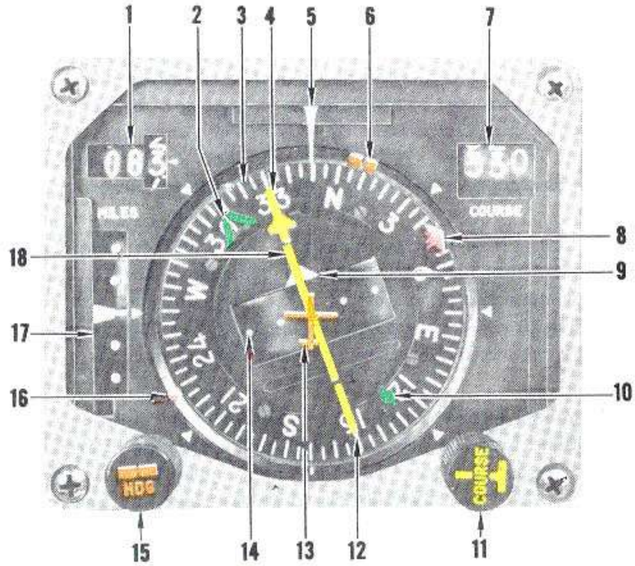
	CONTROL/INDICATOR	FUNCTION
1	MDA (MINIMUM DECISION ALTITUDE) INDICATOR	Lights when the airplane reaches the preset minimum altitude (as selected by MDA index control knob on low range radio altimeter (figure 4-24), at which the landing or go-around decision must be made.
2	PITCH TAPE	Indicates the airplane 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 4-29C (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 4-29J) 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 4-29E). 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 center line. 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 horizonal 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.

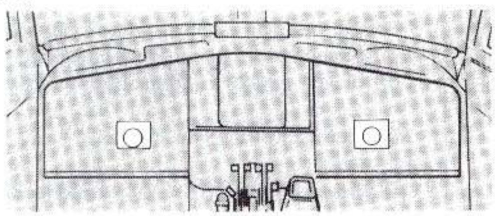
Figure 4-29C (Sheet 2 of 2)

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) (GREEN)	Indicates bearing to tuned radio navigation station (See figure 4-17A).
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 4-29E). 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) (PINK)	Indicates bearing to tuned radio navigation station (See figure 4-17A).

Figure 4-29D (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, heading 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 operations and glide slope receiver malfunctions or quality of 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 4-29D (Sheet 2 of 2)

Horizontal Situation Indicator (HSI)

The horizontal situation indicator (figure 4-29D) 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 4-29E). 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 station. Refer to figure 4-17A 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 the horizontal situation indicator 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(non-computed) information from the glide slope receiver.

Flight Director Control

Three controls are provided on the flight director control panel (figure 4-29E) 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 4-29E) 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 4-29E) 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 4-29E) 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.

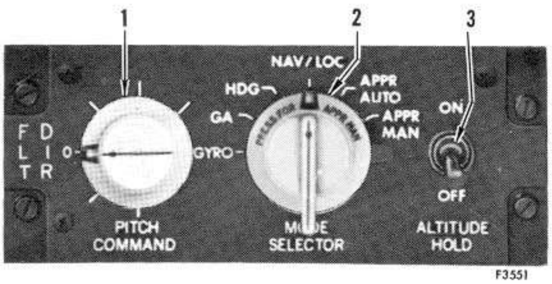
NOTE

> 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 4-29E) 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.

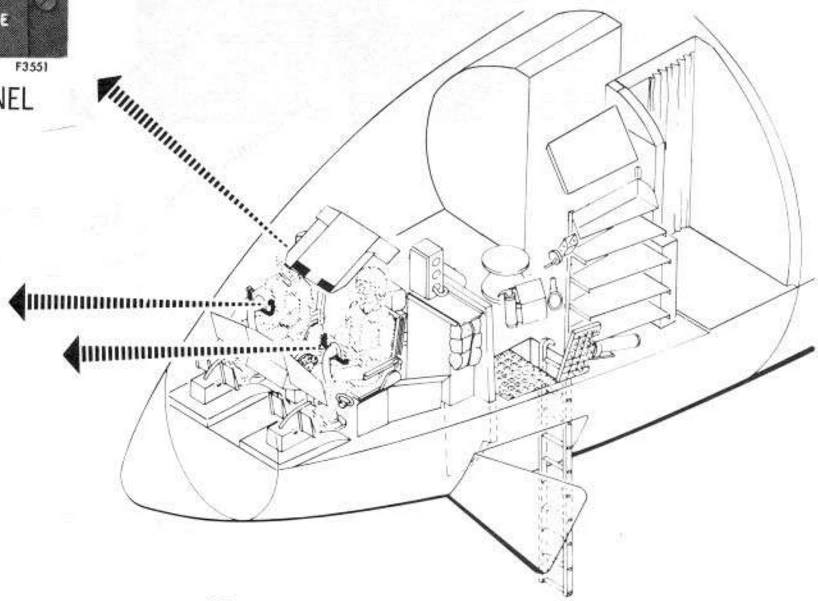
flight director controls

1 PITCH COMMAND KNOB
2 MODE SELECTOR SWITCH
3 ALTITUDE HOLD SWITCH
4 HEADING SLEW CONTROL
5 RGA PUSHBUTTON SWITCH



FLIGHT DIRECTOR CONTROL PANEL

CONTROL WHEEL (TYPICAL)



(1) Copilot's control wheel shown; pilot's control wheel opposite.

Figure 4-29E

Heading Slew Control

A heading slew control (4, figure 4-29E) is located 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 (7A, figure 1-18) 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 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 4-29E) 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

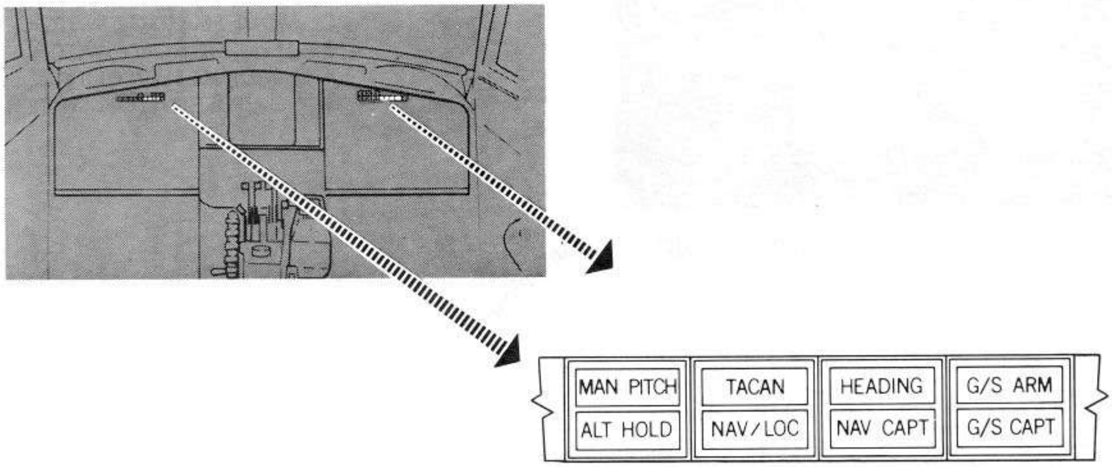


Figure 4-29F

Flight Director System Annunciators

The flight director system annunciators (figure 4-29F) 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

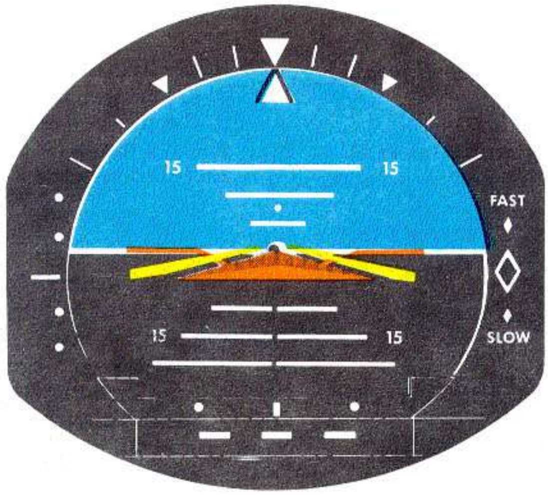
The attitude director indicator (ADI) display is controlled by the position of the mode selector switch (2, figure 4-29E). In each selected mode, except GYRO, the ADI command bars direct airplane steering. Figure 4-29G shows the pilot's view of the airplane symbol and command bars for typical flight 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:

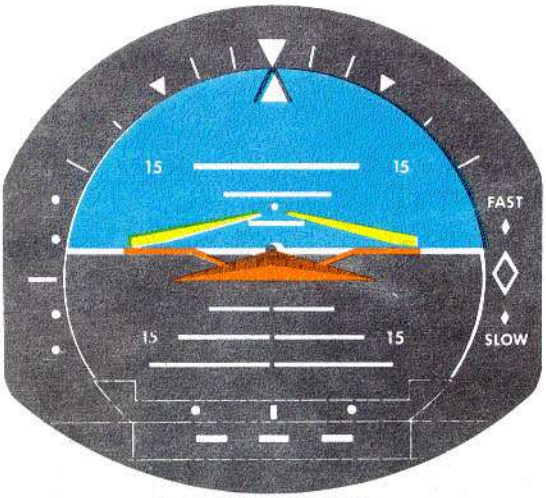
a. Azimuth card displays compass heading.

b. Course deviation indicator displays radio beam deviation (TACAN, VOR or localizer).

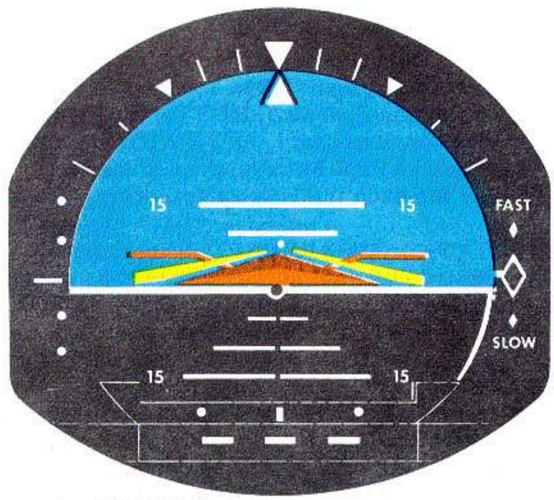
command bars presentation



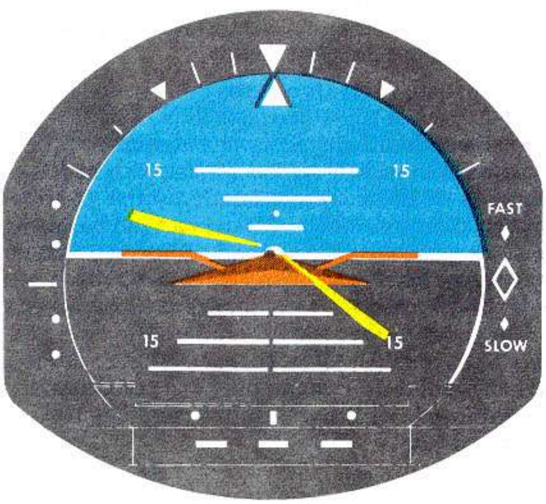
LEVEL FLIGHT
(COMMAND SATISFIED)



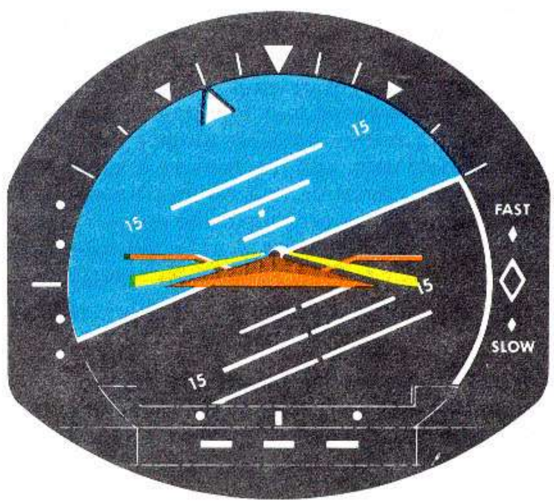
CLIMB COMMAND



CLIMB COMMAND SATISFIED



RIGHT BANK COMMAND



BANK COMMAND SATISFIED

F4407

Figure 4-29G

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 is 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 4-29G.) The rate of turn indicator shows rate of turn and slip indicator displays slip or skid. If the VOR/LOC 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 4-29E) or automatically by the altitude hold switch (3, figure 4-29E). 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 roll-out on the selected heading will result. After roll-out, 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 4-17A) on the flight instrument panel.

Course selection is made on the HSI using the course set knob (11, figure 4-29D). 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 dviation 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 establish 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 capture and at the capture point the system is armed for glide slope capture and the command bars will command a bank (up to 30 degrees) to turn onto the selected 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 4-29H for correct annunciator display for each mode selection.

NOTE

The annunciators must be checked after 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.

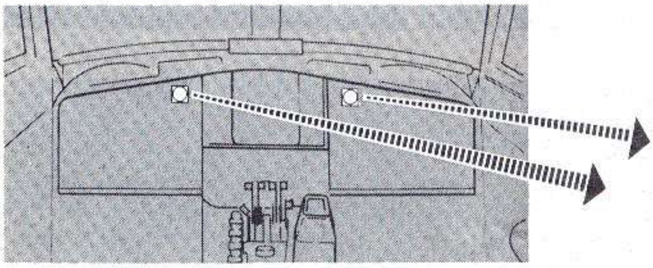
The RGA system has a stall avoidance feature which is automatically activated in certain flight conditions. If the AOA reaches 0.9 plus 0.01, a strong nosedown signal is sent to the command bars to keep the airplane away from stall. This signal overrides all other inputs to the computer. It must be emphasized 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.

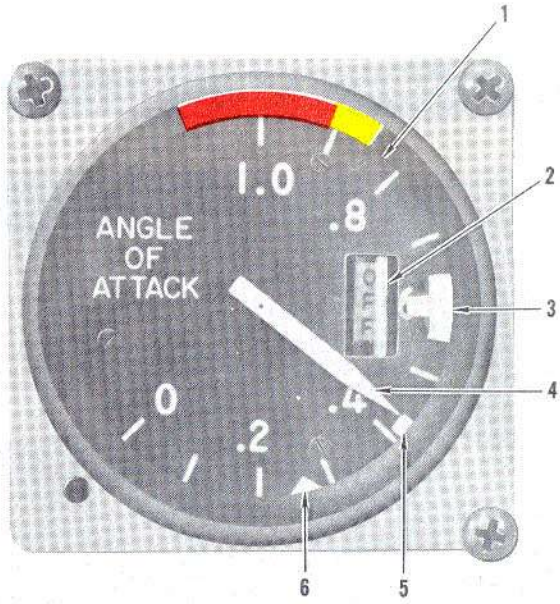
flight director annunciator chart

SELECTED MODE	CONDITION	ANNUNCIATION
RGA		Refer to figure 4-29K **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 4-29H

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 4-29-I

Angle of Attack Indicator

The angle of attack indicator (figure 4-29-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 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 independent 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 4-29J) contains the following controls: RGA power switch, takeoff climb selector switch, and approach speed deviation switch.

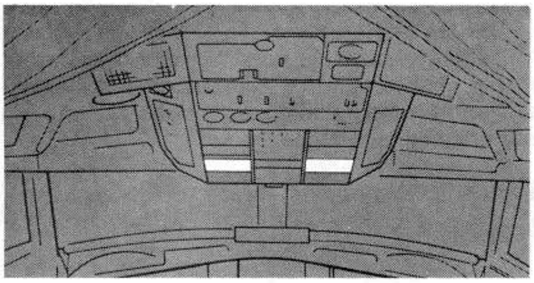
RGA Power Switch

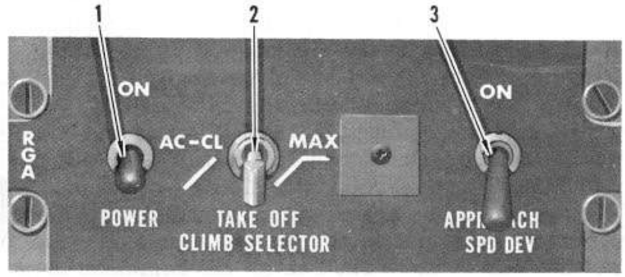
The RGA power switch (1, figure 4-29J) controls power to the RGA system components which provide vertical steering information to the ADI command bars. Power to the angle of attack indicator and speed deviation pointer is provided from another source and is not affected by the RGA power switch position.

Takeoff Climb Selector Switch

The takeoff climb selector switch (2, figure 4-29J) 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.

rotation go-around control panel





1 RGA POWER SWITCH
2 TAKEOFF CLIMB SELECTOR SWITCH
3 APPROACH SPEED DEVIATION SWITCH

Figure 4-29J

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 for accelerating climb-out profiles. 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.

Approach Speed Deviation Switch

The approach speed deviation switch (3, figure 4-29J) controls selection of the ADI speed deviation pointer (7, figure 4-29C) 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 Pushbutton Switch

The RGA pushbutton switch (5, figure 4-29E) 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. 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 is rotated to a position other than RGA.
- If both FD mode selector switches are in RGA position, depressing either the pilot's or copilot's RGA pushbutton switch will cause the takeoff rotation command to be displayed on both pilot's attitude director indicators.

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 4-29K) 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 4-29E) 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 and T/O ARM annunciators indicate the takeoff climb selector switch (2, figure 4-29J) selections. The EWO annunciator is inoperative. Refer to figure 4-29K 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.

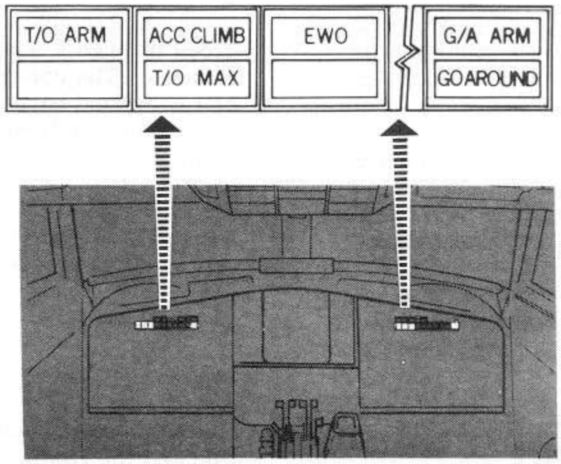
2. Depress RGA pushbutton switch just prior to rotation (within 10 knots).

NOTE

- The RGA rotation steering commands are not displayed by the ADI command bars until the RGA pushbutton switch (5, figure 4-29E) 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.

The rotation go-around system is armed for the takeoff when the airplane is on the ground, the RGA power switch (1, figure 4-29J) is ON and the flight director mode selector switch (2, figure 4-29E) is in RGA position. The takeoff climb selector switch (2, figure 4-29J) is 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.

RGA system annunciators



MODE	CONDITION	ANNUNCIATION
RGA	BEFORE RGA PUSHBUTTON ACTUATION:	
	WEIGHT-ON-WHEELS	ACC CLIMB or T/O MAX
	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
	AIRBORNE (AFTER G/A ARM)	GO AROUND
ALL OTHER MODES	WEIGHT-ON-WHEELS	T/O ARM
	AIRBORNE	G/A ARM

Figure 4-29K

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 the 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 4-29J). 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 push-button switch 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 errors 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 can be switched to another mode and pitch commands may be controlled either by the pitch command knob or altitude hold switch.

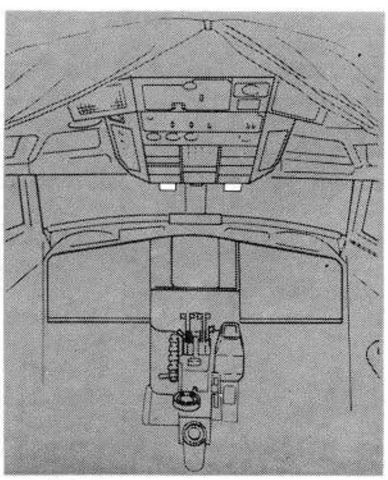
ANNUNCIATOR AND FLIGHT DIRECTOR DIMMER CONTROLS

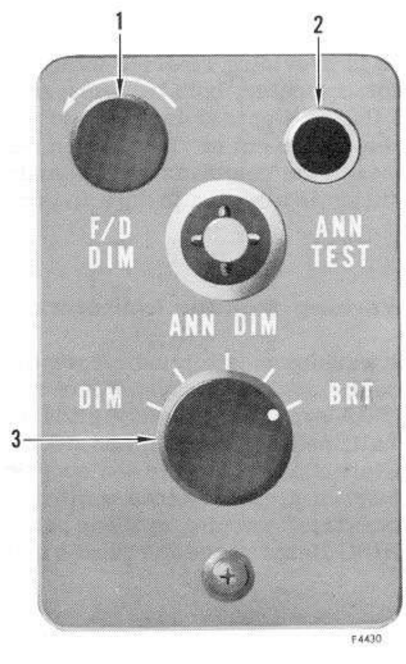
The dimmer controls for the annunciators and flight director instrument lighting are on the pilots' overhead panel. Dimmer switches are provided for each FD/RGA system. The ANN DIM switch (3, figure 4-29L) is a five position switch that provides step dimming control for the annunciator lamps, TACAN select 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 (1, figure 4-29L) dims the lighting for the ADI, HSI, radio altimeter and angle-of-attack indicator when rotated counterclockwise. The ANN TEST switch (2, figure 4-29L) 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 4-29M) 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 4-29C and 4-29D for flag display.

flight director dimmer control panel





1 FLIGHT DIRECTOR DIMMER CONTROL
2 ANNUNCIATOR TEST SWITCH
3 ANNUNCIATOR DIMMER SWITCH

Figure 4-29L

FD/RGA system warning monitor indicators

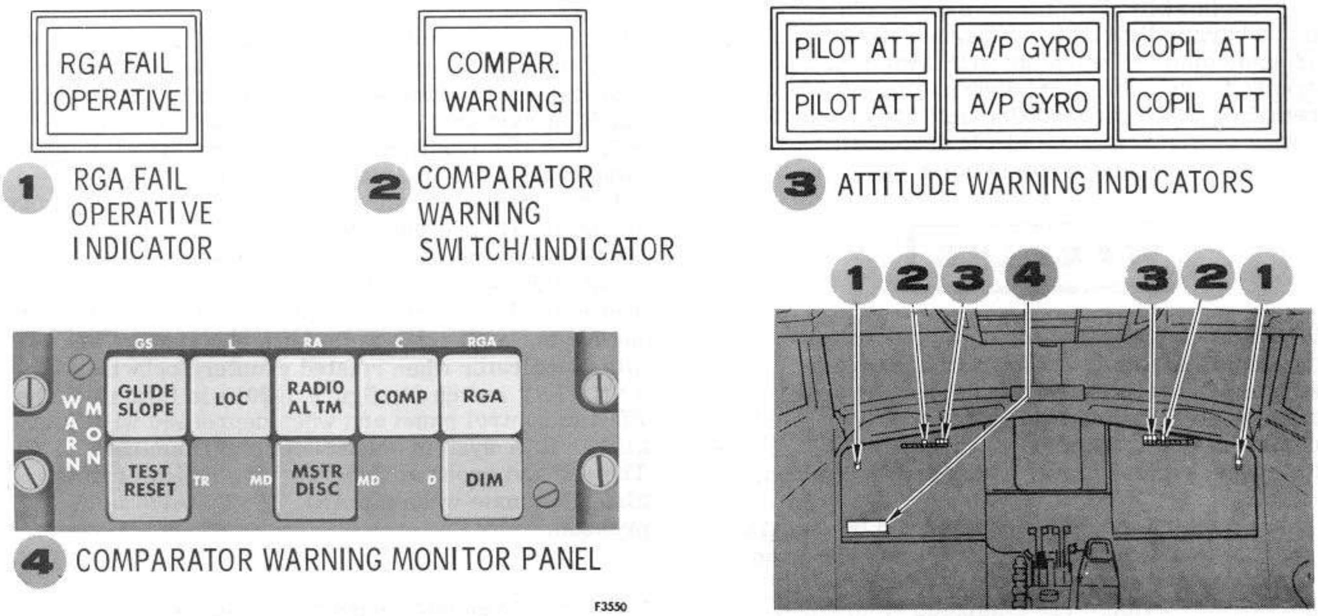


Figure 4-29M

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 and SPEED. Refer to figure 4-29N 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 4-29M) 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 4-29M) 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 4-29M) located above the pilot's and copilot's ADI's illuminate any time 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.

Attitude Warning Indicators

The attitude warning indicators (figure 4-29M) 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 (3, figure 4-29L). 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.

warning flaps 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 4-29N

RGA Fail Operative Indicator

Two RGA FAIL OPERATIVE indicators (figure 4-29M) are installed, one on each flight instrument panel, to indicate a failure of either one of the angle-of-attack transmitters. If the difference between the two angle-of-attack transmitters is 4 degrees or more, both RGA FAIL OPERATIVE indicators will illuminate. 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 will appear and the 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.

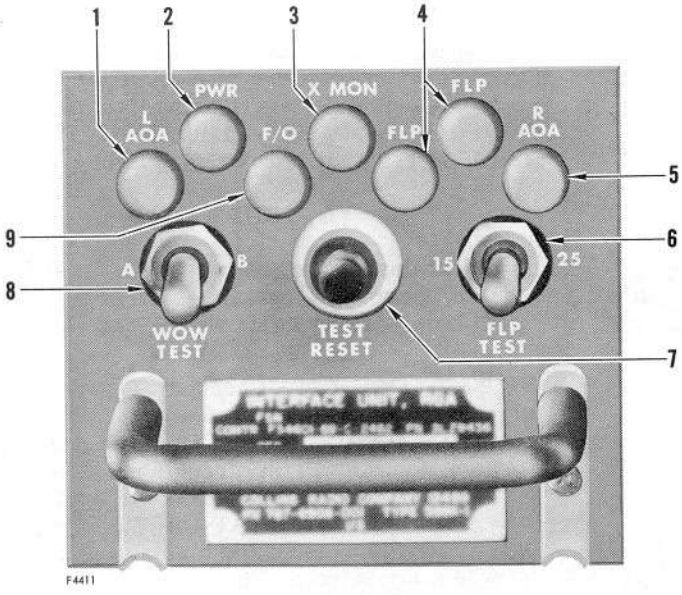
7. FD Mode Selector - GYRO (P, CP)

   Set mode selector switch to GYRO for taxiing.

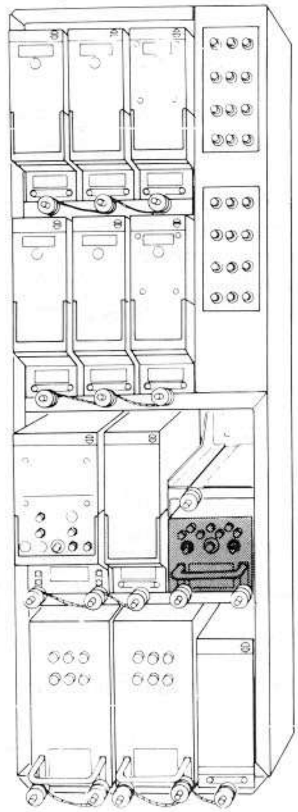
8. Radio Altimeter - Checked (P, CP)

   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



1 LEFT ANGLE-OF-ATTACK MONITOR
2 RGA SYSTEM POWER MONITOR
3 FAILURE LIGHT FOR CROSS MONITOR CIRCUITS
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



FD-109/RGA EQUIPMENT RACK

Figure 4-29-O

before takeoff

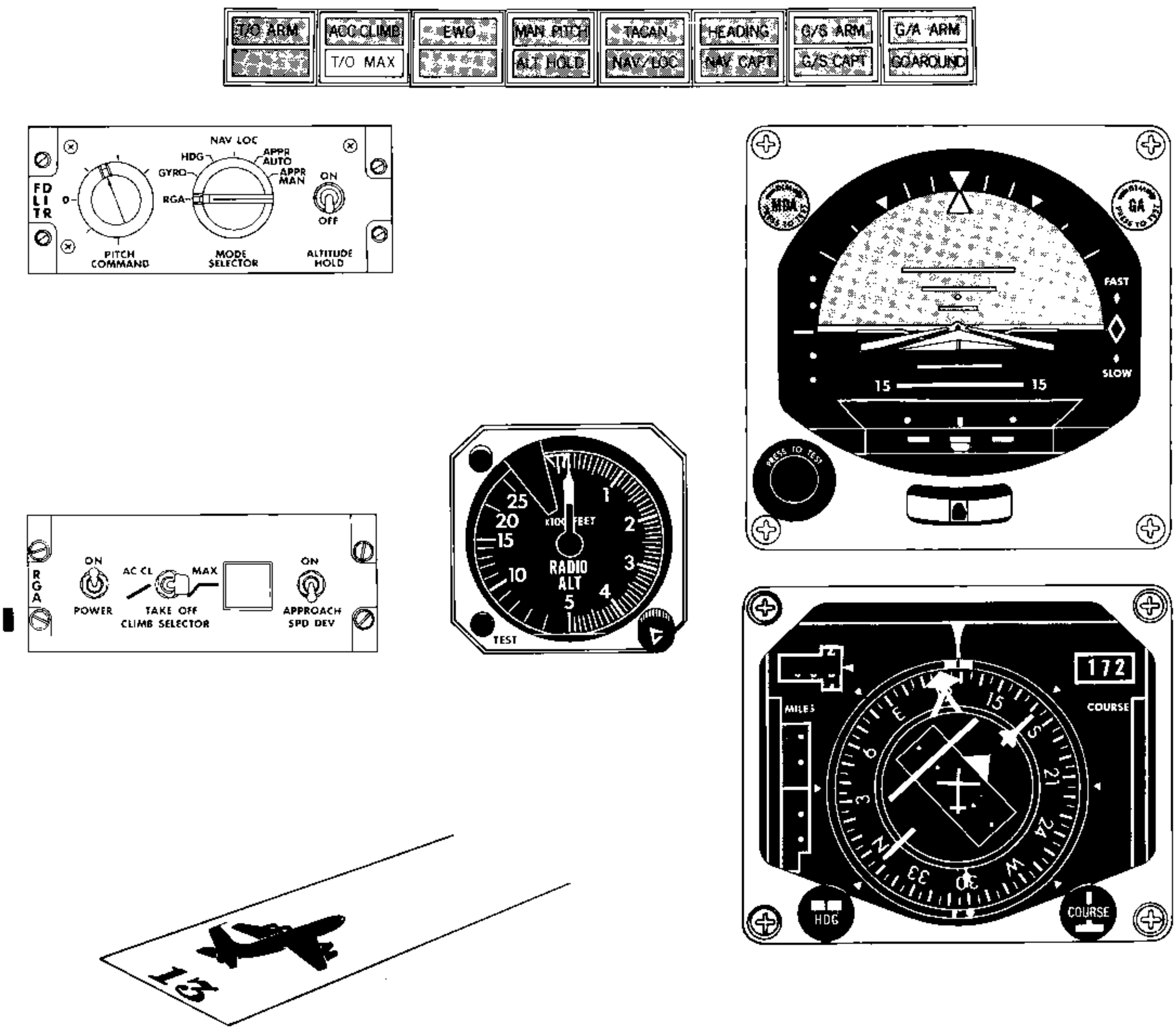


Figure 4-29P

Before Takeoff (Figure 4-29P)

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

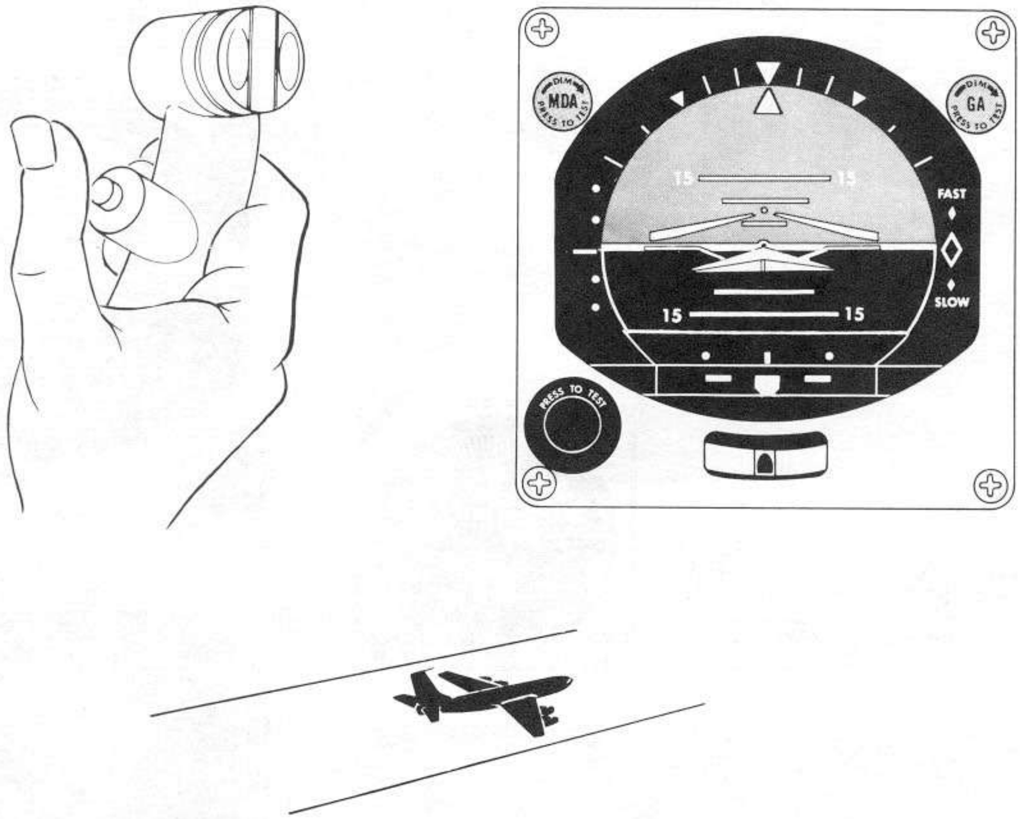


Figure 4-29Q

Takeoff (Figure 4-29Q)

The TAKEOFF illustration shows command bars display after RGA pushbutton is actuated and before airplane rotation.

After Takeoff-Climb (Figure 4-29R)

The AFTER TAKEOFF-CLIMB illustration shows a typical departure using a VOR radial. Check annunciators for correct indication. (Refer to figures 4-29H and 4-29K.) Set the manual pitch command knob for optimum climb command display for the climb to cruise altitude.

For long flights, the RGA power system should be turned off. When RGA power is OFF, inadvertent actuation will not result in any RGA commands (i.e., the command bars will not indicate takeoff or go-around commands, but will continue to display the previously selected commands). The flight director mode controller will not fly back to RGA but will stay in the previously selected mode.

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.

after takeoff-climb

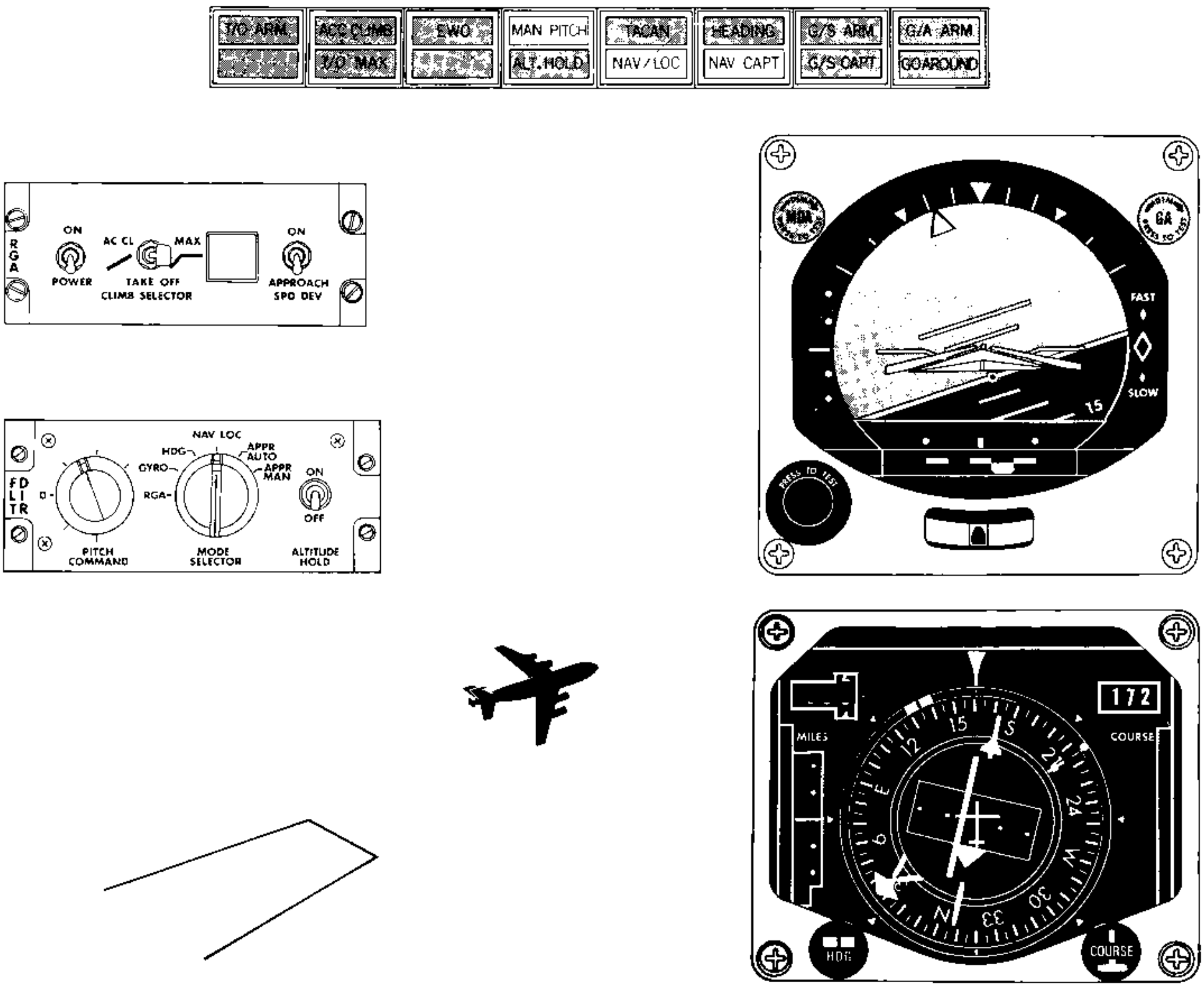


Figure 4-29R

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

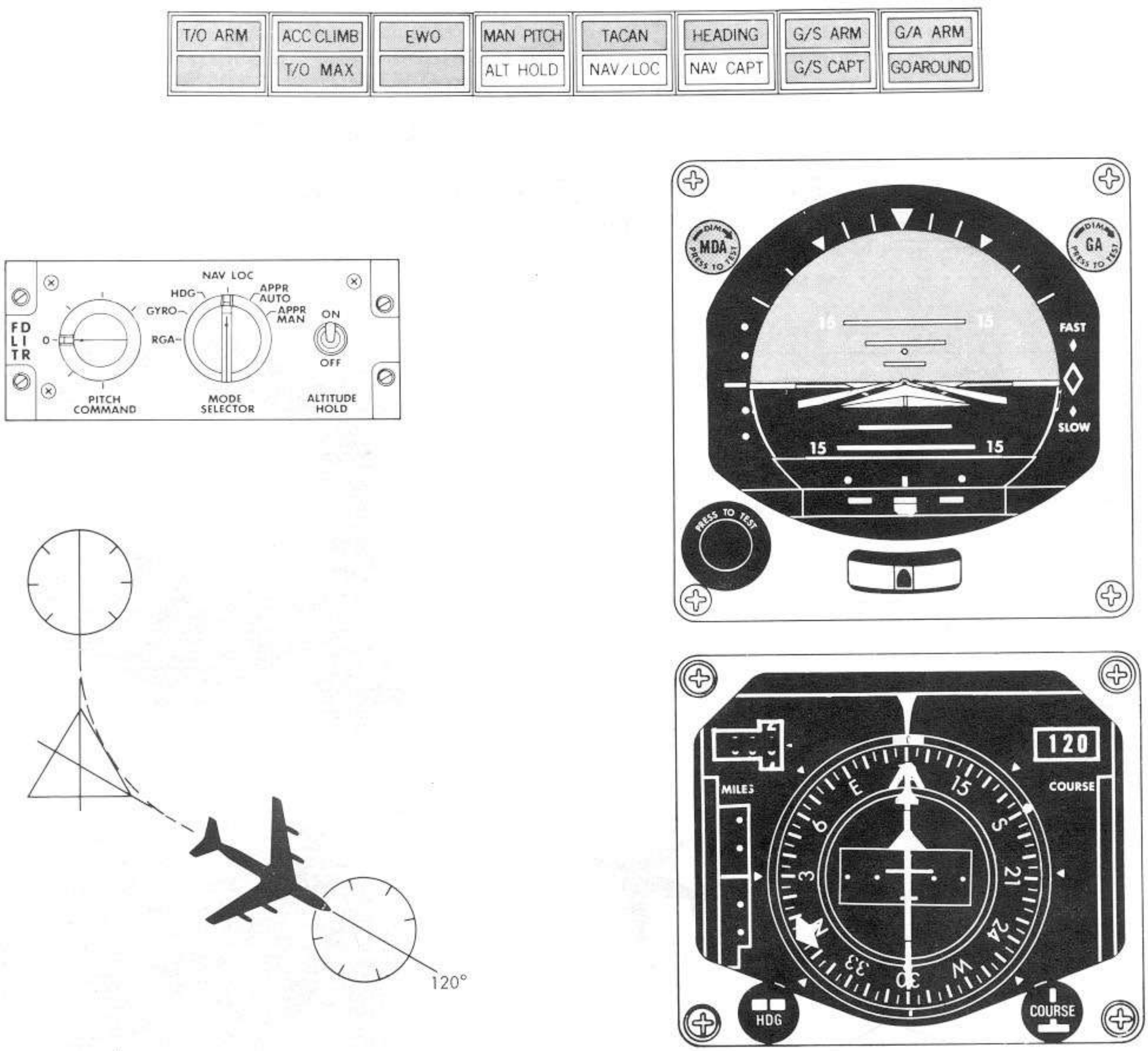


Figure 4-29S

Cruise (Figures 4-29S and 4-29T)

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.

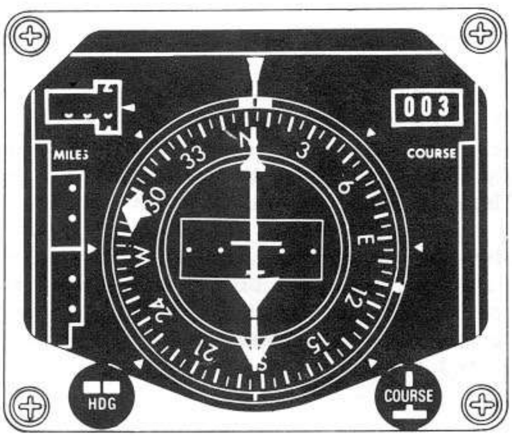
NOTE

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).

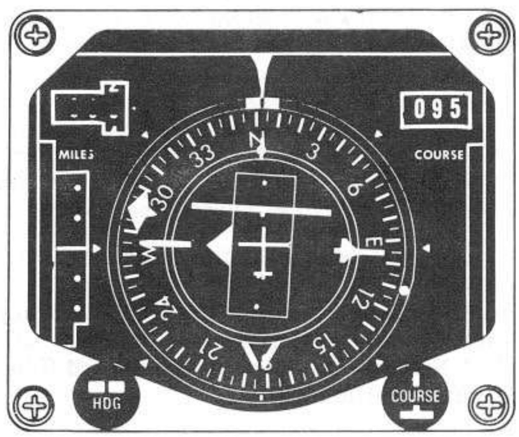
Station passage is indicated on the HSI when the first FROM indication is displayed on the TO/FROM pointer (VOR) or the range indication stops decreasing(TACAN). The ADI command bars will continue to provide course tracking commands during station passage. If the new course to be followed is more than 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.

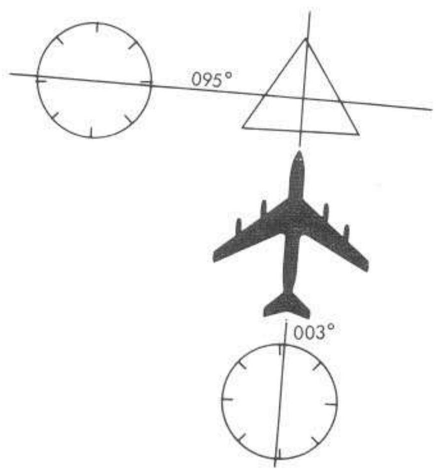
cruise-position fix



PILOT'S HSI



COPILOT'S HSI



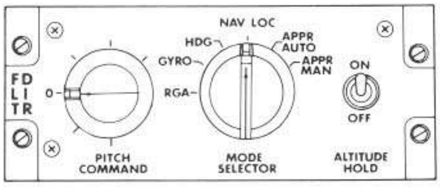


Figure 4-29T

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 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) and air refueling toggles (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 (Figures 4-29U)

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.

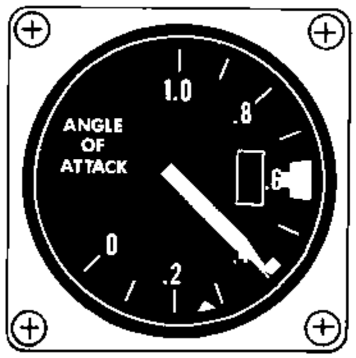
C. When the airplane reaches the holding point, the heading marker should be moved approximately 90 degrees in direction of turn to provide a bank command toward the outbound heading. As the turn progresses, continue to slew the heading marker to the outbound heading. If crosswind correction is required, move heading marker to compensate for the crosswind.

For holding without command bar display:

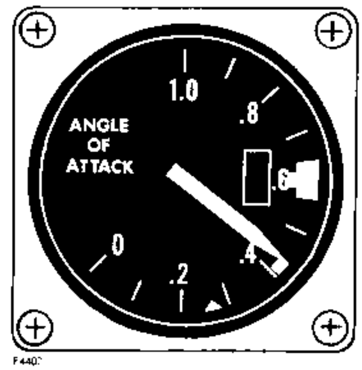
A. Set FD mode selector to GYRO, tune navigation receiver to desired station and set HSI course arrow to inbound course. Follow indications on the HSI to center the course deviation indicator. Maintain the CDI centered while inbound.

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.

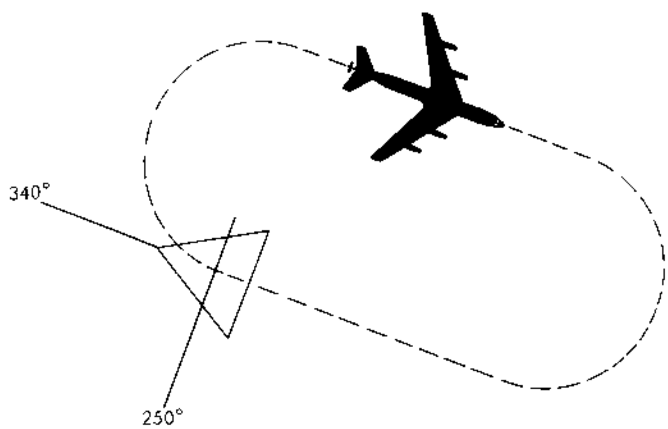
holding



ANGLE OF ATTACK INDICATION
FOR STRAIGHT AND LEVEL



ANGLE OF ATTACK INDICATION
FOR TURNS



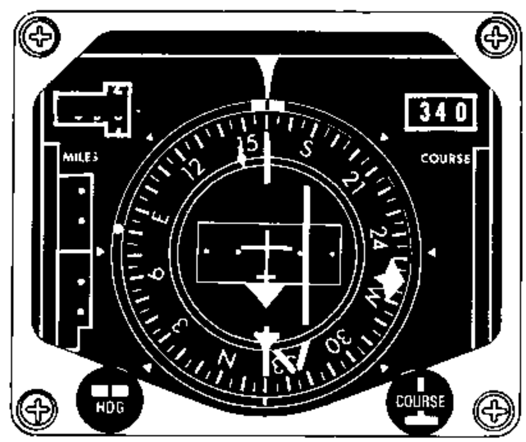


Figure 4-29U

ILS Approach (Figures 4-29V and 4-29W)

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).

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)

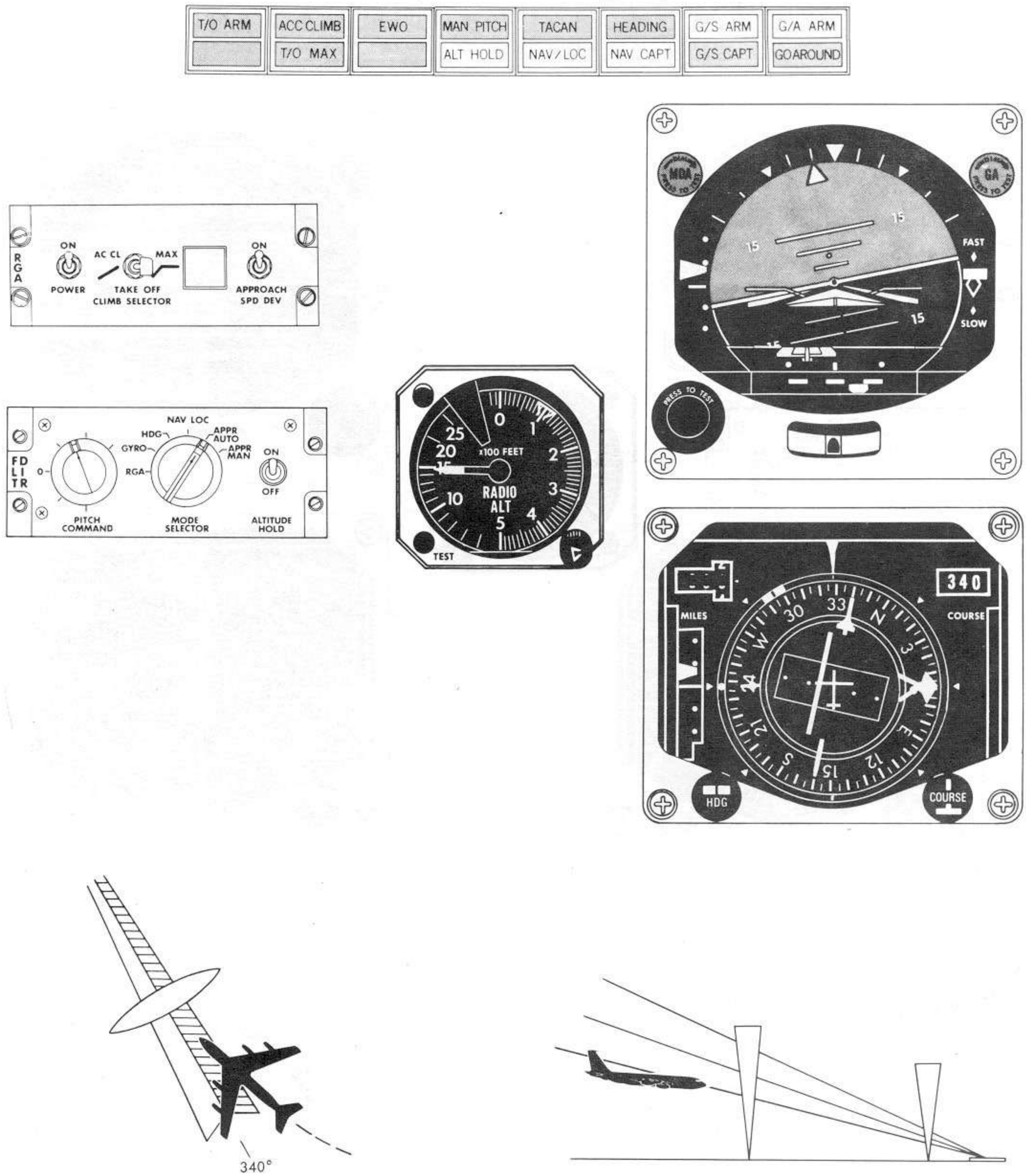


Figure 4-29V

ILS approach (APPR MAN)

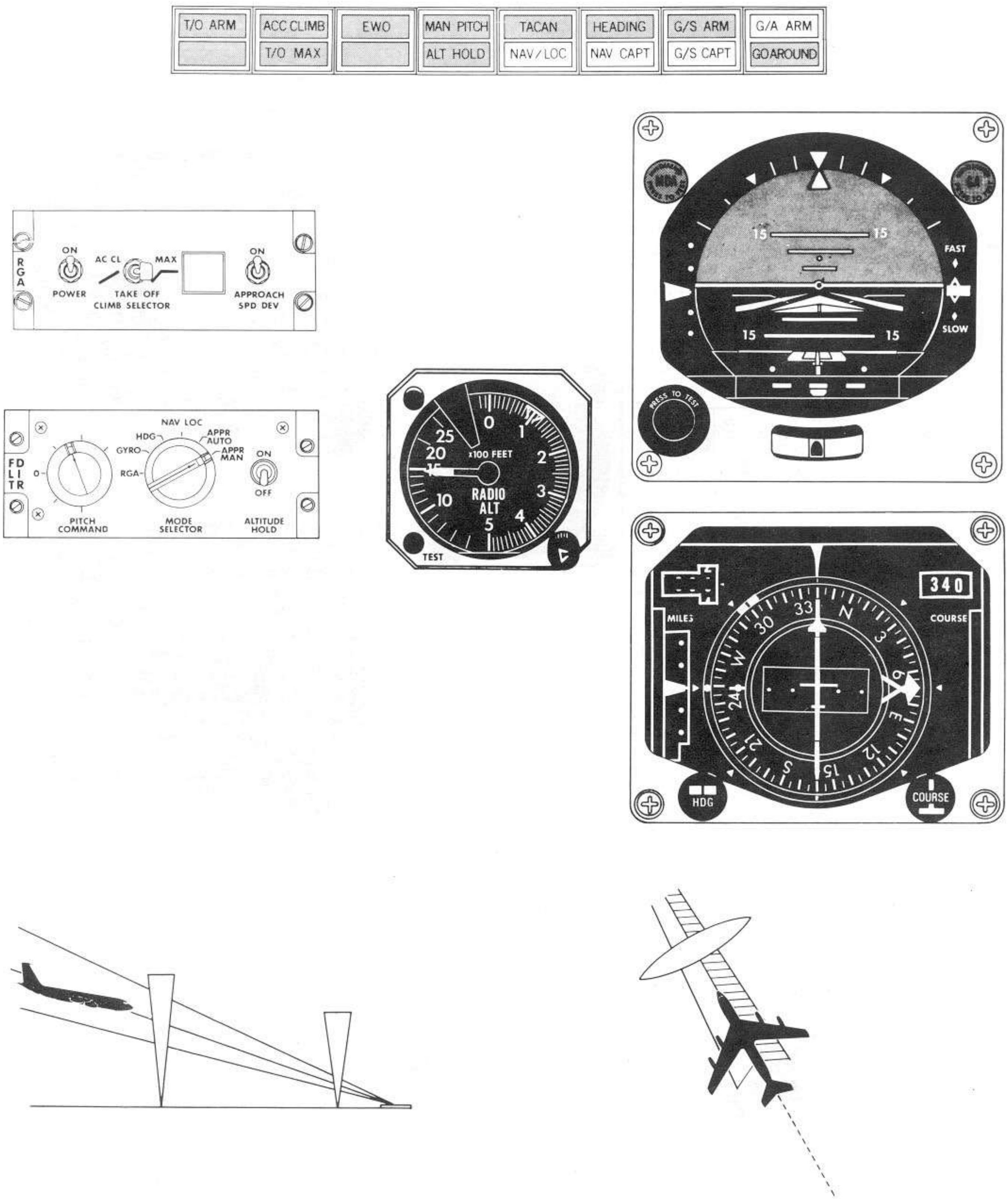


Figure 4-29W

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 4-29X)

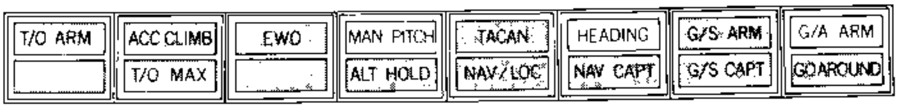
The flight director system does not provide commands for a back course approach; therefore, the localizer backcourse approach is flown with the FD mode selector in either GYRO or HDG. In HDG mode, the pilot manually controls the heading and pitch inputs to the command bars for use in the approach. Always set the course arrow to the published **inbound front course to provide directional indications on the horizontal situation indicator to avoid reversed CDI indications.**

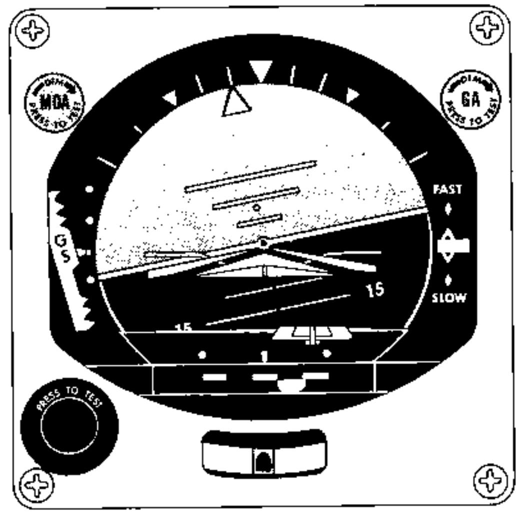
NOTE

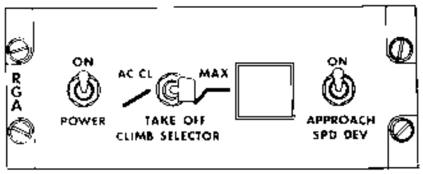
The runway symbol on the attitude director indicator is nondirectional and should not be used as a reference for lateral corrections.

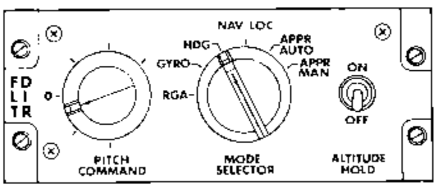
In HDG mode, intercept the backcourse using the heading marker for intercept angle desired and, when established on the localizer with the CDI centered, set the heading marker to the tail of the course arrow. Keeping the command bars and airplane symbol aligned will maintain the proper heading for the 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.

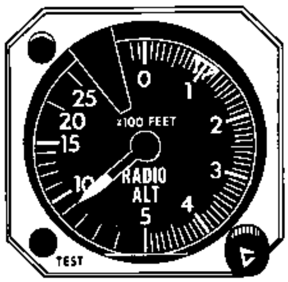
localizer backcourse approach

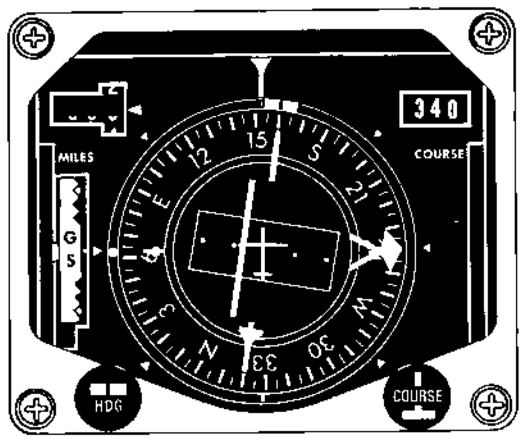












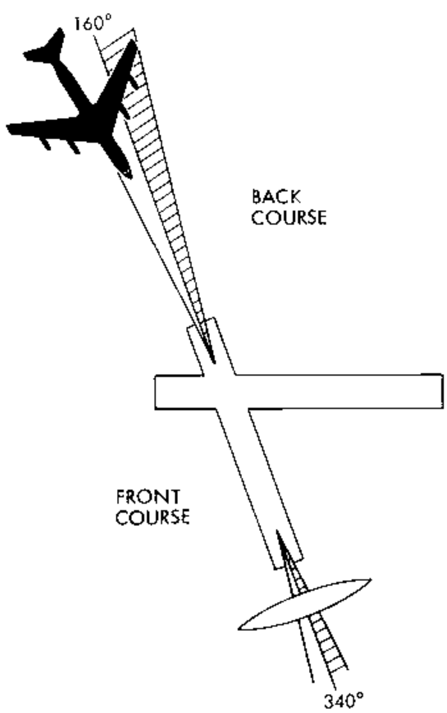


Figure 4-29X

Go-Around (Figure 4-29Y)

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.

go-around

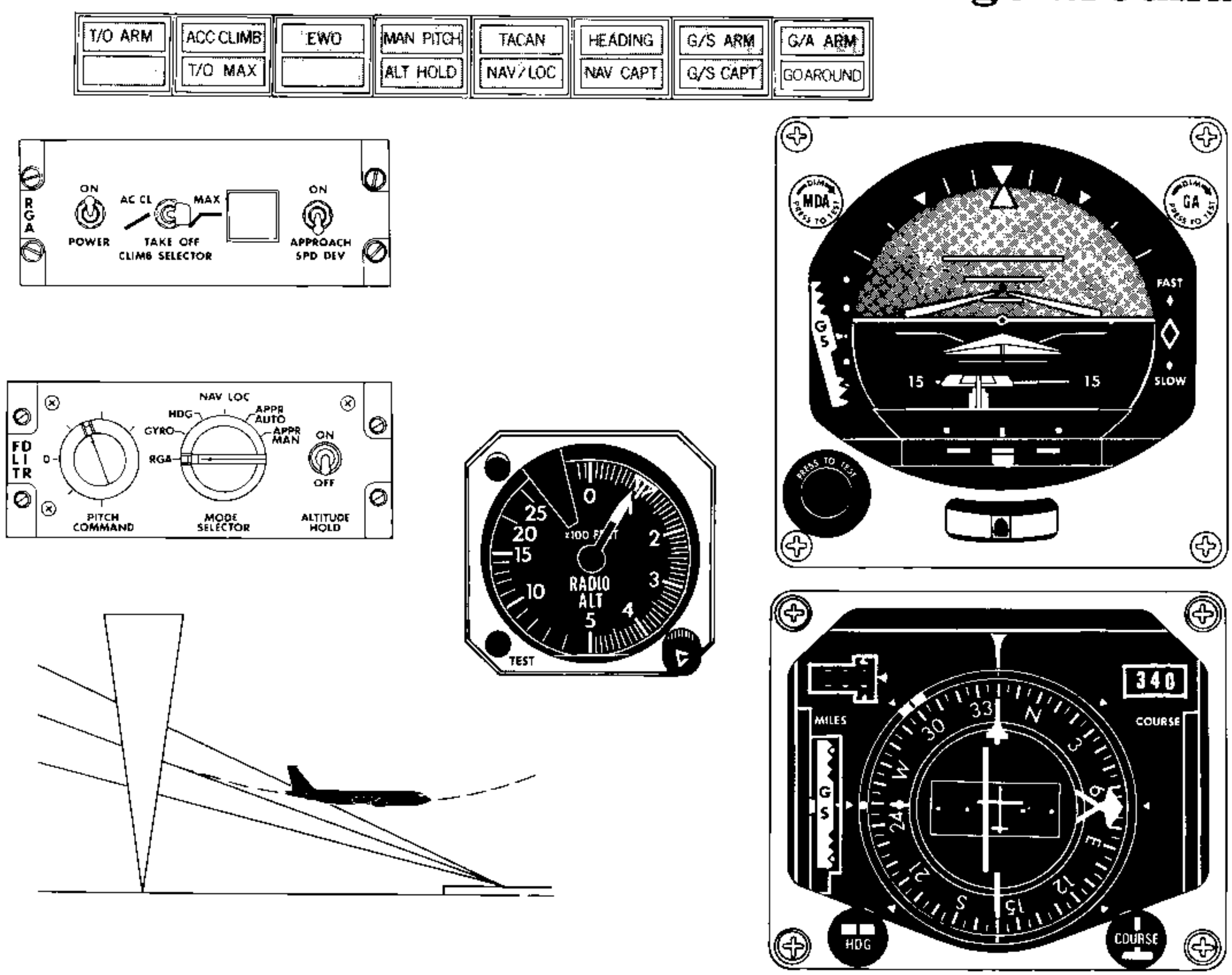


Figure 4-29Y

LIGHTING EQUIPMENT

EXTERIOR LIGHTS

The exterior lights operate on both AC and DC power. Figure 4-31 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 4-30. There is also slipway illumination for use when the airplane is a receiver. Locations of these lights are shown in figure 4-60. 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 wing (nacelle) illumination lights may also be operated from the boom operator's panel or the overhead air refueling receiver panel. Rotating beacon lights on the fuselage are for anticollision and rendezvous purposes.

NOTE

- See Section V for ground 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

The interior lighting consists of panel, console and instrument lights at the various crew, operator and staff stations; overhead lights in all compartments; reading, map and chart lights; entrance and exit lights; wheel well lights; and the portable signal lights.

Boarding Lights

One boarding light is installed in each of the four compartments of the main cabin. The boarding lights provide illumination when no AC power is on the airplane. The 28 volt DC power is supplied to the boarding lights from the battery circuit breaker panel (hot battery bus) in the crew toilet compartment. Power for the lights is routed normally through open contacts of a relay powered by 28 volts from the main circuit breaker panel; when airplane power is applied, the relay removes the boarding lights from the hot battery bus and connects it to 28 volts DC from the communications center circuit breaker panel. The master switch (1, figure 4-6) for the boarding lights is on the main cabin temperature control. This switch must be turned ON to operate the boarding lights. Individual boarding light switches are located at the overhead light switch of the compartments. The switches are used in common with other overhead light circuits. See figure 4-32 for location of overhead light switches for each compartment.

Light Control Panels

Each station is equipped with a light control panel which contains the controls for varying the intensity of instrument panel edge lighting, console lights, selector channel panel lights, chart lights and reading lights. See figures 4-32 and 4-33 for the various light controls and light control panels at the crew, operator and staff stations.

CAUTION

- The boarding light master switch must be OFF before leaving the airplane; otherwise, the battery will be rapidly depleted.
- Turn the SIDE PANEL DIM control OFF prior to changing any light bulbs on the pilot's side panels when power is on the airplane.

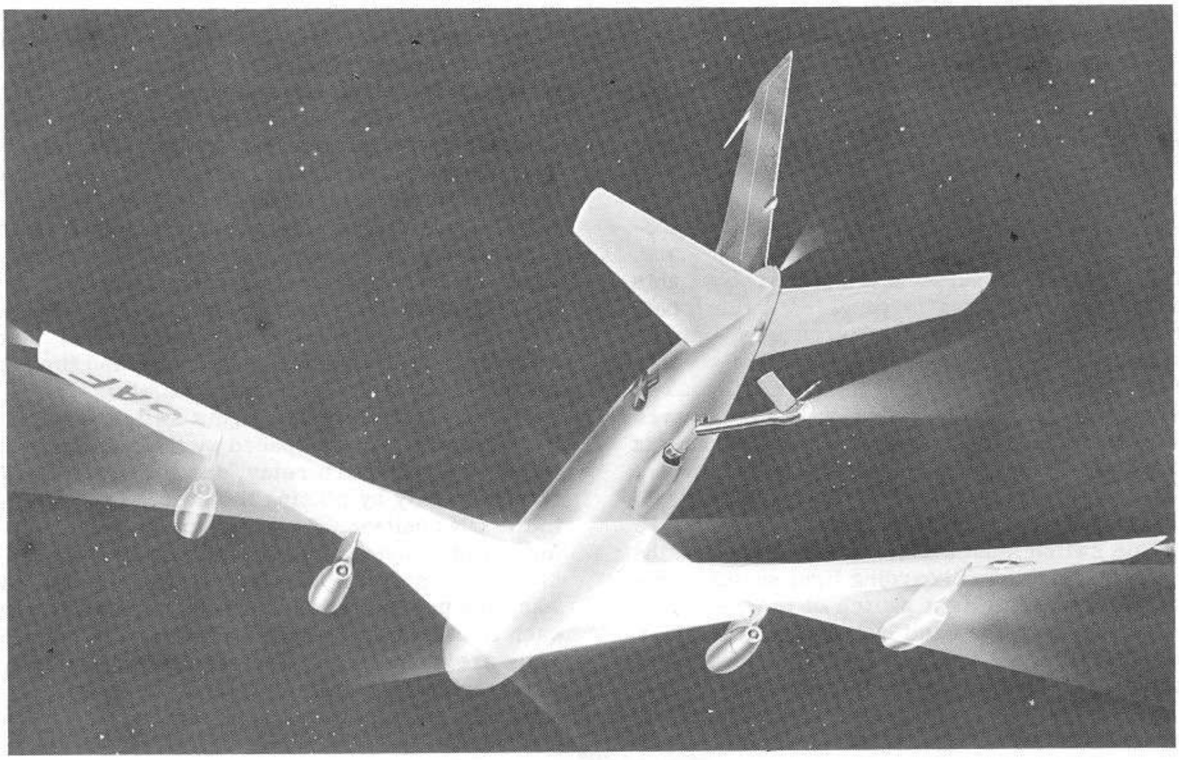
Emergency Exit Lights

Five battery-powered emergency exit lights are installed in the airplane (6, figure 3-1). One unit is mounted over each emergency exit hatch and one unit is mounted forward of the cargo door. Impact switches energize the light circuit if the forward motion of the airplane is stopped abruptly. The lights, which will illuminate each exit when energized, can also be removed and operated as hand lanterns. The lights receive arming power through a circuit breaker on the main circuit breaker panel and the ARMED position of emergency exit lights switch (8, figure 1-63) on the emergency panel. A switch on the light unit has three positions: ARMED--OFF--RESET--ON. With both switches in the ARMED position, the lights will illuminate through the power failure relay if airplane power fails and through the impact relay if the airplane stops abruptly. If the copilot's emergency exit lights switch is OFF, the light circuits will be opened by the arming relay which is a trip-latch relay, and the lights can be turned on only by placing the switch on the light unit in the ON position. An arrow on each unit indicates the correct installed position to ensure operation of the impact switch. This arrow should point forward when the unit is installed. Four dry cell batteries in each lighting unit provide power for the lamp. These cells are connected in series-parallel and are held in two tubes by retaining caps. The switch on the light unit should always be lockwired in the ARMED position.

Crew Entry Door Light

The crew entry door light is a single light over the entry chute. Two-way control switches are located at the entry door and on the switched DC bus circuit breaker panel so that the light may be turned on or off from either switch. The power for the entry light is supplied from the hot battery bus on the battery relay and circuit breaker panel. Power from the hot battery bus is also supplied through the two-way entry door light switches to two other switches located on the switched DC bus circuit breaker panel. One switch, labeled APU Alert Light, routes power to the compartment No. 1 overhead lights for starting and monitoring the APU during night alert status. The other switch, labeled Pilot's Alert Light, routes power to the thunderstorm lights for starting and monitoring the airplane engines during night alert status.

tanker and receiver illumination



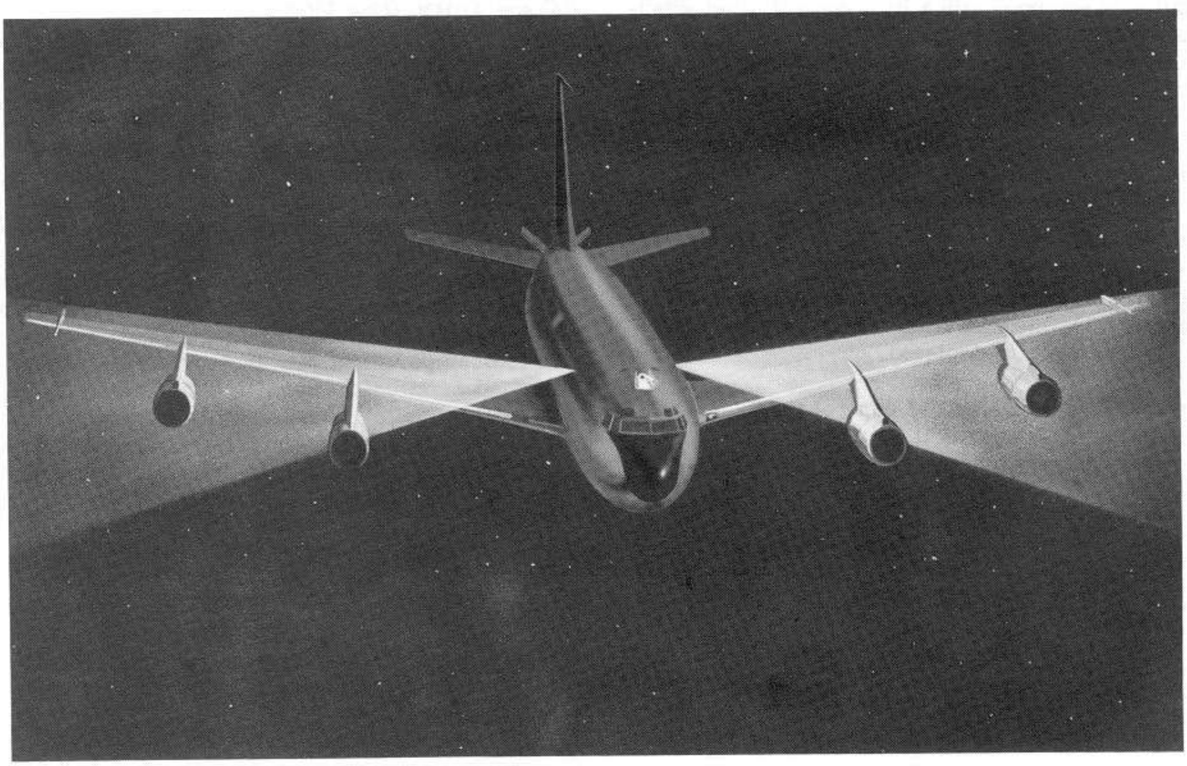


Figure 4-30

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Cargo Door Entry Lights

The cargo door entry lights consist of two lights mounted on the cargo door (15, figure 4-67). Light control is through the cargo door entry lights switch and the cargo door closed relay. The cargo door lights switch (2, figure 4-6) with OFF--ON positions is on the main cabin temperature control panel in compartment No. 1. Closing the cargo door actuates the cargo door closed relay and turns off the entry lights. Power for the lights is supplied from the communications center circuit breaker panel.

Control Cabin Flood, Spot and Dome Lights

The control cabin flood, spot and dome lights consist of lights for illumination of instruments and controls on the panels at all stations in the control cabin. It also includes the cabin dome lights, lower nose compartment dome lights, toilet compartment dome and mirror lights, and the electronics cabinet No. 1 lights. The control cabin lights are supplied 28 volts DC from the copilot's instrument power panel and the switched DC bus circuit breaker panel. The 28 volt AC power is supplied from the main circuit breaker panel.

The controls for varying the intensity of the floodlights are the pilots' light control on the pilots' overhead panel and the light control on the navigator's instrument panel. The control for the control cabin dome light is on the navigator's instrument panel. The spot lights and dome lights for the sextant, crew toilet, electronics cabinet No. 1, and lower nose compartment are operated with controls located near each light.

Compartment 1 Lights

The overhead lighting for compartment No. 1 consists of the overhead dome lights, multiplex spot and floodlights, service light, and the power supplies and controls (figure 4-32). The multiplex spot and floodlights and compartment overhead lights operate on 28 volts AC from the communications center circuit breaker panel. The service light is supplied 28 volts DC from the communications center circuit breaker panel. Both the multiplex spot light and the service light come on when airplane power is on. The compartment No. 1 overhead lights and the multiplex floodlights are turned on with the compartment No. 1 light switch located on the aft bulkhead of the crew's toilet compartment. Compartment No. 1 lights may also be turned on through a switch labeled APU Alert Light on the switched DC bus circuit breaker panel when either of the entry door light switches are on.

Compartment 2 Lights

The overhead lighting for compartment No. 2 consists of the overhead dome lights, LF antenna console lights, radio operator's console and table lights, crypto table lights, and the power supplies and controls (figure 4-32). All lights in compartment No. 2 are supplied 28 volts AC through circuit breakers on the communications center circuit breaker panel. The overhead lights are turned on and off by the compartment No. 2 light control switch which is mounted on the LF control cabinet by the forward door to compartment No. 2. The console lights are variable intensity lights and are controlled by autotransformers and rheostats located on the consoles.

Compartment 3 Overhead Lights

The overhead lighting for compartment No. 3 consists of the compartment dome lights, the power supplies and the control switch (figure 4-32). The lights are supplied 28 volts AC through the communications center circuit breaker panel. The lights are turned on and off at the compartment No. 3 light control panel on the forward bulkhead of compartment No. 3.

Compartment 3 Reading and Chart Lights

The reading and chart lights consist of single-contact bayonet-base lights and rheostats for intensity control. The lights are mounted over the staff consoles. The power for the circuits is supplied through 28 volt AC circuit breakers on the communication center circuit breaker panel. Illumination intensity variation for the chart lights is provided through an autotransformer located on each reading light fixture.

Compartment 4 Overhead Lights

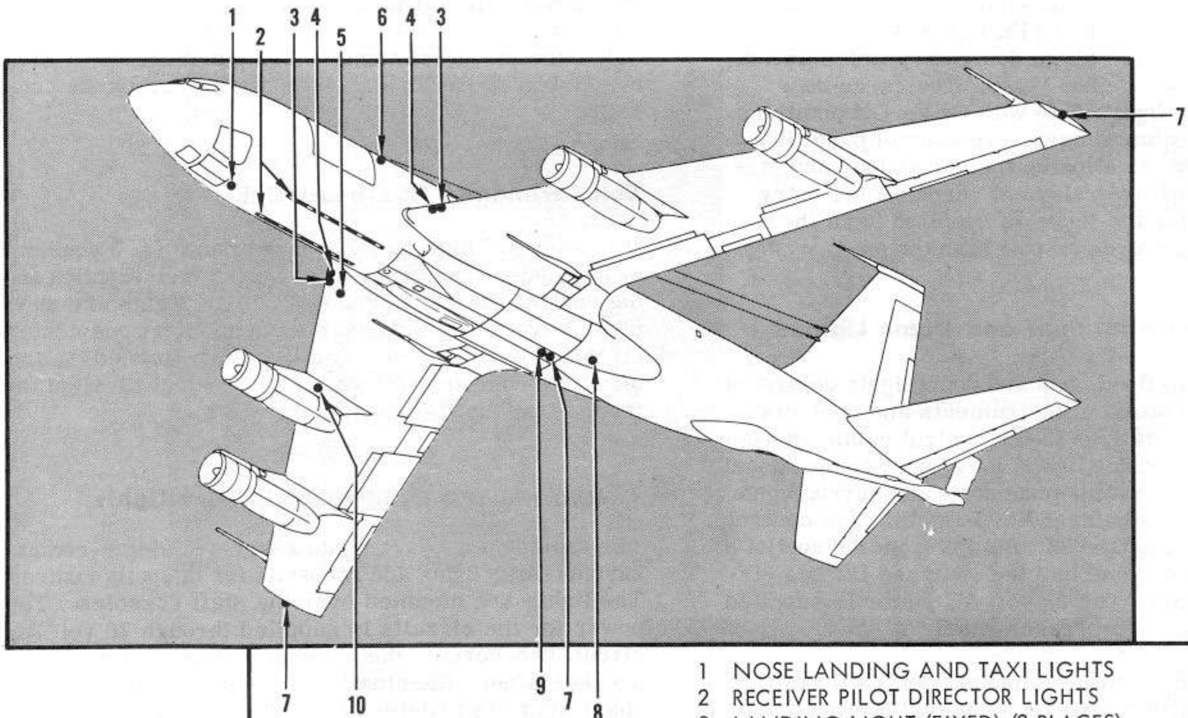
The overhead lighting for compartment No. 4 consists of the compartment dome lights, power supplies and control switches (figure 4-32). The lights are controlled through a relay on the electrical equipment rack. The relay operates on 28 volts DC from the communications center circuit breaker panel. Power is applied to the relay by turning on the dome and ceiling light switch on the forward bulkhead of compartment No. 4.

The aft pair of overhead lights can be turned off by the rest area lights switch. The switch is adjacent to the bunk reading light on the right side of the airplane.

Compartment 4 Reading and Bunk Lights

The reading lights for compartment No. 4 are the forward and aft reading lights. The bunk lights are located over the bunks. The reading lights have separate on-off switches for two of the three lights at each position. The third light of each reading light installation can be varied in intensity. The variable intensity lights of both reading light installations are controlled by the station lights rheostat on the light control panel at the flight traffic specialist's console. The power for the reading lights and the control illumination and indicator lights is supplied through a 28 volt DC circuit breaker on the communications center circuit breaker panel. The intensity of the control illumination and indicator light is varied with the panel lights rheostat on the light control panel.

exterior lighting



1 NOSE LANDING AND TAXI LIGHTS
2 RECEIVER PILOT DIRECTOR LIGHTS
3 LANDING LIGHT (FIXED) (2 PLACES)
4 TAXI LIGHT (2 PLACES)
5 TERRAIN LIGHT (RETRACTABLE)
6 NACELLE ILLUMINATION LIGHT (TYPICAL) (2 PLACES)
7 NAVIGATION LIGHT (7 PLACES)
8 UNDERWING ILLUMINATION LIGHT (TYPICAL)
9 ROTATING BEACON LIGHTS (2 PLACES)
10 UNDERBODY ILLUMINATION LIGHT (TYPICAL)
11 SLIPWAY ILLUMINATION LIGHTS
12 BOOM MARKER LIGHTS (FLUORESCENT)
13 BOOM NOZZLE LIGHT

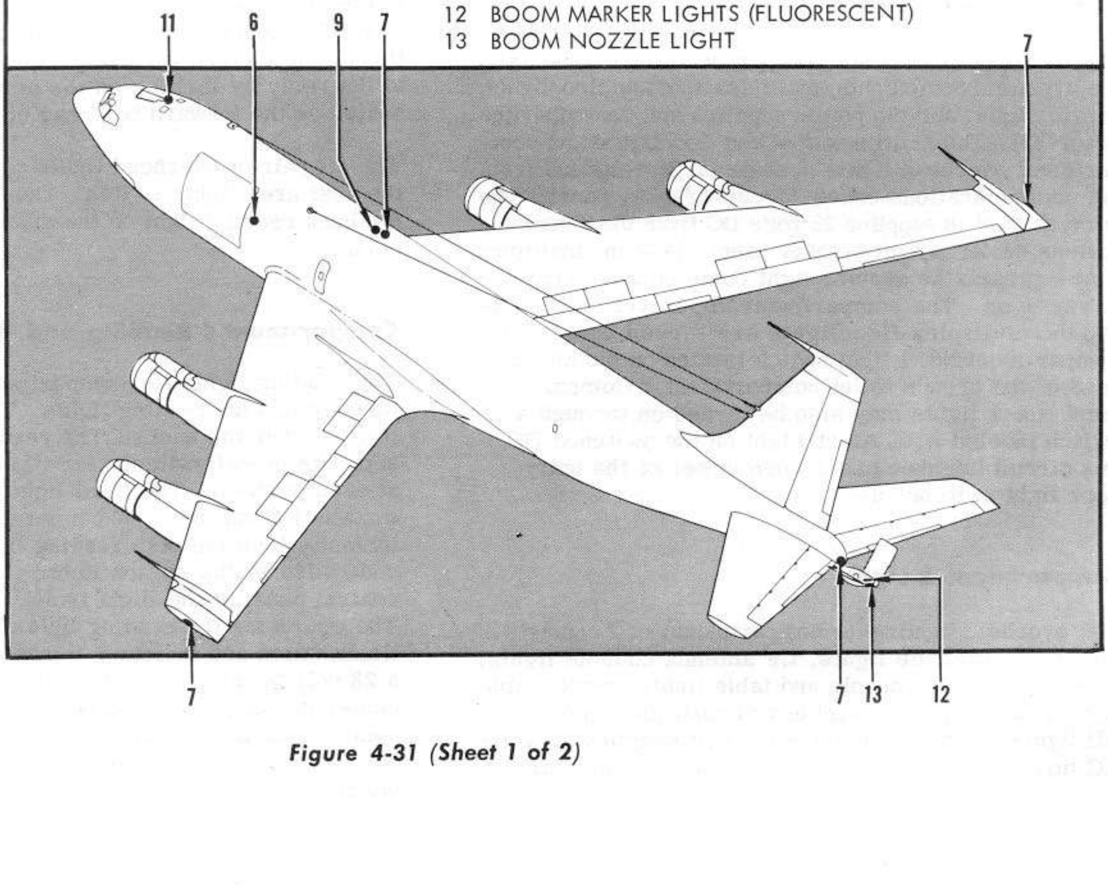


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Figure 4-31 (Sheet 1 of 2)

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 AND TAXI LIGHTS				(4) Landing Light Wing, Landing Light Nose, Taxi & Landing Light Control, and Retractable Landing Light Control on the MCBP; also (1) in lower nose compartment, (2) in R wing, (1) in L wing adjacent to light fixture
LANDING LIGHTS	3 White	Leading edge of inboard wing and nose gear	Pilot's center instrument panel	
TAXI LIGHTS	2 White	Leading edge of inboard wing		
TERRAIN LIGHT (RETRACTABLE)	1 White	Under leading edge of right wing	Pilot's center instrument panel	
NACELLE ILLUMINATION	2 White	On fuselage above and forward of the leading edge of wing	Overhead air refueling receiver panel, pilot's center instrument panel and boom operator's panel	(1) External Lights, Nac on the BOCBP, (3) Nacelle Illum Lt on MCBP
NAVIGATION LIGHTS	6 White Red Green Yellow	Wing tips and tail cone upper and lower fuselage	BRIGHT--DIM switch and FLASH--STEADY switch on overhead panel	(3) Navigation Light Flasher, Navigation-Body, and Navigation Wing and Tail on the MCBP
PORTABLE SIGNAL LAMP	1 White	Forward emergency equipment panel in control cabin	Switch on signal lamp	(1) Portable Signal 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	2 Red Green White	Upper and lower surface of fuselage at trailing edge of wing	Overhead panel	(2) Rendezvous, Lower and Upper on the MCBP
SLIPWAY ILLUMINATION	3 White	In air refueling receptacle and on slipway doors	Rheostat switch on overhead air refueling receiver panel	(1) A/R Receptacle Light on the MCBP
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	(1) Wheel Well on the MCBP

* All color lights are white bulbs with color filters

Figure 4-31 (Sheet 2 of 2)

interior lighting

* All color lights are white bulbs with color filters

LIGHTS	*QTY COLOR	LIGHT LOCATION	SWITCH LOCATION	NO. OF CB'S LABEL & LOC
PILOTS				
PILOTS' FORWARD AND SIDE PANEL FLOOD LIGHTS	4 Red	Pilots' instrument panel light and glare shield	Rheostat switch on pilots' overhead panel light control	(1) Flood, Pilot Panel on the MCBP
PILOTS' INSTRUMENT PANEL AND CONTROL CABIN THUNDERSTORM LIGHTS	3 White	Pilots' instrument panel light and glare shield, and aft of overhead panel	Rheostat switch on pilots' overhead panel light control also Pilot's Alert Light switch on switched DC bus CBP	(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 pilots' overhead panel light control	(1) Flood, Control Stand on the MCBP
MAGNETIC COMPASS LIGHT	1 Red	Magnetic compass, top center of pilots' instrument panel	Rheostat switch on overhead air refueling receiver panel	(1) Magnetic Compass Light on the SBCBP
TAKEOFF AND LANDING DATA CARD HOLDER	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	38 White	Adjacent to Each Instrument	Rheostat Switch on Pilot's Overhead Light Control Panel	(1) Pilot Panel on the MCBP
PILOT'S SIDE PANEL LIGHTS	23 Red	Adjacent to Each Instrument	Rheostat Switch on Pilot's Side Panel	(1) Pilot Panel on the MCBP
COPILOT'S FLIGHT INSTRUMENT PANEL LIGHTS	45 White	Adjacent to Each Instrument	Rheostat Switch on Copilot's Overhead Light Control Panel	(1) Panel Lights on the CIPP
COPILOT'S SIDE PANEL LIGHTS	17 Red	Adjacent to Each Instrument	Rheostat Switch on Copilot's Side Panel	(1) Panel Lights on the CIPP
PILOT'S FLIGHT DIRECTOR LIGHTS	22 White	Interior of Each Instrument	Rheostat Switch on Pilot's Side of Overhead Panel	(1) Pilot Panel on the MCBP
COPILOT'S FLIGHT DIRECTOR LIGHTS	22 White	Interior of Each Instrument	Rheostat Switch on Copilot's Side of Overhead Panel	(1) Panel Lights on the CIPP
ENGINE INSTRUMENT PANEL LIGHTS	29 White	Adjacent to instruments	Rheostat switch on pilots' overhead panel light control	(1) Engine Instrument on the MCBP

Figure 4-32 (Sheet 1 of 5)

LIGHTS	QTY COLOR	LIGHT LOCATION	SWITCH LOCATION	NO. OF CB'S LABEL & LOC
FUEL PANEL LIGHTS	24 White	Adjacent to instruments	Rheostat switch on copilots' overhead panel light control	(1) Fuel Panel on the MCBP
PILOTS' OVERHEAD PANEL LIGHTS	116 Red	Adjacent to instruments	Rheostat switch on copilot's overhead panel lights control	(1) Overhead Panel on the MCBP
PILOTS' OVERHEAD PANEL FLOOD LIGHT	1 Red	On floor between pilots' seats	Rheostat switch on copilot's overhead panel light control	(1) Overhead Instrument Panel Flood on the MCBP
STABILIZER TRIM INDICATOR LIGHT	1 Red	Adjacent to trim wheel	Same as fuel panel lights	(1) Fuel Panel on the MCBP
NAVIGATOR				
NAVIGATOR'S INSTRUMENT FLOOD LIGHTS	1 White or 2 Red	Above navigator's instrument panel	RED--WHITE switch and rheostat switch on navigator's instrument panel	(1) Flood, Navigator Instrument on the MCBP
NAVIGATOR'S INSTRUMENT PANEL LIGHTS	83 Red	Adjacent to instruments	Rheostat switches on navigator's instrument panel	(1) Navigator Instrument and Panel on the MCBP
NAVIGATOR'S TABLE FLOOD LIGHTS	4 White or 4 Red	Bottom of navigator's instrument panel	RED--WHITE switch and rheostat switch on navigator's instrument panel	(1) Flood, Navigator Table on the MCBP
NAVIGATOR'S WORK AND SPOT LIGHT	1 White or Red	Right side of navigator's table	Rheostat switch on spotlight cover	(1) Spot Lights on the CIPP
SEXTANT LIGHT	1 Red	Sextant	This light is illuminated when sextant is connected	(1) Sextant on the MCBP

Figure 4-32 (Sheet 2 of 5)

* All color lights are white bulbs with color filters

LIGHTS	* QTY COLOR	LIGHT LOCATION	SWITCH LOCATION	NO. OF CB'S LABEL & LOC
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
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 spotlight cover	(1) Spot Lights on the CIPP
ELECTRONIC RACK LIGHT	1 White	Forward end of electronic rack	Forward end of electronic rack	(1) Dome, Cabin on the MCBP
EMERGENCY EXIT LIGHT	1 White	Above crew entry chute	Pilots' overhead panel and inertia switch in unit	(2) Emerg Exit Light on the MCBP and the Battery CBP
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 CBP
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 & Compt Lights on the BOCBP
BOOM OPERATOR'S COMPARTMENT LIGHT	1 White	Fwd bulkhead of boom operator's compt	On boom operator instructor's panel and on right side of entryway to compt	(1) Panel & Compt 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 AND INSTRUCTOR'S PANEL LIGHTS	60 Red	Adjacent to instruments	Two rheostat switches on boom operator's circuit breaker panel	(2) Panel Lights and Panel & Compt Lights on the BOCBP
BOOM OPERATOR'S AND INSTRUCTOR'S OXYGEN PANEL FLOOD LIGHTS	2 White	Over each oxygen panel	Boom operator's circuit breaker panel	(1) Panel & Compt Lights on the BOCBP
COMPARTMENT LIGHTS				
LOWER NOSE COMPARTMENT AFT LIGHT	1 White	On the ceiling of the lower nose compartment	Adjacent to the light	(1) Dome, Lower Compartment on the MCBP

Figure 4-32 (Sheet 3 of 5)

interior lighting (cont)

* All color lights are white bulbs with color filters

[illegible]	[illegible]	LIGHT LOCATION	SWITCH LOCATION	NO. OF CB'S LABEL & LOC
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
MIRROR LIGHT	1 White	Above mirror in crew toilet	Same as crew toilet dome light (mirror light works in WHITE position only)	(1) Dome, Cabin on the MCBP
TAIL COMPARTMENT DOME LIGHT	1 White	On ceiling aft of aft pressure bulkhead	Aft pressure bulkhead	(1) Panel & Compt Lights on the BOCBP
MAIN CABIN				
AFT TOILET DOME LIGHTS	2 White	Overhead in aft toilet compartments	Toilet wall	(1) Compt 4 Lighting, Toilet on the CCBP PL-26
AIRBORNE PERFORMANCE MONITOR CONSOLE PANEL LIGHTS	20 White	On APM console panels	Rheostat switch on APM console light control panel	(1) PM CSL PNL LTG on the CCBP PL-25
AIRBORNE PERFORMANCE MONITOR CONSOLE STATION LIGHTS	4 White	Top of APM console	Rheostat switch on APM console light control panel	(1) PM CSL OVHD LTG on the CCBP PL-25
BOARDING LIGHTS	4 White	On ceiling in each compartment	Main cabin temperature control panel in compt 1 (fwd of cargo door) and a switch in each compartment	(2) Boarding Lts on the CCBP PL-26 and Boarding Lights on the Battery CBP
BUNK READING LIGHTS	2 White	Aft bulkhead of compt 4	Rheostat switches on light support	(1) Compt 4 Lighting, Bunk on CCBP PL-26
CARGO DOOR LIGHTS	2 White	On cargo door	Main cabin temperature control panel	(1) Compt 1 Cargo Door Entry on the CCBP PL-26
CHART LIGHTS	26 White	Above the consoles in compt 3	Rheostat switches on right fwd bulkhead of compt 3	(4) Compt 3 Chart Lights on CCBP PL-26
COMPARTMENT 1 OVERHEAD LIGHTS	4 White	Compt 1 ceiling	Left bulkhead in passage to control cabin	(2) Compt 1 Fwd and Ctr on CCBP PL-26
COMPARTMENT 2 OVERHEAD LIGHTS	4 White	Compt 2 ceiling	Side of L.F. radio control console near door also, APU Alert Light switch on switched DC bus CBP	(2) Compt 2 Sta 710 and 790 on CCBP PL-26
COMPARTMENT 3 OVERHEAD LIGHTS	26 White	Compt 3 ceiling	Right fwd bulkhead of compt near door	(8) Compt 3 Sta 870, 900, 940, 960, 1000, 1020, 1060 and 1080 on CCBP PL-26
COMPARTMENT 3 PANEL AND ATC SIGNAL LIGHTS	21 White	Compt 3 command consoles	Rheostat switches on compt 3 command consoles	(7) Compt 3 Panel Lights L.H. and R.H. on the CCBP PL-25 and Control Indicator Lights on the CCBP PL-27
COMPARTMENT 4 CONSOLE LIGHTS	9 White	Adjacent to instruments	Rheostat switches on the light control panel	(1) Compt 4 Lights, Stewards Station, on the CCBP PL-25

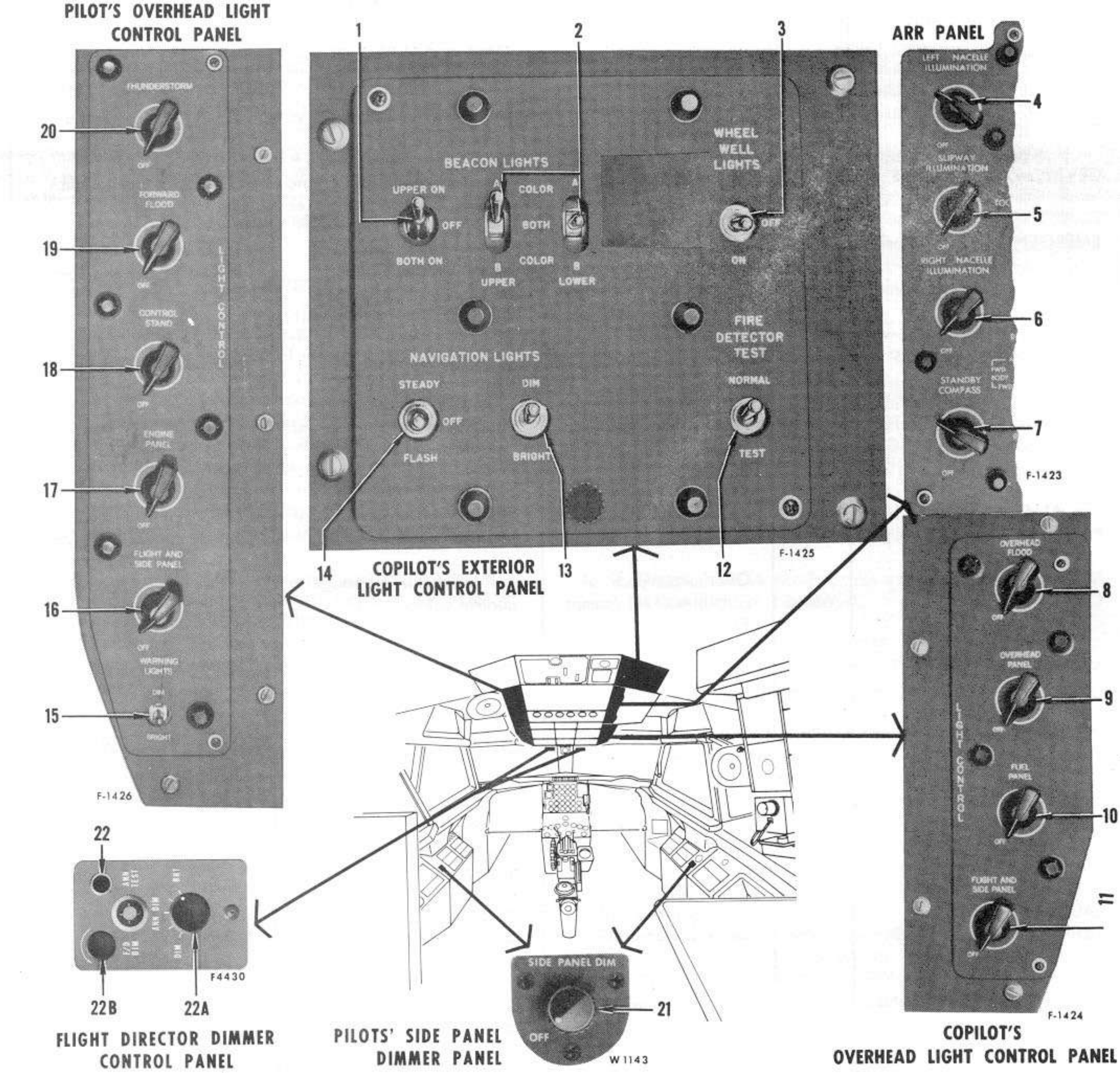
Figure 4-32 (Sheet 4 of 5)

LIGHTS	* QTY COLOR	LIGHT LOCATION	SWITCH LOCATION	NO. OF CB'S LABEL & LOC
COMPARTMENT 4 OVERHEAD LIGHTS	5 White	Compt 4 ceiling	Fwd bulkhead of compt near door and on aft bulkhead of compt 4 (RH) for 2 aft lights	(3) Compt 4 Sta 1180 and 1270 on CCBP PL-26, and Compt 4 Ovhd Lt on CCBP PL-25
CRYPTO CONSOLE TABLE LIGHTS	5 White	Crypto console table, fwd and aft	Rheostat switch on the crypto light control panel	(1) Crypto Opr Station on the CCBP PL-25
CRYPTO PANEL LIGHTS	9(11▷) White	Adjacent to instruments	Rheostat switches on crypto console light control panel	(1) Crypto Opr Pnl on the CCBP PL-25
EMERGENCY EXIT LIGHTS	4 White	Near cargo door and above each emergency exit hatch	ON--ARMED switch on pilots' overhead panel, switches on lights, and inertia switch in each unit	(2) Emerg Exit Light on the MCBP and the Battery CBP
GALLEY HOOD LIGHTS	2 White	Under galley hood	Under galley hood	See Compt 4 Ovhd Lights
L.F. ANTENNA OPERATOR'S CONSOLE STATION LIGHT	2 White	L.F. coupler tuning panel	Rheostat switch on L.F. ant. console	(1) Compt 2 LF Ant Opr Ovhd on the CCBP PL-26
L.F. ANTENNA OPERATOR'S PANEL LIGHTS	10(12▷) White	Adjacent to instruments	Rheostat switch on L.F. ant. operator's dimmer panel	(1) Compt 2 LF Ant Opr Pnl on the CCBP PL-26
MULTIPLEX RACK OVERHEAD LIGHT	1 White	Overhead support of multiplexer set (compt 1)	Left bulkhead in passage to control cabin	(1) Compt 1 Aft on the CCBP PL-26
MULTIPLEX SPOT LIGHT	1 White	Multiplexer rack	On the light	(1) Compt 1 Fwd on the CCBP PL-26
POWER PANEL FLOOD LIGHTS	2 White	On multiplexer support above main AC power panel (compt 1)	Left bulkhead in passage to control cabin	(1) Compt 1 Aft on the CCBP PL-26
RADIO OPERATOR'S CONSOLE STATION LIGHT	7 White	Top of radio operator's console	Rheostat switch on radio operator's light control panel	(1) Radio Opr Station on CCBP PL-25
RADIO OPERATOR'S CONSOLE TABLE LIGHT	5 White	Under shelf on radio operator's console	Rheostat switch on radio operator's light control panel	(1) Radio Opr Table on CCBP PL-25
RADIO OPERATOR'S PANEL LIGHTS	147 White	On radio panel	Rheostat switches on radio operator's light control panel	(1) Radio Opr Panel on CCBP PL-25
READING LIGHTS	17 White	Compartments 3 and 4 consoles	Rheostat switches on consoles	(3) Compt 3 Reading L.H. and R.H., and Compt 4 Bunk on the CCBP PL-26
SERVICE LIGHT	1 White	Electronic equipment cabinet in compt 1	On the light	(1) Compt 4 Ovhd Lt on CCBP PL-25
TROOP WARNING SIGNS	5 Sets	On ceiling or bulkhead in each compartment	Pilots' overhead panel	(3) Fasten Seat Belt, No Smoking, and Troop Oxygen Warning Signs on the MCBP

▷ With

Figure 4-32 (Sheet 5 of 5)

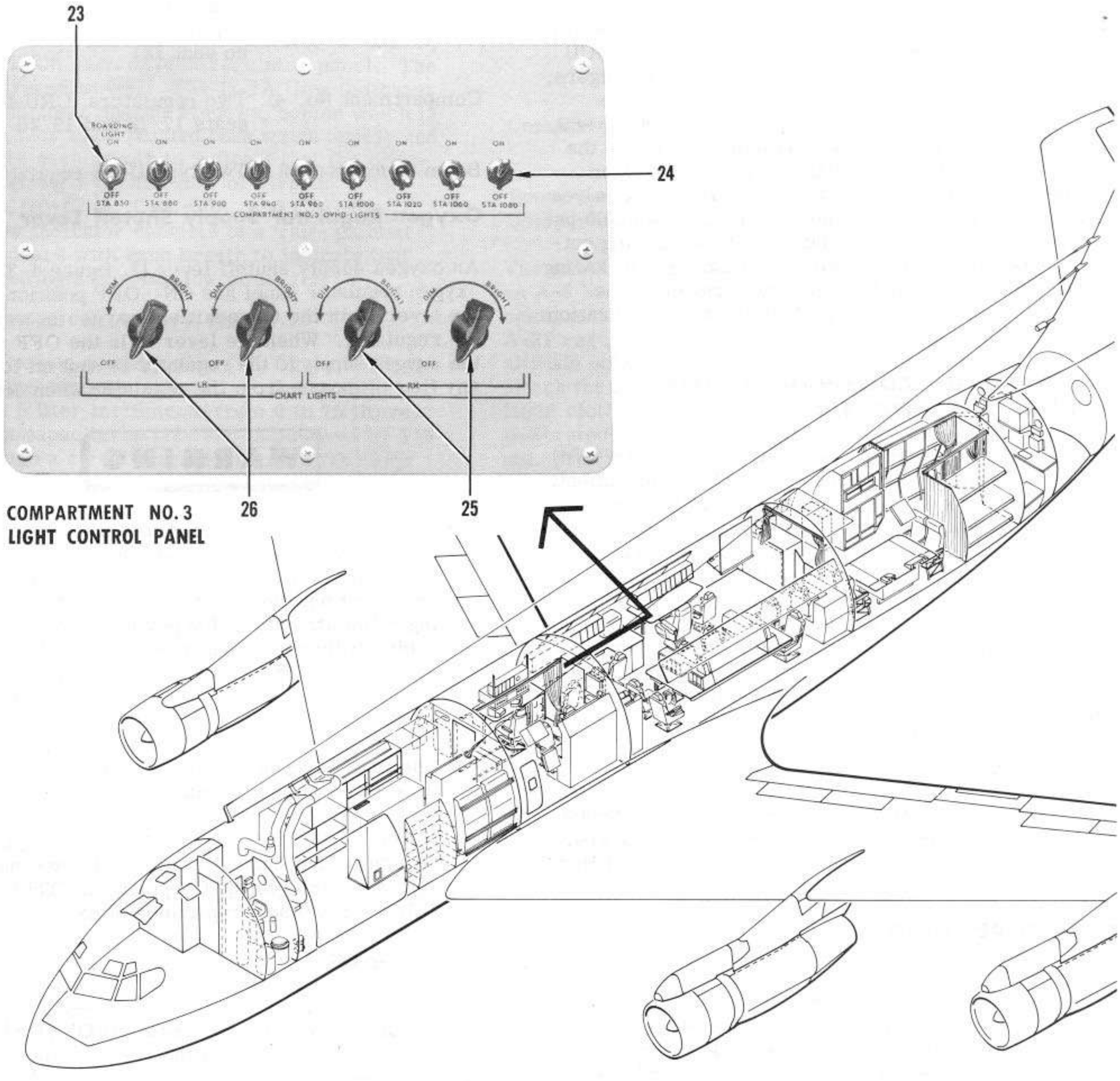
lighting control panels



1. ROTATING BEACON (ANTI-COLLISION) LIGHTS SWITCH
2. BEACON LIGHTS COLOR SELECTOR SWITCH
3. WHEEL WELL LIGHTS SWITCH
4. LEFT NACELLE ILLUMINATION CONTROL
5. SLIPWAY ILLUMINATION CONTROL
6. RIGHT NACELLE ILLUMINATION CONTROL
7. STANDBY COMPASS LIGHT CONTROL
8. OVERHEAD PANEL FLOODLIGHT CONTROL
9. OVERHEAD PANEL LIGHTS CONTROL
10. FUEL PANEL LIGHTS CONTROL
11. COPILOT'S FLIGHT AND SIDE PANEL LIGHTS CONTROL
12. FIRE DETECTOR TEST SWITCH
13. NAVIGATION LIGHTS BRIGHT-DIM SWITCH
14. NAVIGATION LIGHTS FLASH-STEADY SWITCH
15. WARNING LIGHTS BRIGHT-DIM SWITCH
16. PILOT'S FLIGHT AND SIDE PANEL LIGHTS CONTROL
17. ENGINE PANEL LIGHTS CONTROL
18. CONTROL STAND LIGHTS CONTROL
19. FORWARD FLOODLIGHTS CONTROL
20. THUNDERSTORM LIGHTS CONTROL
21. SIDE PANEL DIMMER RHEOSTAT
22. ANNUNCIATOR TEST SWITCH

22A FLIGHT DIRECTOR DIMMER CONTROL
22B ANNUNCIATOR DIMMER SWITCH

Figure 4-33 (Sheet 1 of 2)



COMPARTMENT NO. 3
LIGHT CONTROL PANEL

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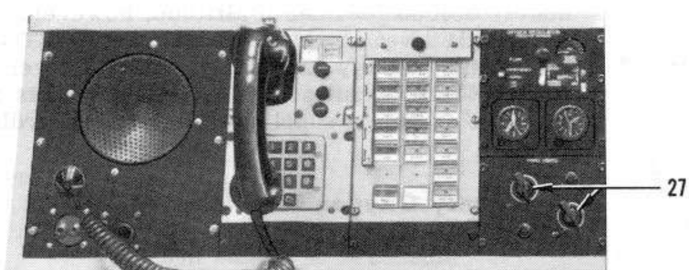


STAFF CONSOLE PANEL (TYPICAL)

23 BOARDING LIGHT SWITCH
24 COMPARTMENT 3 OVERHEAD LIGHT SWITCHES
25 RIGHT CHART LIGHT RHEOSTATS
26 LEFT CHART LIGHT RHEOSTATS
27 STAFF CONSOLE PANEL LIGHTS CONTROL (TYPICAL)

Figure 4-33 (Sheet 2 of 2)

OXYGEN SYSTEM

The airplane is equipped with a liquid oxygen system, (figure 4-34), consisting of three 25-liter type GCU -17/A liquid oxygen converters with heat exchangers, seven type D-2A oxygen regulator panels for the crew, nineteen type CRU(-21/A, -52/A, -68/A, -69, -68A/A, -69A/A or -73/A) regulator panels for the staff, nine outlets for recharging portable oxygen bottles, three combination filler build-up vent valves and three drain valves. The system provides 300 psi gaseous oxygen to the regulators and recharging outlets. Operation of the system is automatic, following servicing. Figure 4-35 shows the location of the oxygen equipment and figure 4-36 the oxygen duration at different altitudes.

LIQUID OXYGEN COMBINATION FILLER, BUILD-UP AND VENT VALVE

Three filler, build-up and vent valves, (1, figure 4-34) on the underside of the boom operator's compartment, are provided for servicing the individual converters. The valves automatically vent the system when a standard filler hose is connected, and automatically return to pressure build-up when the filler hose is disconnected. Normally, build-up time should not exceed approximately 10 minutes following servicing. The system should then be allowed to stabilize to preclude an erroneous quantity reading, resulting from the boiling effects of the liquid oxygen immediately following the filling of the converters.

Drain Valve

Liquid oxygen is drained from the converters through drain valves located on the underside of the boom operator's compartment adjacent to the combination filler, build up and vent valves (2, figure 4-34).

OXYGEN REGULATORS

The airplane oxygen system is equipped with two types of pressure demand oxygen regulators: seven type D-2A for the flight crew and nineteen CRU type regulator panels for the staff. The operation of the regulators is identical except that the CRU-73/A is an improved type replacement that incorporates an interlock between the oxygen supply shutoff lever and the regulator diluter lever. When the supply lever is turned to OFF, the interlock automatically switches the diluter lever to the 100% oxygen position, shutting off all cabin air to the mask. The regulators are located as follows:

Control Cabin:	Five regulators, type D-2A, at the pilot's, copilot's navigator's, crew instructor's, and boom operator's stations
Compartment No. 1:	None
Compartment No. 2:	Six regulators (CRU-type) at seats 2, 3, 4, 4A, APM console, and ARC-96 TWA cabinet.
Compartment No. 3:	Eleven regulators (CRU-type) at seats 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, and 16. (There is no seat 12)
Compartment No. 4:	Two regulators (CRU-type) at seats 17/18 and 19/20
Boom Compartment:	Two type D-2A regulators

Oxygen Regulator Supply Shutoff Lever

An oxygen supply shutoff lever (2, figure 4-35) 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

- For regulators other than the CRU-73/A, if the 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 the 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.

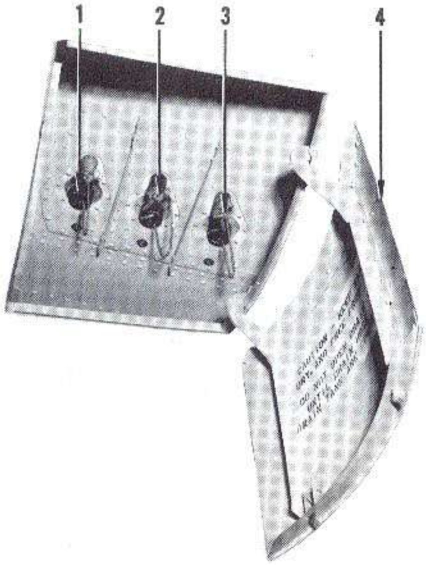
Regulator Diluter Lever

The regulator diluter lever (1, figure 4-35) on the oxygen regulator panel has NORMAL OXYGEN--100% OXYGEN positions. With the lever in the NORMAL 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 Regulator Toggle Lever

An emergency oxygen toggle lever (3, figure 4-35) is on each oxygen regulator panel. The lever is guarded to prevent inadvertent actuation to the EMERGENCY position. Pushing the lever to the EMERGENCY position gives a continuous positive pressure to the

oxygen system



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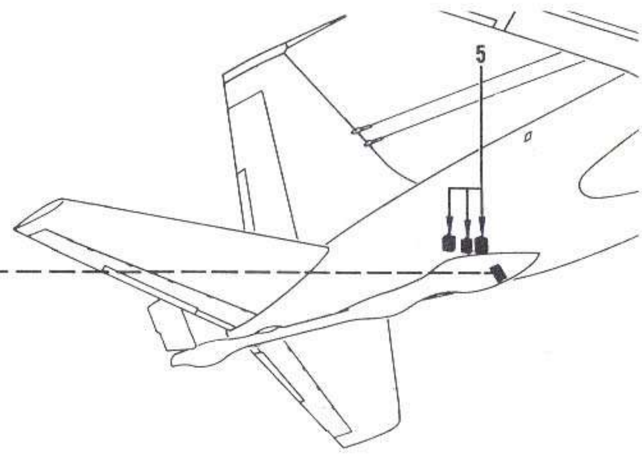
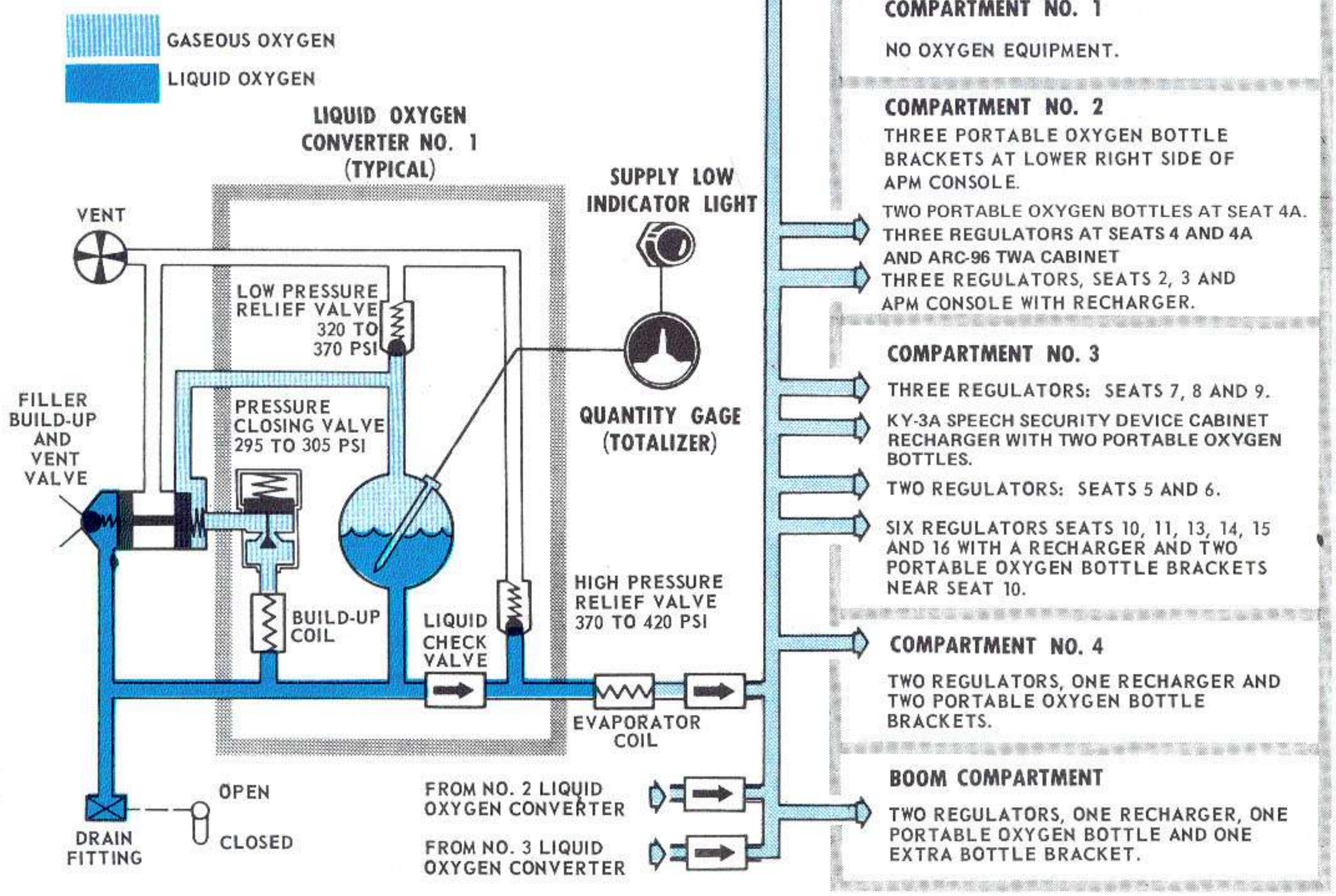


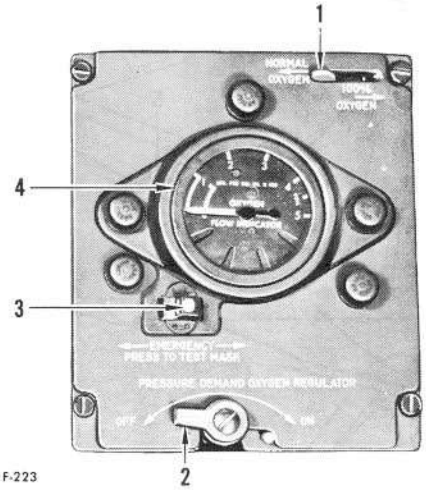
1 COMBINATION FILLER BUILD-UP VENT VALVE
2 DRAIN VALVE
3 DRAIN HOSE FITTING
4 LOX SERVICING ACCESS DOOR
LIQUID OXYGEN FILLER VALVES
5 LOX CONVERTERS, MAIN CABIN TOILET



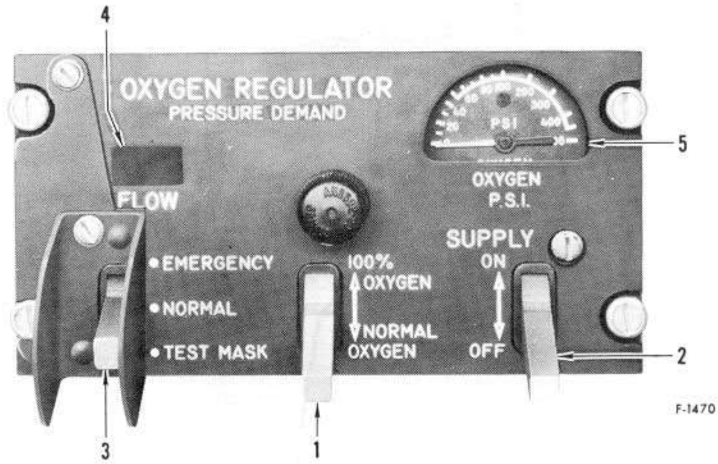
F-623

Figure 4-34

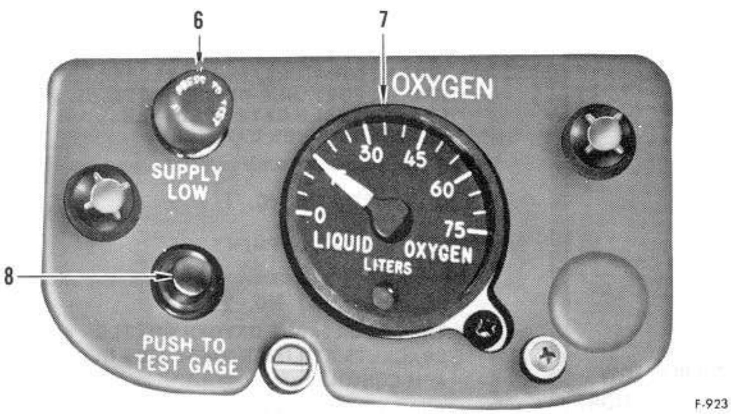
oxygen equipment (typical)



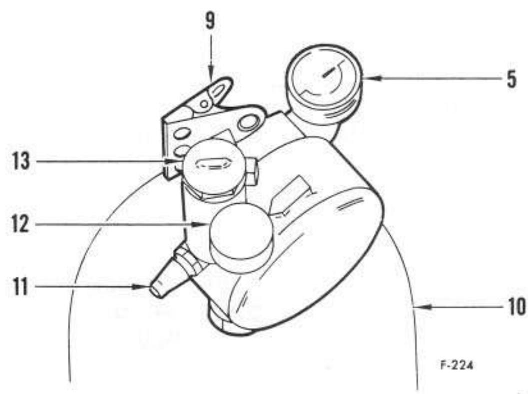
D-2A OXYGEN REGULATOR



CRU-21/A, CRU-52/A, CRU-68/A, CRU-69, AND CRU-73/A OXYGEN REGULATOR



OXYGEN QUANTITY GAGE



MA-1 PORTABLE OXYGEN BOTTLE

1 REGULATOR DILUTER LEVER (2 PLACES)
2 OXYGEN SUPPLY SHUTOFF LEVER (2 PLACES)
3 EMERGENCY OXYGEN TOGGLE LEVER (2 PLACES)
4 OXYGEN PRESSURE GAGE AND FLOW INDICATOR (2 PLACES)
5 OXYGEN PRESSURE GAGE (2 PLACES)
6 SUPPLY LOW INDICATOR LIGHT
7 LOX QUANTITY GAGE
8 PUSH TO TEST GAGE BUTTON
9 CLIP
10 A-6 OXYGEN BOTTLE
11 OXYGEN BOTTLE FILLER PORT
12 ALTITUDE SELECTOR KNOB
13 OXYGEN MASK HOSE CONNECTION

Figure 4-35

crewmember for emergency use. Pushing or pressing the emergency oxygen toggle lever straight to the TEST MASK position 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 insure no leakage, then 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 could also result in extremely cold oxygen flowing to the mask.

Oxygen Regulator Pressure Gage and Flow Indicator

An oxygen pressure gage and flow indicator (5, and 4), figure 4-35) is on each oxygen regulator panel. The gage is calibrated in PSI. The D-2A 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 crewmember is getting a normal flow of oxygen. The CRU-21/A, CRU-52/A, CRU-68A, and CRU-69 regulator flow indicator consists of a white painted bar which appears with each breath to indicate that the user is getting a normal flow of oxygen.

LIQUID OXYGEN QUANTITY GAGE

An airplane oxygen quantity gage (7 , figure 4-35) is provided on the copilot's sidewall oxygen panel, and is marked in 5 liter increments from 0 to 75 liters. The gage is a capacitance type and is powered by 115 volt AC through a circuit breaker marked OXYGEN QUANTITY WARNING on the MCBP (figure 1-33, sheet 2).

Oxygen Supply Low Indicator Light

An amber light marked SUPPLY LOW (6 , figure 4-35) on the copilot's sidewall oxygen panel illuminates when the liquid oxygen supply is depleted to 7.5 liters or less. Operating power is 28 volt DC through a circuit breaker marked OXYGEN WARNING on T-R BUS NO. 1 of the MCBP (figure 1-33, sheet 1).

Push to Test Gage Button

Actuation of this button (8, figure 4-35) will cause the indicator needle on the oxygen quantity gage to deflect downscale. When the indicator needle reaches 15 liters or less the SUPPLY LOW warning light will illuminate indicating correct operation of the indicating system.

PORTABLE OXYGEN BOTTLES

Portable oxygen bottles are provided at the pilots', navigator's and boom operator's stations. Extra brackets for holding portable oxygen bottles are provided in the forward (crew) toilet and the main cabin compartments. Portable oxygen bottles (figure 4-35) and extra brackets are located as follows:

Control Cabin:	Two bottles behind pilot's seat One bottle behind copilot's seat One bottle at navigator's station One bottle at boom operator's station
Compartment No. 1:	None
Compartment No. 2:	Three brackets just at lower right side of APM console Two bottles at crypto operators' station below the crypto operator's console
Compartment No. 3:	Two bottles above KY-3A speech security device cabinet, one bracket on aft end of console at rear of seat No. 10 and one bracket on aft side of map stowage box
Compartment No. 4:	Two brackets above the parachute stowage rack
Boom Operator's Compartment:	One bottle and one bracket

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 crewmember's flight clothing. The pressure gage (5, figure 4-35) is calibrated from 0 to 500 psi and is red lined at 450 psi. The altitude selector knob (12, figure 4-35) has NORM--30M--42M--EMER positions. Since the A-21 regulator does not incorporate a diluter mechanism, 100 percent 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 these 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 4-36.

WARNING

- Oxygen duration is extremely limited for crewmembers using the firefighter's mask with the MA-1 portable oxygen system. (See figure 4-36). The A-21 regulator must be set to the NORM position when used in conjunction with the firefighter's mask.
- 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.

The portable oxygen bottle assemblies at the crypto operators' stations are of the type using an A-21 regulator and a M57-100 bottle and function as above.

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 4-37A). The masks are stowed in quick-release hanging suspension holders located just aft of the pilot/copilot's No. 5 windows and are always immediately available.

PORTABLE OXYGEN BOTTLE RECHARGING

WARNING

Prior to servicing portable oxygen bottles, insure that oxygen bottle filler port and oxygen recharger outlet are free of oil or grease.

Nine portable oxygen bottle rechargers are provided in the airplane at the following positions:

Control Cabin:	Pilot's station Navigator's station Boom operator's station
Compartment No. 1:	None
Compartment No. 2:	Forward side of APM console
Compartment No. 3:	Overhead between stowage cabinet and seat No. 6 Aft of RH console rear seat No. 10
Compartment No. 4:	Forward bulkhead rear parachute stowage rack LH aft bulkhead rear bunks
Boom Operator's Compartment:	LH side

OXYGEN DURATION

The oxygen duration charts, figure 4-36, show the duration of liquid oxygen in terms of manhours and hours for the number of persons aboard the airplane in relation to cabin altitude. These charts are based on average oxygen consumption rates and liquid oxygen conversion rates.

OXYGEN SYSTEM NORMAL OPERATION

Preflight

A. Oxygen Converter Quantity Gauge - Check quantity (CP)

NOTE

It may not be possible to service the three converters to their full 75 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 emergency oxygen toggle lever.

F. Emergency Oxygen Toggle Lever - EMERGENCY

Breathe normally for a minimum of 3 cycles. The blinker should show alternately 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; 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.

Oxygen Usage

The following procedure should be used when going on oxygen.

A. Oxygen Regulator Panel Supply Shutoff Lever - ON

B. Regulator Diluter Lever - As required

C. Oxygen Regulator Flow Indicator - Check frequently for normal operation.

NOTE

- Illuminate the NO SMOKING sign manually when going on oxygen, if the main cabin is occupied.
- Approximate oxygen duration can be obtained from figure 4-36.

WARNING

When oxygen equipment is used, check to insure 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 is OFF.

OXYGEN SYSTEM EMERGENCY OPERATION

With symptoms of hypoxia or if smoke or fumes are present, immediately place the oxygen regulator supply shutoff lever ON, and move the regulator diluter lever to 100% OXYGEN. Place the regulator emergency oxygen toggle lever in the EMERGENCY position if required.

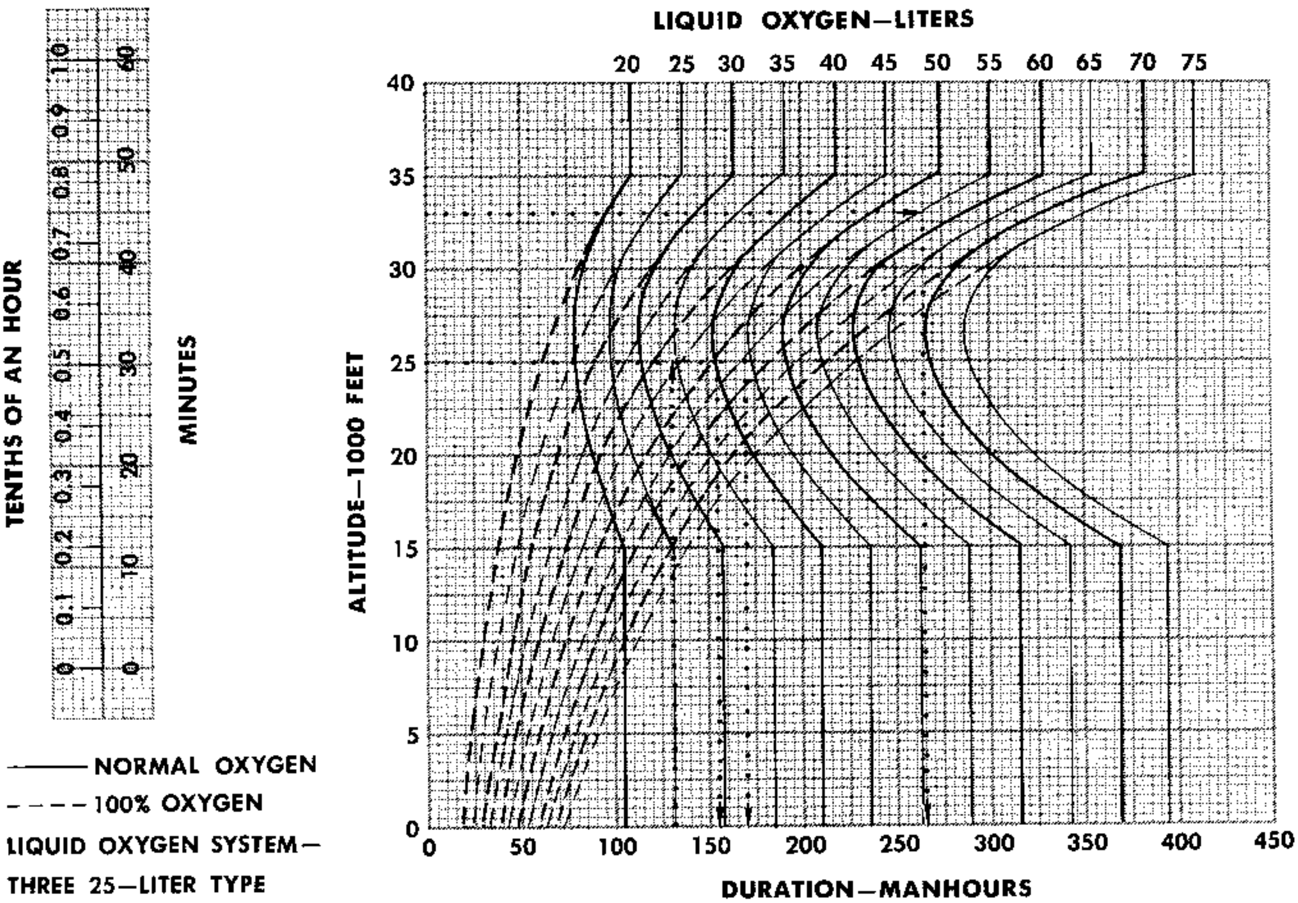
NOTE

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.

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.

oxygen duration



——— NORMAL OXYGEN

- - - - 100% OXYGEN

LIQUID OXYGEN SYSTEM—
THREE 25—LITER TYPE
GCU17/A CONVERTERS

EXAMPLE PROBLEM 1

Assume cabin pressurization is lost during a mission being conducted at 33,000 feet, with 17 crewmen aboard. The mission has 14 hours to continue before descent; the liquid oxygen gage reads 55 liters. Will sufficient oxygen be available to continue the mission? Enter the altitude scale of the chart at 33,000 feet and project horizontally to the 55 liter NORMAL OXYGEN line, then project down to the DURATION - MAN-HOURS and read 265 man-hours. Divide the man-hours by the number of persons aboard for duration in hours, ie, 265 ÷ 17 = 15.6 hours. Referring to the TENTHS OF AN HOUR conversion scale, 0.6 hours converts to 36 minutes making the total oxygen time available equal to 15 hours and 36 minutes. Therefore, 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 23 go on 100% OXYGEN with a liquid oxygen gage reading of 50 liters. The mission has 8-1/2 hours to go before scheduled completion. Approximately 60 minutes later the smoke and fume emergency is eliminated; however, the cabin must remain depressurized. Can the mission be completed on the remaining oxygen using the NORMAL setting? Enter the altitude scale of the chart at 25,000 feet and project horizontally to the 50 liter 100% OXYGEN line; then project down to the DURATION - MAN-HOURS and read 155 man-hours. The time on 100% oxygen, 60 minutes or 1 hour, (length of emergency) multiplied by 23 persons equals 23 man-hours. Subtracting 23 from 155 equals 132 man-hours. Project upward from 132 man-hours to the 25,000 feet altitude line and read approximately 44 liters on the intersecting 100% oxygen lines. Locate the intersection of the 25,000 feet line and the 44 liter normal oxygen line and project down to the man-hours and read approximately 170 man-hours. Dividing 170 man-hours by 23 persons equals approximately 7.4 hours of oxygen remaining on normal setting. Therefore, the oxygen supply is marginal for completion of the mission which has 7.5 hours remaining, at 25,000 feet. However, the oxygen curves indicate that an increase or decrease in altitude will increase the duration of the available oxygen.

Figure 4-36 (Sheet 1 of 2)

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.

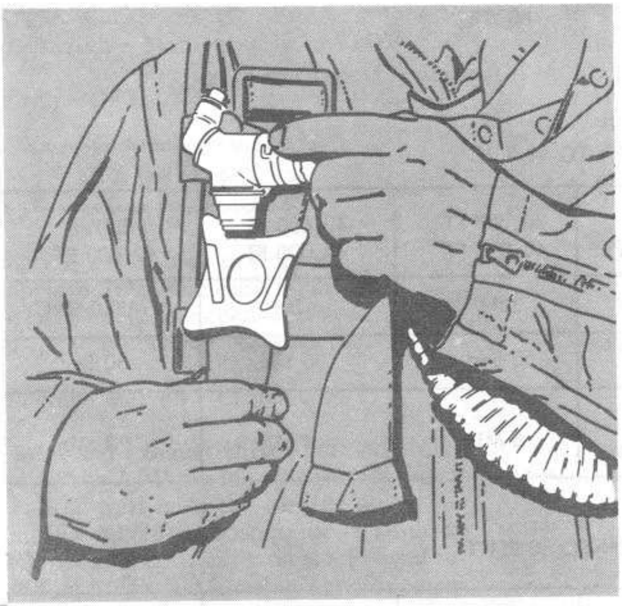
* Mask cannot be fitted to stop all leakage. All other readings are with no mask leakage.

CAUTION

The oxygen pressure in the MA-1 portable oxygen bottle should not be permitted to drop below 50 psi.

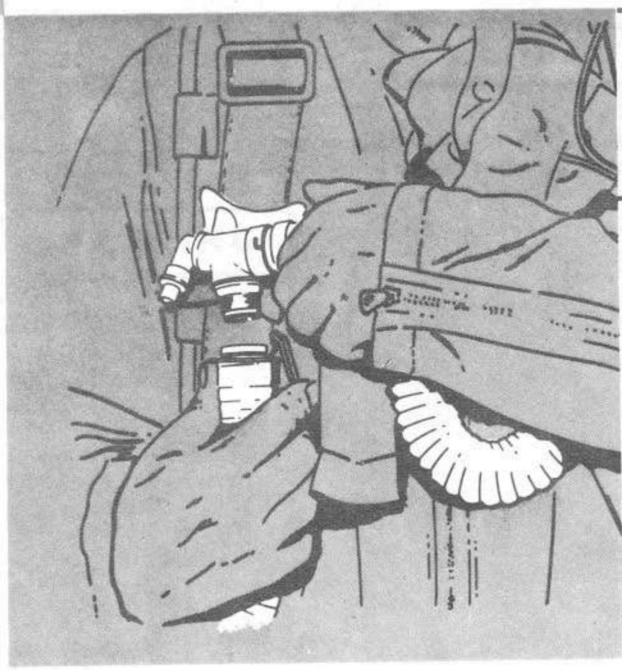
Figure 4-36 (Sheet 2 of 2)

oxygen hose connection
(with type cru-8/p connector)



1 ATTACH CRU-8/P OR CRU-60/P CONNECTOR INTO PARACHUTE HARNESS PLATE BY ENGAGING MALE DOVE-TAILED PLATE ON CONNECTOR INTO FEMALE RECEIVING TRACK UNTIL SPRING-LOADED PIN DROPS INTO PLACE.

2 CONNECT AIRPLANE OXYGEN SUPPLY HOSE TO THE QUICK DISCONNECT FITTING ON THE CONNECTOR AND CHECK THAT SEALING GASKET IS ONLY HALF EXPOSED



3 ATTACH MD-1 BAIL-OUT BOTTLE HOSE TO MALE BAYONET CONNECTOR ON CRU-8/P OR CRU-60/P CONNECTOR. PUT ON OXYGEN MASK AND CHECK OXYGEN FLOW INDICATOR

NOTE

This illustration shows the procedure for connecting the oxygen hose and does not necessarily reflect the type of head gear, oxygen mask and oxygen mask straps to be used.

Figure 4-37

QUICK-DONNING OXYGEN MASK AND SMOKE GOGGLES

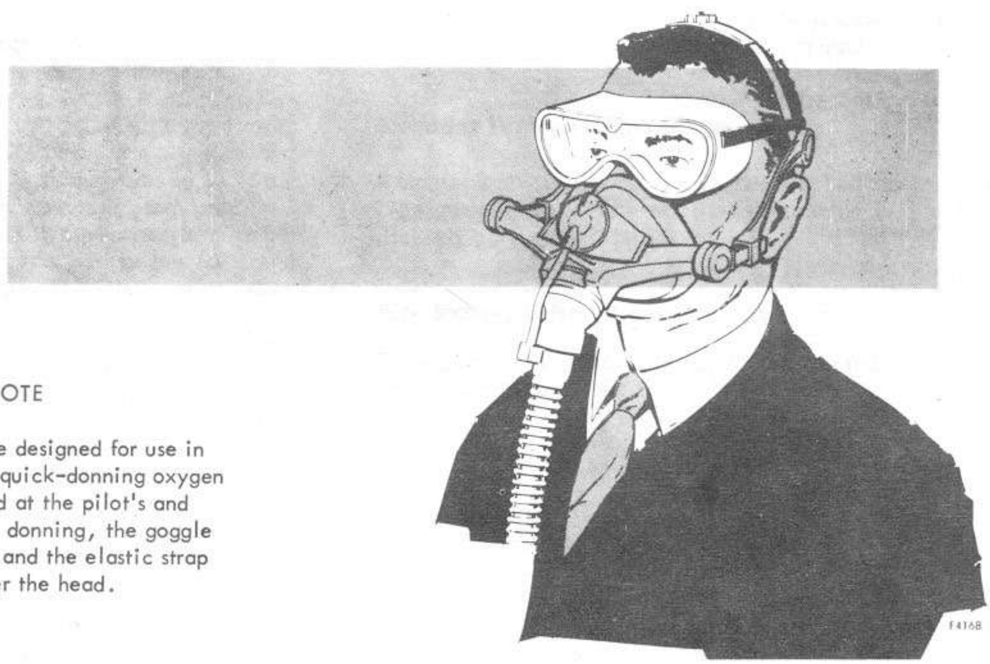
1 When ready to don the mask, take a firm grasp around the valve and hose assembly, with either the right or left hand. A sharp downward pull will release the mask from the quick-release hanger.

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 4-37A

All data on page 4-84 (Deleted)

AUTOPILOT SYSTEM

The airplane has a type MC-1 electronic autopilot system. The system consists of an autopilot control panel (figure 4-38) on the overhead panel, an autopilot flight controller (figure 4-39) on the control stand and gyros to control the system with servomotor 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 3 circuit breakers marked AUTOPILOT on ENG 4 GENERATOR of the MCBP (figure 1-33, sheet 2). Control power is 28 volt DC from T-R BUS NO. 1 through a circuit breaker marked AUTOPILOT on the MCBP (figure 1-33, sheet 1).

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.
- If the autopilot fails, the autopilot coupler and amplifier fuses may be checked (figure 4-29B) after opening applicable circuit breakers.

AUTOPILOT POWER SWITCH

The autopilot power switch (6, figure 4-38) 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 4-38) 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 4-38) 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 4-38) 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 4-38) on the autopilot control panel has ON--OFF positions. When the altitude hold switch is placed in the ON position, the altitude hold mode will maintain the airplane with ± 50 feet of the engaged reference pressure altitude during straight and level flight. During turns, the autopilot may not maintain the engaged reference altitude due mainly to loss of lift. The altitude deviation from engaged reference altitude during turns should not exceed ± 150 feet. After completion of the turn, the airplane should return to within ± 50 feet of the engaged reference altitude. The altitude hold switch will automatically be disengaged when the slide slope or Mach No. control is engaged.

autopilot control panel

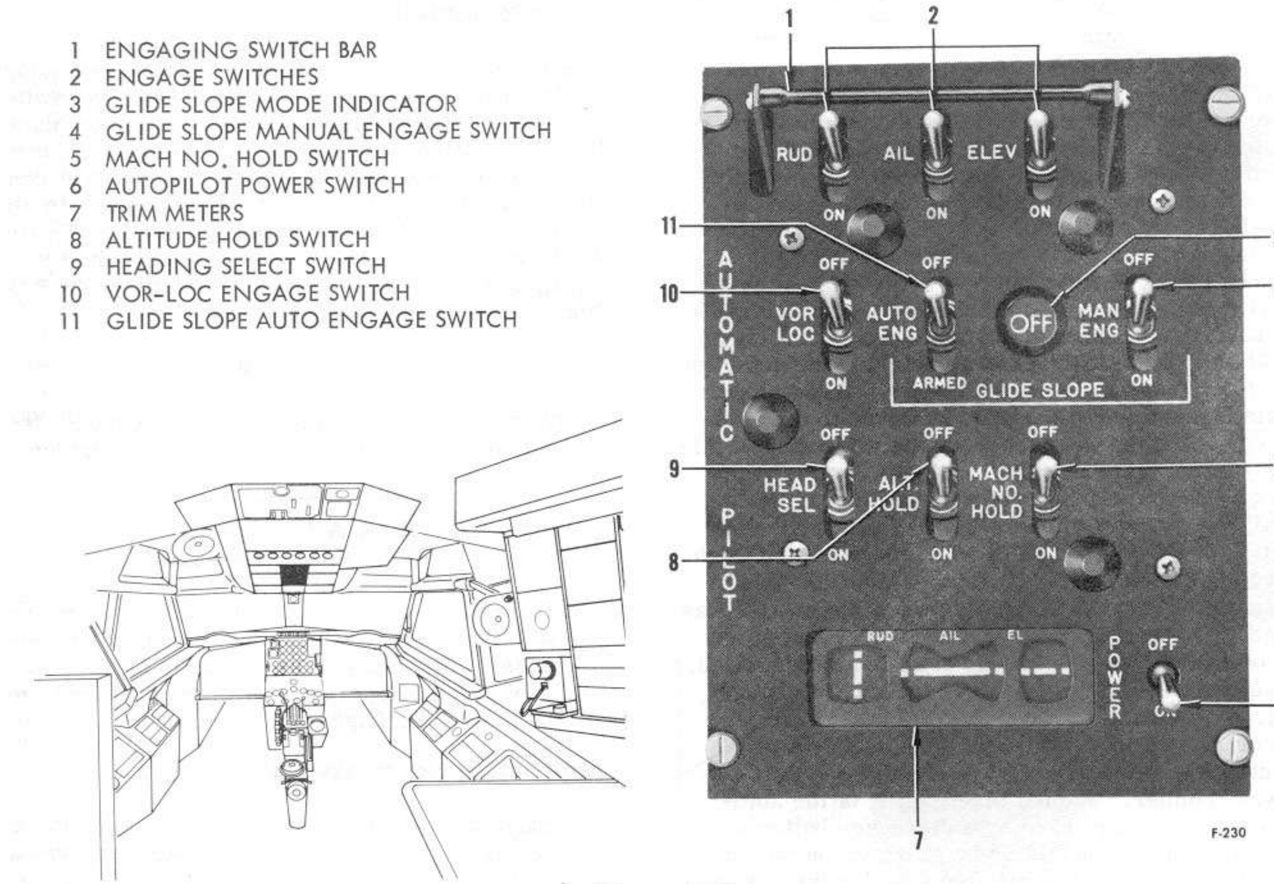


Figure 4-38

HEADING SELECT SWITCH

The heading select switch (9, figure 4-38) 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 4-38) 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 4-38) 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.

autopilot flight controller

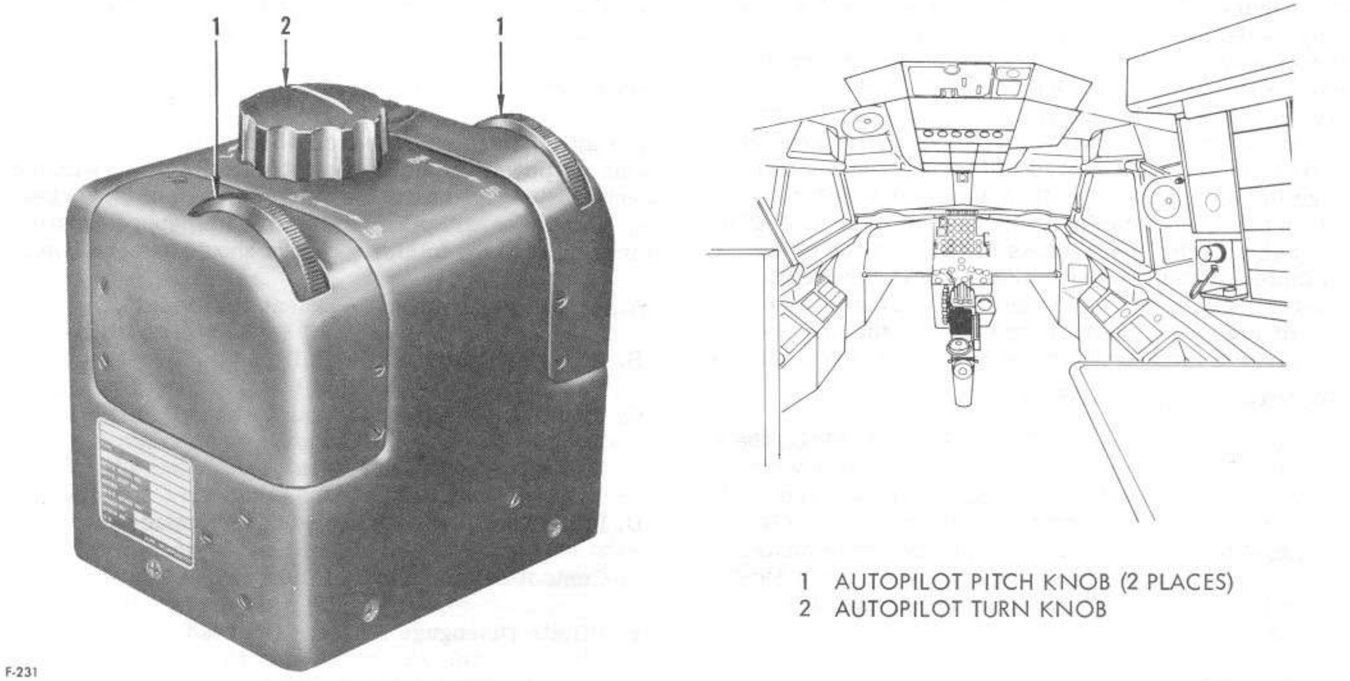


Figure 4-39

GLIDE SLOPE MANUAL ENGAGE SWITCH

The glide slope manual engage switch (4, figure 4-38) 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 4-39) 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 4-39) on the autopilot flight controller has UP--DN indicating arrows to indicate pitch 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.

RGA/AP/ARR DISENGAGE BUTTON

The RGA/AP/ARR disengage button (9, figure 1-11 and 3, figure 1-12) on the pilots' control wheels is a spring loaded button. When depressed, this button will disengage the autopilot and ARR latching toggles. 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 re-engage the autopilot. The RGA pushbutton switch function has been combined with the autopilot and ARR disengage switch. Regardless of the position of the RGA power switch, actuation of the RGA/AP/ARR pushbutton will result in the autopilot being disengaged (if engaged) and the disconnect of the air refueling toggle latches (if connected).

AUTOPILOT DISENGAGE LIGHT

The autopilot disengage light (25, figure 1-16) on the pilot's flight instrument panel is a yellow 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 4-38) on the autopilot control panel consist of three meters marked RUD, AIL, ELEV, 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 (figure 4-38) 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 in flight 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

autopilot operational tolerances

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 Rnage 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 lease ±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 (Straight and Level Flight)	Engaging Altitude	± 50 ft max from engaged	Altimeter
Altitude Hold	Altitude Hold (During Turns)	Return to ± 50 ft of engaged reference altitude after completion of turn	± 150 ft max dev from ref altitude	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 4-40.

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 through 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. 4 deenergizes all three axes of the autopilot without the autopilot disengage light illuminating, but the autopilot control switches and servo clutches remain engaged. The airplane will revert to free flight in all three axes and will assume the trim conditions in the aileron and rudder axes that were established prior to autopilot engagement. The airplane pitch trim will remain at the position established at the time of generator -4 bus failure.

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 tanker refueling operations. The aileron axis may be used as it will help stabilize the airplane and make the tanker 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 operation during air refueling.

CAUTION

The pitch axis may be used during tanker refueling or when boom is lowered; however, prior to tanker refueling the autopilot stabilizer trim follow-up should be checked for proper operation. Autopilot operation will be monitored closely during the tanker refueling operation. At any indication of autopilot malfunction a BREAKAWAY shall be initiated immediately.

D. Autopilot Stabilizer Trim Follow-Up - Check

a. This step is to be accomplished prior to tanker refueling or any time it is suspected that the stabilizer trim system is not functioning normally. Check operation of the system as follows:

(1) With autopilot pitch axis engaged, manually move the control column to overpower the autopilot and obtain an out-of-trim condition.

(2) 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.

(3) 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.

b. 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 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 one 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 copilot'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 degree 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 minimums by using a standard glide slope and localizer beam. When performing an automatic ILS approach, disengage the autopilot at an altitude not lower than the published ILS minimum to avoid 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/ARR switch and the RGA power switches are ON, the command bars will display go-around command. See GO-AROUND, figure 4-29Y.

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

NOTE

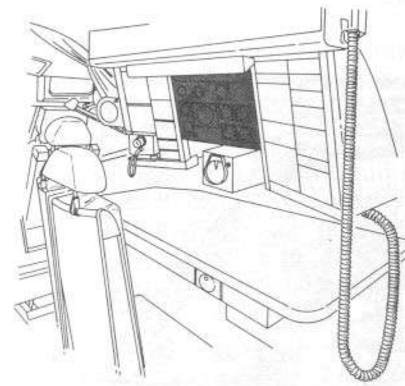
The following navigation equipment and its operation is described in this Section under COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT:

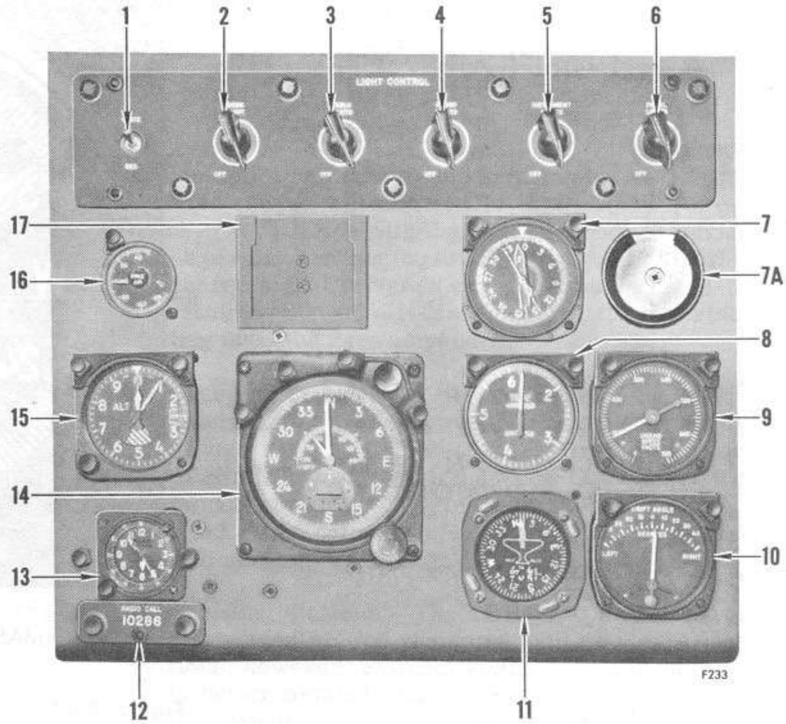
UHF-ADF AN/ARA 25
VOR/ILS RECEIVER (VHF-NAV) 51R-6 AND 51V-4A
TACAN (UHF-NAV) AN/ARN-21 or AN/ARN-72
MARKER BEACON Receiver AN/ARN-32
AUTO-NAV (DOPPLER) RADAR AN/APN-81
NAV-COMPUTER AN/ASN-7
SEARCH RADAR AN/APN-59
RADAR BEACON AN/APN-69
SIF AN/APX-25
SIF/IFF TRANSPONDER SET AN/APX-64 (AIMS)
HIGH RANGE RADIO ALTIMETER AN/APN-133

NAVIGATOR'S INSTRUMENTS

INDICATOR	INDICATOR DESCRIPTION LOCATION
Free Air Temperature Gage, Type G-10 (16, figure 4-41)	See FREE AIR TEMPERATURE GAGES, Section I.
Radio Magnetic Indicator (RMI), ID-250/ARN (7, figure 4-41)	See RADIO MAGNETIC INDICATOR (RMI), this Section
Altimeter, Type AAU8/A or Type MA1 (15, figure 4-41)	See ALTIMETER, Section I.
Master Heading Indicator, N-1 Master (14, figure 4-41)	See N-1 COMPASS SYSTEM in following paragraphs.
Ground Speed Indicator, ID-341/APN-81 (9, figure 4-41)	See RADAR NAVIGATION SET (AN/APN-99) in this Section
Clock, Type A-13A (13, figure 4-41)	See MISCELLANEOUS INSTRUMENTS, figure 1-55.
Destination Indicator, ID-390/ASN-7 (11, figure 4-41)	See DESTINATION INDICATOR in this Section.
Drift Angle Indicator, ID-342/APN-81 (10, figure 4-41)	See RADAR NAVIGATION SET (AN/APN-99) in this Section.

navigator's instrument panel





1 COLOR SELECTOR SWITCH
2 CABIN DOME LIGHT CONTROL
3 NAVIGATOR'S TABLE LIGHTS CONTROL
4 NAVIGATOR'S FLOOD LIGHTS CONTROL
5 NAVIGATOR'S INSTRUMENT LIGHTS RHEOSTAT
6 NAVIGATOR'S PANEL LIGHTS CONTROL
7 RADIO MAGNETIC INDICATOR (RMI) (SEE FIGURE 4-17)
7A NAVIGATOR'S WATCH CLIP
8 TRUE AIRSPEED INDICATOR
9 GROUND SPEED INDICATOR (SEE FIGURE 4-18)
10 DRIFT ANGLE INDICATOR (SEE FIGURE 4-18)
11 DESTINATION INDICATOR (SEE FIGURE 4-18)
12 RADIO CALL PLATE
13 CLOCK
14 MASTER HEADING INDICATOR (N-1 COMPASS SYSTEM) (SEE FIGURE 4-42)
15 ALTIMETER
16 FREE AIR TEMPERATURE GAGE (OAT)
17 ALTIMETER CORRECTION CARD HOLDER

Figure 4-41

The navigator's instrument lights rheostat (5, figure 4-41) controls the intensity of instrument illumination.

True Airspeed Indicator, Type M-5 (8, figure 4-41)	See TRUE AIRSPEED INDICATOR in this Section.

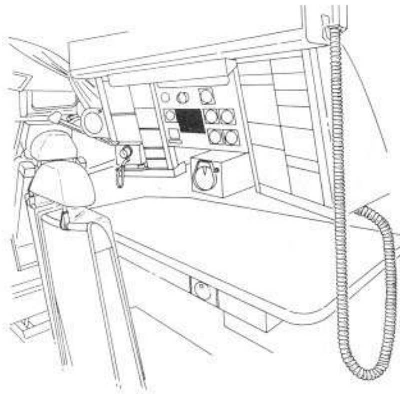
TRUE AIRSPEED INDICATOR

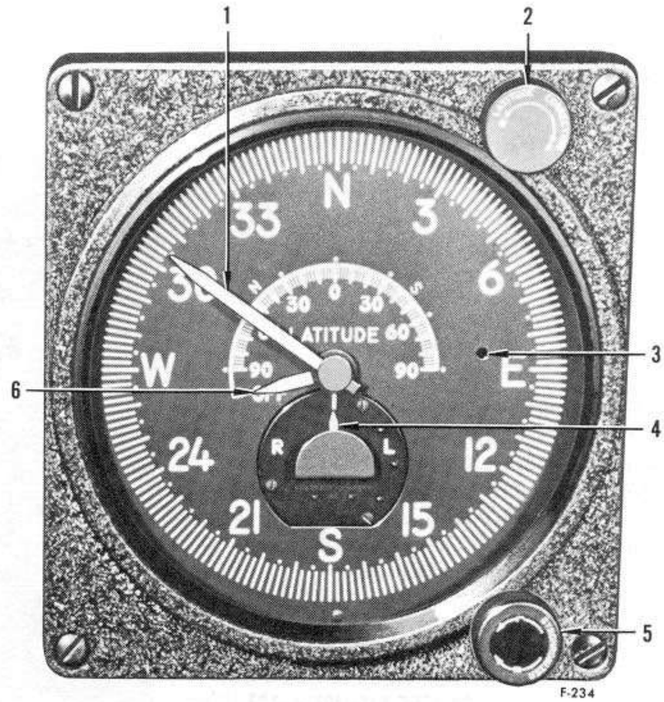
The true airspeed indicator (8, figure 4-41) utilizes an aneroid, a differential pressure diaphragm, and a bulb temperature diaphragm which respond respectively to changes in barometric pressure, impact pressure, and corrected free air temperature. The accuracy of the instrument is generally within ± 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

N-1 compass controls





1. HEADING POINTER
2. LATITUDE CORRECTION CONTROL KNOB
3. CORRECTION INDICATOR PORT
4. ANNUNCIATOR POINTER
5. SYNCHRONIZER KNOB
6. LATITUDE CORRECTION POINTER

MASTER HEADING INDICATOR

Figure 4-42

field is too weak or distorted for magnetic-slaved operation. When operated in the magnetic mode with the heading indicator 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 4-42). The system is energized whenever there is 28 volt DC and 115 volt AC power on the airplane and the pilot's instrument gyro switch (17, figure 1-16) 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 4-41); pilot's flight director system, HSI and ADI (12 and 8, figure 1-16); and the radio magnetic indicators (RMI) at the copilot's and navigator's stations (figure 4-17). The 28 volt DC power is from T-R BUS NO. 2 on the MCBP (figure 1-33, sheet 1) 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 ENG 4 GENERATOR section of the MCBP (figure 1-33, sheet 2).

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 Pointer

The heading pointer (1, figure 4-42) indicates the correct magnetic heading while the compass is in magnetic mode (providing the pointer is properly synchronized), 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 4-42) 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 4-42) positions the latitude correction pointer (6, figure 4-42) 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's 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 4-42) 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. If 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 airplane 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 4-42). 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 4-42) 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.

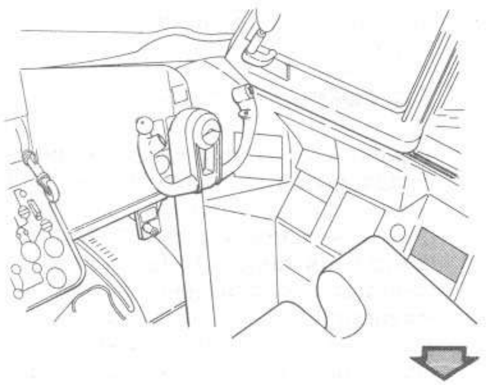
J-4 COMPASS SYSTEM

The J-4 compass operates either as a latitude corrected gyro directional 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 (27 and 4, figure 1-17); and the pilot's RMI (21, figure 1-16). 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 1-33, sheet 3).

NOTE

The J-4 compass system completes a synchronization cycle within 15 seconds after the compass has been placed in MAG operation. This synchronization removes any error that exists between the airplane magnetic heading and the heading indicated on the directional indicator.

J-4 compass controls



1 INDICATOR SET SWITCH
2 SYNCHRONIZING INDICATOR
3 ANNUNCIATOR
4 HEMISPHERE INDICATOR
5 HEMISPHERE SELECTOR SWITCH
6 LATITUDE CORRECTION DIAL
7 MODE SELECTOR SWITCH

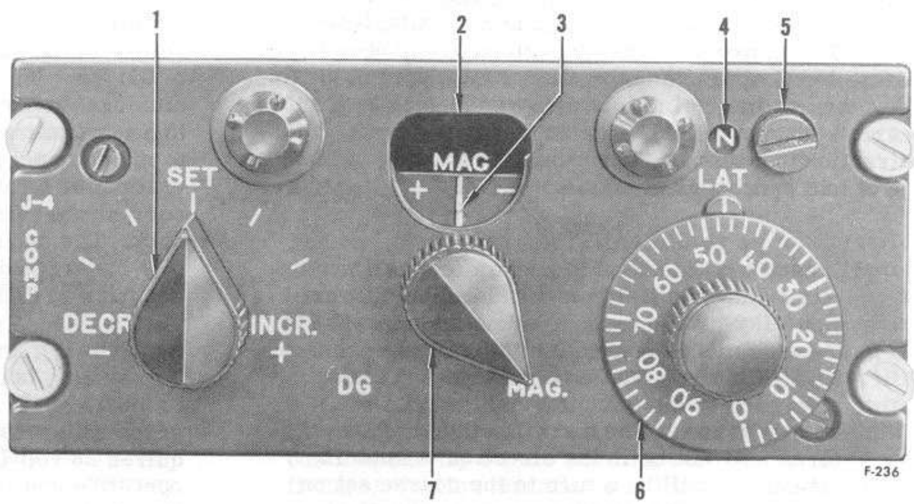


Figure 4-43

Mode Selector Switch

The mode selector switch (7, figure 4-43) 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-stabilizer 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 4-43) 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 4-43) on the J-4 compass control panel, marked DECR(-)--SET--INCR(+) is used to slew the copilot's HSI azimuth card (3, figure 4-29D) and pilot's RMI compass card (17, figure 4-17). 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 azimuth card 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 indicator set switch for the slew operation excessively or continuously for longer than 30 seconds. Excessive or continuous use may cause overheating 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 4-43) 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 4-43) to the local latitude to compensate for the drift. The indicated latitude should be plus or minus 4 degrees from the airplane position and should be changed to mid-latitude for each 8 degree change in latitude, or computed false latitude.

sextant vision obstruction

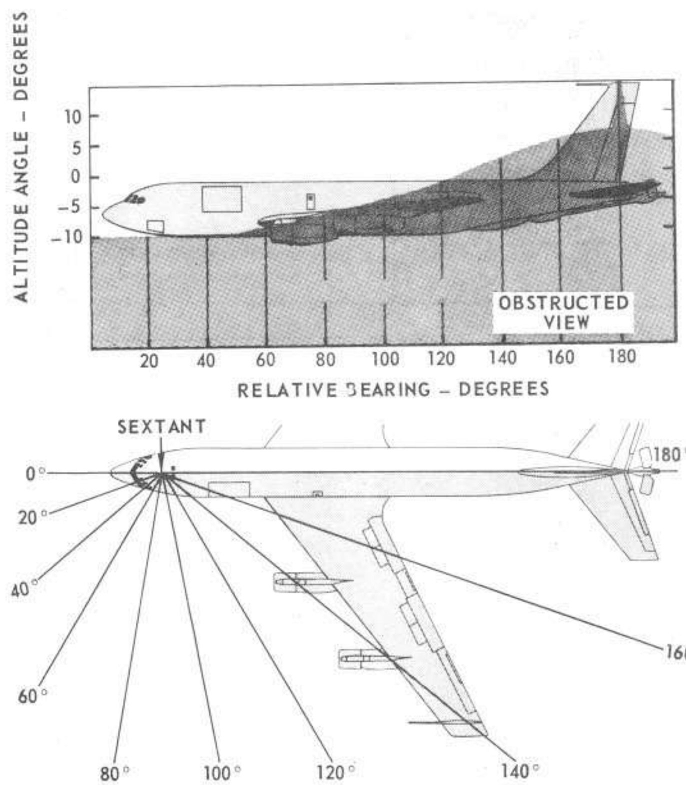


Figure 4-44

PERISCOPIC SEXTANT AND MOUNT

The sextant (figure 4-45) 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 (52, figure 1-3) near the boom operator's seat.

The sextant is mounted in a special mount on the ceiling in the control cabin. The sextant mount (figure 4-45), consists of shutter and receptacle assemblies.

Illumination Switch

An ON-OFF switch (19, figure 4-45) 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 4-45). 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 1-33).

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 4-45) after an observation, automatically sets the average or mean altitude on the sextant counter (4, figure 4-45) from which it may be read directly. The averager winding lever (12, figure 4-45) and the actuating lever (11, figure 4-45) 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 4-44 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 4-45). The bubble control knob should be in full increase position when stowing the sextant.

Projection Lens and Diffuser

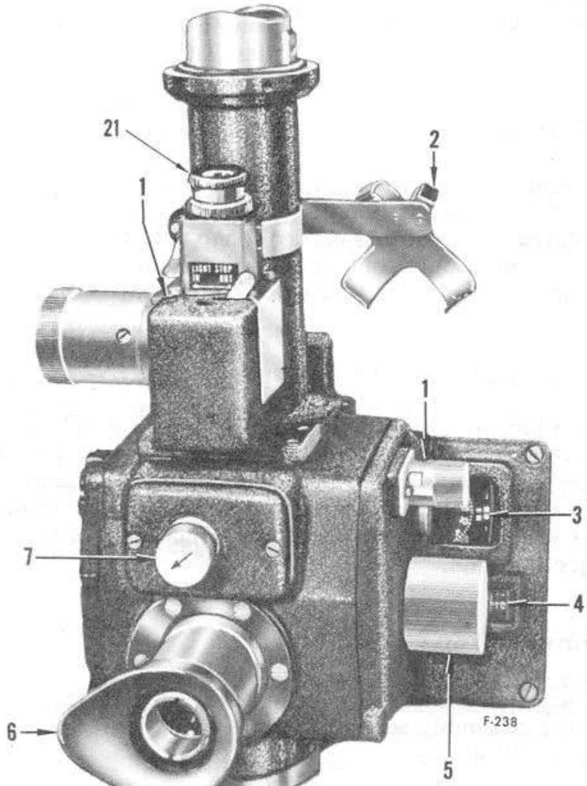
A true heading projection lens (21, figure 4-45) and diffuser lever (8, figure 4-45) are mounted on the top of the bubble unit to regulate the amount of natural light entering the bubble dome. Minor sextant alignment errors can be corrected by adjustment of the projection lens.

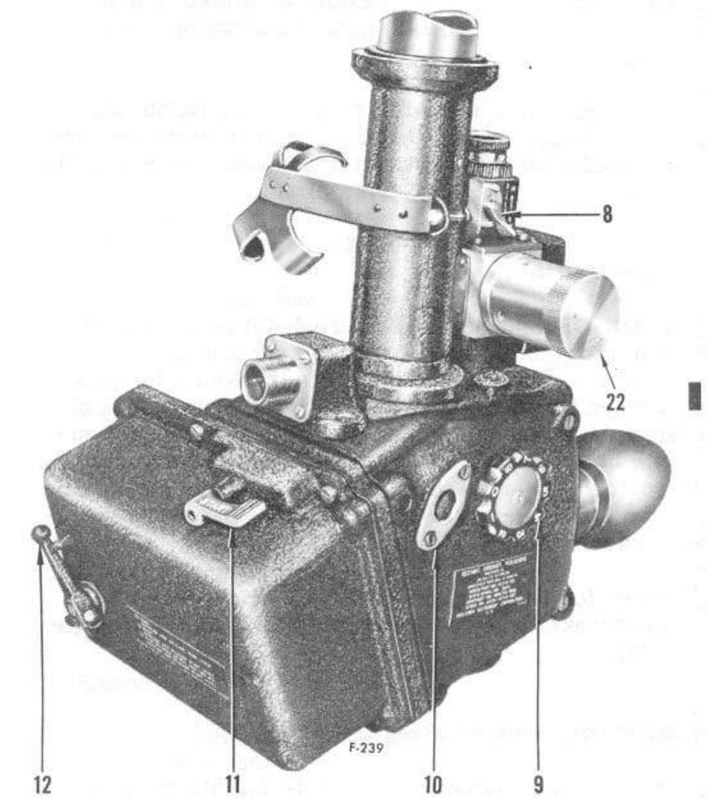
Azimuth Crank and Shutter

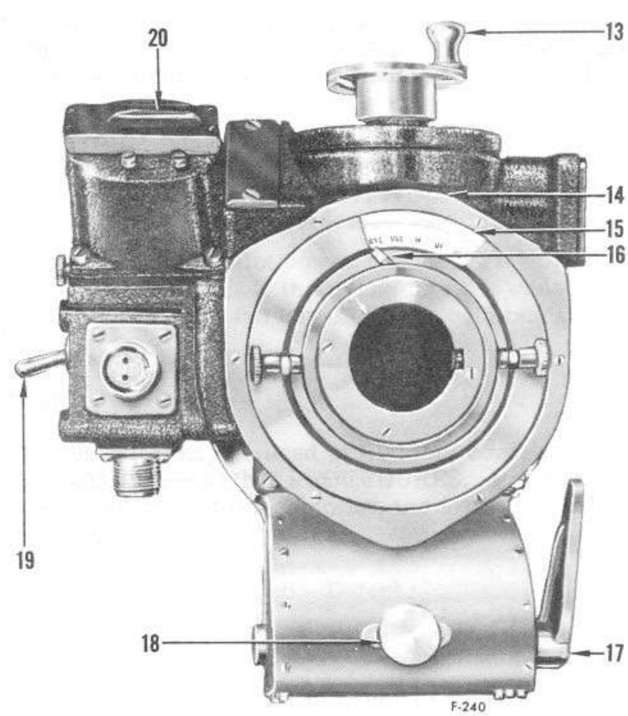
The azimuth crank (13, figure 4-45) operates the dial counter assembly which allows 360 degrees of azimuth rotation.

The shutter lever (17, figure 4-45) controls the opening and closing of the sextant tube opening by means of a mechanical linkage to the shutter.

periscopic sextant and mount







1 LAMP (2 PLACES)
2 WATCH CLIP
3 HALF TIME DIAL AND AVERAGER INDICATOR
4 ALTITUDE COUNTER
5 ALTITUDE KNOB
6 EYEPIECE
7 RHEOSTAT
8 DIFFUSER LEVER
9 FILTER ADJUSTMENT SELECTOR
10 DESICCANT
11 ACTUATING LEVER
12 AVERAGER WINDING LEVER
13 AZIMUTH CRANK
14 LUBBER LINE RING
15 AZIMUTH SCALE
16 LOCKING LEVER
17 SHUTTER LEVER
18 DRAIN PLUG
19 ILLUMINATION SWITCH
20 AZIMUTH COUNTER
21 PROJECTION LENS
22 BUBBLE KNOB

Figure 4-45

AUXILIARY POWER UNIT

The APU is installed in the forward right side of compartment No. 1 (figure 4-69). The unit is powered by a gas turbine engine using JP-4 fuel from the airplane forward 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 (10, figure 4-47) connect the APU with the airplane electrical system. 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 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.

APU CONTROLS AND INDICATORS

APU Temperature Control

Refer to CABIN AIR CONDITIONING, PRESSURIZATION, and VENTILATING SYSTEM in this Section.

Master Switch

This switch (11, figure 4-48) 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 4-48).

Start-Stop Switch

This is a momentary switch (9, figure 4-48) 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 4-48).

Primer Switch

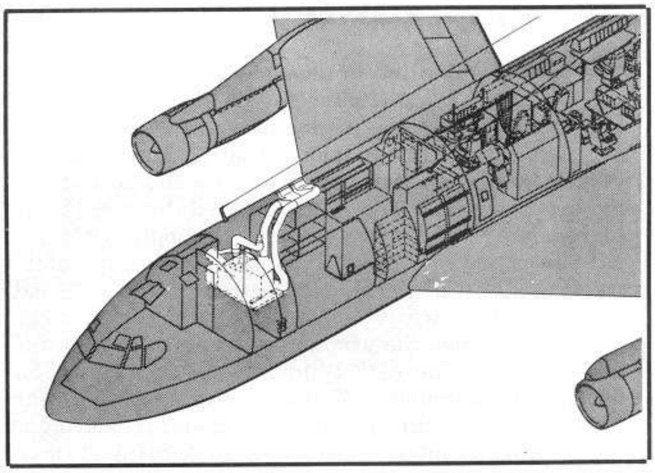
This switch (10, figure 4-48) with ON--OFF positions, controls the fuel boost pump. It is placed in the ON position to deliver priming fuel for starting the engine. Normally this switch is returned to OFF after the start is accomplished. Under high ambient temperatures or heavy load conditions, turbine 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 4-48).

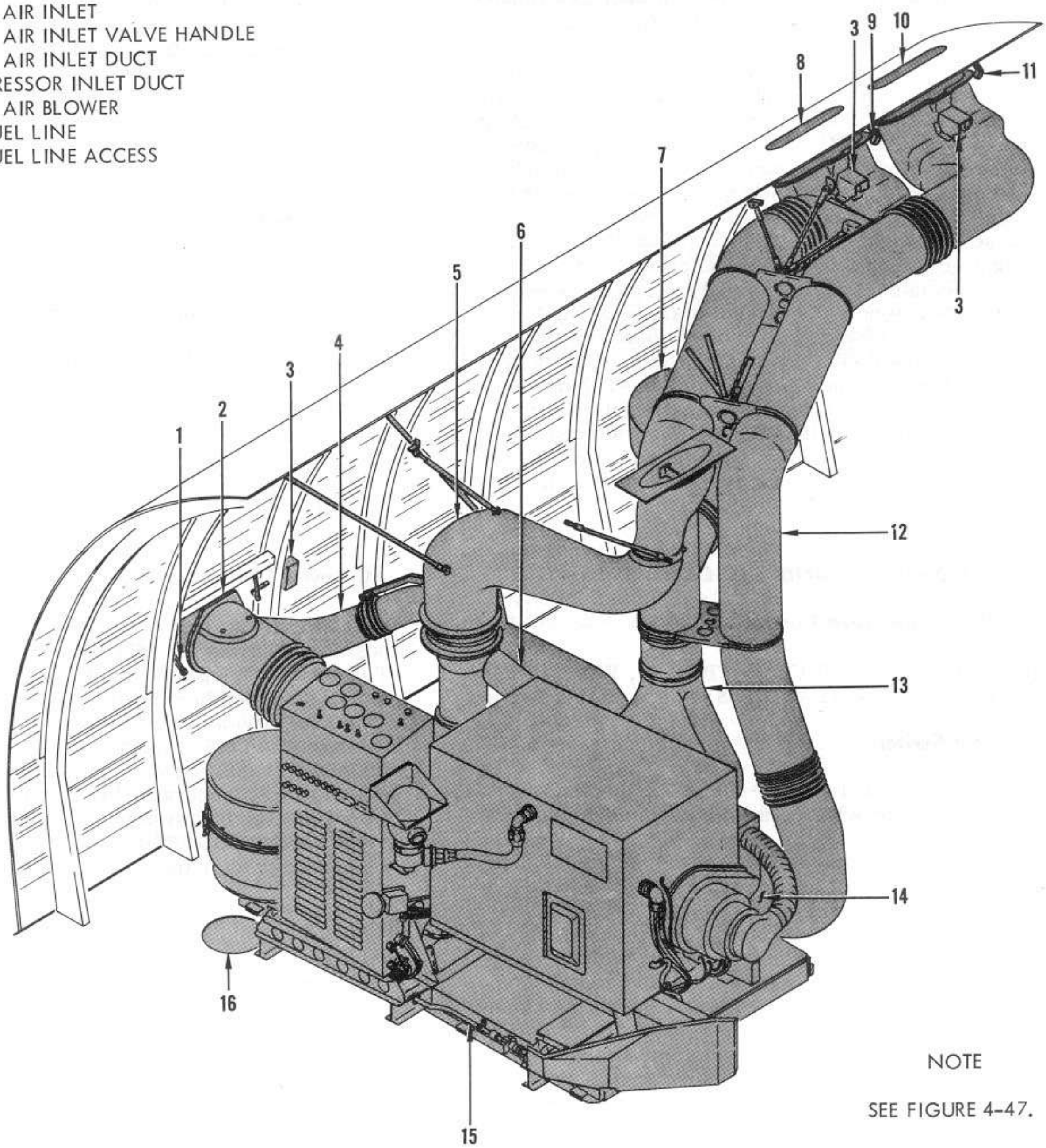
AC Power Control Switch

This switch (13, figure 4-48) 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 4-48).

APU installation

1 TURBINE EXHAUST VALVE HANDLE
2 TURBINE EXHAUST DUCT
3 VALVE SWITCH (3 PLACES)
4 APU ENCLOSURE COOLING AIR DISCHARGE DUCT
5 CONDITIONED AIR TO OVERHEAD DISTRIBUTION DUCT
6 COOLING AIR BYPASS DUCT
7 CABIN AIR OUTLET WITH NOISE SUPPRESSOR
8 COMPRESSOR AIR INLET
9 COMPRESSOR INLET VALVE HANDLE
10 CABIN AIR INLET
11 CABIN AIR INLET VALVE HANDLE
12 CABIN AIR INLET DUCT
13 COMPRESSOR INLET DUCT
14 CABIN AIR BLOWER
15 APU FUEL LINE
16 APU FUEL LINE ACCESS





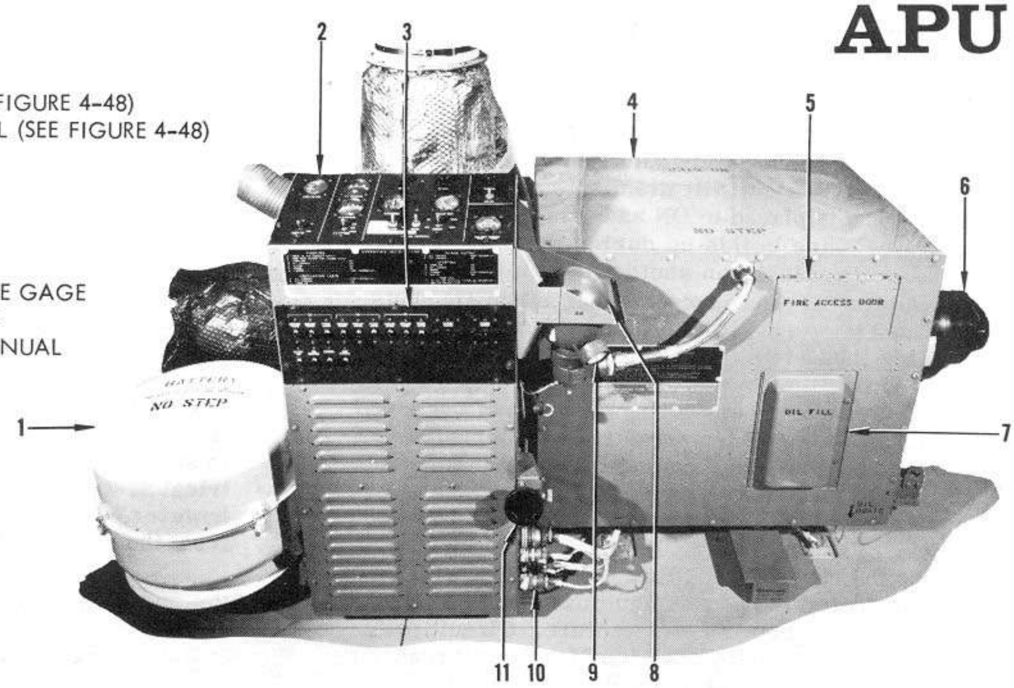
NOTE

SEE FIGURE 4-47.

Figure 4-46

APU

1 BATTERY
2 APU CONTROL PANEL (SEE FIGURE 4-48)
3 APU CIRCUIT BREAKER PANEL (SEE FIGURE 4-48)
4 APU ENCLOSURE
5 FIRE ACCESS DOOR
6 GENERATOR
7 OIL TANK FILLER ACCESS
8 FIRE EXTINGUISHER
9 FIRE EXTINGUISHER PRESSURE GAGE
10 ELECTRICAL CONNECTIONS
11 TEMPERATURE CONTROL MANUAL OVERRIDE



F-1438

Figure 4-47

Cabin Air Temperature Gage

This gage (1, figure 4-48) 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.

Fire Test Switch and Warning Light

The fire test switch (6, figure 4-48) 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 4-48).

Cabin Air Switch

This switch (14, figure 4-48) 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 4-48).

Tachometer

This instrument (12, figure 4-48) 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

Exhaust gas temperature is registered on this gage (7, figure 4-48). The normal operating range is indicated by a green band.

Fire Extinguisher Pressure Gage

This gage (9 , figure 4-47) indicates the pressure within the fire extinguisher.

Oil Pressure and Oil Temperature Warning Lights

These two red press-to-test lights (3 and 4, figure 4-48) 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 4-48).

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 pounds per hour for high electrical loads.

NOTE

When the APU is to be used immediately after landing:

a. It may be necessary to keep one engine operating, until the APU is supplying heat and power.

b. Before shutting down the engines, it may be necessary to transfer fuel to the forward body tank to have fuel for the APU. The APU will become inoperative with less than approximately 2000 pounds of fuel in the forward body tank. See FUEL TRANSFER FOR APU OPERATION, Section VII. If fuel transfer is necessary, maintain the center of gravity within the allowable limits. See figure 5-5.

WARNING

To prevent the possibility of igniting fuel vapors, do not operate the APU during fueling operations.

Starting

NOTE

The APU can only be started 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 Switch - ON

D. Primer Switch - ON

E. Start-Stop Switch - Momentarily ON

NOTE

- The turbine should start within 60 seconds. The duty cycle for the starter motor is one minute. After a one minute starting cycle, allow the starter motor to cool four minutes before another start attempt is made.
- When starting the engine at extremely low temperatures, the engine may be shutdown automatically due to the low pressure of the cold lubricating oil. Several starts may be necessary before the unit will operate continuously.

F. Oil Pressure - Warning light extinguished.

The light should go out when the rpm is between 20% and 40%.

G. Tachometer - Check

Should indicate 100 ± 0.5%

H. Primer Switch - OFF

I. AC Power Control Switch - RESET then ON

Check that voltage is between 192 and 207 volts.

J. Cabin Air Switch - As desired

K. Instruments - Check for proper readings

Cabin Air Temperature - 121°C maximum

DC Volt ammeter - 25 to 28 volts

AC voltmeter - 192 to 207 volts

AC ammeter - 107 amps maximum

Tachometer - 100 ± 0.5%

Exhaust temperature - within the marked range

L. Battery Charge Circuit Breakers - Pull when battery is charged.

Pull the BATTERY CHARGE circuit breakers on the APU panel and the circuit breakers marked APU BATTERY CHARGE on the ENG 2 GENERATOR section of the MCBP.

Pull the circuit breakers when the ammeter reading drops to 4 amps. If the DC Voltammeter 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.

(Refer to BATTERY CHARGE LEVEL in 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 Main Cabin

A. Main Cabin Temperature Control Switch - OFF

B. Air Conditioning Master Switch (Control Cabin) - RAM

C. Switchboard/Cabin Cooling Valve (With TCTO EC552) - CABIN AIRFLOW

CAUTION

APU heat can damage electronics equipment if switchboard/cabin cooling valve is not in CABIN AIRFLOW position.

D. Flow Divider Valve - As desired for control cabin heating

This valve is located in the overhead air conditioning duct above the APU and is operated by a pull chain.

E. Boom Operator's Compartment Air Outlet Doors - Close

Close the emergency defrost slide prior to closing the outlet doors.

F. Main Cabin Distribution Duct Diffusers - As desired

G. Cabin Air Switch (APU Control Panel) - ON

H. APU Temperature Control - As desired

The APU temperature control is on the main cabin temperature control panel (left side of the forward bulkhead in compartment No. 1).

NOTE

If the APU temperature control does not effectively regulate the cabin temperature after a normal stabilization period, adjust the temperature with the temperature control manual override (11, figure 4-47). Refer to APU TEMPERATURE CONTROL, this Section.

Stopping APU

A. Cabin Air Switch - OFF

B. AC Power Control Switch - OFF

C. Start - Stop Switch - Momentarily to STOP

D. Master 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. Switchboard/Cabin Cooling Valve - SWITCHBOARD COOLING, locked

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.

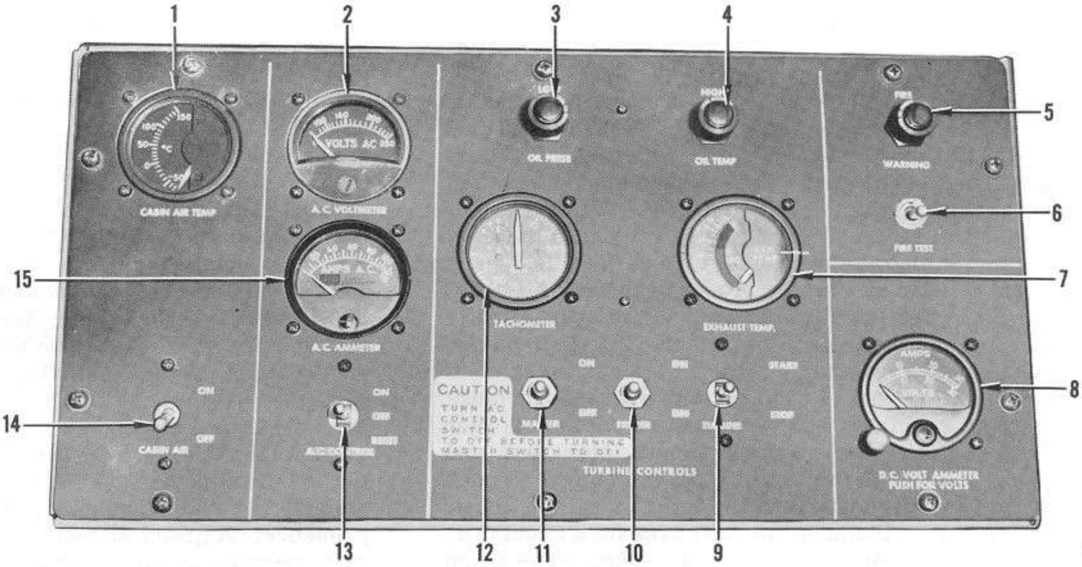
A. Fire - Combat (as required)

If the APU fire extinguisher fails or additional fire extinguishing agent is required, discharge hand fire extinguisher into the turbine section through fire access doors (5, figure 4-47). Use some device, such as a crash axe to hold the doors open, permitting access to the turbine section.

WARNING

- Using the extinguisher nozzle to hold the doors open may subject the extinguisher operator to possible burns.
- 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.
- After being inspected by a maintenance specialist, 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.

APU control panels



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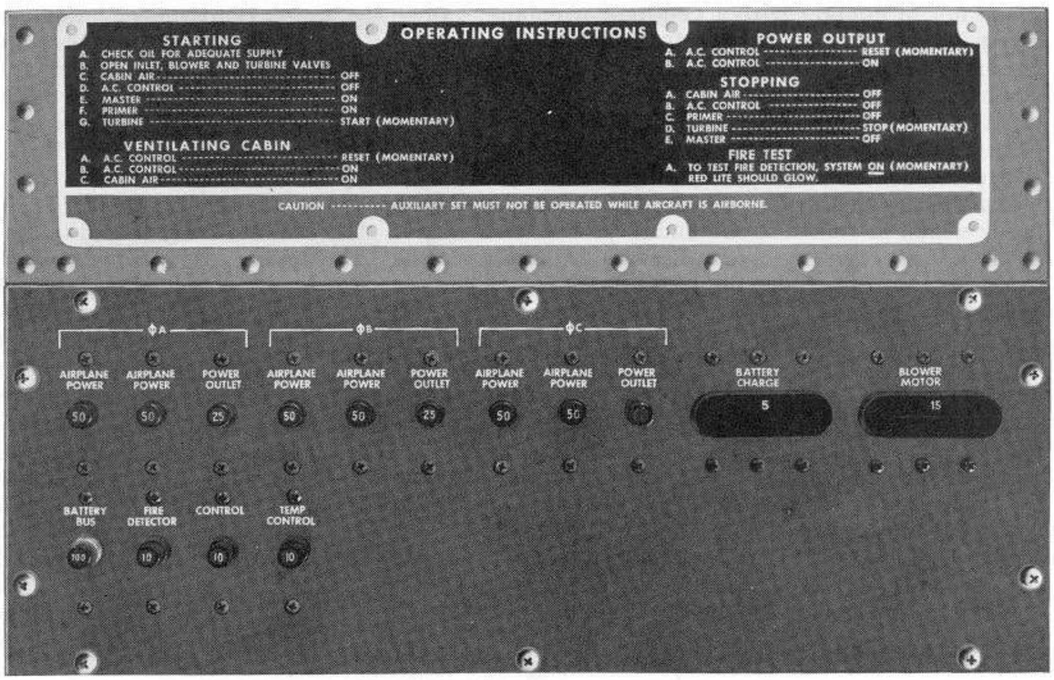


F-267

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

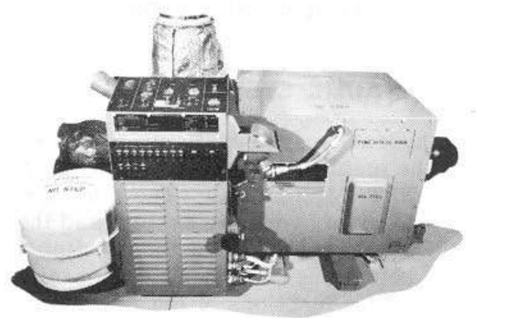


Figure 4-48

AIR REFUELING TANKER SYSTEM

The airplane is equipped to transfer fuel in flight to receiver airplanes by means of the flying boom air refueling system. As a receiver, the airplane can be refueled in flight by tanker airplanes equipped with the air refueling boom; refer to AIR REFUELING RECEIVER SYSTEM in this Section. Fuel is carried in two body tanks (figure 4-57) which can be supplemented with fuel from the wing tanks. See figure 1-22. All of the wing tank fuel can be transferred by gravity into the body tanks, except amounts indicated in figure 7-6. Body tank fuel can be fed to the engines. Refer to 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, to 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. Refer to HYDRAULIC SYSTEM Section I and figure 1-35. The forward air refueling pumps in the body tanks are 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 4-49) is pressurized by the main hydraulic system. Refer to 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 the automatic functions of 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 hydraulically actuated ruddevator control system will fly 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 and the fuel dump switch 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 the event of damage to any portion of the boom hydraulic system return plumbing except the boom hoist.

Boom Operator's Sighting Door Lever

The boom operator's sighting door lever (8, figure 4-50) 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

boom hydraulic system

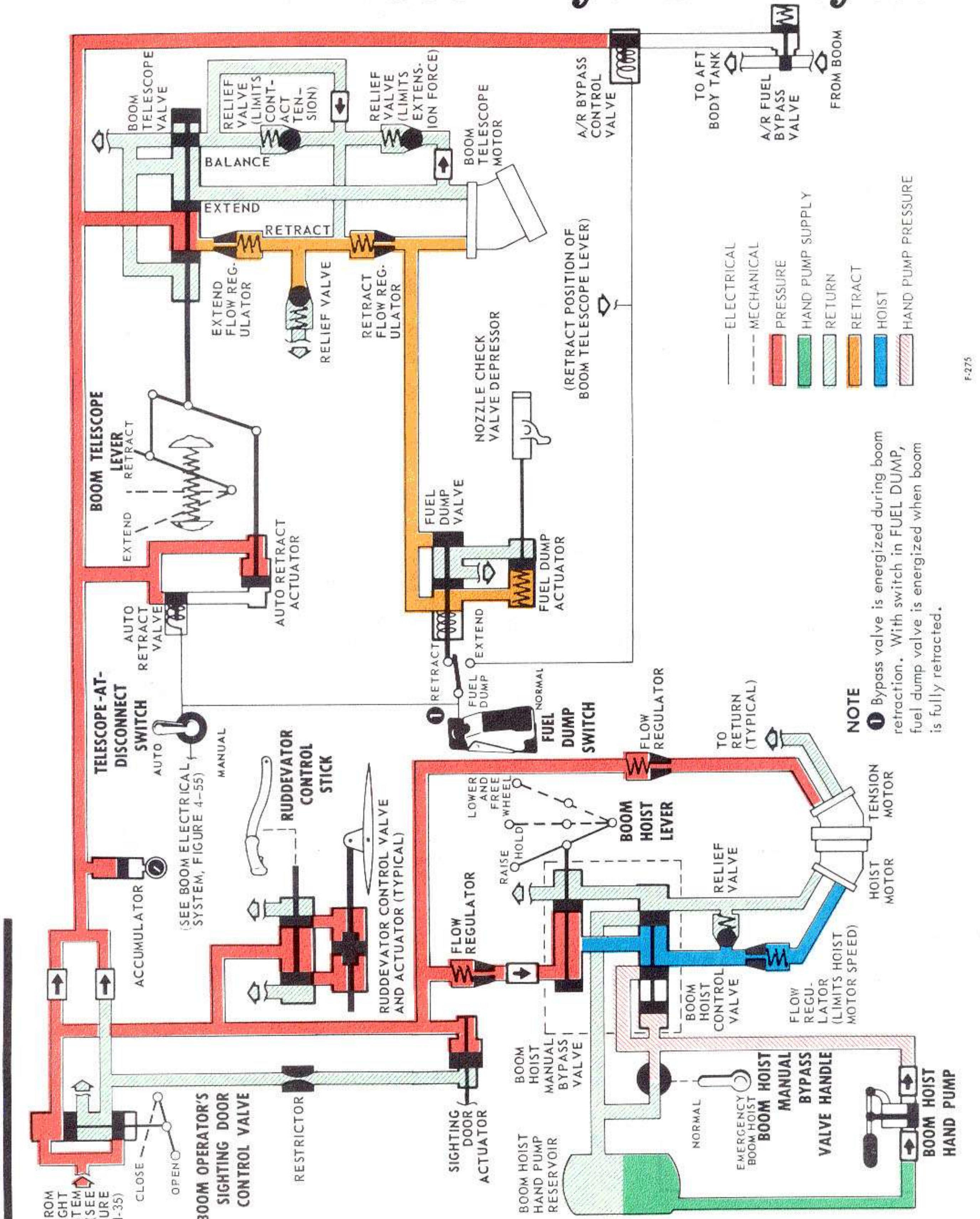


Figure 4-49

boom operator's compartment

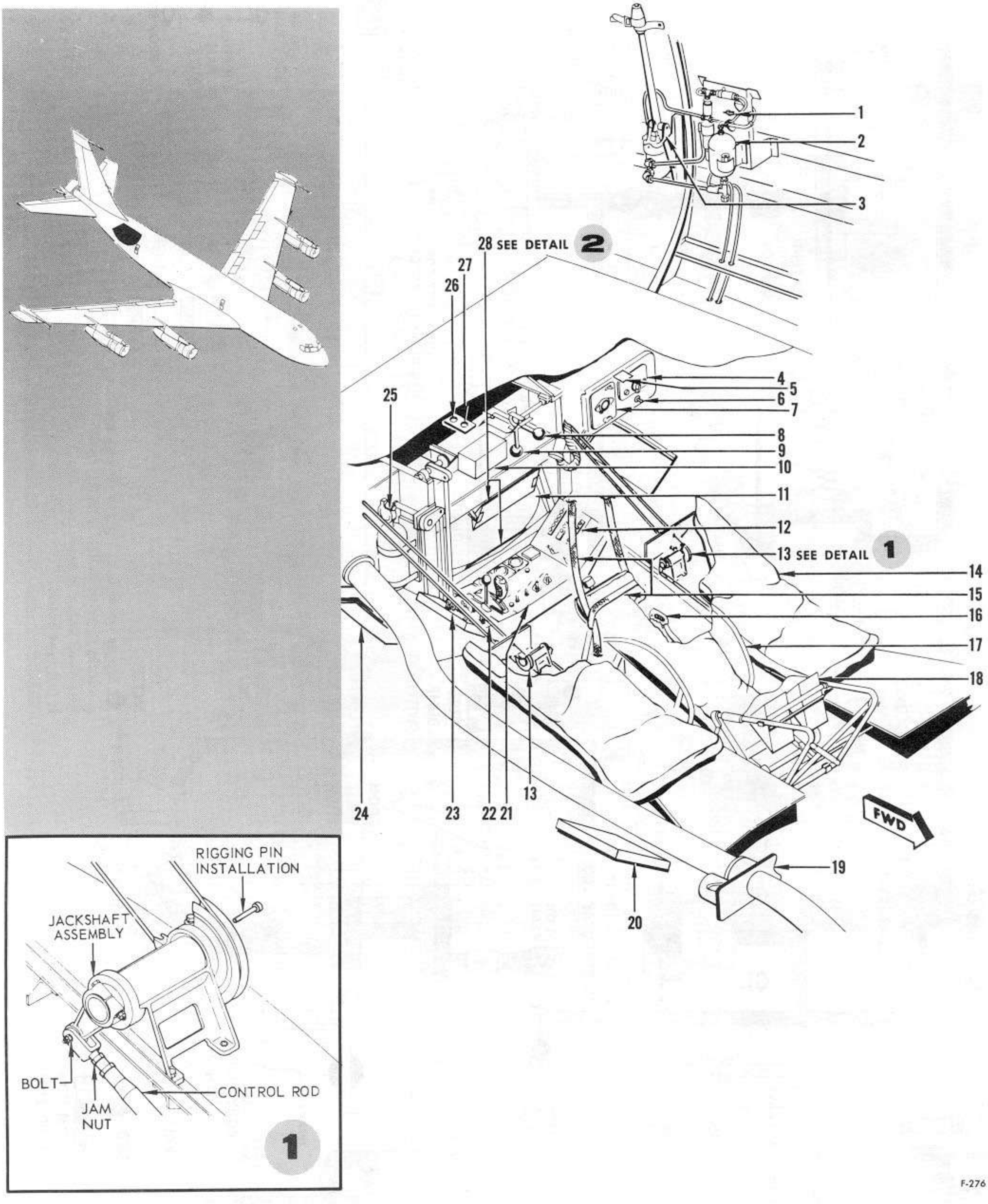
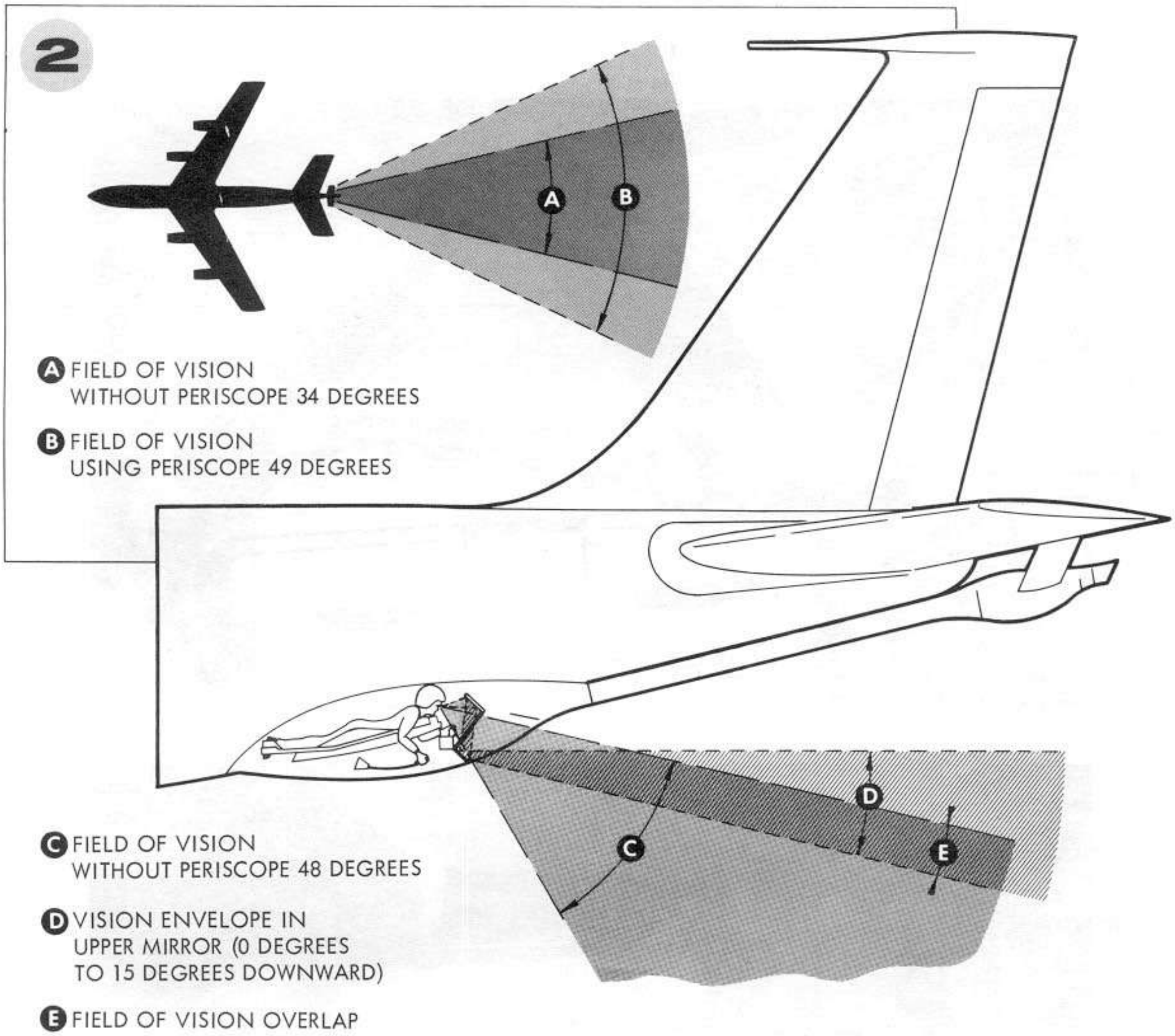


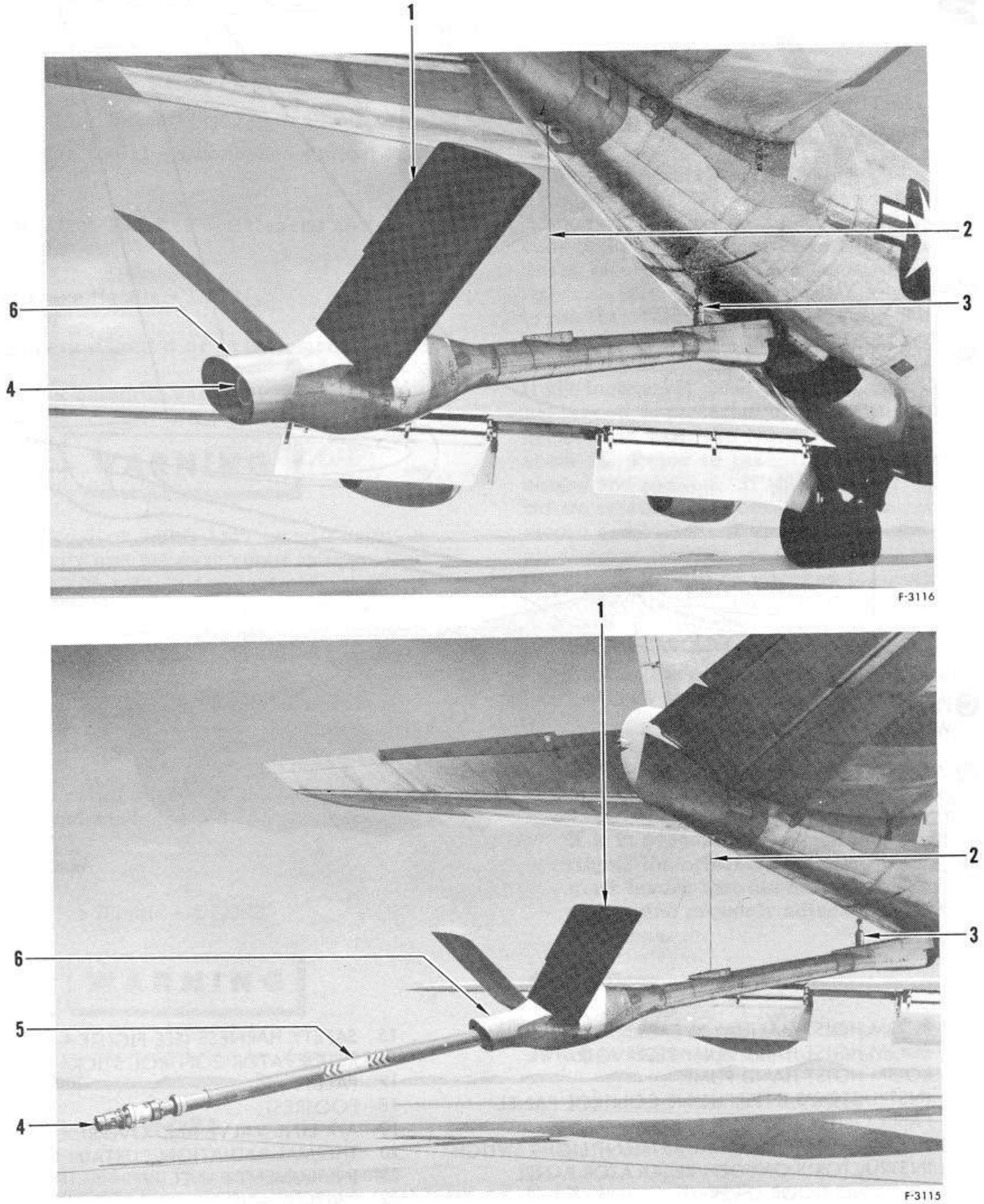
Figure 4-50 (Sheet 1 of 2)



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 FAN CONTROL SWITCH
6 BOOM OPERATOR'S COMPARTMENT LIGHT SWITCH
7 INSTRUCTOR'S OXYGEN REGULATOR PANEL
8 SIGHTING DOOR LEVER
9 BOOM LATCHING LEVER
10 SIGNAL AMPLIFIER
11 SIGHTING WINDOW
12 CIRCUIT BREAKER PANEL
13 RUDDEVATOR CONTROL JACK SHAFT (2 PLACES)
14 INSTRUCTOR'S PALLET
15 SAFETY HARNESS (SEE FIGURE 4-74)
16 RUDDEVATOR CONTROL STICK
17 PALLET
18 FOOTREST
19 A/R LINE VALVE AND OVERRIDE HANDLE
20 THERMAL RADIATION CURTAIN STOWAGE
21 INSTRUMENT PANEL
22 SWITCH PANEL
23 OXYGEN REGULATOR AND INTERPHONE CONTROL PANEL
24 SIDE WINDOW
25 PORTABLE OXYGEN BOTTLE STOWAGE
26 COMPARTMENT LIGHT
27 ALARM BELL
28 PERISCOPE

Figure 4-50 (Sheet 2 of 2)

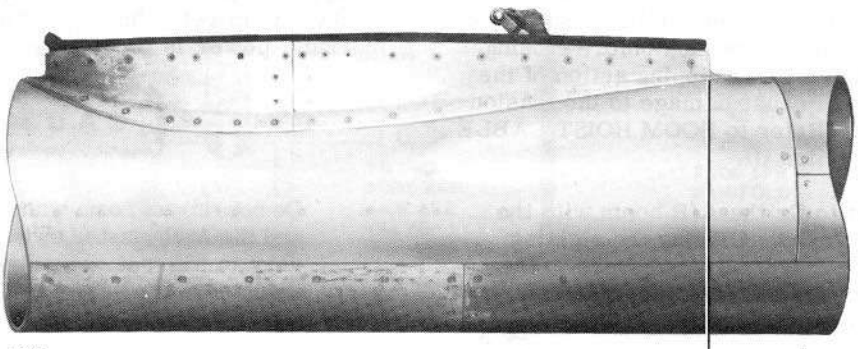
air refueling boom



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)

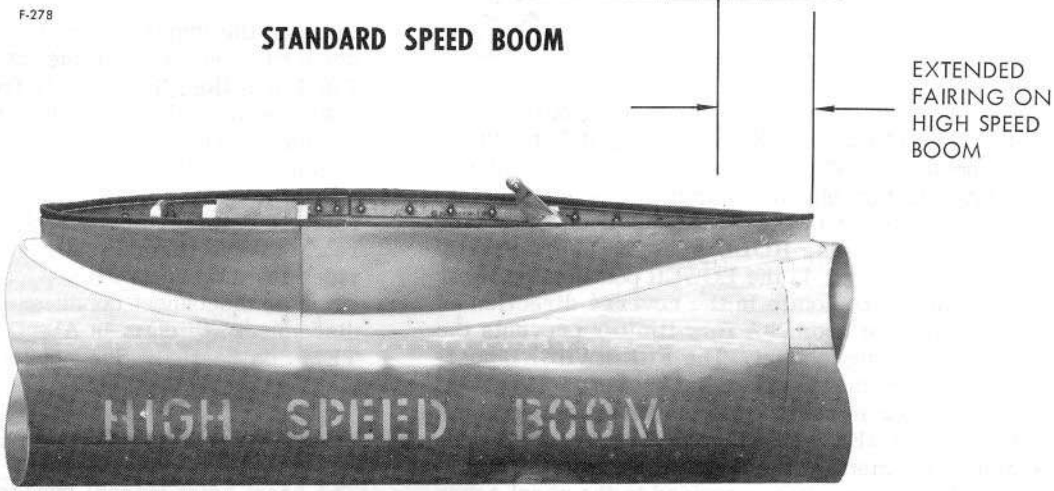
Figure 4-51 (Sheet 1 of 2)

BOOM IDENTIFICATION



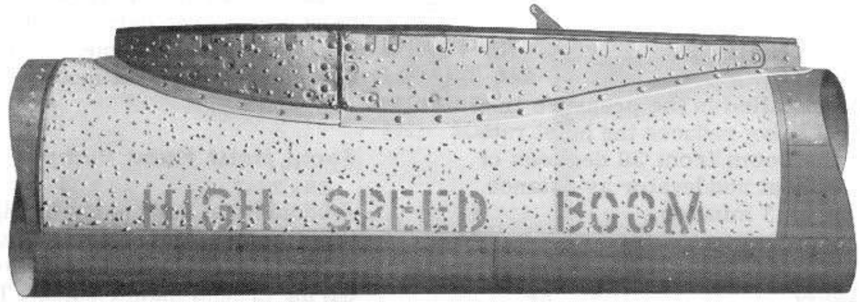
F-278

STANDARD SPEED BOOM



F-279

HIGH SPEED BOOM



F-279

HIGH SPEED BOOM WITH BOUNDARY LAYER CONTROL

Figure 4-51 (Sheet 2 of 2)

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 regardless of the valve 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, in 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 4-52) 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 so that raising the boom from 30 degrees of down elevation, without ruddevator assistance, could take as long as 3 minutes.

Boom Telescope Lever

The telescoping lever (4, figure 4-52) 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 4-49), electrically actuated, provides for automatic retraction of the boom during fuel dump or disconnect conditions, when the telescope-at-disconnect switch is in AUTO. Refer to SIGNAL SYSTEM this Section. See figure 4-56.

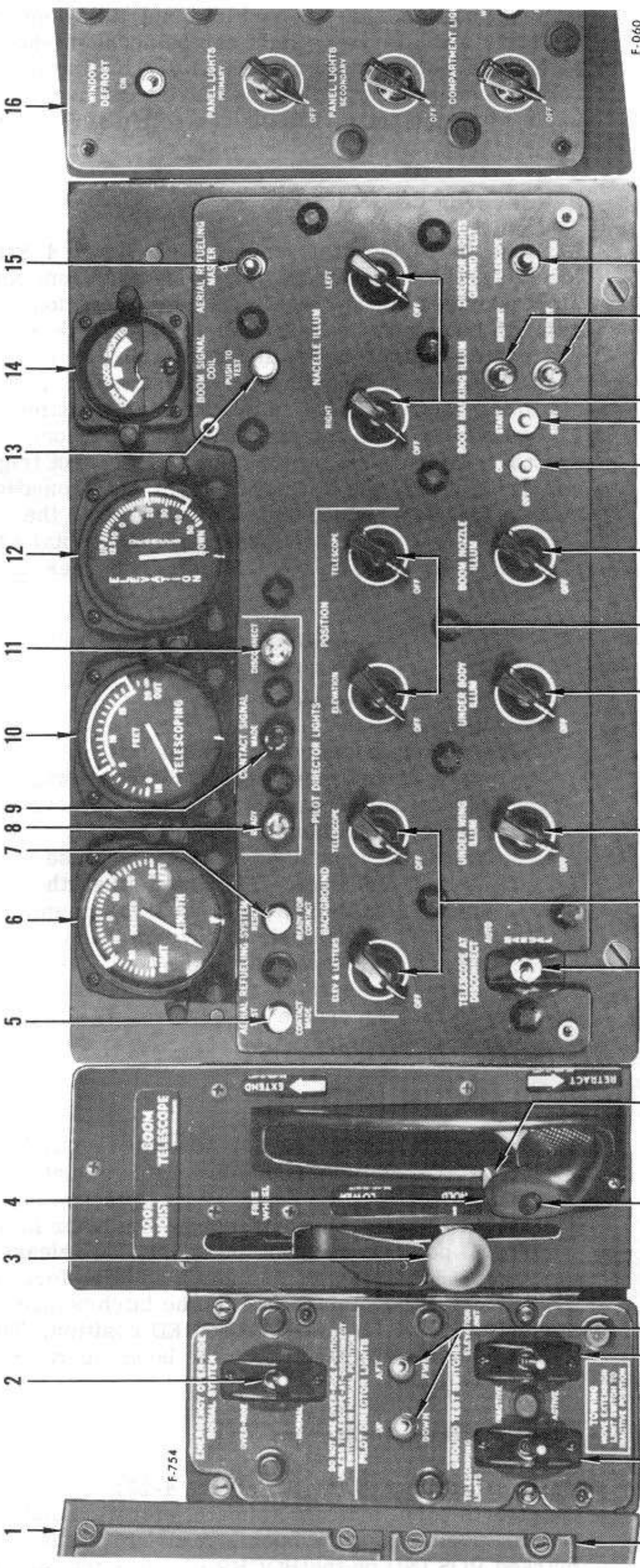
Boom Hoist Manual By-Pass Shutoff Valve

The boom hoist manual bypass shutoff valve (1, figure 4-50) 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 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.

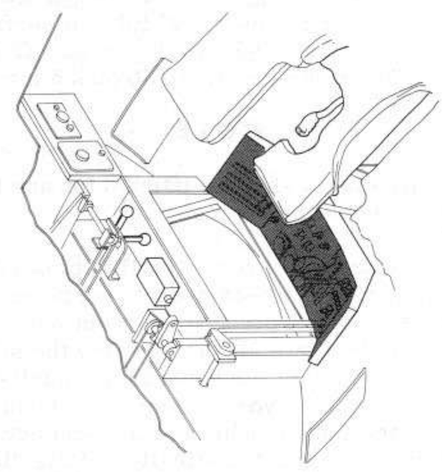
Boom Hoist Hand Pump

A boom hoist hand pump (3, figure 4-50) in the aft left toilet compartment can be used to hoist the boom in event of main hydraulic system pressure failure or during ground maintenance. The pump uses hydraulic fluid from a 1.5 quart reservoir (2, figure 4-50) and can be used to hoist the boom, provided the boom hoist manual bypass shutoff valve is in the EMERGENCY HOIST position.

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-280

Figure 4-52

AIR REFUELING BOOM

There are two types of booms that can be installed on the airplane, high speed and standard speed. The airplanes were equipped with high speed booms during production. 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(E)C-1-1, for boom 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 4-51. 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, the air refueling booms 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.

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 shall 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 of the receiver pilots 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 4-53) located to the right and slightly below the boom operator, provides aerodynamic control of elevation and azimuth boom position. Alignment marks are on the ruddevator control jackshaft installation to the right and left of the sighting window. These marks 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 4-53). 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. Do not move boom more than 20 degrees in azimuth. Movement beyond 20 degrees could cause damage to fuel lines. The rated strength of the hoist cable is 7000 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.

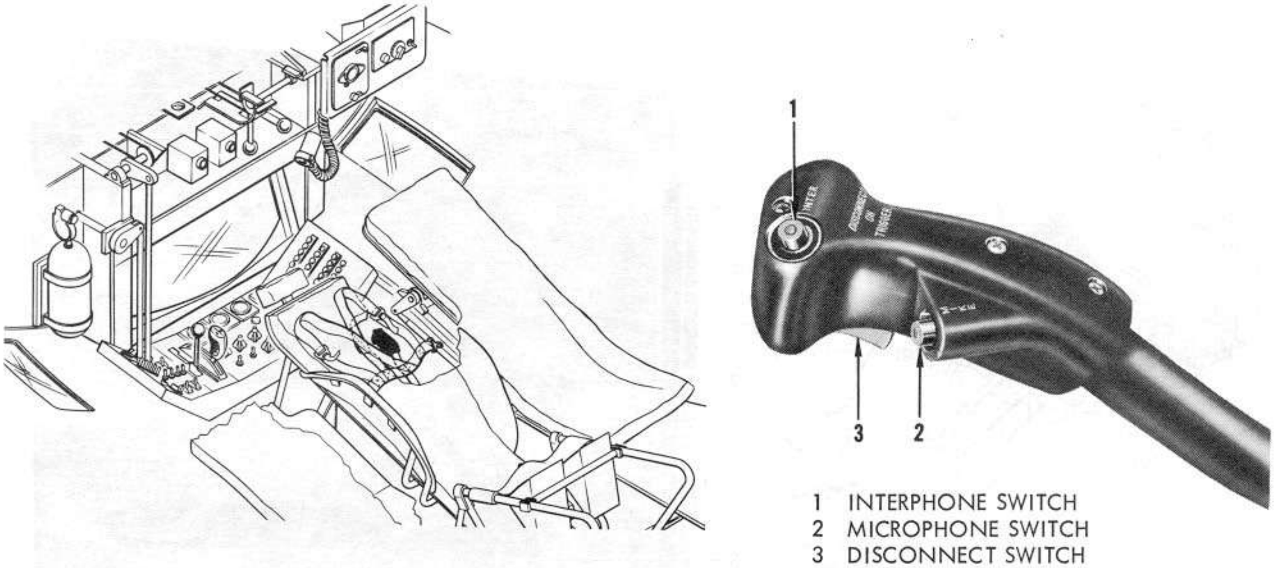
Boom Latching Lever

The latching lever (9, figure 4-50) 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 4-52) 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 4-54.

ruddevator control stick



1 INTERPHONE SWITCH
2 MICROPHONE SWITCH
3 DISCONNECT SWITCH

Figure 4-53

AIR REFUELING ELECTRICAL SYSTEM

The air refueling electrical system operates on power received from the tanker 28 volt DC system. See figure 4-55. The A/R master switch controls all electrical equipment in the boom operator's compartment, except fuel dumping, panel and compartment lighting, 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. All boom electrical controls and indicators on the boom operator's panel operate on 28 volt DC power through circuit breakers on the SBCBP (figure 1-33) and the BOCBP (figure 4-54). The SBCBP breakers for the air refueling system are marked A/R CONT FEED. Markings for the various circuit breakers on the BOCBP are described in the text for the individual circuits. The boom marker lights use 115 volt AC.

Boom Signal System (Amplifier Control)

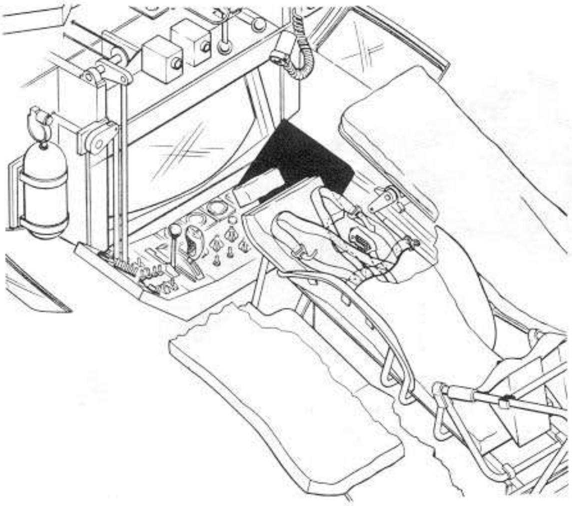
The tanker signal system for boom refueling is an electrical system which works in conjunction with a signal system in the receiver airplane to set up the automatic features of the boom hydraulic and fuel systems for the ready, contact made, and disconnect conditions; see figure 4-55. When the A/R master 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.

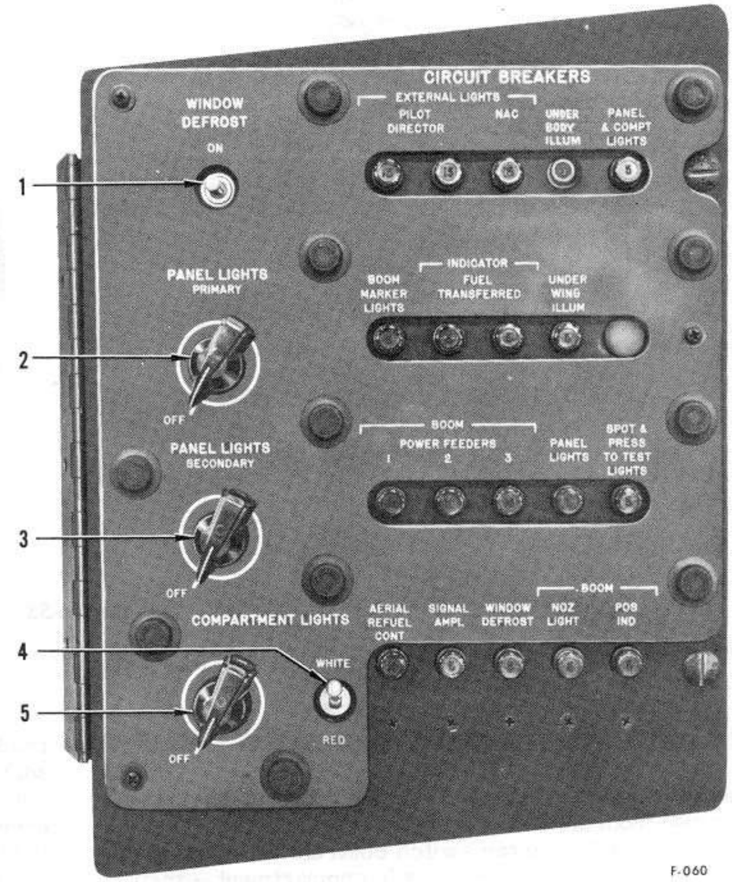
NOTE

The telescope-at-disconnect switch should be in MANUAL when the receiver is in emer--gency boom latching since the tankers disconnect signal will not release the toggles.

The system may be advanced to contact made by a signal from the receiver airplane through the boom signal coil or by depressing the A/R system test

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 4-54

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.

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 4-49 and 4-55. 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

boom electrical system

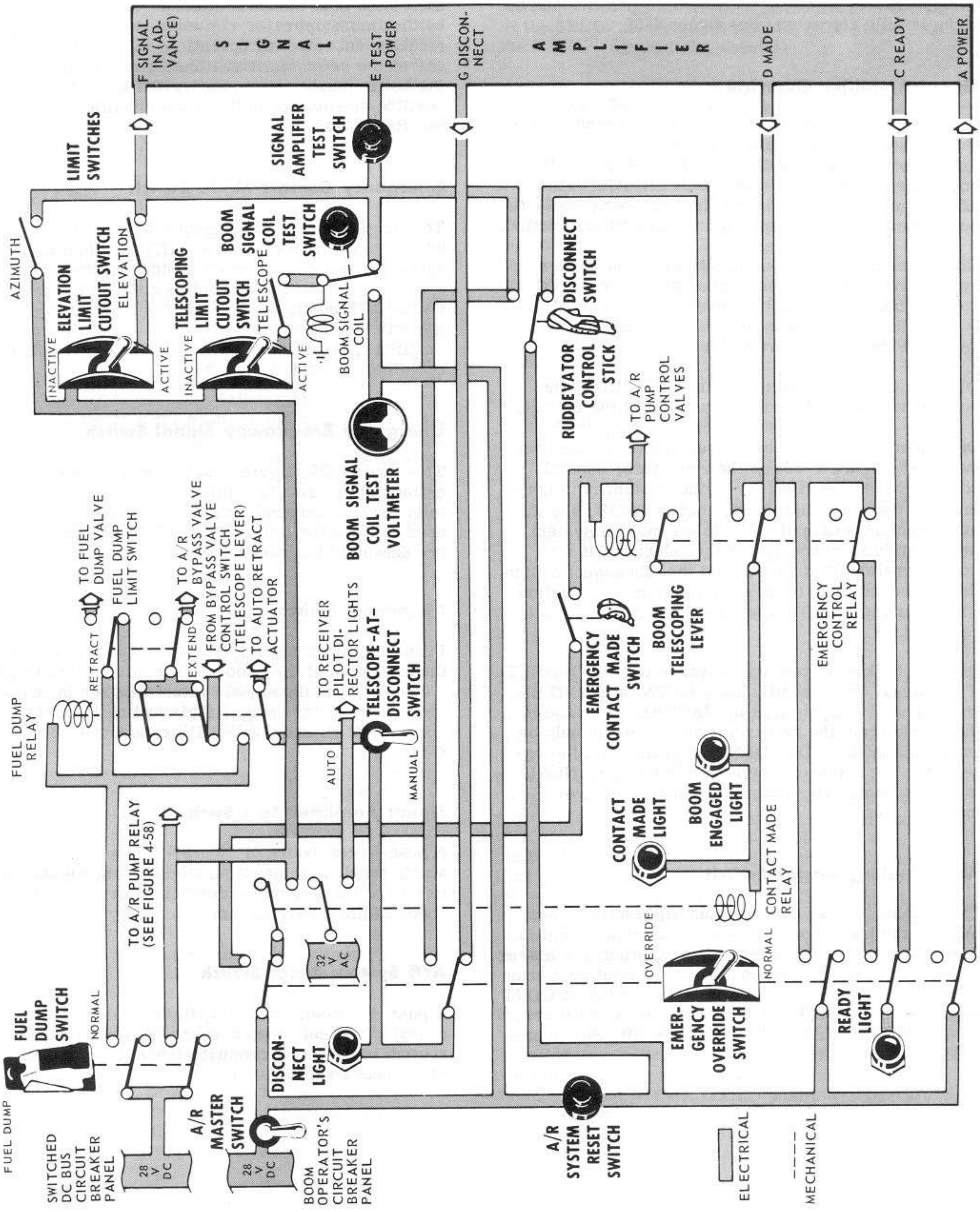


Figure 4-55

always energize the auto retract valve. For a description of the air refueling pump solenoids, refer to AIR REFUELING FUEL SYSTEM and figure 4-58, 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 4-55.

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 4-52) 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 4-52) 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.

Disconnect is initiated by depressing the disconnect switch (3, figure 4-53) on the ruddevator control stick provided the receiver signal system is in normal and 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.

Only the tanker system will advance to DISCONNECT if the signal coil circuit checks OPEN or SHORTED. or the receiver system is in MANUAL. 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

The A/R master switch controls all electrical equipment in the boom operator's compartment except fuel dumping, panel and compartment lighting, the alarm bell, and communications equipment. Circuit protection is provided by circuit breakers marked A/R CONT FEED on the SBCBP and circuit breakers marked BOOM, POWER FEEDERS on the BOCBP. See figures 1-33 and 4-54.

Emergency Override Switch

This switch with NORMAL--OVERRIDE positions (2, figure 4-52) 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 4-55.

Emergency Contact Made Switch

This trigger switch (28, figure 4-52) 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 4-55.

Emergency Breakaway Signal Switch

This switch (29, figure 4-52) 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.

Disconnect Switch

Pressing this trigger type switch (3, figure 4-53) 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 4-56.

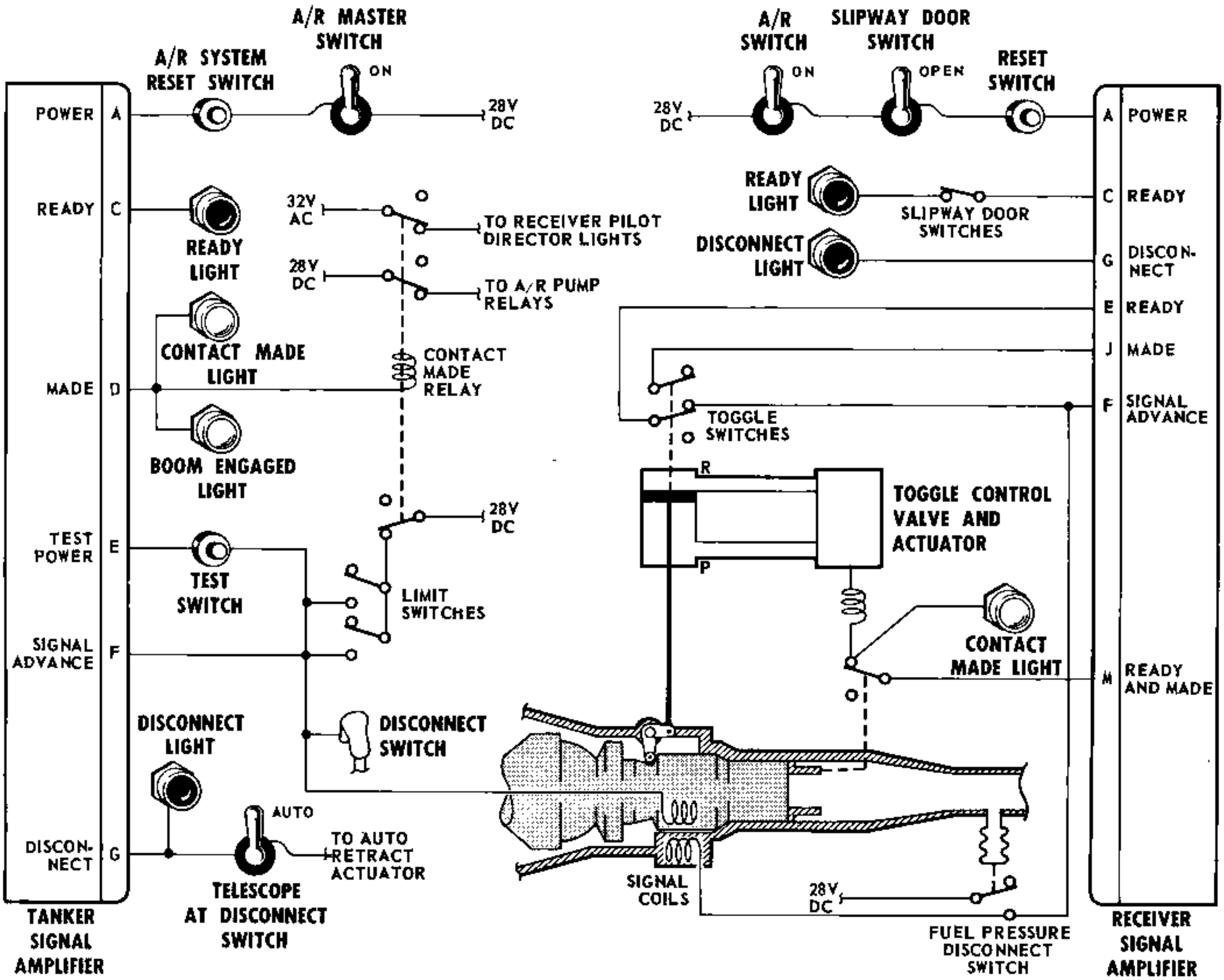
Signal Amplifier Test Switch

A push-to-test button (5, figure 4-52) 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 4-52) on the boom operator's panel, when pressed, will return the signal system to the ready condition from either the made or disconnect condition.

tanker-receiver electrical marriage (typical)



F-286

Figure 4-56

Limit Cutout Switches

Two channel guarded INACTIVE--ACTIVE limit cutout switches (31, figure 4-52) on the boom operator's panel, when in the INACTIVE position will cut out the elevation and telescope limits on the boom for ground test purposes. The ACTIVE position is used during air refueling to restore the four limits and prevent structural damage. The INACTIVE position of the telescope cutout switch can be used in flight for towing fighter airplanes. See figure 4-55.

Telescope-at-Disconnect Switch

This switch, with AUTO--MANUAL positions (27, figure 4-52) on the boom operator's panel, selects control of boom telescoping at disconnect. The AUTO position results in automatic telescoping of the boom when the signal system advances to a disconnect condition. When in the MANUAL position at disconnect, the boom will remain static until the boom telescoping lever is moved to the RETRACT position. See figure 4-55.

CAUTION

With the boom stowed, do not select automatic retracting. In the stowed position, gravity and pressure tend to force the boom against the stops with excessive force. With manual control of the boom do not allow the boom to strike the stops at high retraction rates.

NOTE

The telescope-at-disconnect switch should be in MANUAL when the receiver is in emergency boom latching since the tanker's disconnect signal will not release the toggles.

Boom Signal Coil Test Voltmeter

This instrument (14, figure 4-52) is used in conjunction with the push-to-test signal coil button (13, figure 4-52) to determine if the boom signal coil circuit is operating properly. The instrument is marked to indicate whether the signal coil is electrically open, good or shorted when the test button is pressed.

NOTE

Do not press the signal coil test switch in contact made as this will send the receiver to disconnect.

Contact Signal Lights

Three contact lights (8, 9, 11, figure 4-52) on the boom operator's panel indicate the condition of the air refueling system. When the blue ready light is illuminated, the tanker air refueling system is ready for contact with a receiver airplane. When the green made light is illuminated, contact has been made and fuel can be transferred to a receiver airplane. When the amber disconnect light is illuminated the tanker and receiver airplanes have broken contact and the fuel flow in the tanker air refueling system is stopped. These conditions can be duplicated through switches.

Boom Engaged Light

A boom engaged light (11, figure 1-16) on the pilot's flight instrument panel illuminates when the signal system is in the contact made condition. Power is 28 volt DC through a circuit breaker marked SIGNAL AMPL on the BOCBP (figure 4-54).

Air Refueling Exterior Lighting

Lights are installed on the fuselage and boom to illuminate the exterior of the airplane and boom for night operation. See figures 4-30 and 4-31. Rendezvous lights are installed to identify the tanker during night air refueling operation. See figures 1-34 and 4-31.

NOTE

The A/R master switch controls all DC electrical equipment in the boom operator's compartment except fuel dumping, panel and compartment lighting, the alarm bell and communications equipment.

Underbody Illumination Lights

One light is flush mounted on the inboard side of each inboard nacelle strut to illuminate the underbody of the airplane. These lights are controlled by a rheostat switch (24, figure 4-52) on the boom operator's panel. Operating power is 28 volt AC through a circuit breaker marked UNDERBODY ILLUM on the BOCBP (figure 4-54).

Underwing Illumination Lights

One light is flush mounted in the lower wing to body fairing aft of each wing to illuminate the underwing area of the airplane. These lights are controlled by a rheostat switch (25, figure 4-52) on the boom operator's panel. Operating power is 28 volt DC through a circuit breaker marked UNDERWING ILLUM on the BOCBP (figure 4-54).

Nacelle Illumination Lights

Engine nacelles and wing leading edges are illuminated by a flush mounted scanning light on each side of the fuselage, above and slightly forward of the wing leading edge. These lights are controlled by a switch on the pilots' center instrument panel (7, figure 1-15) and brilliance controls on the boom operator's panel (19, figure 4-52) and the ARR panel. When operated from 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 a circuit breaker marked TAXI & LANDING LIGHT CONTROL on the T-R BUS NO. 1 section of the MCBP and a circuit breaker marked NAC on the BOCBP (figures 1-33, sheet 10 and 4-54). For ARR panel controls, refer to NACELLE ILLUMINATION SWITCHES under ARR EXTERIOR LIGHTING in this Section.

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 4-52) and a spring loaded, three position START switch (20, figure 4-52) 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 4-52). 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 BOCBP (figure 4-54) and the A/R CONTROL PANEL circuit breaker on the ENG 4 GENERATOR section of the MCBP. The white light in the bottom of the nozzle fairing is used to illuminate the boom nozzle for the boom operator during night air refueling operation. It is controlled by a rheostat switch (22, figure 4-52) on the boom operator's panel. Operating power is 28 volt DC through a circuit breaker marked NOZ LIGHT on the BOCBP (figure 4-54).

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 anti-collision lights both beacon light colors will be used. These lights rotate through 360 degrees at a speed of 45 ± 10 rpm. The lights cover minus 25 degrees to plus 25 degrees of elevation, depending upon the desired mode of operation. The two lamps in each assembly are angled to rotate in the same plane. The rendezvous beacon lights switch (1, figure 4-33) on the overhead panel has UPPER ON--OFF--BOTH ON positions. The rendezvous beacon lights color selector switches (2, figure 4-33) provide a means for individual or multiple color selection. Four colors, red, blue, green and amber with ground changing provisions only are provided with two filters of each color. The two color selector switches are decalled UPPER and LOWER, and each switch is three position, COLOR A--BOTH--COLOR B. Normally color A selects the red filter and color B selects white. 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, LOWER on the 28V AC section of the MCBP (figure 1-33).

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 the boom movements in both 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. The receiver pilot director light switches (30, figure 4-52) actuate the red panels adjacent to the letters so that the boom operator may direct the receiver into the contact position. There are two three-position toggle switches which are spring-loaded to the center (neutral) position. The left switch has UP--DOWN positions and the right switch has AFT--FWD positions. 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 nominal contact position. The lights will remain illuminated and follow the boom movements in both the contact made and disconnect conditions. A breakaway signal switch button on the top of the telescope lever will turn off and on the receiver pilot director lights (except the background lights) to signal an emergency breakaway. There is also a three-position ground test switch (17, figure 4-52) 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 4-52) are also on the boom operator's panel. Power is 32 volt AC through the PILOT DIRECTOR circuit breakers on the BOCBP (figure 4-54) and the 28 VOLT TRANSFORMER circuit breaker on the ENG 4 GENERATOR section of the MCBP (figure 1-33, sheet 2).

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

There are three compartment lights, two dome lights and a spotlight. One dome light has two lamps (red and white), selected by a color selector switch (4, figure 4-54). The intensity is controlled by a brilliance control (5, figure 4-54). Power is 28 volt AC through a circuit breaker marked PANEL & COMPT LIGHTS on the BOCBP. The spotlight has a rheostat on the light, requires 28 volt DC through a circuit breaker marked SPOT & PRESS-TO-TEST LIGHTS on the BOCBP.

Boom Operator's Compartment Light Switch

A compartment light switch (6, figure 4-50) is installed on the instructor boom operator's panel. The switch is wired to permit control of the compartment light from either the entry to the boom operator's compartment or the instructor boom operator's station. Operating power is 28 volt AC through the circuit breaker marked PANEL & COMPT LIGHTS on the BOCBP (figure 4-54).

Panel Lights

The boom operator's primary and secondary panel lights are each controlled by rheostat switches (2 and 3, figure 4-54) 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 use 28 volt DC through the PANEL LIGHTS circuit breaker. The secondary lights use 28 volt AC through the PANEL & COMPT LIGHTS circuit breaker on the BOCBP.

Boom Operator's Heated Window

Refer to WINDOW ANTI-ICING SYSTEM in this Section.

AIR REFUELING FUEL SYSTEM

Air refueling fuel is carried in 2 lower body tanks (figure 4-57). 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 body 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 4-57. The fuel dump switch on the fuel 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. Refer to FUEL DUMPING, Section III. For a description of air refueling fuel system controls and indicators, refer to FUEL SYSTEM in Section I.

AIR REFUELING OPERATION

NOTE

All air refueling operations, amplified and abbreviated checklists, are contained in T.O. 1-1C-1.

air refueling fuel system

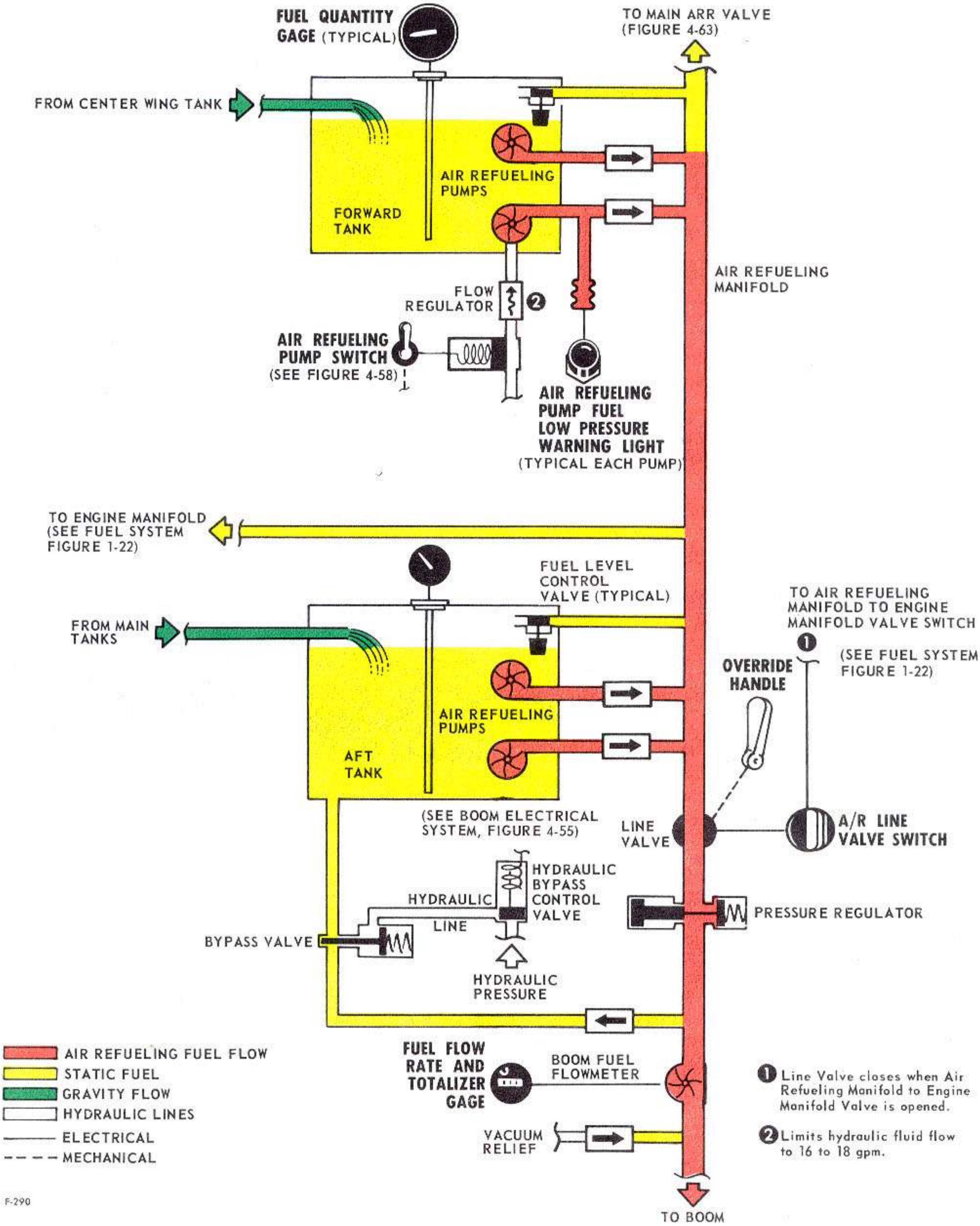
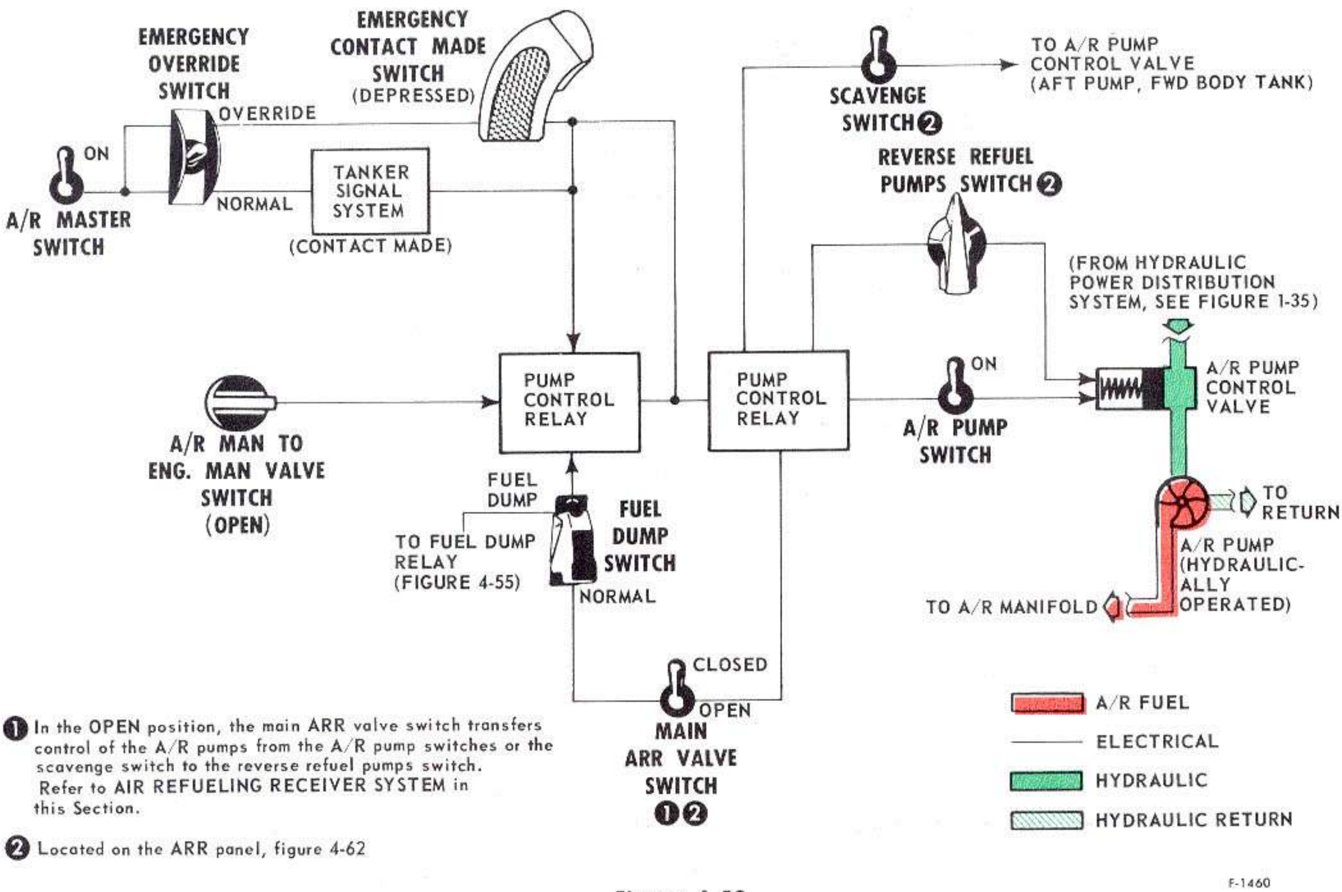


Figure 4-57

air refueling fuel pump control



❶ In the OPEN position, the main ARR valve switch transfers control of the A/R pumps from the A/R pump switches or the scavenge switch to the reverse refuel pumps switch. Refer to AIR REFUELING RECEIVER SYSTEM in this Section.

❷ Located on the ARR panel, figure 4-62

Figure 4-58

A/R SYSTEM EMERGENCY OPERATION

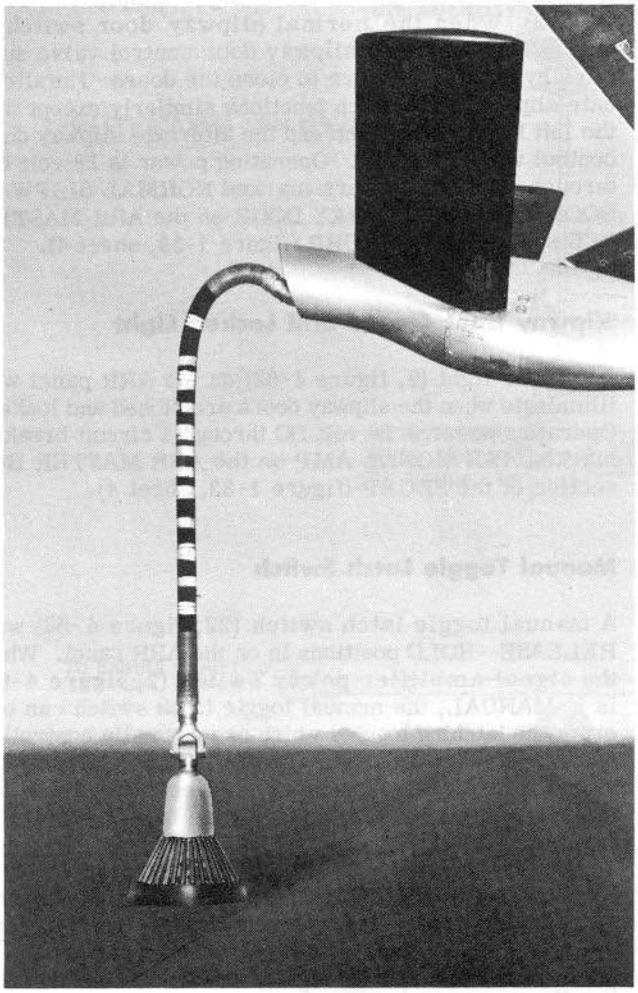
Air Refueling Fuel System Failure

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 use 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.

boom drogue attachment



F-302

Figure 4-59

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 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 REFUELING

Description

The boom to drogue adapter air 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 includes 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 addition of the boom drogue on the end of the boom has only a slight adverse effect on airplane performance. The drag effect will increase three percent. See Part 7 of T.O. 1C-135(E)C-1-1 for more specific fuel mileage at various airspeeds, altitudes and gross weights.

AIR REFUELING RECEIVER (ARR) SYSTEM

The air refueling receiver system provides the capability of transferring fuel in flight either from or to a boom-type tanker airplane. An air refueling slipway and receptacle (figure 4-60), which are covered by hydraulically operated slipway doors when not in use, are on the top centerline of the fuselage, slightly aft of the pilots' station. The ARR fuel system is an extension of the air refueling and single point refueling systems so that all the airplane fuel tanks can be filled from the receptacle. See figures 4-57 and 4-63. A scavenge system is used to remove fuel from the ARR manifold. A signal system controls the refueling sequence and indicates the sequence conditions by means of signal system lights. Controls and press-to-test indicator lights for the air refueling receiver system are on the air refueling receiver panel (figure 4-62), the pilots' light and glare shield (figure 1-14) and pilots' control wheels (figures 1-11 and 1-12). The ARR panel is also used to control airplane refueling and defueling on the ground.

ARR HYDRAULIC SYSTEM

Hydraulic pressure (figure 4-61) normally supplied by the airplane's right hydraulic system operates the ARR slipway door system. The left hydraulic system serves as an alternate source of pressure. Normal and alternate slipway door control valves are electrically controlled by slipway door switches. A dual shuttle valve, positioned by the selected pressure source, allows hydraulic pressure to operate the slipway door actuators and position the toggle actuator to unlock the toggles. Pressure is also supplied to the electrically operated normal and alternate toggle control valves. The normal toggle control valve is controlled automatically by the signal amplifier. The alternate toggle control valve is controlled by the manual toggle latch switch. Opening a toggle control valve allows hydraulic pressure to lock the latching toggles which hold the air refueling boom nozzle in the receptacle.

Slipway Door Switches

Normal and alternate slipway door switches (8 and 10, figure 4-62) with OPEN--CLOSED positions are on the ARR panel. Electrical power is supplied to these switches when the ARR master refuel switch (1, figure 4-62) is ON. When the normal slipway door switch is OPEN, the normal slipway door control valve allows hydraulic pressure from the right hydraulic system to open the doors. In the OPEN position, this switch also directs electrical power to the signal amplifier power switch. When the normal slipway door switch is CLOSED, the normal slipway door control valve supplies hydraulic pressure to close the doors. The alternate slipway door switch functions similarly except that the left hydraulic system and the alternate slipway door control valve are used. Operating power is 28 volt DC through circuit breakers marked NORMAL SLIPWAY DOOR and ALT SLIPWAY DOOR on the ARR MASTER BUS section of the SBCBP (figure 1-33, sheet 4).

Slipway Door Closed and Locked Light

An amber light (9, figure 4-62) on the ARR panel will illuminate when the slipway doors are closed and locked. Operating power is 28 volt DC through a circuit breaker marked ARR SIGNAL AMP on the ARR MASTER BUS section of the SBCBP (figure 1-33, sheet 4).

Manual Toggle Latch Switch

A manual toggle latch switch (22, figure 4-62) with RELEASE--HOLD positions is on the ARR panel. When the signal amplifier power switch (2, figure 4-62) is in MANUAL, the manual toggle latch switch can operate the latching toggles which are normally controlled by the signal amplifier. In the HOLD position, the alternate toggle control valve is energized and the latching toggles hold the boom nozzle in the receptacle. In the RELEASE position, the valve is de-energized to release the toggles. The latching toggles may also be released by depressing the ARR disengage button on the pilot's or copilot's control wheel, by high fuel pressure, or by brute force pullouts. Operating power is 28 volt DC through a circuit breaker marked ARR MAN CONT on the ARR MASTER BUS section of the SBCBP (figure 1-33, sheet 4).

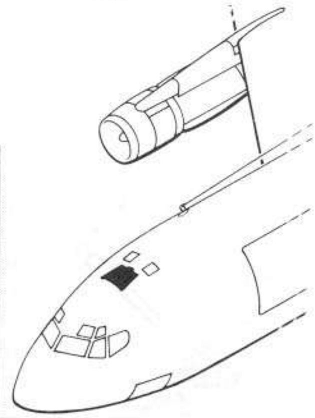
ARR ELECTRICAL SYSTEM

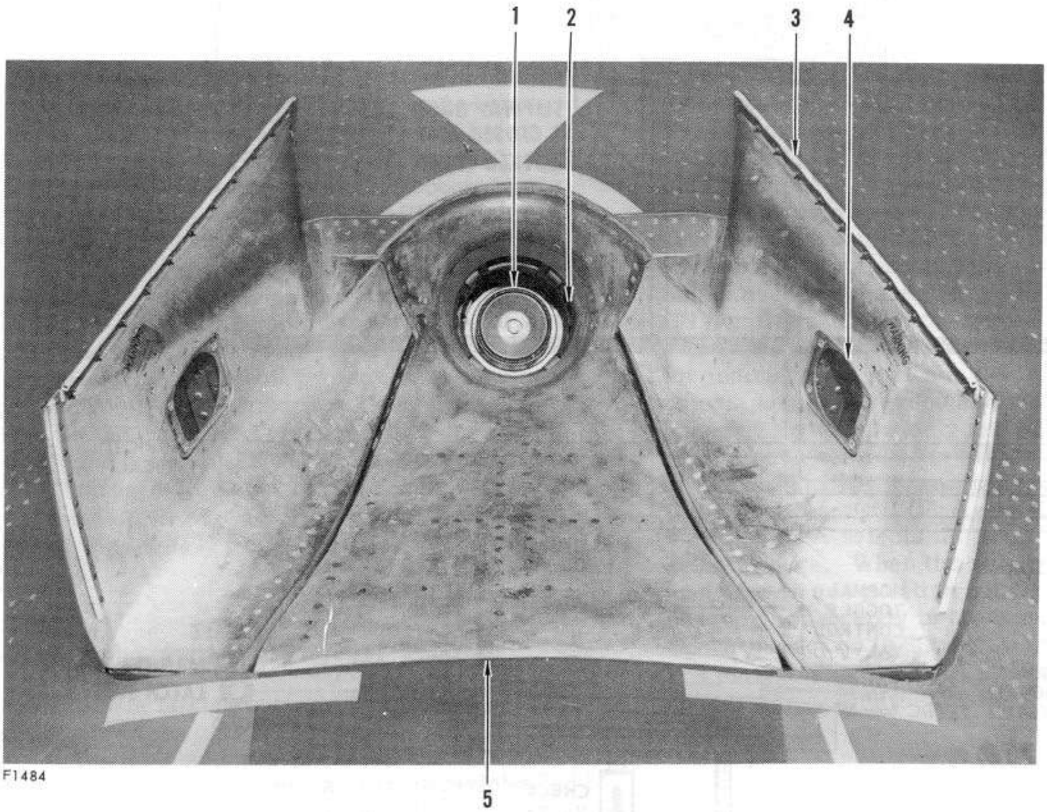
The ARR electrical system operates on 28 volt DC power from the SBCBP (figure 1-33, sheet 4). The master refuel switch (1, figure 4-62) controls all switches and lights on the ARR panel which obtain power from the ARR MASTER BUS section of the SBCBP.

ARR Signal System

The ARR signal system operates in conjunction with the signal system in the tanker airplane. Refer to BOOM SIGNAL SYSTEM (AMPLIFIER CONTROL) and figures 4-55 and 4-56 in this Section. The system includes the receptacle signal coil, slipway door limit

ARR receptacle





1 RECEPTACLE
2 TOGGLE
3 SLIPWAY DOOR
4 SLIPWAY DOOR LIGHT
5 SLIPWAY

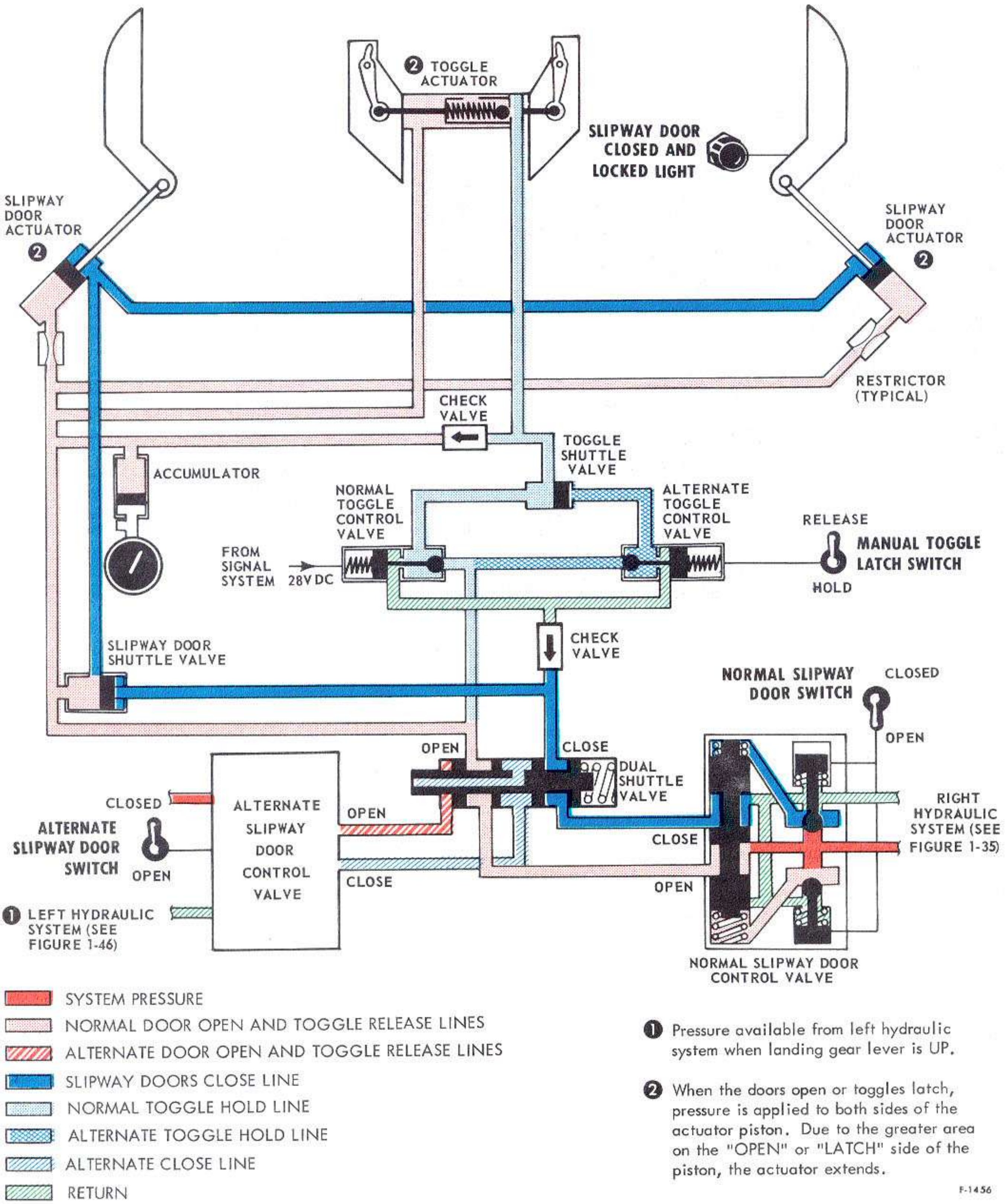
Figure 4-60

switches, a receptacle plunger limit switch actuated by the boom nozzle, toggle limit switches, signal lights and a signal amplifier which is identical to that used in the boom signal system. With the master refuel switch in the ON position, the slipway doors closed and locked light will be on. When the signal amplifier power switch is in NORMAL and the slipway doors are open, the closed and locked light will be out, the signal amplifier will be energized and the blue READY light will illuminate. When the receptacle plunger limit switch is depressed by the boom nozzle, the latching toggles will actuate, the green CONTACT light will illuminate and the READY light will go out. The signal system will advance to DISCONNECT when any one of the following occurs: (1) actuation of the RGA/AP/ARR pushbutton on either the pilot's or copilot's control wheel, (2) a disconnect signal is received from the tanker, (3) excessive fuel pressure actuates the pressure switch in the ARR fuel manifold, or (4) the latching toggles are released. A signal amplifier power reset button is used to return the signal system to the READY condition. When the signal amplifier power switch is in the MANUAL position, the ARR signal amplifier is not energized. The signal lights will continue to indicate the sequence condition of the system; however, the latching toggles must be latched with the manual toggle latch switch. The manual toggle latch switch or the ARR disengage button on either pilots' control wheel may be used to release the toggles. If the manual toggle latch switch is in HOLD, the toggles will relatch when the disengage button is released.

Signal Lights

The signal lights (2, figure 1-14) are on the pilots' light and glare shield. The blue light marked READY will illuminate when the system is in the ready-for-contact condition. When the system is in the contact-made condition, the green light marked CONTACT will illuminate and the READY light will go out. When the system is in the disconnect condition, the amber light marked DISCONNECT will illuminate and the CONTACT light will go out. Operating power is 28 volt DC from the ARR MASTER BUS section of the SBCBP (figure 1-33, sheet 4). When the signal amplifier power switch

ARR hydraulic system



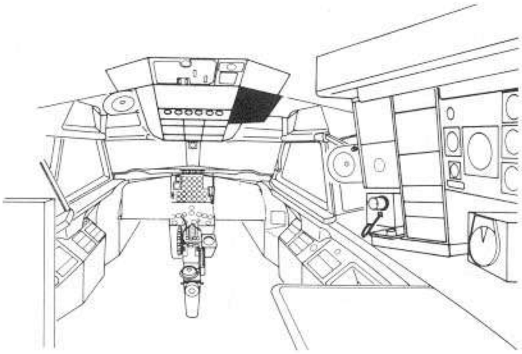
1. Pressure available from left hydraulic system when landing gear lever is UP.

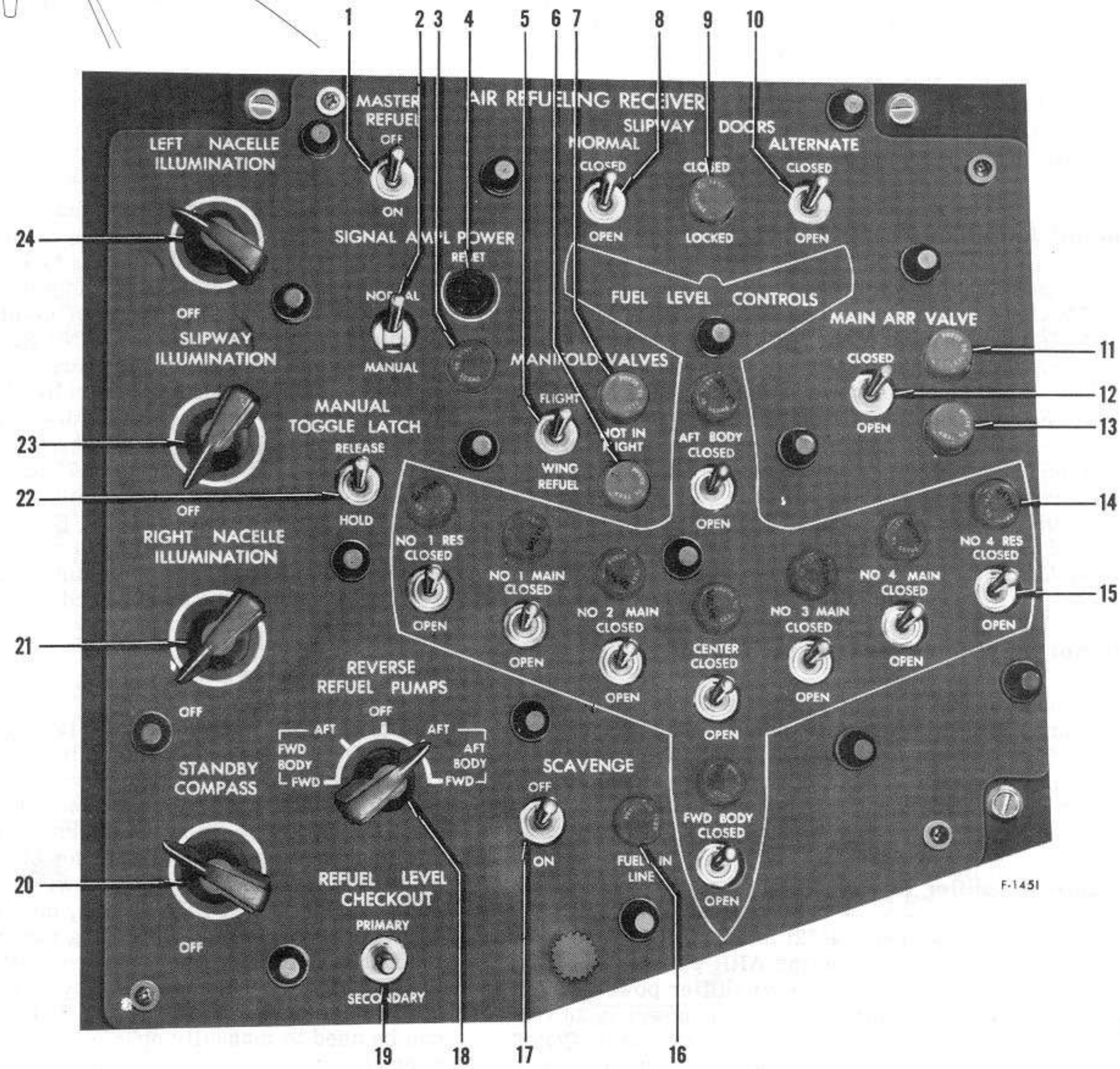
2. When the doors open or toggles latch, pressure is applied to both sides of the actuator piston. Due to the greater area on the "OPEN" or "LATCH" side of the piston, the actuator extends.

F-1456

Figure 4-61

ARR panel





1 MASTER REFUEL SWITCH
2 SIGNAL AMPLIFIER POWER SWITCH
3 SIGNAL AMPLIFIER POWER LIGHT
4 SIGNAL AMPLIFIER POWER RESET BUTTON
5 MANIFOLD VALVES SWITCH
6 MANIFOLD VALVES WING REFUEL LIGHT
7 MANIFOLD VALVES NOT IN FLIGHT LIGHT
8 NORMAL SLIPWAY DOOR SWITCH
9 SLIPWAY DOORS CLOSED & LOCKED LIGHT
10 ALTERNATE SLIPWAY DOOR SWITCH
11 MAIN ARR VALVE CLOSED LIGHT
12 MAIN ARR VALVE SWITCH
13 MAIN ARR VALVE OPEN LIGHT
14 FUEL LEVEL CONTROL VALVE CLOSED LIGHT
15 FUEL LEVEL CONTROL VALVE SWITCH
16 FUEL IN LINE LIGHT
17 SCAVENGE SWITCH
18 REVERSE REFUEL PUMPS SWITCH
19 REFUEL LEVEL CHECKOUT SWITCH
20 STANDBY COMPASS ILLUMINATION SWITCH
21 RIGHT NACELLE ILLUMINATION SWITCH
22 MANUAL TOGGLE LATCH SWITCH
23 SLIPWAY ILLUMINATION SWITCH
24 LEFT NACELLE ILLUMINATION SWITCH

Figure 4-62

is in NORMAL, the lights obtain power through a circuit breaker marked ARR SIGNAL AMP; in the MANUAL position, the READY and CONTACT lights obtain power through a circuit breaker marked ARR MAN CONT and the DISCONNECT light through a circuit breaker marked MANUAL DISCONNECT.

Master Refuel Switch

The master refuel switch (1, figure 4-62) with OFF--ON positions is on the ARR panel. In the ON position, the switch connects the ARR MASTER BUS to the SBCBP; see figure 1-30. Power is 28 volt DC through a control circuit breaker marked ARR BUS CONT and a power circuit breaker marked ARR MASTER BUS PWR on the SBCBP (figure 1-33, sheet 4).

Signal Amplifier Power Switch

The signal amplifier power switch (2, figure 4-62) with NORMAL--MANUAL positions is on the ARR panel and controls the operation of the ARR signal system. When the normal or alternate slipway door switch is OPEN and the signal amplifier power switch is in the NORMAL position, the signal amplifier is energized and will operate automatically in conjunction with the tanker signal system. In the MANUAL position, the signal amplifier is de-energized. Operating power is 28 volt DC through a circuit breaker marked ARR SIGNAL AMP on the ARR MASTER BUS section of the SBCBP (figure 1-33, sheet 4).

Signal Amplifier Power Reset Button

This push-to-reset button (4, figure 4-62) for the signal amplifier is on the ARR panel. When depressed after a disconnect has been obtained, the button will reset the automatic control circuit of the signal amplifier in preparation for an air refueling contact.

Signal Amplifier Power Light

An amber light (3, figure 4-62) is adjacent to the signal amplifier power switch on the ARR panel. The light will illuminate when the signal amplifier power switch is in the MANUAL position. Operating power is 28 volt DC through a circuit breaker marked ARR MAN CONT on the ARR MASTER BUS section of the SBCBP (figure 1-33, sheet 4).

Autopilot and ARR Disengage Button

An RGA/AP/ARR pushbutton (16, figure 4-29A) is on each pilot's control wheel. Depressing the button during contact with a tanker airplane releases the latching toggles and energizes the receptacle induction coil to signal a disconnect in the receiver and tanker signal system. For additional information concerning this switch, refer to AUTOPILOT SYSTEM in this section. Operating power is 28 volts DC through a circuit breaker marked MANUAL DISCONNECT on the ARR MASTER BUS section of the SBCBP (figure 1-33, sheet 4).

ARR FUEL SYSTEM

The ARR fuel system (figure 4-63) connects the ARR receptacle to the air refueling manifold to permit inflight transfer of fuel either from or to another tanker airplane. During contact with the tanker airplane, fuel flows from the receptacle through the ARR manifold and main ARR valve to the A/R manifold. With the manifold valves switch in the WING REFUEL position, fuel flows into the single point refueling manifold. Flow into the individual tanks is controlled by the fuel level control valve switches. A pressure switch in the ARR fuel manifold will initiate a disconnect signal when fuel pressure exceeds approximately 75 psi. A surge relief valve protects the ARR fuel manifold from fuel surges. The scavenge system (figure 4-63) removes trapped fuel from the ARR manifold and consists of a shutoff valve, a float switch, a fuel-in-line light and the vapor removal section of the forward body tank aft A/R pump.

Main ARR Valve Switch

The main ARR valve switch (12, figure 4-62) with CLOSED--OPEN positions is on the ARR panel. In the OPEN position, the main ARR valve opens to permit fuel flow between the ARR and A/R manifolds. In addition, the OPEN position transfers control of the A/R pumps from the A/R pump switches or scavenge switch to the reverse refuel selector switch. When the fuel dump switch is in FUEL DUMP, the main ARR valve automatically closes. Operating power is 28 volt DC through a circuit breaker marked ARR VALVE on the SBCBP (figure 1-33, sheet 4). The main ARR valve has a manual override handle (detail 1, figure 4-63) which can be used to manually open or close the valve. The override handle is covered by an access door located in the main cabin floor between the electronic switching rack and the electronic cabinet No. 2.

Main ARR Valve Indicator Lights

Two green lights are adjacent to the main ARR valve switch (12, figure 4-62) on the ARR panel. The CLOSED light (11, figure 4-62) will illuminate when the switch is in the CLOSED position, the valve is closed and the master refuel switch is in the ON position. The OPEN light (13, figure 4-62) will illuminate when the switch is in the OPEN position, the valve is open and the fuel dump switch is NORMAL. Operating power is 28 volt DC through the ARR VALVE circuit breaker on the SBCBP (figure 1-33, sheet 4).

Manifold Valves Switch

The manifold valves switch (5, figure 4-62) with FLIGHT--WING REFUEL positions is on the ARR panel. The switch controls two valves simultaneously (see figure 4-63); one valve controls the flow of fuel from the A/R manifold to the wing single point refueling manifold while the other valve controls the gravity flow of fuel from the wing tanks into the aft body tank. The valves are mechanically connected so that, when one valve is open, the other valve is closed. When the switch is in the FLIGHT position, the wing single point refueling manifold is isolated from the A/R manifold and the gravity flow line to the aft body tank is opened. In the WING REFUEL position, the gravity flow line to the aft body tank is closed and fuel can flow into the wing single point refueling manifold from the A/R manifold. Operating power is 28 volt DC through a circuit breaker marked MANIFOLD VALVE on the ARR MASTER BUS section of the SBCBP (figure 1-33, sheet 4). A manual override handle (detail 2, figure 4-63) can be used to manually operate the manifold valves. The override handle is covered by an access door located in the main cabin floor of compartment 3.

CAUTION

To avoid damage to valve seals, do not operate the manual override handle when the A/R manifold is pressurized.

Manifold Valves Indicator Lights

Two indicator lights are on the ARR panel adjacent to the manifold valves switch (5, figure 4-62). The manifold valves NOT IN FLIGHT amber light (7, figure 4-62) will illuminate when the valve connecting the A/R manifold to the wing single point refueling manifold is in any position other than the fully closed position. The WING REFUEL green light (6, figure 4-62) will illuminate when the valve connecting the wing single point refueling manifold to the aft body tank is fully closed, provided the master refuel switch is ON. Both lights, therefore, illuminate when the manifold valves are in the wing refuel position. If the manifold valves are in an intermediate position (both valves are mechanically connected), the NOT IN FLIGHT light will illuminate regardless of master refuel switch position. Operating power is 28 volt DC through circuit breakers marked WING REFUEL IND LT on the ARR MASTER BUS section of the SBCBP and VALVE NOT IN FLT POS LT on the SBCBP (figure 1-33, sheet 4).

Fuel Level Control Valve Switches

The fuel level control valve switches (15, figure 4-62) with OPEN--CLOSED positions are on the ARR panel. There are 9 switches, one for each fuel tank. In the OPEN position, each switch energizes 3 solenoids in its respective fuel level control valve to allow fuel flow when the manifold is pressurized. When the tank is full, when the switch is in the CLOSED position, or when any of its 3 solenoids is de-energized, the valve is closed. Operating power is 28 volt DC through circuit breakers marked FUEL TANK LEVEL CONTROL VALVES on the ARR MASTER BUS section of the SBCBP (figure 1-33, sheet 4).

Fuel Level Control Valve Closed Lights

Indicator lights (14, figure 4-62) for the fuel level control valves are on the ARR panel. Each light will illuminate when its respective fuel level control valve closes provided its fuel level control valve switch is in the OPEN position. For operating power, refer to FUEL LEVEL CONTROL VALVE SWITCHES in this Section.

Refuel Level Checkout Switch

The refuel level checkout switch (19, figure 4-62) with PRIMARY--OFF--SECONDARY positions is on the ARR panel and is spring-loaded to the center unmarked position. The switch is normally used during ground servicing to check the operation of the primary and secondary float systems of the fuel level control valves when the fuel level control valve switches are in the OPEN position, the fuel manifold is pressurized and the tanks are less than full. In the PRIMARY or SECONDARY positions, the selected float system will simulate a full tank, thereby closing the valve and causing the valve CLOSED light to illuminate. Operating power is 28 volt DC through a circuit breaker marked FUEL LEVEL CHECKOUT on the SBCBP (figure 1-33, sheet 4).

Scavenge Switch

The scavenge switch (17, figure 4-62) with OFF--ON positions is on the ARR panel. The main ARR valve switch must be in the CLOSED position to operate the scavenge system. In the ON position, the scavenge valve opens and the control valve for the aft A/R pump in the forward body tank is energized open.

ARR fuel system

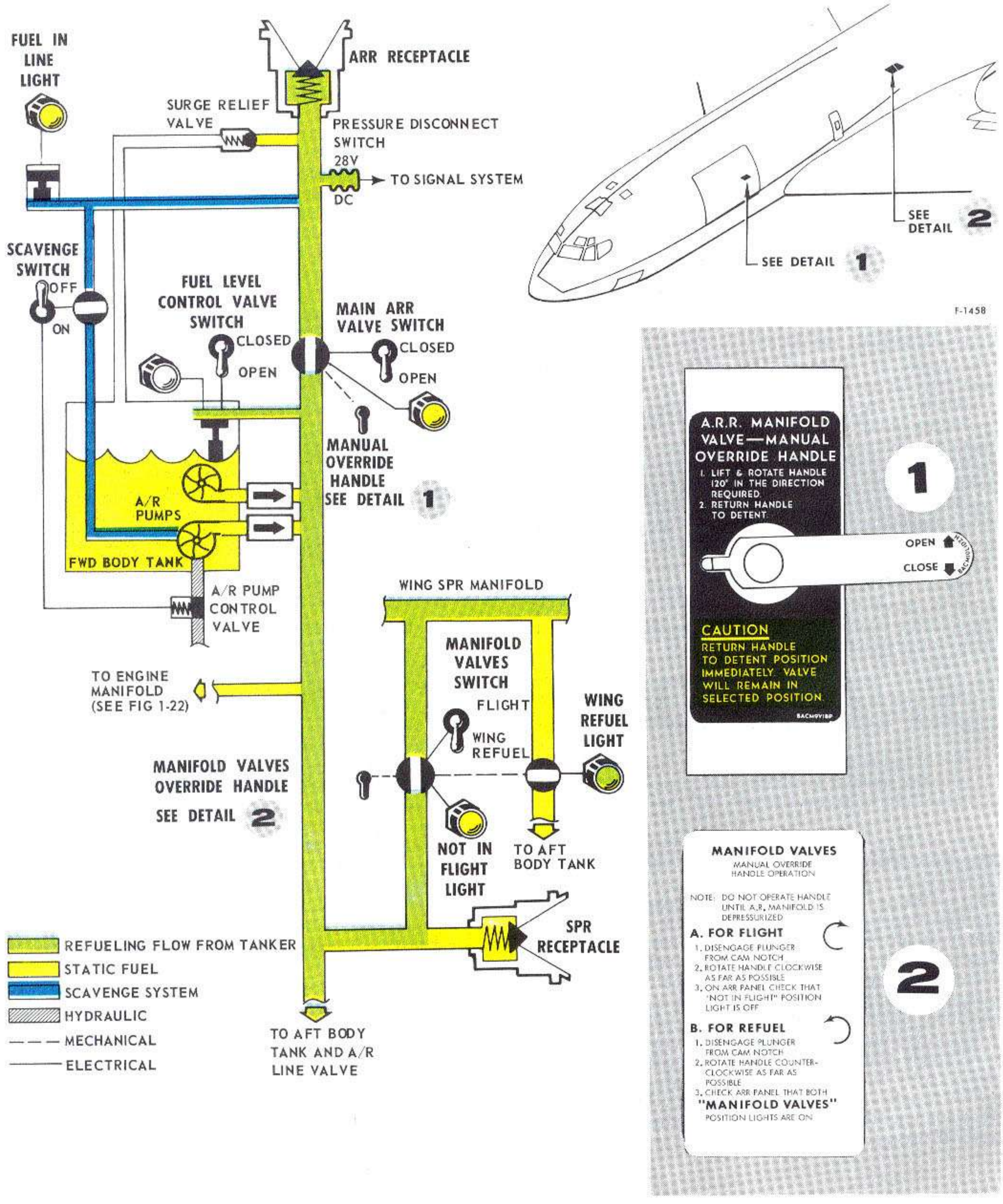


Figure 4-63

Hydraulic pressure then operates the pump to scavenge fuel from the ARR fuel manifold to the forward body tank. Operating power is 28 volt DC through a circuit breaker marked SCAVENGE VALVE on the SBCBP (figure 1-33, sheet 4).

Fuel in Line Light

The fuel in line amber light (16, figure 4-62) is on the ARR panel and will illuminate whenever fuel is present in the ARR manifold. For operating power, refer to SCAVENGE SWITCH in this Section.

Reverse Refuel Pumps Switch

The reverse refuel pump switch (18, figure 4-62) with FWD BODY FWD--FWD BODY AFT--OFF--AFT BODY AFT--AFT BODY FWD is on the ARR panel. The switch controls the operation of the A/R pumps as reverse refueling pumps. Only one pump can be operated at a time during reverse refueling. When a pump position has been selected, the pump control valve opens admitting hydraulic fluid under pressure to operate the pump. The main ARR valve switch must be in the OPEN position and the fuel dump switch in NORMAL to energize the reverse refuel pumps. Operating power is 28 volt DC through a circuit breaker marked REFUEL PUMP CONTROL, FWD TANK, AFT on the SBCBP (figure 1-33, sheet 4).

ARR EXTERIOR LIGHTING

Lights are installed in the ARR slipway doors and receptacle to aid the tanker boom operator during night refueling operation. See figures 4-31 and 4-60. The nacelle illumination lights can also be controlled from the ARR panel.

Slipway Illumination Switch

The slipway illumination switch (23, figure 4-62) is a rheostat switch on the ARR panel and controls three lights, one in each slipway door and one in the receptacle. Operating power is 28 volt AC through a circuit breaker marked A/R RECEPTACLE on the MCBP (figure 1-33, sheet 2).

Nacelle Illumination Switches

Two nacelle illumination switches (21 and 24, figure 4-62) are on the ARR panel. When the slipway doors are open, control of the nacelle illumination lights is transferred from the taxi and wing illumination switch on the pilots' center instrument panel and the nacelle illumination switches on the boom operator's panel to the left and right nacelle illumination switches on the ARR panel. Operating power is 28 volt AC through circuit breakers marked NACELLE ILLUM LT LH and NACELLE ILLUM LT RH on the MCBP (figure 1-33, sheet 2).

ARR SYSTEM CHECK

To check the operation of the ARR system, refer to AIR REFUELING RECEIVER (ARR) SYSTEM - CHECK-OUT in T.O. 1C-135(E)C-2-6.

ARR FUEL MANAGEMENT

When receiving fuel from a tanker airplane, the engines shall be fed from the main wing tanks or the center wing tank. All of the airplane fuel tanks should be refueled simultaneously until the main wing tanks have filled. If additional fuel is required, continue refueling tanks with space available, except the forward body tank, until the center wing tank is filled. If additional fuel is still required, continue refueling remaining tanks, including the forward body tank, to the maximum allowable quantity. Fuel gages should be monitored and the center of gravity position checked frequently to insure that structural and cg limits are not exceeded. Refer to WEIGHT LIMITATIONS in Section V. Inflight cg limits are shown in figure 5-5. For fuel usage subsequent to air refueling, refer to FUEL MANAGEMENT PROCEDURES in Section VII.

WARNING

Do not exceed the maximum inflight gross weight limits shown in Section V; see figure 5-4.

CAUTION

- The maximum gross weight at which the outboard reserve tanks may be empty is 293,000 pounds provided the main wing tanks are full. However, since flight with empty reserve tanks has an adverse effect on wing fatigue life, they should be kept full as long as practicable.
- The main wing and reserve tanks shall remain full at inflight gross weights above 301,600 pounds.
- Do not exceed a fuel load of more than 32,700 pounds in the forward body tank and 39,450 pounds in the aft body tank. In an emergency, the aft body tank may be filled to capacity provided the cg limits are not exceeded.

ARR SYSTEM EMERGENCY OPERATION

Slipway Door Emergency Operation

Failure of the right hydraulic system will prevent actuation of the slipway doors from the normal system. In such an emergency, place the alternate slipway doors switch to OPEN to operate the slipway doors. Hydraulic pressure is supplied from the left system with this switch in OPEN position provided the landing gear lever is UP.

SINGLE POINT REFUELING AND DEFUELING

A single point ground refueling and defueling receptacle (figure 4-64) is provided to allow fueling and defueling of all tanks from a single point. The tanks can also be serviced separately through an 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 the body tanks are filled through the A/R manifold. Through the interconnection of manifold lines, fuel can flow to all tanks simultaneously and will continue to flow, provided the level control valves are open, 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. Pressure defueling of the airplane is accomplished by using the boost pumps for the wing tanks, the override pumps for the center wing tank, and the air refueling pumps for the body tanks. The reserve tanks drain by gravity into the outboard mains. During pressure defueling of the wing tanks, fuel flows from the 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 4-64.) Controls and indicator lights for single point refueling and defueling are located on the air refueling receiver (ARR) panel (figure 4-62). During refueling and defueling, the master refuel switch (1, figure 4-62) must be ON to connect the ARR master bus to the switched DC bus. This provides power for operating the manifold valves and fuel level control valves. For a description of the manifold valves switch, fuel level control valve switches, and indicator lights, refer to AIR REFUELING RECEIVER SYSTEM in this Section. See figure 4-66 for standard fuel loads.

NOTE

For single point refueling and defueling procedures, refer to T.O. 1C-135(K)A-2-2.

MANUAL DEFUELING VALVE HANDLE

A manual defueling valve (figure 1-22 and figure 4-65) 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. The 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. It 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 manifold valves. Body tank fuel will flow directly from the air refueling manifold to the receptacle when those tanks are being defueled.

MISCELLANEOUS AIRPLANE EQUIPMENT

ENTRANCE DOORS

Two doors, the crew entry door and the cargo door, are used for normal entry and exit to and from the airplane.

Crew Entry Door

The crew entry door (figure 1-64) is the primary flight crew entrance/exit to the airplane. Refer to Section I.

Cargo Door

The cargo door (10, figure 4-67), located on the left side of the fuselage forward of the wing, is the staff personnel entrance/exit to the airplane. This door can only be operated from inside the airplane. See figure 4-67 for cargo door hydraulic controls. A

single point refueling and defueling receptacle

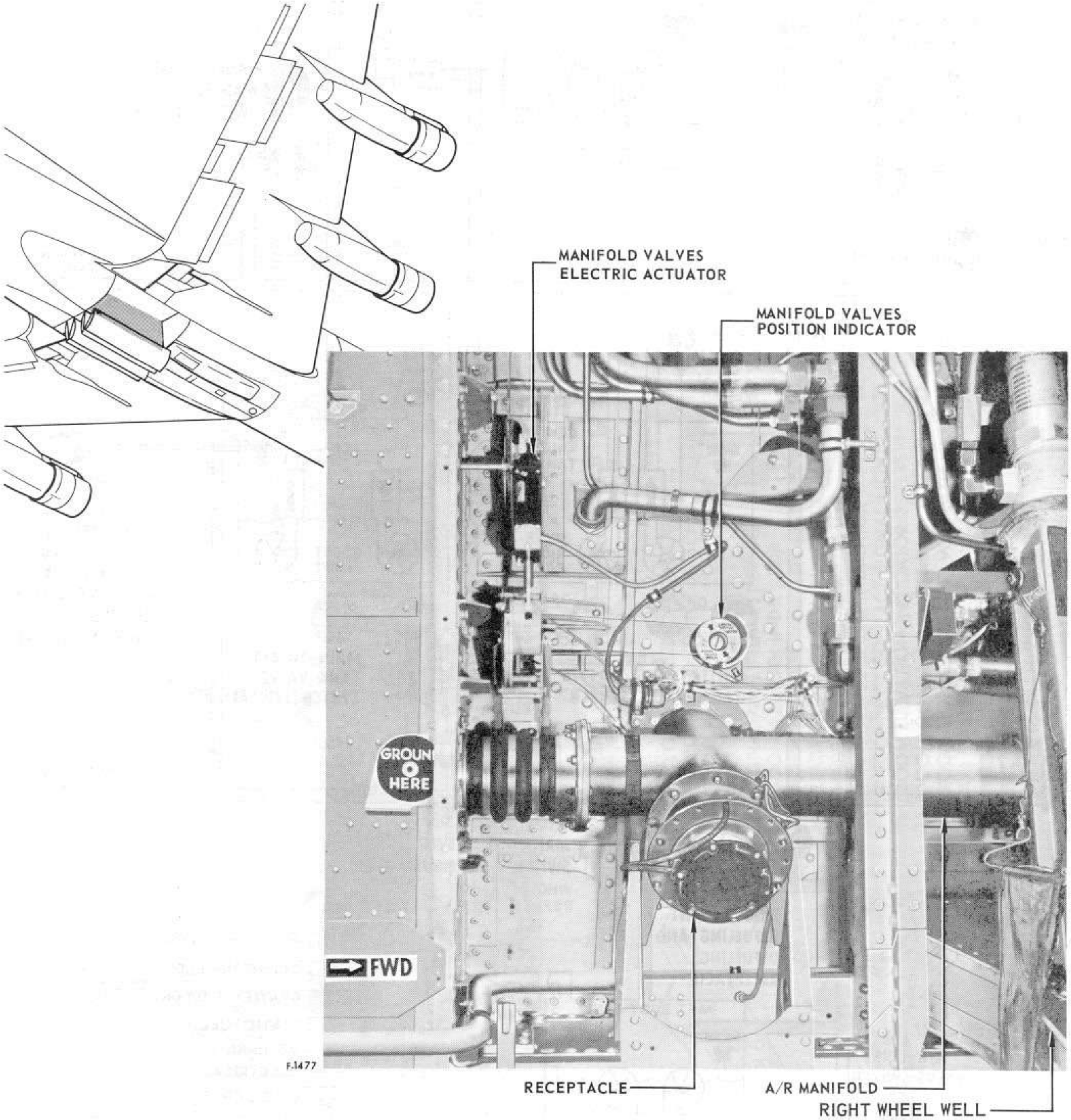


Figure 4-64

single point refueling and defueling system

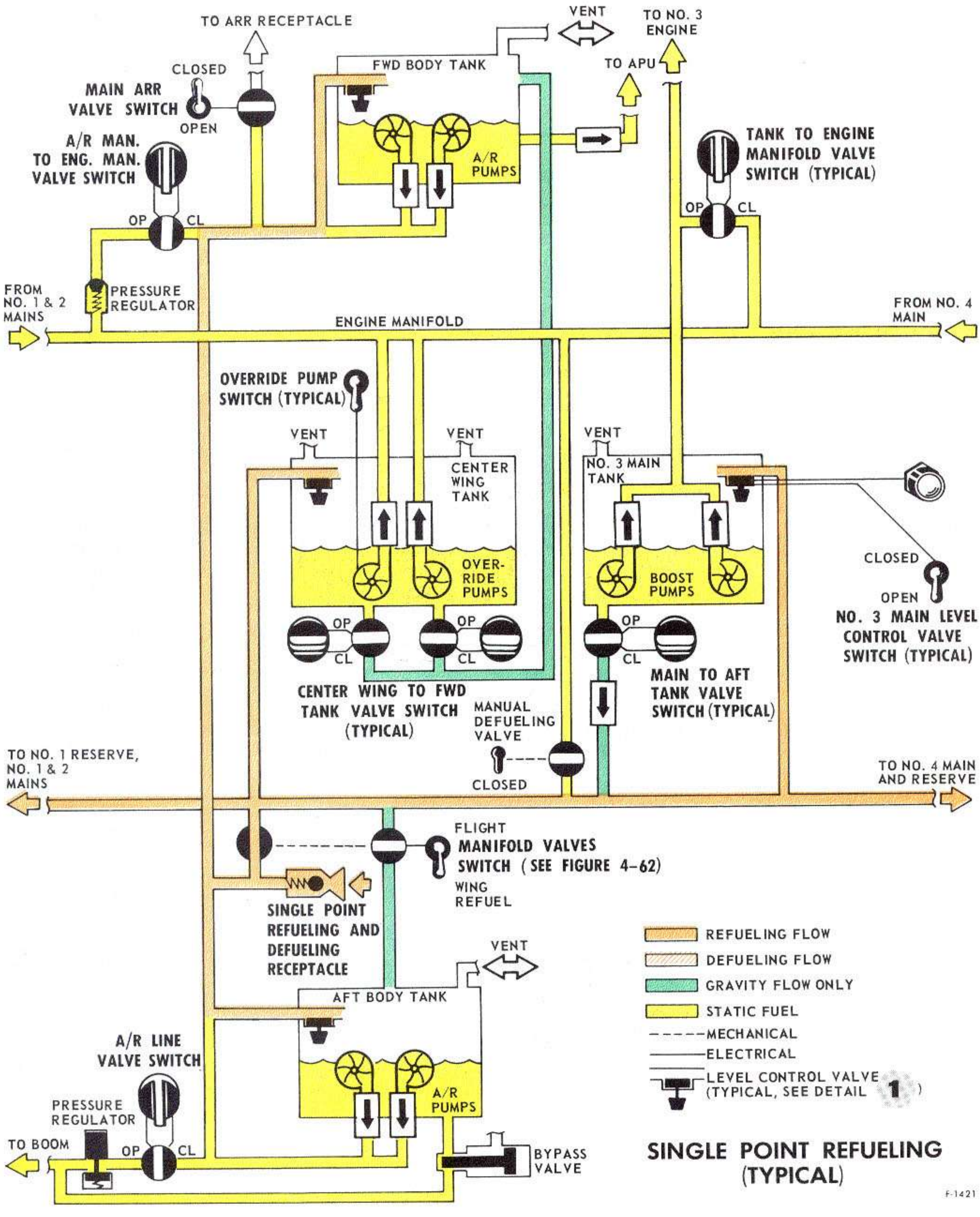
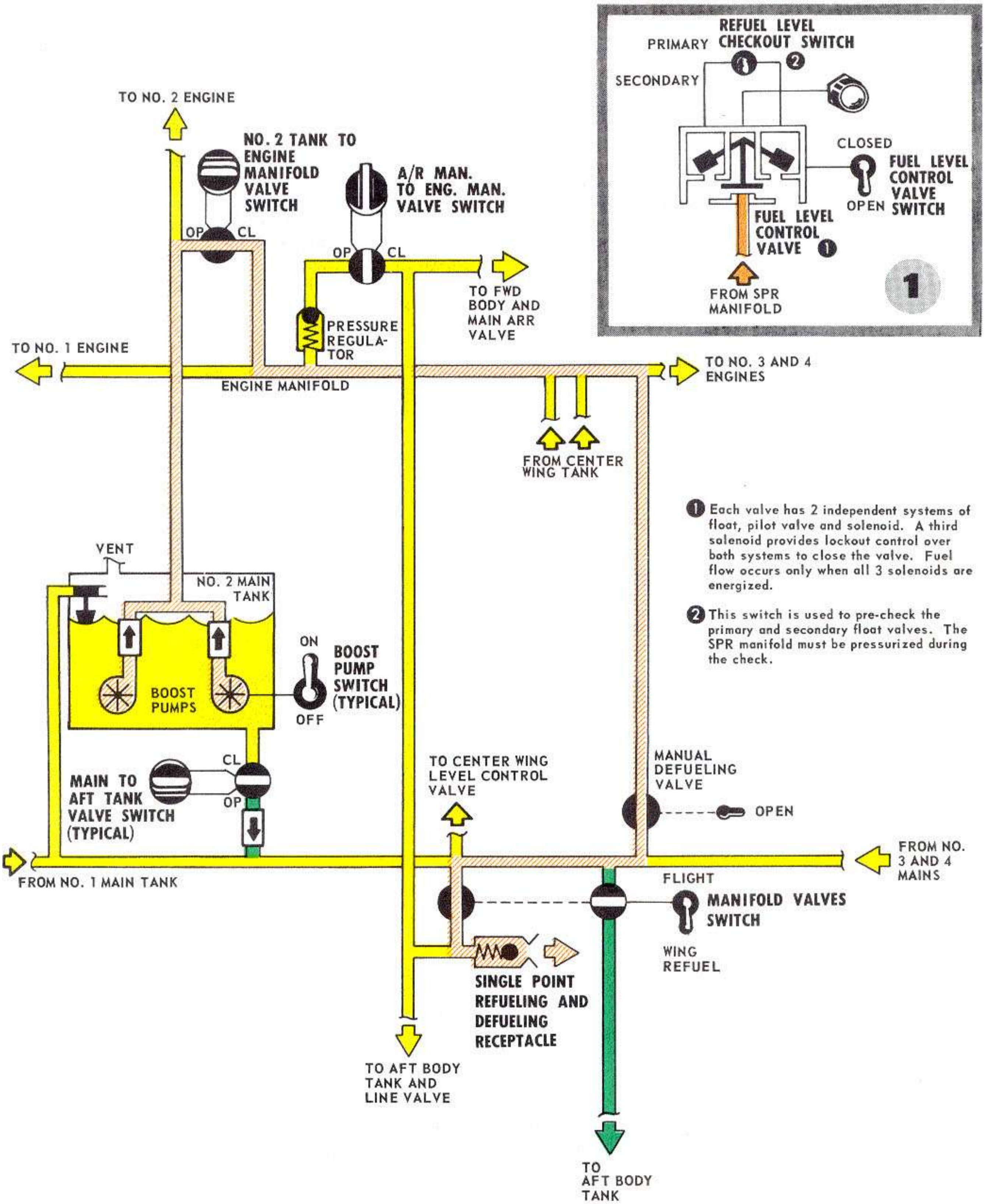


Figure 4-65 (Sheet 1 of 2)



1. Each valve has 2 independent systems of float, pilot valve and solenoid. A third solenoid provides lockout control over both systems to close the valve. Fuel flow occurs only when all 3 solenoids are energized.
2. This switch is used to pre-check the primary and secondary float valves. The SPR manifold must be pressurized during the check.

DEFUELING NO. 2 MAIN TANK (TYPICAL)

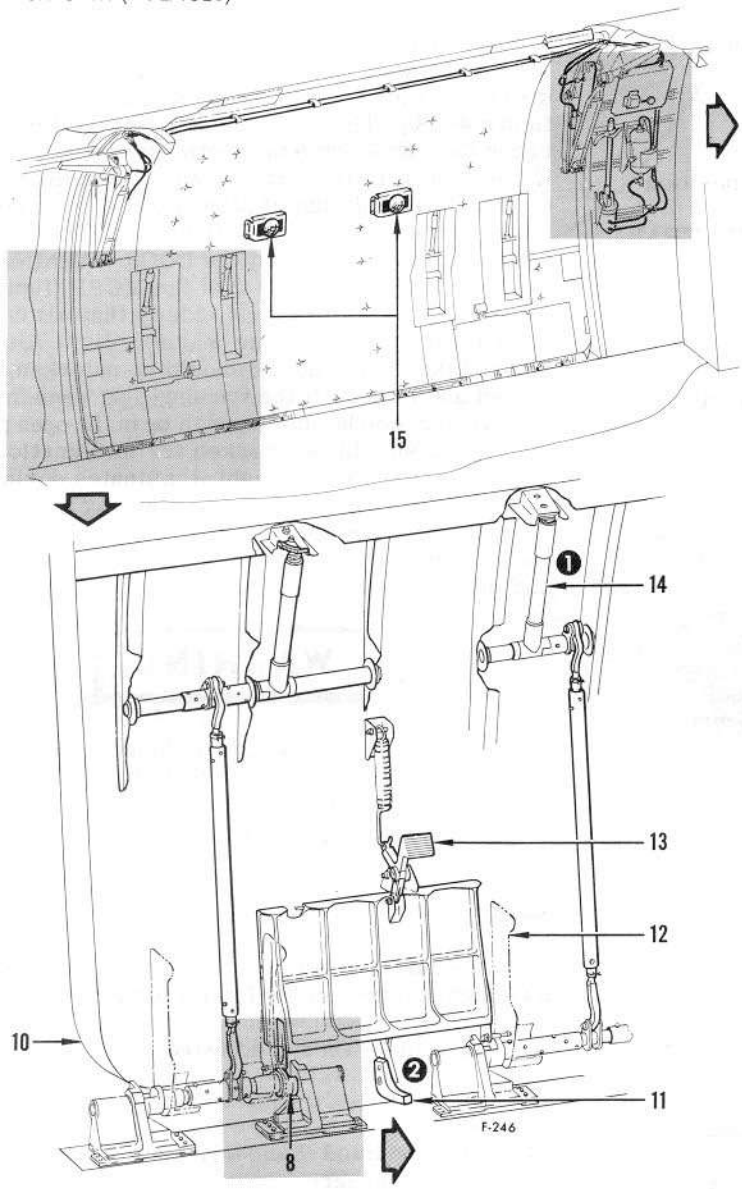
Figure 4-65 (Sheet 2 of 2)

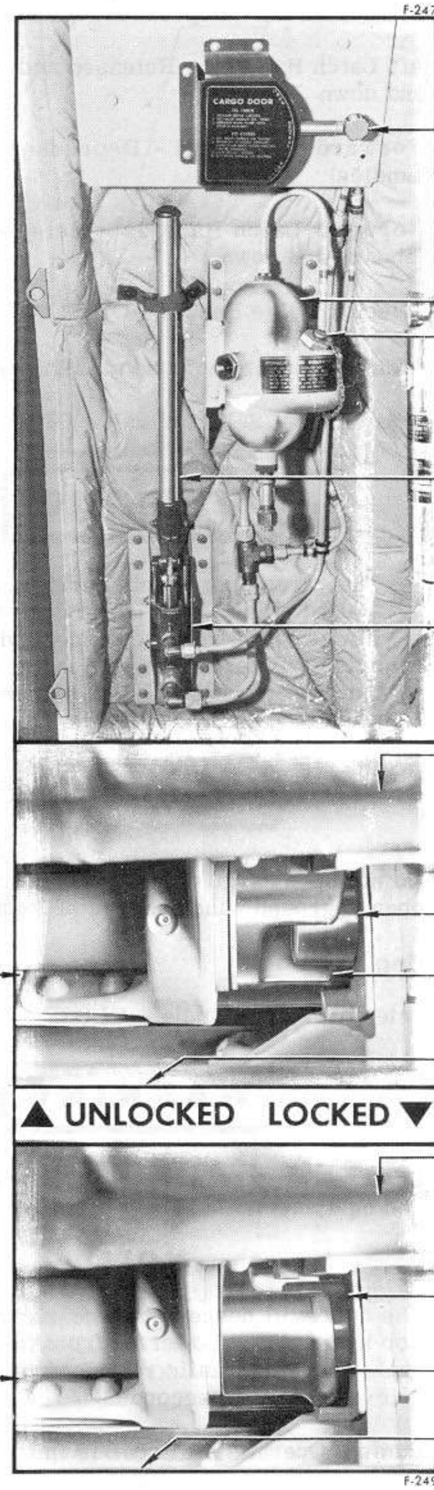
cargo door safety barrier, in the form of web straps is provided for installation across the door opening to protect personnel from accidentally falling out of the airplane. It should always be placed across the opening while the door is open and not being used for loading. The door is locked closed 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 4-67) has OPEN--NEUTRAL--CLOSE position. 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. An electric pump supplies hydraulic pressure to the door actuators. Pressure relief valves prevent overpressurization of the system, even though the pump is operated when the door is fully open or closed. A hand pump (5, figure 4-67) is added in parallel with the electric pump. An ON--OFF switch guarded to the OFF position is on the adjacent bulkhead. 28V DC power for the pump and switch is from the hot battery bus through a circuit breaker marked CARGO DOOR HYD PUMP & CONTROL on the battery circuit breaker panel.

Figure 4-66 Deleted

cargo door controls

1 SELECTOR VALVE HANDLE
2 HYDRAULIC RESERVOIR
3 HYDRAULIC RESERVOIR FILLER PORT
4 HAND PUMP HANDLE
5 HYDRAULIC HAND PUMP
6 BOTTOM SEAL STRIP (2 PLACES)
7 LATCH PIN (2 PLACES)
8 LATCH CAM (3 PLACES)
9 CARGO FLOOR (2 PLACES)
10 CARGO DOOR (3 PLACES)
11 PRESSURE DOOR ARM
12 PRESSURE DOOR (TYPICAL)
13 TOE PEDAL (TYPICAL)
14 LATCH HANDLE (TYPICAL)
15 CARGO DOOR LIGHTS





NOTE

1. Each latch handle operates two latch cams. The cargo door has a total of eight latch cams.

2. The pressure door arms actuate the door warning switches when the latches are locked and the pressure doors are closed. See figure 4-68.

Figure 4-67

CARGO DOOR OPERATION

Opening the Door

A. Seal Strip (bottom of door) - Roll up and fasten

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. Pump - Operate until door is in desired position

H. Door Hold - Selector valve OPEN or NEUTRAL

WARNING

The cargo door safety barrier will be installed anytime 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 cargo door or leave cargo door open if ground winds exceed 65 knots (75 mph).

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. Pump - 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 4-67.)

F. Selector Valve Handle - NEUTRAL

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 4-68.) 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 latch unlocked warning light (9, figure 1-17) 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 1-33, sheet 1). 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 insure that his helmet and parachute are on and properly adjusted prior to making the check.

Cargo Door

All eight latch cams and both pressure door closed switches are accessible for inspection inflight.

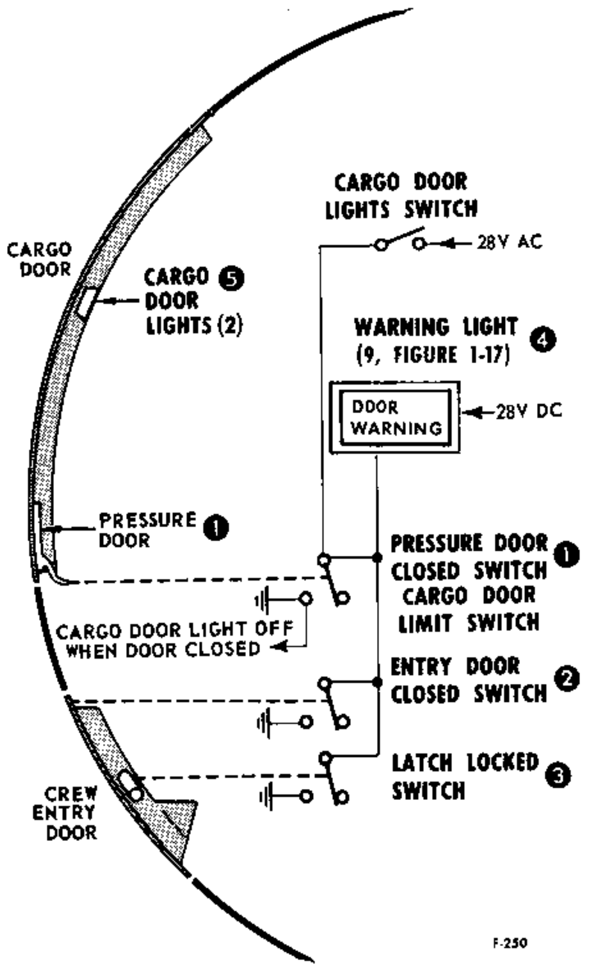
A. Parachute - On and adjusted

B. Selector Valve Handle - CLOSED

C. Hydraulic Hand Pump - Actuate to insure positive closing pressure

D. Forward and Aft Latch Handles - Checked Up

door warning system



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.
5. Cargo door light circuit is opened when door is closed.

Figure 4-68

E. Forward and Aft Toe Pedals - Checked released, pressure doors closed

F. Latch Cams - Visually check latch cams (See figure 4-67.)

G. Pressure Door Closed Switches - Check pressure door arms in positive contact with switches. (See figure 4-67.)

Cargo Door Entry Lights

Two lights (15, figure 4-67) are provided on the inside of the cargo door for illuminating the entrance/exit of the airplane. Operating power is 28V AC through a circuit breaker marked CARGO DOOR ENTRY on the 50 PL26 circuit breaker panel (figure 1-33, sheet 8). The cargo door lights switch (2, figure 4-6) is mounted on the main cabin temperature control panel and marked CARGO DOOR LIGHTS. The cargo door limit switch turns the cargo door lights off when the cargo door is closed. (See figure 4-68.)

Crew 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. Winch and Interior Latch Handle - Apply closing force to winch and check latch handle in locked position

B. Parachute - On and adjusted

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 locked switch. (See figure 4-68.)

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.

PARTITIONS

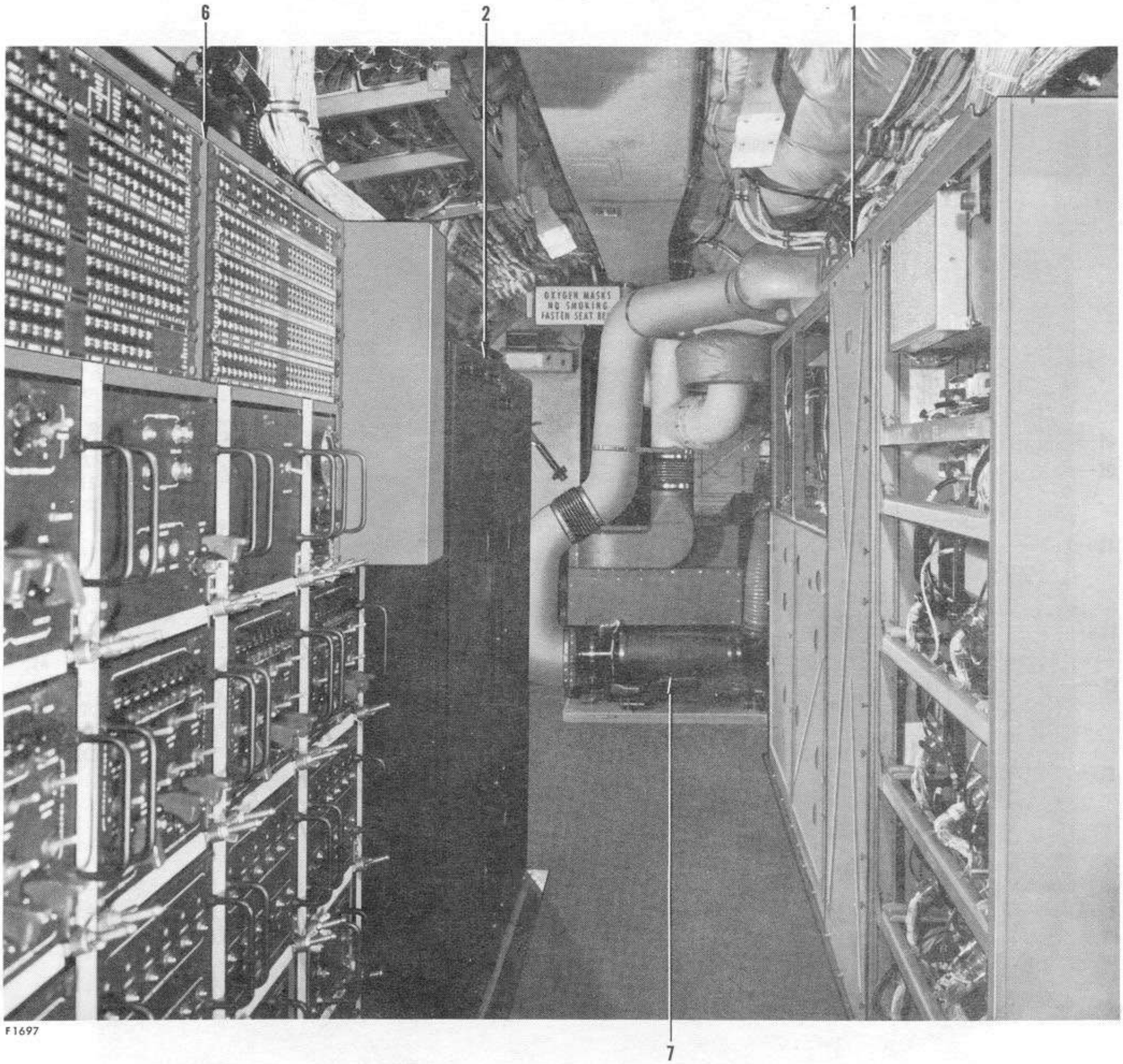
Three partitions have been installed in the airplane to sub-divide the main cabin into four compartments, numbered 1, 2, 3 and 4. The partitions are bolted to the sidewall and floor. The partitions separating compartments 1 & 2 and 2 & 3 have swinging doors. The compartment 3 & 4 partition has a dutch door and a sliding curtain for the upper portion of the doorway. The two 30 x 36 projection screens rotate up to the ceiling in compartment No. 4. The four compartments contain the staff stations, their equipment and facilities and miscellaneous support equipment for the airplane. See figures 1-3 and 4-69.

main cabin

COMPARTMENT NO. 1 - LOOKING AFT

1 ELECTRONICS CABINET NO. 2 (2 PLACES)
2 RADIO SIGNAL DISTRIBUTION SWITCHBOARD (2 PLACES)
3 AUXILIARY SWITCHING EQUIPMENT GROUP
4 MAIN AC POWER PANEL
5 AFT ELECTRICAL EQUIPMENT RACK
5A ALCC EQUIPMENT RACK
6 MULTIPLEXER SET
7 AUXILIARY POWER UNIT

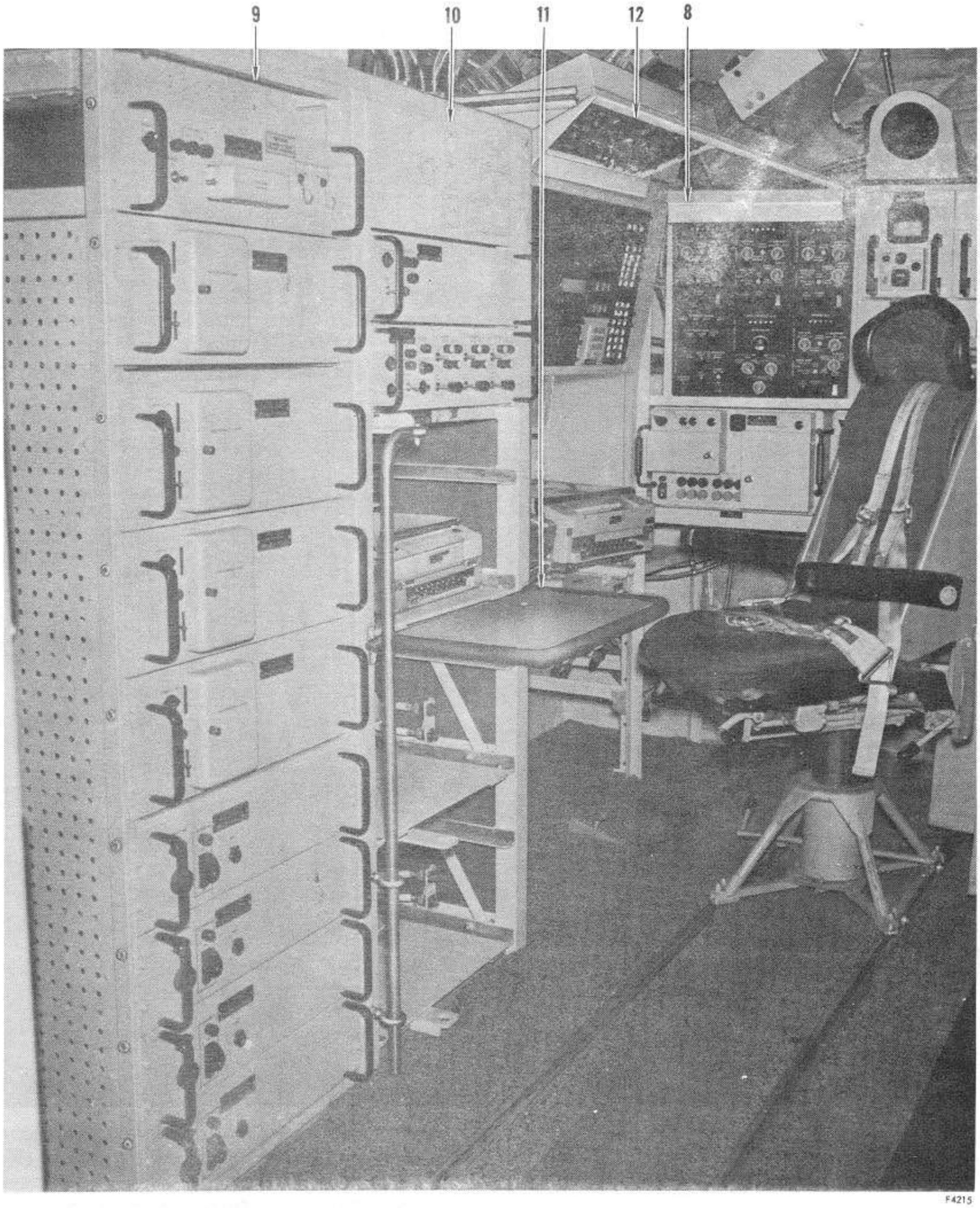
Figure 4-69 (Sheet 1 of 8)



COMPARTMENT NO. 1- LOOKING FORWARD

Figure 4-69 (Sheet 2 of 8)

main cabin (cont)



COMPARTMENT NO. 2 - LOOKING AFT

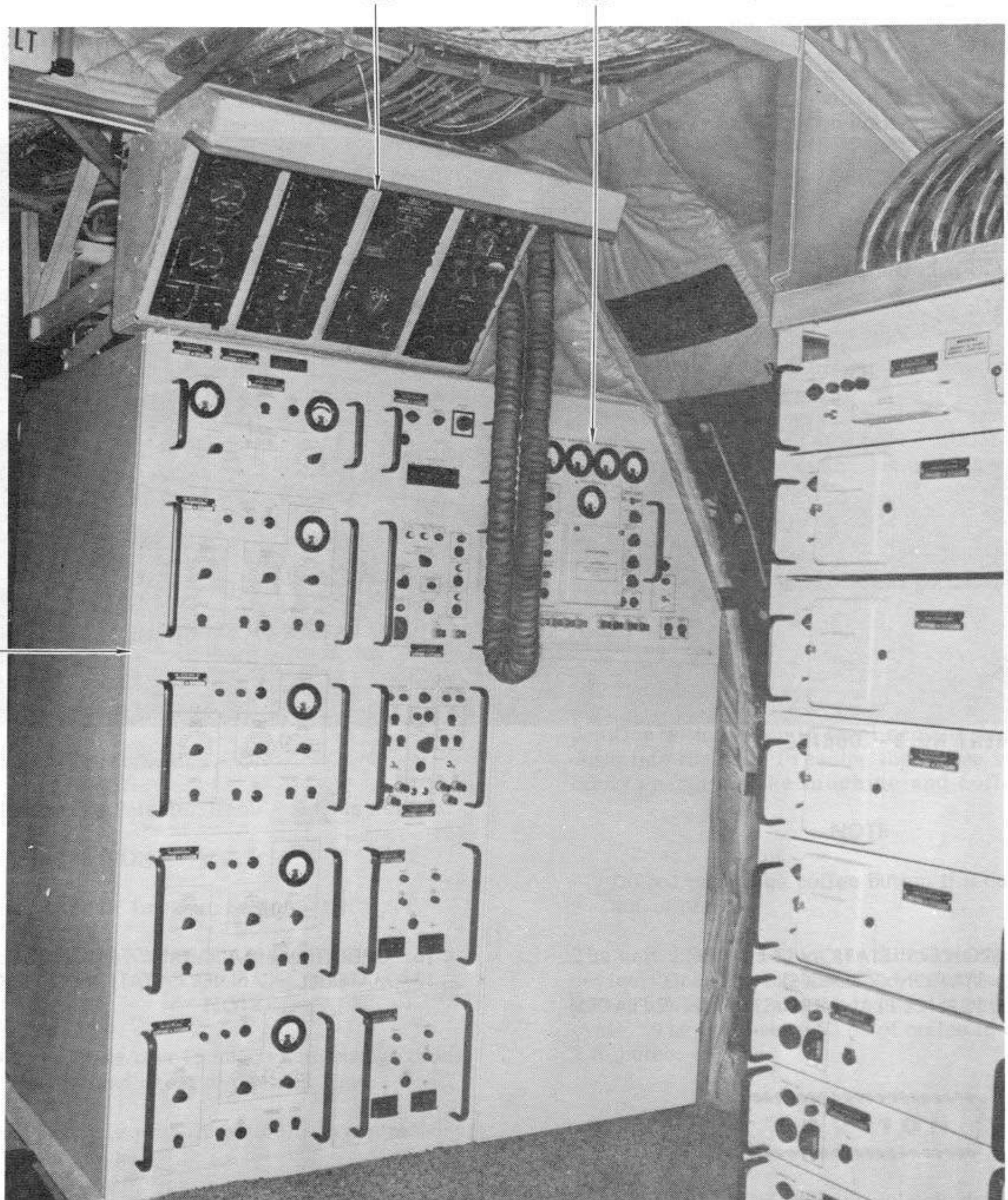
(CURTAIN NOT SHOWN)

8 CRYPTO OPERATORS' S CONSOLE
9 RECEIVER GROUP
10 CABINET V GROUP
11 STOWABLE WRITING TABLE
12 SATCOM CONTROL PANELS

Figure 4-69 (Sheet 3 of 8)

12A 12B

12C



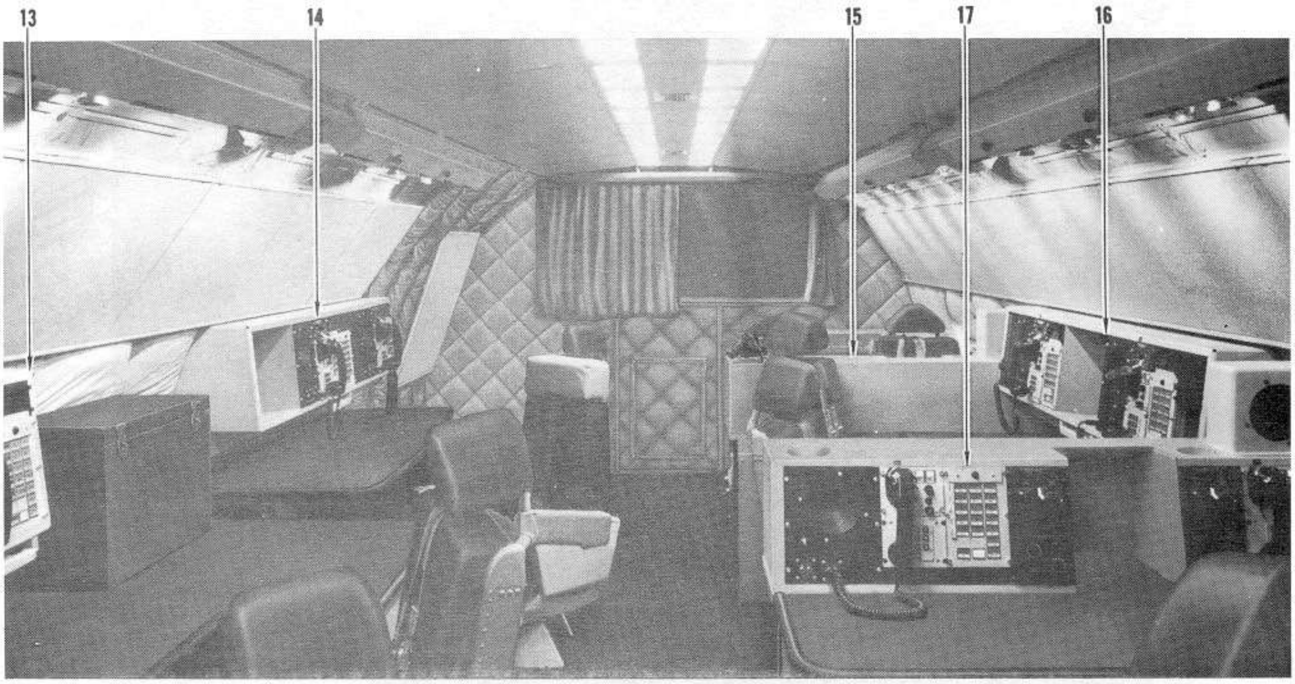
COMPARTMENT NO. 2 - LOOKING FORWARD

(CURTAIN NOT SHOWN)

12A TRAILING WIRE ANTENNA CONTROL PANEL
12B LF TRANSMITTER COUPLER
12C POWER AMPLIFIER

Figure 4-69 (Sheet 4 of 8)

main cabin (cont)



COMPARTMENT NO. 3 - LOOKING AFT

F1715

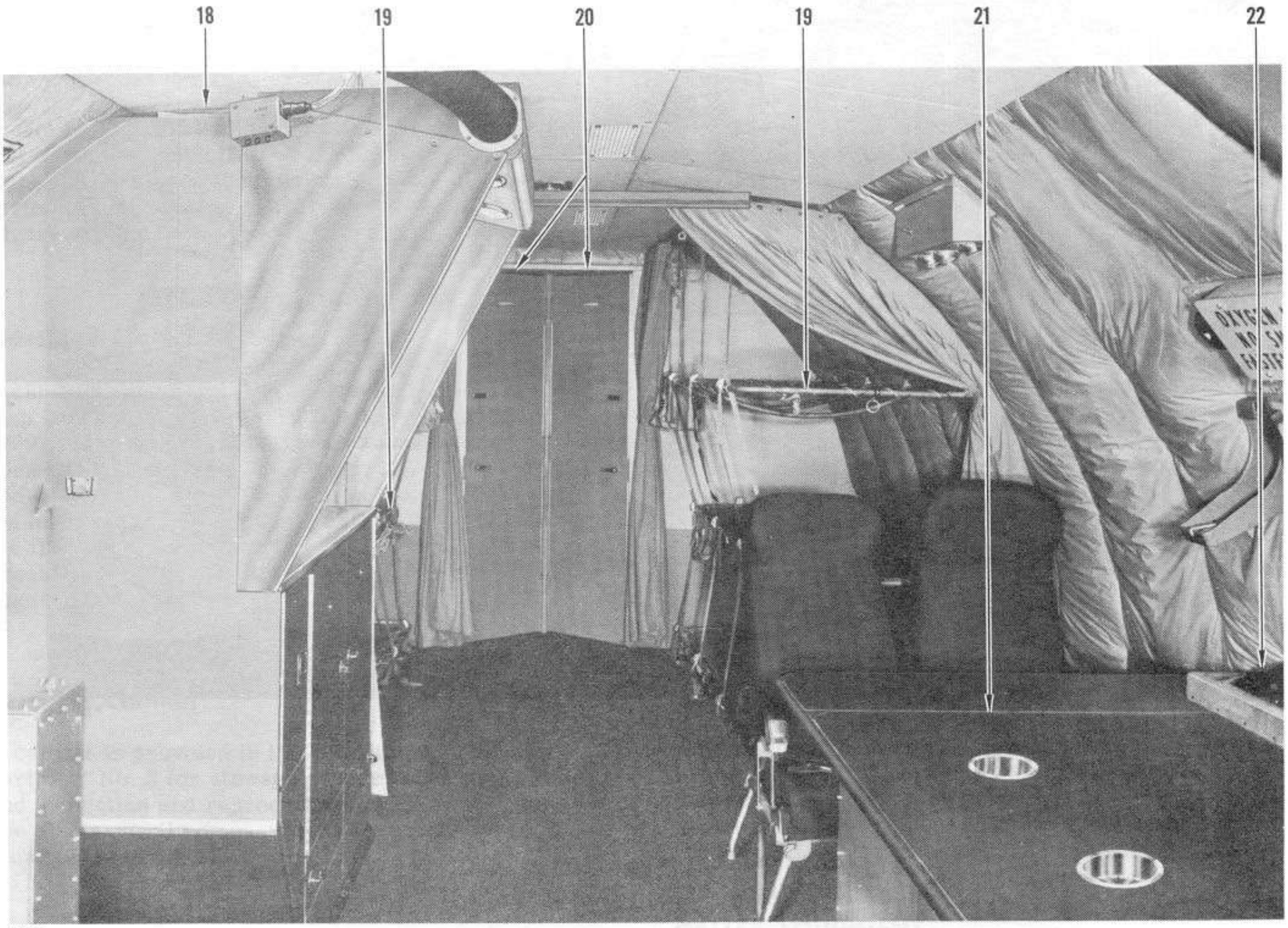
13 CONTROLLERS' STATION (2 PLACES)
14 AEAO STATION (2 PLACES)
15 INTELLIGENCE PLANNERS' STATION (2 PLACES)
16 OPERATION PLANNERS' STATION (2 PLACES)
17 MATERIEL PLANNERS' STATION (2 PLACES)

Figure 4-69 (Sheet 5 of 8)

COMPARTMENT NO. 3 - LOOKING FORWARD

Figure 4-69 (Sheet 6 of 8)

main cabin (cont)



COMPARTMENT NO. 4 - LOOKING AFT

18 GALLEY (2 PLACES)
19 BUNKS (4 PLACES)
20 AFT TOILETS
21 REST AREA TABLE (2 PLACES)
21A AFT FIREFIGHTER'S EQUIPMENT CONTAINER
22 FLIGHT TRAFFIC SPECIALIST'S CONSOLE
23 PARACHUTE STOWAGE

Figure 4-69 (Sheet 7 of 8)

COMPARTMENT NO. 4 - LOOKING FORWARD

Figure 4-69 (Sheet 8 of 8)

AIRBORNE LAUNCH CONTROL CENTER

ALCC Capabilities

An airborne launch control center (ALCC) provides a secure command and control capability for selective programming and launch of WS-133 series Minuteman missiles. Additional capability for voice and message insertion and programming and interrogation of 494L command and control system payloads are also provided. Selected commands result in automatic initiation of classified or unclassified digital messages for modulation of an AN ART-42 UHF transmitter FM carrier. An automatic relay mode of operation may also be employed for UHF reception, conditioning, and retransmission of Minuteman messages generated by other ALCC airplanes or ground facilities. The ALCC equipment interfaces with the AN ART-42 transmitters, AN ARR-68 receivers, and the AN ACC-3 multiplexer which are part of the communications center equipment complement.

NOTE

See T.O. 1C-135(E)C-1-2 and T.O. 21M-LGM30F-1-7 for ALCC detailed description, theory of operation and data flow, MCCC and DMCCC procedures, and malfunction analysis.

ALCC Switch

The ALCC switch (19, figure 1-11) is located on the pilot's left side panel. It is an edge lighted panel with a cover-guarded switch and marked with ALCC ON--OFF positions. The switch provides additional control over the capability to decrypt encrypted classified commands stored in the ALCC DATA PROCESSOR memory. These command selections (INHIBIT, ENABLE, AUTO, EXECUTE LAUNCH, and a part of the Enable Commanded Timer Command) cannot be decrypted without use of this switch. When this switch is used in conjunction with the CRYPTO ALARM OVERRIDE switch the code processor alarm interlocks are deactivated. ALCC operation is normal with the switch positioned to OFF.

NOTE

Operation of the ALCC switch will be accomplished upon request of the MCCC IAW applicable command directives.

ALCC Battery

The ALCC equipment has an integral battery and battery charging T-R unit. A battery charge indicator (figure 5-1, sheet 4) is installed on the equipment. The battery furnishes an emergency source of power for code store holding power even though power from the airplane electrical system is not available. Battery power to the ALCC equipment will be available only when the V store power switch on the right AEAO miscellaneous panel is in the BATTERY position.

SEATS

The arrangement of the airplane seating appears on figure 4-70.

Miscellaneous Crew Seats

There are three miscellaneous crew seats; the navigator's, boom operator's and crew instructor's (figure 4-70). The seats for the navigator and boom operator (12, figure 1-5, 15, figure 1-24 and figure 4-71) are identical, except for arm rests (see figure 4-71), that are only on the boom operator's seat. 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. The crew instructor's seat is stowed under the navigator's table. The hinged back of the seat operates the lock assembly (11, figure 4-71). Raising 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 4-71). The seats for the pilot and copilot are described in Section I.

WARNING

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.

Main Cabin Seats

There are twenty staff seats installed in the main cabin. The staff seats are numbered 2 thru 20, except for the omission of 12 (figure 4-70). In addition, there is an APM console operator's seat.

Thirteen seats 2 and 3, 5 thru 10 and 13 thru 16 and the APM console seat are similar to the navigator's seat described in this section (figure 4-71).

Seats 4 and 4A are crew seats similar to the navigator's seat except for additional seat tracks which permit movement alongside the crypto console. See figure 4-71.

Seat 11 is an executive seat with recline capability. The controls are similar to those of the crew seats but without elevation. See figure 4-70.

Two 2-man seats are installed at positions 17 & 18 and 19 & 20 in compartment No. 4. These seats have recline controls and seat belts. See figure 4-71.

WARNING

Seats 19 and 20 face forward and do not have shoulder harnesses. These seats may be occupied during takeoff and landing provided that they are equipped with the wide MD-2 safety belts, and each occupant rests his head and upper body on the table during these phases of flight.

Seat Equipment

The seats have seat and back cushions, seat belts, head rests, cup holders, and hard hat stowage. The hard hats are stowed under the table top at the respective seat. A hard hat holder is installed high on the aft bulkhead of compartment No. 2 for crypto operator No. 1 and on the aft side of the COMSAT control panel (10D, figure 4-69) for crypto operator No. 2. All seats have a shoulder harness except the two 2-man seats, 17 & 18 and 19 & 20. All seats are stressed for 16G loads or greater except the crew instructor's seat.

TABLES

Six tables are installed in the main cabin; five in compartment No. 3 at positions 5 & 6, 7 & 8 & 9, 10 & 11, 13 & 14 and 15 & 16 and one table, with drop leaf extensions, in compartment No. 4 for seats 17, 18, 19 & 20. The tables are constructed of wood and metal with grey formica tops. The tables are bolted to the sidewall and the floor cargo tiedown fittings. There is a drawer at each of the table/seat positions, except the AEAO prime position. (See figures 1-3 and 4-69.)

A stowable writing table (10C, figure 4-69) is installed on the aft side of the cabinet V group rack adjacent to the crypto operators' console. The table is pulled out for use and rotated downward to engage a stop on the forward end of the rack, giving a writing table just below the SATCOM teletypewriter. The table may be stowed by rotating the forward end up and pushing the vertical table in until engaging a stowage clip. There is a cup holder in the table top.

ASH TRAYS

Sliding tray type ash trays are located under the sidewall consoles. Those positions with table top consoles have the ash trays on top of the console. Two ash trays are located on the middle of the table in compartment No. 4. Ash trays are also located at each crew station except the boom operator's stations.

STEWARD CALL

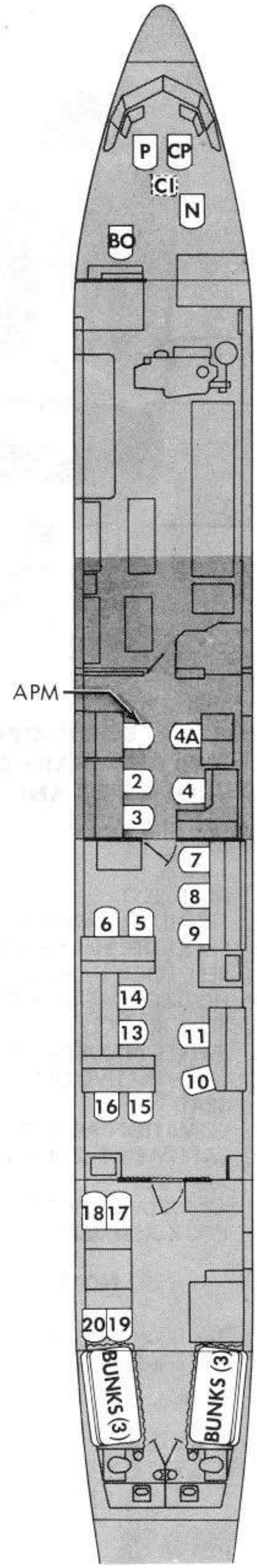
A steward call system consists of a light mounted on the flight traffic specialist's console at seat 20, a chime under the rest table and a loudspeaker mounted over the rest table. The steward call is energized from the staff consoles in compartment No. 3 by depressing the console switch marked STEWARD.

CLOCKS

Thirty two 8-day clocks, with a 12 hour outer dial and a 24 hour inner dial, are installed in the airplane. Two clocks are located in the cockpit and at each position in the main cabin.

airplane seating

SEAT NO.	SHOULDER HARNESS	AFT FACING CAPABILITY	TAKEOFF, LANDING, CRASH LANDING CAPABILITY	OCCUPANT
P	Yes	No	Yes	PILOT
CP	Yes	No	Yes	COPILOT
CI	No	No	No	CREW INSTRUCTOR
N	Yes	Yes	Yes	NAVIGATOR
BO	Yes	No	Yes	BOOM OPERATOR
APM	Yes	Yes	Yes	APM OPERATOR
2	Yes	Yes	Yes	RADIO OPERATOR
3	Yes	Yes	Yes	RADIO OPERATOR
4	Yes	Yes	Yes	CRYPTO OPERATOR
4A	Yes	Yes	Yes	CRYPTO OPERATOR NO. 2
5	Yes	Yes	Yes	DIRECTOR OF MATERIEL (DM)
6	Yes	Yes	Yes	DIRECTOR OF MATERIEL (DM)
7	Yes	Yes	Yes	CONTROLLER
8	Yes	Yes	Yes	CONTROLLER
9	Yes	Yes	Yes	CONTROLLER
10	Yes	Yes	Yes	AIRBORNE EMERGENCY
11	Yes	Yes	Yes	ACTION OFFICER (AEAO)
13	Yes	Yes	Yes	DIRECTOR OPERATIONAL
14	Yes	Yes	Yes	PLANNING (DOPL)
15	Yes	Yes	Yes	DIRECTOR OF INTELLIGENCE (DI)
16	Yes	Yes	Yes	DIRECTOR OF INTELLIGENCE (DI)
17	No	Yes	Yes	RADIO MAINTENANCE TECHNICIAN
18	No	Yes	Yes	FLIGHT TRAFFIC SPECIALIST
19	No	No	No	REST SEAT
20	No	No	No	REST SEAT
Bunks (6)	No	No	No	BUNKS



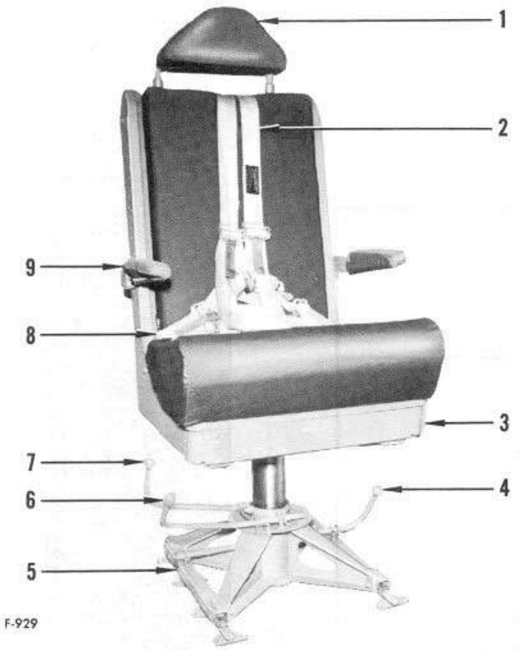
F-1435

NOTE

Seats 19 and 20 may be occupied during takeoff and landing provided the seats are equipped with the wide MD-2 safety belts and each occupant rests his head and upper body on the table during these phases of flight.

Figure 4-70

miscellaneous seats



NAVIGATOR, BOOM OPERATOR, APM OPERATOR AND MAIN CABIN SEATS 2 AND 3, 5 THROUGH 10 AND 13 THROUGH 16

1 HEAD REST
2 SHOULDER HARNESS
3 SHOULDER HARNESS INERTIA REEL LOCK HANDLE
4 HORIZONTAL ADJUSTMENT LEVER
5 SEAT TRACKS
6 SWIVEL ADJUSTMENT LEVER (INOPERATIVE ON BOOM OPERATOR'S SEAT)
7 ELEVATION ADJUSTMENT LEVER
8 SAFETY BELT (2 PLACES)
9 ARM REST
10 ADJUSTABLE FOOT
11 LOCK ASSEMBLY

NOTE

See figure 1-65 for the pilot's and copilot's seats.

CREW INSTRUCTOR

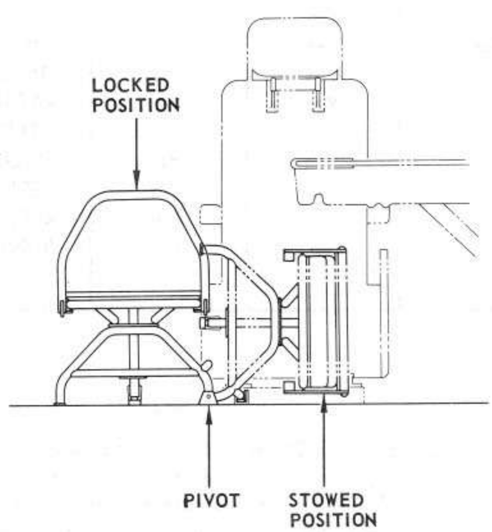
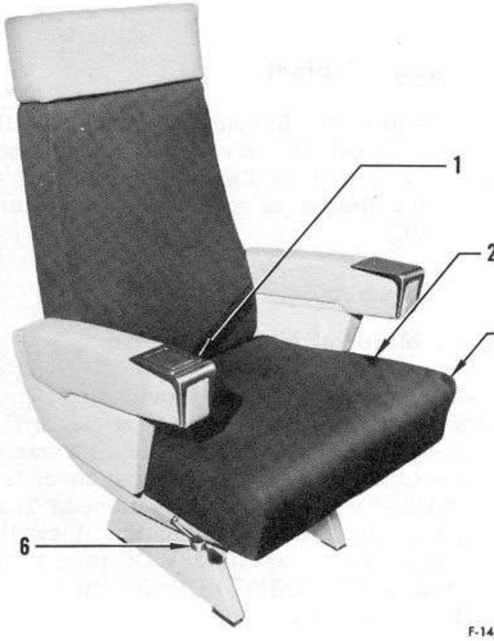


Figure 4-71 (Sheet 1 of 2)

CRYPTO (NO. 4)
CRYPTO (NO. 4A)

EXECUTIVE (NO. 11)



REST (17-18 AND 19-20)

1. RECLINE ADJUSTMENT (3 PLACES)
2. SHOULDER HARNESS INERTIA REEL LOCK HANDLE
3. FORWARD AND AFT ADJUSTMENT LEVER
4. ELEVATION ADJUSTMENT LEVER
5. SWIVEL ADJUSTMENT LEVER
6. HORIZONTAL ADJUSTMENT LEVER

NOTE

Shoulder harness and safety belts not shown.

Figure 4-71 (Sheet 2 of 2)

STOWAGE CABINETS AND BOXES

Stowage Cabinet, Double Door

A shelfless, double door, storage cabinet is provided in the forward, left-hand corner of compartment No. 3.

Map Stowage Cabinet

A cabinet is provided in compartment No. 3, RH side, just aft of the controller's console, for stowage of maps. The cabinet contains sixteen 7x7x36 inch compartments for storage of roll charts and/or maps (figure 4-69).

Classified Material File

A classified material file, is provided on top of the map stowage cabinet in compartment No. 3 (figure 4-69). A warning system consisting of a warning horn and a light is activated when the cover is opened and deactivated when the cover is closed. The warning horn and light are mounted on the sidewall above the file. Operating power is 28V DC thru a circuit breaker marked WARNING HORN on the SBCBP (figure 1-33, sheet 4).

Graphics Cabinet

A cabinet is provided in the LH aft corner of compartment No. 3 for stowage of sidewall charts, slides and projection and reproduction equipment. There are also several compartments for miscellaneous stowage (figure 4-69).

CONSOLES

Consoles are installed on the sidewalls and/or tables in compartments No. 2, 3 and 4. The consoles contain electronic and communication equipment, oxygen regulators and bookcases.

PROJECTION EQUIPMENT

Vu-graph

A Bessler vu-graph, model 7750 THB is mounted on top of the graphics cabinet in the aft LH corner of compartment No. 3. The vu-graph handles transparencies up to 10x10 in. and projects onto a screen mounted on the opposite sidewall (figure 4-69).

Screens

Three projection screens are installed in the airplane. The vu-graph transparency projection screen is mounted on the aft RH sidewall of compartment No. 3 opposite from the vu-graph (figure 4-69). The screen rotates back against the sidewall when not in use. Two 30x60 inch projection screens are mounted on the forward center partition in compartment No. 4 (figure 4-69). These screens cover the upper portion of the doorway above the dutch door and rotate up to the compartment No. 4 ceiling when not in use.

Sidewall Charts

Sidewall chart corkboards, with rails, are installed along the upper, RH and LH, forward sidewalls in compartment No. 3. Seven 20x30 in. charts will slide into the LH rails and six 20x30 in. charts will slide into the RH rails. The corkboard backing may be used as a pinup board (figure 4-69).

Graphics Cabinet

Projection materials and sidewall charts are stowed in the graphics cabinet. See STOWAGE CABINETS AND BOXES, this Section.

PARACHUTE STOWAGE

A stowage cabinet with 18 compartments is provided in the forward RH corner of compartment No. 4 for stowage of parachutes. There are three rows of six shelves with a strap and hook attached to each row for retaining the parachutes (figure 4-69).

GALLEY EQUIPMENT

The galley (figure 4-72), stressed for 16G loading, is installed in compartment No. 4. Galley equipment includes two ovens, two hot cups, liquid and miscellaneous storage bins, a coffee brewer, two dry ice cooled freezer compartments and a galley control panel. An exhaust filter system is in the galley hood. The galley hood is vented overboard and is controlled by a manual shutoff valve mounted on the forward end of the hood. Two dome lights are installed in the hood and are controlled by a switch (1A, figure 4-72), with ON--OFF positions. The individual galley circuits are protected by circuit breakers (figure 4-72). Operating power is 115/200 volt AC with circuit protection through a circuit breaker labeled GALLEY on the ENG 2 GEN section of the main AC power panel (figure 1-33, sheet 5). For overhead lighting, see LIGHTING EQUIPMENT, this Section.

Galley Control Panel

Each control panel contains the master switches and circuit breakers for the ovens, hot cups, and coffee brewer. Each switch has an adjacent light which indicates when power is ON through the respective switch. See details I and II of figure 4-72.

Oven Controls

Each oven has a timer-buzzer control (13, figure 4-72), a temperature selector (11, figure 4-72), an oven switch (12, figure 4-72), a circuit breaker switch (15, figure 4-72) for the heater element and a ruby operating light (14, figure 4-72). A variable thermostat, adjusted by the temperature selector knob, acts to maintain the oven temperature within ± 10 degrees of the selected temperature. The ruby operating light is on whenever power is being supplied to the heater element and cycles on and off as controlled by the thermostat. Each timer has a buzzer which sounds to indicate that the cooking cycle is complete. Each oven has a metal encased heating element and a fan in the back of the oven. The fan circulates air within the oven to give uniform heating without hot spots. The heater baffle is held in place by four jacks so that it can be readily removed for cleaning. Each fan is held on the shaft by quick disconnect spring catches so that it can be removed for cleaning after the heater baffle is removed.

To initiate oven operation

A. Galley Control Panel Circuit Breakers - Checked closed.

B. Main Power Switch - ON

C. Numbered Oven Switch - ON

D. Temperature Selector Knob - Set, as desired

E. Oven Switch - ON

F. Heater Circuit Breaker Switch - ON

G. Timer - Set for 5 minute preheat

NOTE

- Turn timer past 15 minutes (to engage timer spring) and reset to desired time.
- A 5 minute preheat period is recommended prior to use.
- If the ruby light is not on, the heating element is not receiving power.

When buzzer sounds, load the oven and set timer to appropriate cooking cycle.

NOTE

- When oven reaches the desired temperature, the ruby light goes off. The control thermostat cycles power to the heating element and ruby light, to maintain the desired oven temperature, until the timer-buzzer reaches OFF.
- If the oven is still warm from previous use, and a lower temperature is selected, the ruby light may not come on until the oven has cooled sufficiently.
- The oven should be cleaned after each cooking operation has been completed. Allow the inner chamber to cool, remove heater baffle and fan, clean the entire chamber and then wipe chamber dry.

Coffee Brewer Operation

The brewer is a self-contained unit (3, figure 4-72) which supplies gravity-fed water at ambient temperature, pumped hot water and pumped hot water (filtered) for coffee brewing. Each outlet is separate; the hot water and ambient water may be used independently and while coffee is being brewed. The hot water is metered flow, delivering approximately 0.5 gallons per minute. The brewing section of this unit utilizes fresh coffee grounds packaged in filter bags. By lifting the handle on the brewer head, the lower half of the head swings down. A filter bag of coffee is placed in the recessed lower head, then the handle is lifted and rotated to the locked position. A coffee pot is placed in position with the liquid level sensing device extending down into the pot. Pressing the coffee button momentarily energizes the machine and coffee is brewed.

NOTE

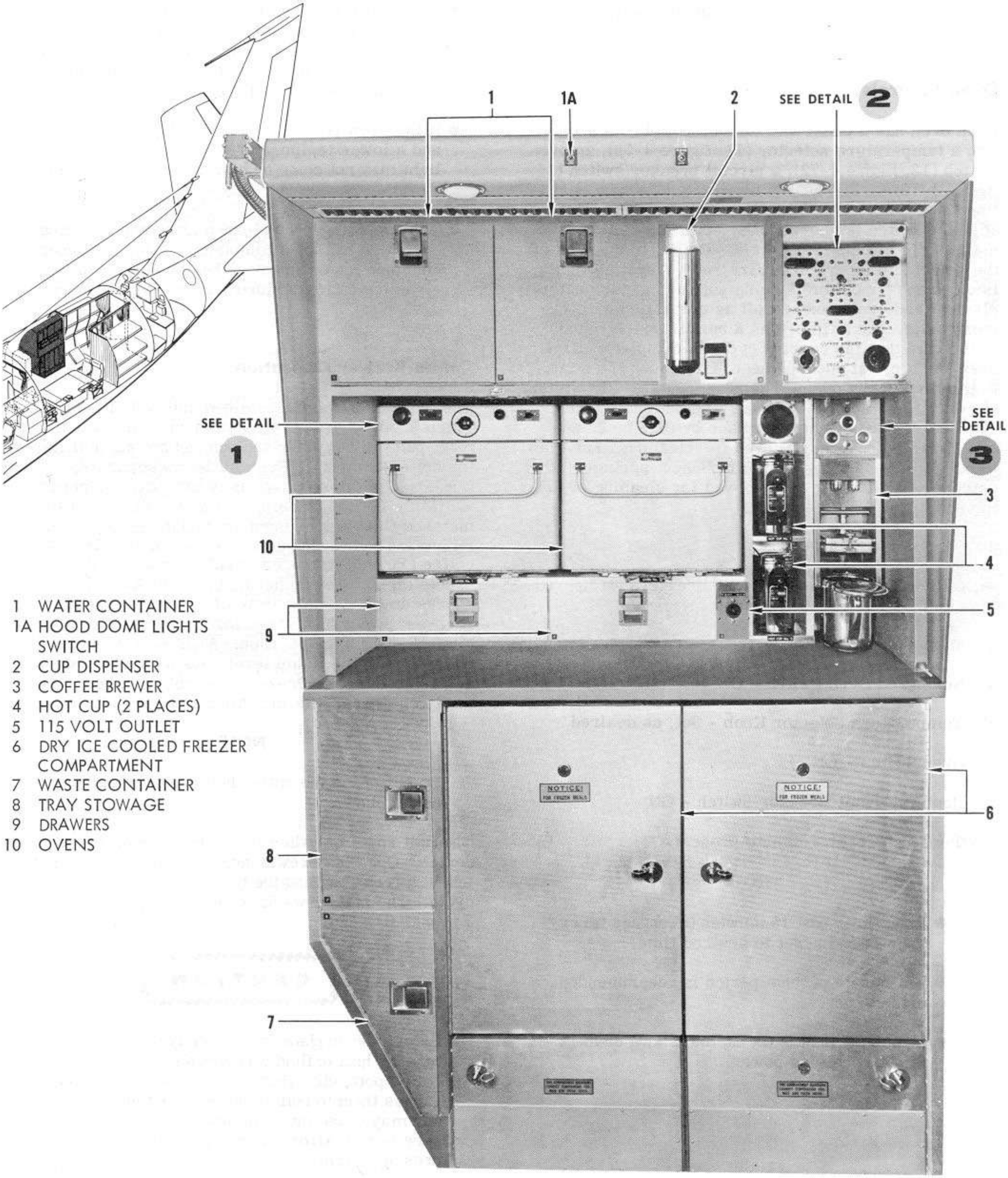
Do not press the coffee button if a container is not in place.

The unit shuts off when the fluid reaches the sensing device. Open the brewer head, remove the filter bag, insert a fresh bag and the brewer is ready for another cycle. The unit brews 52 oz of coffee in approximately 3 minutes.

CAUTION

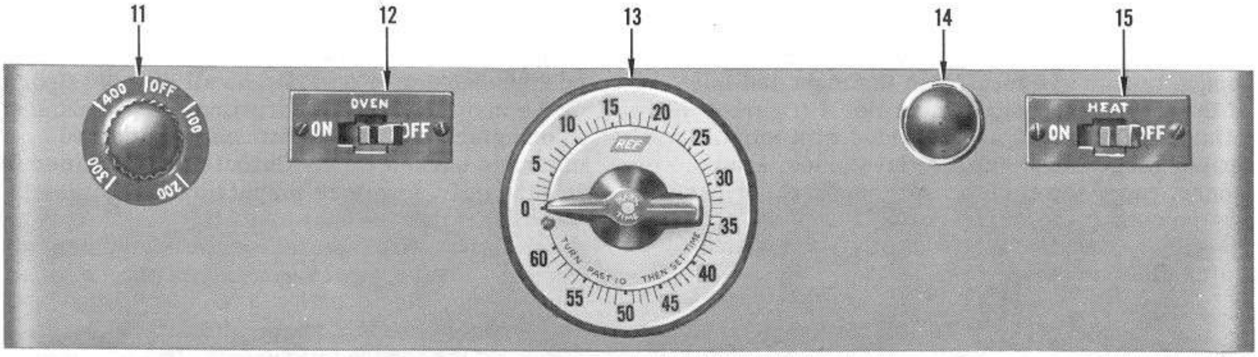
Before the airplane is completely depressurized, turn off heat to fluid containers such as hot cups, coffee pots, etc. Heating fluids at high altitudes causes them to boil at much lower temperatures and may cause the container to rupture if pressure is not allowed to equalize during depressurization.

galley equipment



1 WATER CONTAINER
1A HOOD DOME LIGHTS SWITCH
2 CUP DISPENSER
3 COFFEE BREWER
4 HOT CUP (2 PLACES)
5 115 VOLT OUTLET
6 DRY ICE COOLED FREEZER COMPARTMENT
7 WASTE CONTAINER
8 TRAY STOWAGE
9 DRAWERS
10 OVENS

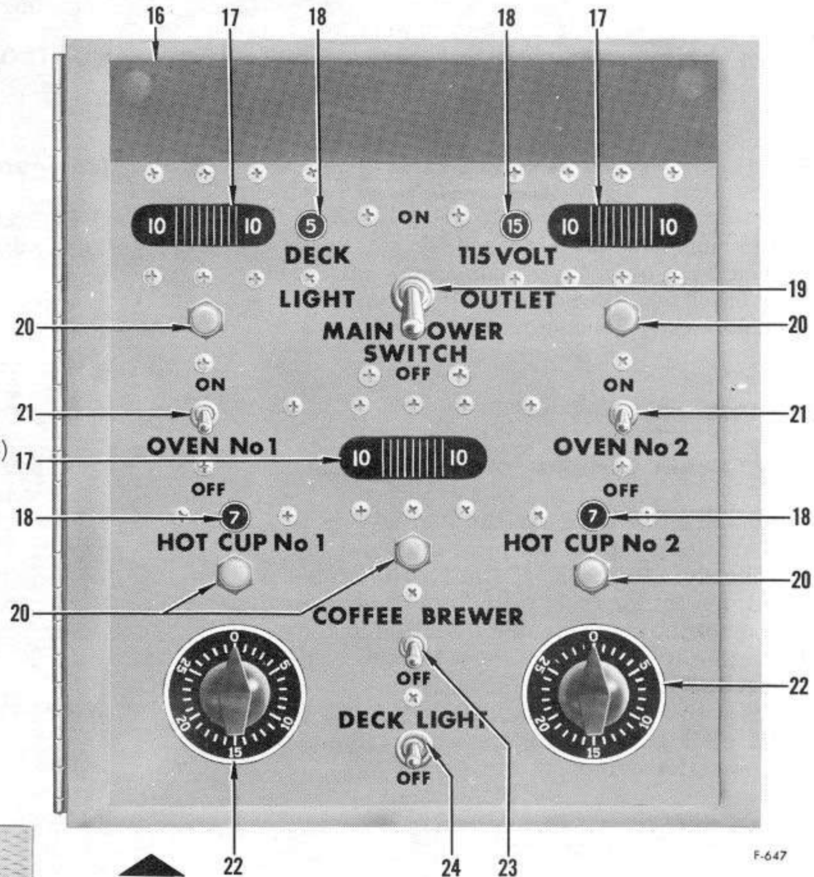
Figure 4-72 (Sheet 1 of 2)



F-648

1 OVEN CONTROLS

11 TEMPERATURE SELECTOR
12 OVEN SWITCH
13 OVEN TIMER-BUZZER CONTROL
14 OPERATING LIGHT
15 HEATER SWITCH
16 LIGHT SHIELD
17 GUARDED CIRCUIT BREAKER 115/200V AC (3 PLACES)
18 CIRCUIT BREAKERS 115V AC (4 PLACES)
19 MAIN POWER SWITCH
20 POWER ON INDICATOR LIGHT (4 PLACES)
21 NUMBERED OVEN SWITCH (2 PLACES)
22 HOT CUP TIMER (2 PLACES)
23 COFFEE BREWER SWITCH
24 DECK LIGHT SWITCH
25 COLD WATER BUTTON
26 STOP BUTTON
27 HOT WATER BUTTON
28 COFFEE BUTTON



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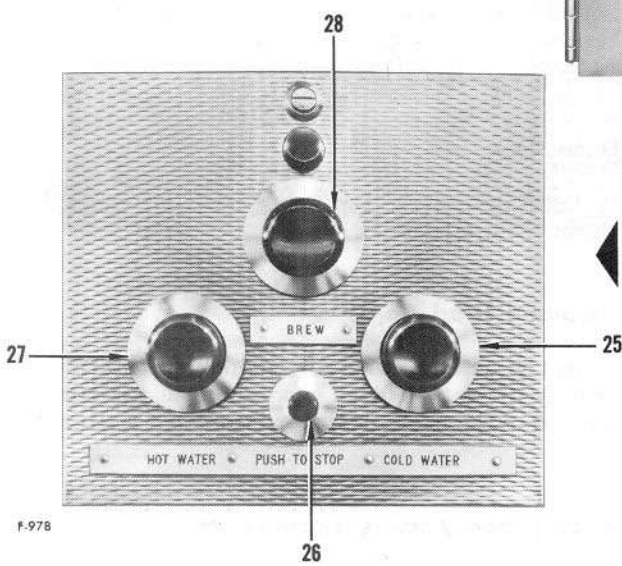


F-978

2 GALLEY CONTROL PANEL

3 COFFEE BREWER CONTROL PANEL

Figure 4-72 (Sheet 2 of 2)

TOILET COMPARTMENTS

Two toilet compartments are installed in the airplane. The compartments are located on the right and left side of the aft end of compartment No. 4 (figure 4-73). The toilet compartments are provided with toilets, toilet paper dispensers, urinals, lavatories, soap dispensers, paper towel dispenser, waste paper baskets, water containers, mirrors and power outlets for electric shavers. Flush type toilets are provided in the aft toilet compartments.

BUNKS

Six bunks are installed in compartment No. 4, three on each side in each aft corner (figure 4-69).

WARNING

The bunks are not stressed for side loads and should not be occupied during takeoff, landing, or other condition where side loads on the bunks may be encountered.

CURTAINS

Control Cabin Curtains

Curtains are installed for the four eyebrow windows above and forward of the pilot and copilot seats. A large blackout curtain (4, figure 1-5) separates the navigator's station from the pilot's 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. A sliding curtain is installed at the entrance to the crew toilet compartment.

Main Cabin Curtains

A weather curtain is provided at the cargo door. The curtain provides full closure of the door area and incorporates a door frame and flap for entrance/exit.

Sliding curtains are provided to enclose the crypto station (seat 4) in compartment No. 2 and the bunks in compartment No. 4. A sliding curtain is provided on the compartment No. 3 and 4 doorway, above the dutch door, on the compartment No. 3 side. See figure 4-69. The curtains on the forward side of the bunks can be drawn closed to isolate the rest area in compartment 4.

The security curtain at the crypto station terminates at the forward end of receiver group rack and does not obscure the right wing emergency exit hatch. The curtain may be used to enclose seat 4A if the seat is near the aft end of travel. The seat may be used outside the curtain if at the forward end of travel.

CARPETING

A black and white tweed nylon carpet with rubber cushion backing is provided on all exposed floor areas of the main cabin. The carpeting and pad are installed in one piece in each compartment and attached by means of double backed tape. Cutouts are provided for the landing gear downlock inspection doors, single point refueling valve manual operation, landing gear door release, both pressurization outflow valves, aft body tank fuel level control valve, the forward body tank and aft body tank fuel quantity probes, alternate pressurization and auxiliary heat valve and cargo tie-down attach points for the tail support strut and escape slide retaining straps.

CONTROL CABIN MISCELLANEOUS EQUIPMENT

The following is equipment not contained in Section I.

Navigator's Stowage Cabinet

A navigator's stowage cabinet (1, figure 4-29) is directly above the navigator's table. This cabinet is used for stowing 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 (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. The stool is raised and lowered by a ten inch screw column. A friction brake on the screw prevents the stool adjustment from creeping.

Navigator's Table

A table (8, figure 4-29) with a drawer and map bin is provided at the navigator's station. The map bin (9, figure 4-29) provides stowage for maps and charts.

Data Case

A data case for each pilot is on his respective side panel (39 and 61, figure 1-3).

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.

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

toilet compartments

1 ELECTRIC SHAVER OUTLET
2 OXYGEN SYSTEM EVAPORATOR (LEFT AFT TOILET ONLY)
3 MIRROR
4 PAPER TOWEL DISPENSER
5 WASH WATER CONTAINER
6 WASTE PAPER RECEPTACLE
7 WASH BASIN
8 OXYGEN CONVERTERS (TWO IN LEFT TOILET AND ONE IN RIGHT)
9 LEFT AFT TOILET COMPARTMENT
10 FLUSH TYPE TOILET
11 TOILET PAPER DISPENSER
12 URINAL
13 AFT TOILET COMPARTMENT DOOR
14 RIGHT AFT TOILET COMPARTMENTS

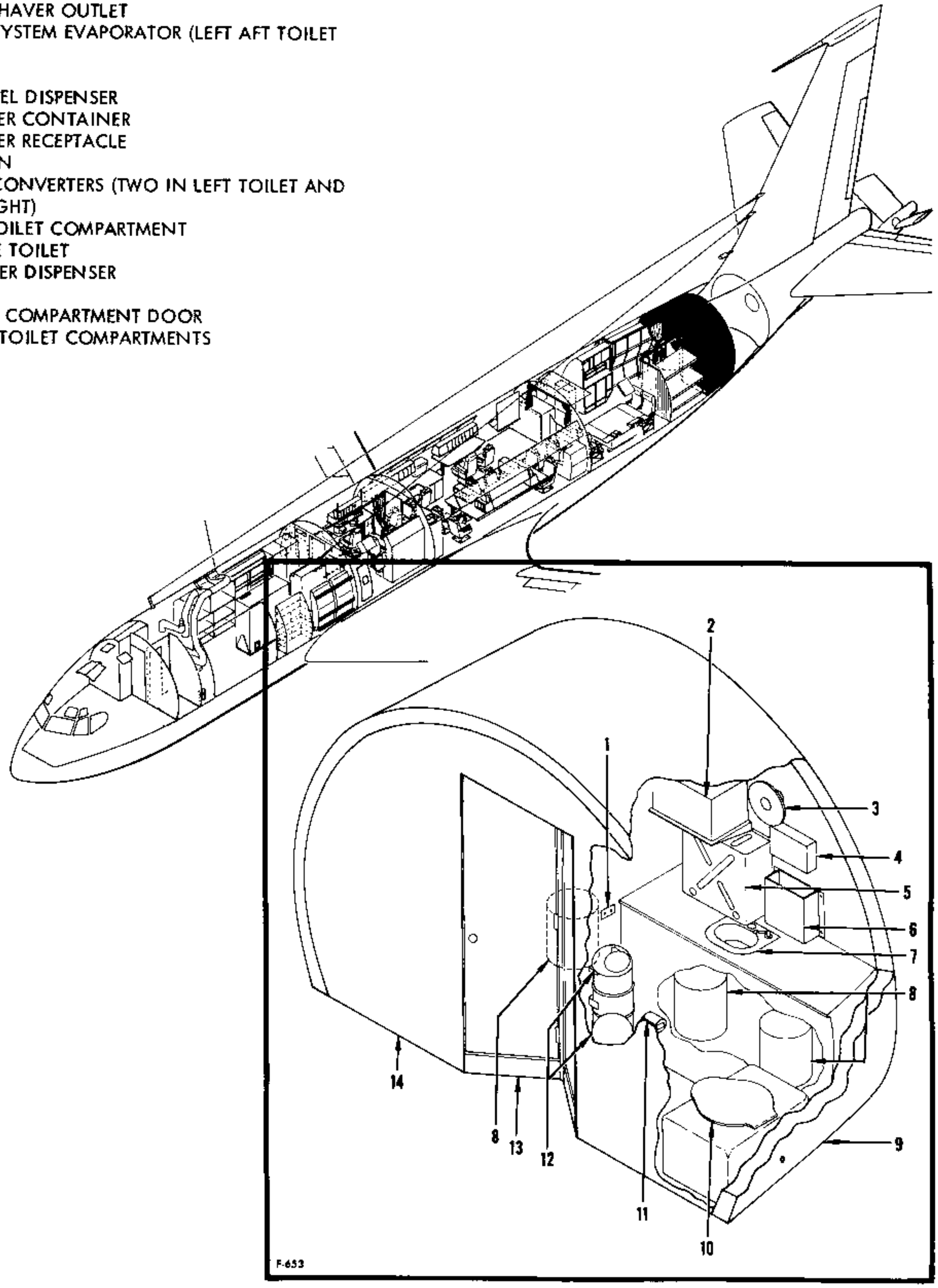


Figure 4-73

boom operator's safety harness

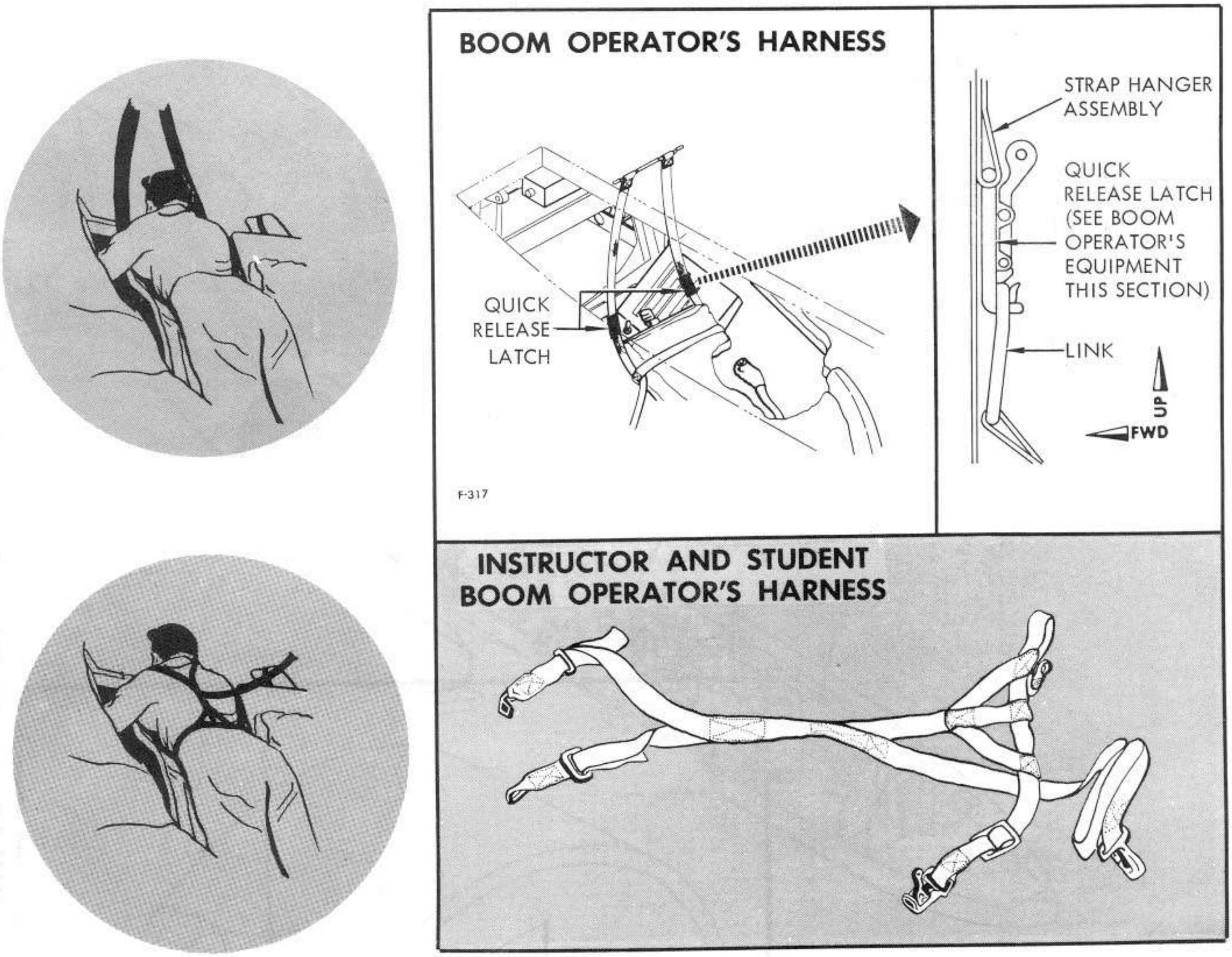


Figure 4-74

and controls for operation of the A/R boom, communication equipment, oxygen equipment and an alarm bell. (See figure 4-50.) 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 the 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 4-74.) 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 (28, figure 4-50) is installed at the boom operator's window. 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.

Boom Operator's Window Cover Plates

Cover plates are provided for the window of the boom operator's compartment. These are to be installed whenever the boom operator's compartment floor cover is installed. They are a safeguard against structural damage to the airplane in the event of failure of the window. If the window were to blow out the boom operator's compartment could depressurize very rapidly unless restricted. This could cause a pressure differential across the floor above the boom operator's compartment. Collapse of this floor could damage control cables, within the floor, which control empennage surfaces. The window cover plates restrict by 90% the size of the hole which could be produced by window failure, such that a slow decompression would result from window failure. The covers consist of two aluminum plates, one-quarter inch thick, each of which covers one-half of the window. They are held in position by clips at the bottom and winged cowl fasteners around the edges. Whenever the boom operator's compartment floor cover is not installed, the plates are stowed to the left of the boom operator. The plates are then held down by a strap.

SERVICING AND GROUND EQUIPMENT

The following equipment is provided with each airplane for servicing and ground use and may be stowed in the airplane in accordance with mission requirements: engine inlet and exhaust and fan exhaust plugs, anti-ice duct exhaust outlet plugs, breather outlet plugs, generator and heat exchanger plugs, generator drive oil cooler inlet plugs, air conditioning ram air inlet and outlet plugs, rotating rendezvous lights, light filters, pilot's window enclosure covers and the navigator's window cover. This equipment may be stowed in compartment No. 1 just aft of the APU. 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, boom nozzle cover and chinning bar safety lock is stowed on the wall below the landing gear lock kits. Two starter cartridges are stowed on the sidewall below the cargo door controls.

TAIL SUPPORT STRUT

A tail support strut (figure 4-75) may be carried in the airplane when required by the mission. The tail support strut is stowed in the left side of compartment No. 1 alongside the electrical equipment rack and main AC power shield. Access to floor tie down fittings has been provided by slits in the carpet.

The tail support strut supports 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 4-75) and base (10, figure 4-75). Handles (6, figure 4-75) 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 equipment loading and unloaded settings. The white mark (5, figure 4-75) indicates the equipment loading setting and the red mark (3, figure 4-75) the equipment unloaded setting. After loading or unloading is accomplished the strut may be secured to tie-down fittings on the floor of compartment No. 1, alongside the electrical equipment rack. See figure 4-75. Slits have been provided in the carpet for access to the tie-down fittings. 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

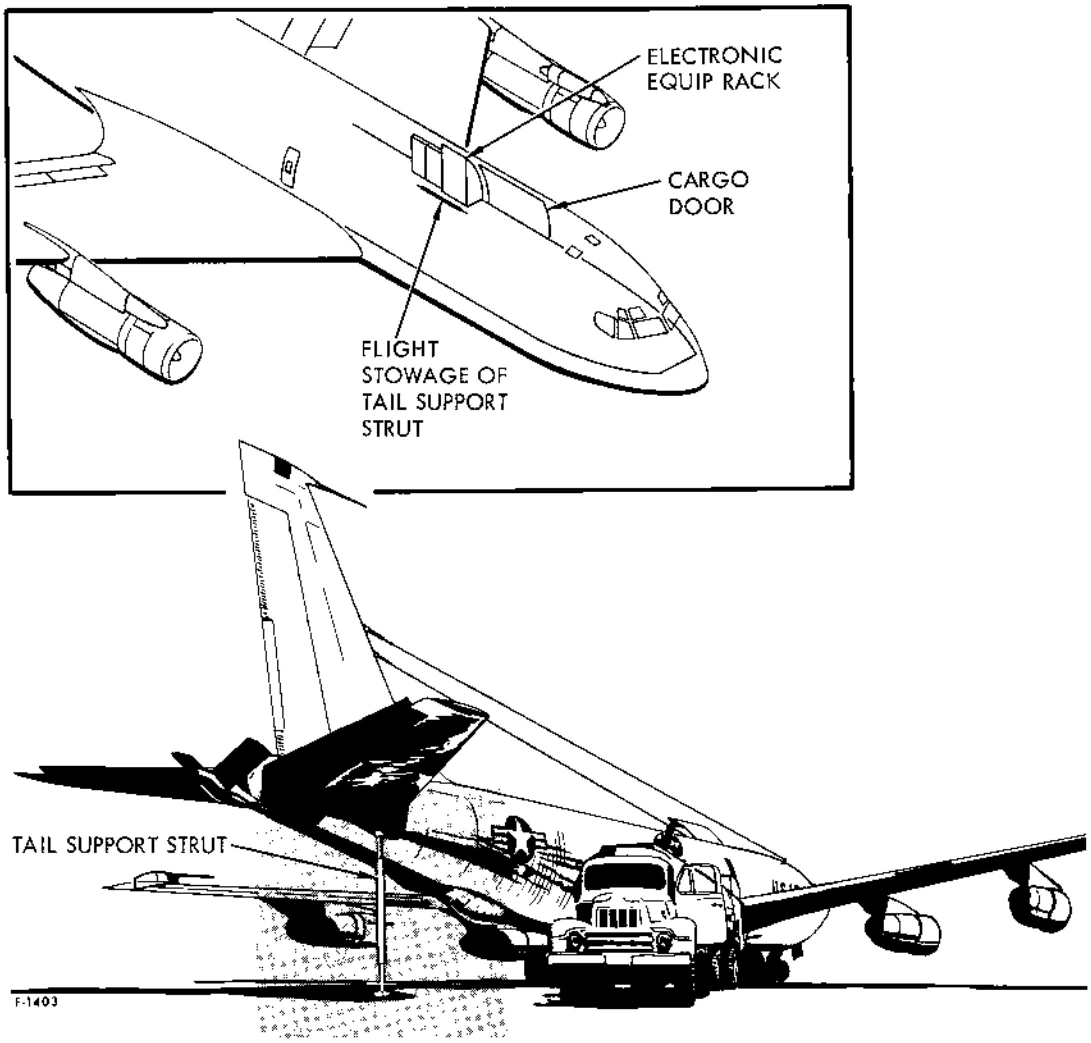
Insert this adapter fitting (1, figure 4-75) in jacking fitting located at the aft end of the airplane.

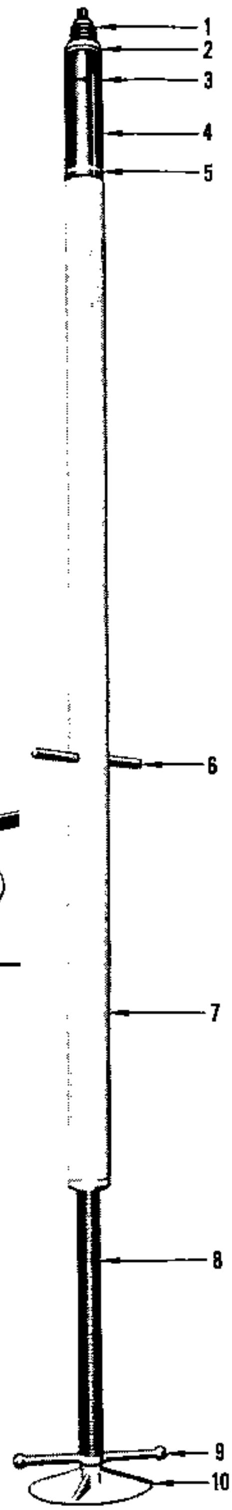
C. Support Strut - Adjust to vertical position

D. Turning Arm - Hold with foot

This arm (9, figure 4-75) is held firmly with foot to prevent adjusting screw (8, figure 4-75) from turning while handle is being turned.

tail support strut





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

CAUTION

TO PREVENT DAMAGE TO THE AIRPLANE STRUCTURE, DO NOT ALLOW COLLAR (2) TO BOTTOM ON OUTER TUBE (7).

Figure 4-75

E. Handle - Grasp and rotate

This handle (6, figure 4-75) should be rotated in a counterclockwise-direction to extend the outer tube (7, figure 4-75). When loading equipment, the outer tube should be extended until the white mark (5, figure 4-75) aligns with the top of the outer tube. When unloading equipment tube is extended until the red mark (3, figure 4-75) aligns with the top of the outer tube.

Removal of the tail support strut after loading or unloading operations is as follows:

A. Handle - Grasp and rotate

The handle (6, figure 4-75) should be rotated in a clockwise direction to retract the outer tube and allow the strut to be freed from the airplane.

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 4-76) 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 the battery circuit breaker panel (figure 1-33, sheet 3).

CAUTION

Do not operate windshield wipers on dry windshields.

WINDSHIELD RAIN REPELLENT SYSTEM

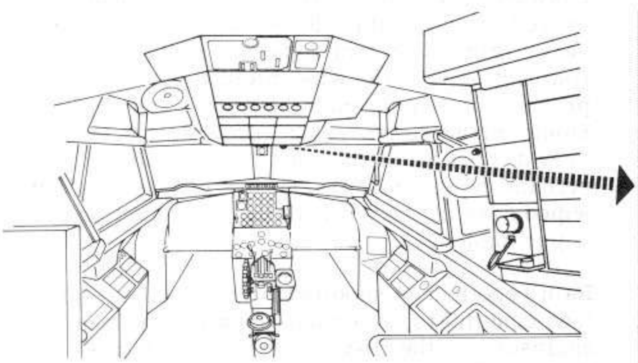
A windshield rain repellent system provides improved forward visibility when flying in moderate or heavy rain. The rain repellent system is used in conjunction with the windshield wiper system to improve visibility through the pilot's and copilot's windshield during heavy rain. The solution is spread 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.

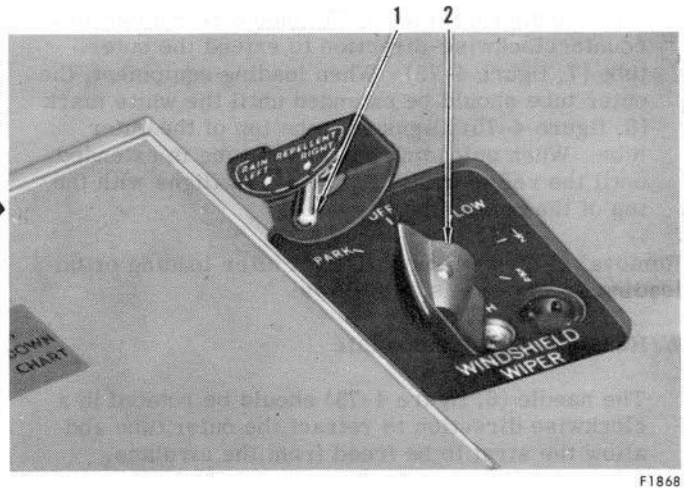
Rain repellent is supplied from one of two pressurized containers, a normal and a spare, located in an enclosure on the floor beneath the navigator's table. Each container supplies enough fluid for 20 to 25 applications to each windshield. Each application provides repellency for 5 to 10 minutes in moderate 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 airflow. 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 4-76), 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 1-33, sheet 1).

windshield wiper and rain repellent switches





1 RAIN REPELLENT SWITCH
2 WINDSHIELD WIPER SWITCH

Figure 4-76

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 4-76) 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. Re-application 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.

TAKEOFF AND LANDING DATA CARD HOLDER

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

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.

LETDOWN CHART HOLDER (WITH ICTO 846)

An illuminated letdown chart holder (10A, figure 1-11 and 2A, figure 1-12) is installed on both the pilot's and copilot's control wheels. The holder permits illumination of letdown or enroute charts without allowing light to escape into the cockpit. Controls consist of two ON/OFF rheostats at the top of the holder which regulate the intensity of white to red light. The left rheostat controls red light intensity and the right rheostat controls white light intensity. Operating power for the holders is 28 volt AC through a circuit breaker marked LETDOWN CHARTHOLDER on the 28 volt AC (MCBP).

FLIGHT LOADS DATA RECORDER SYSTEM (WITH ICTO 763)

A flight loads data recorder system (FLDRS) 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.

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 AFB 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 4-77).

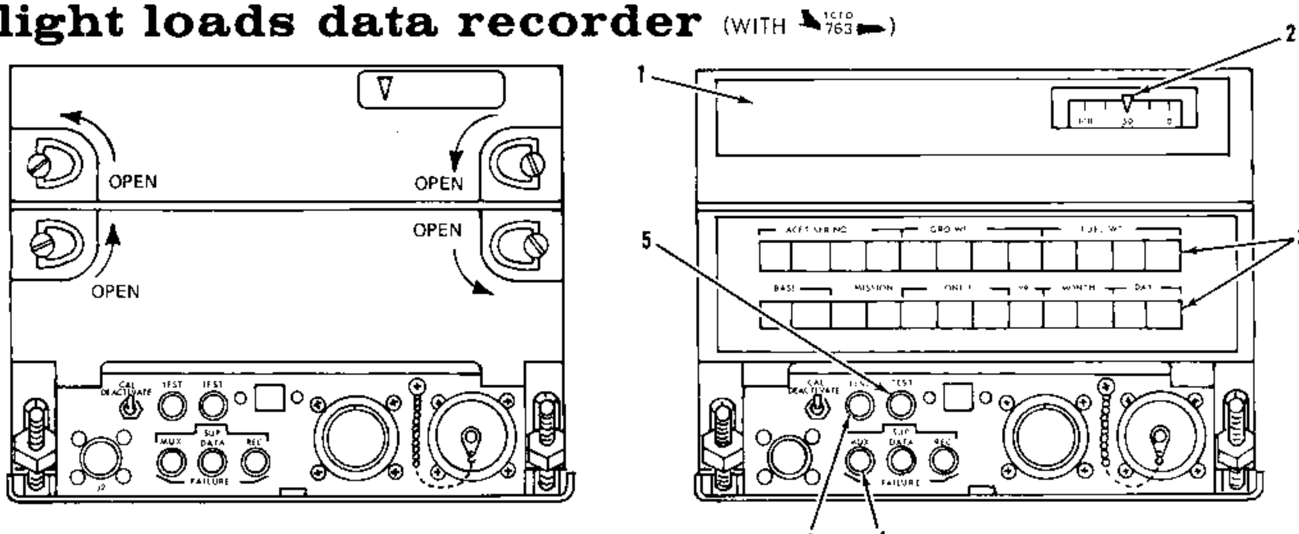
RECORDER POWER CIRCUIT

The crew entry/cargo door not latched warning circuit activates the recorder. Both doors must be closed and locked to activate the recorder.

NOTE

For operational checkout, loading and insertion of data elements, see T.O. 1C-135(K)A-2-9.

flight loads data recorder (WITH ICTO 763)



FRONT VIEW WITH DOORS CLOSED

FRONT VIEW WITH DOORS OPEN

1 TAPE CARTRIDGE
2 TAPE REMAINING
3 DOCUMENTARY DATA DIALS
4 TEST AND FAILURE LIGHTS
5 BUILT IN TEST BUTTON

Figure 4-77

section V

OPERATION LIMITATIONS

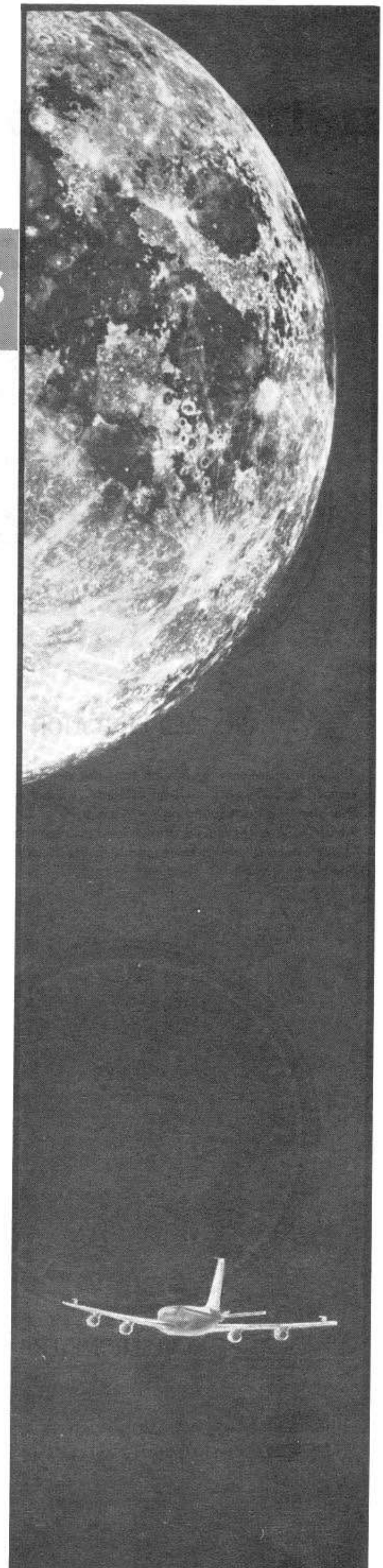


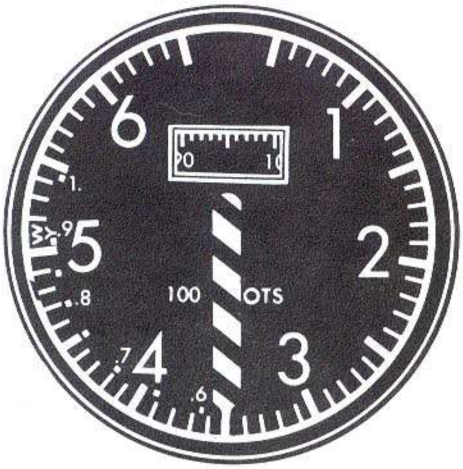
TABLE OF CONTENTS

This Section covers the airplane operating limitations 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. The instrument marking system consists of three colors and intermediate blank spaces. 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.

instrument markings

NOTE

The maximum allowable airspeed pointer may be black and white striped or red and white striped.



F-324

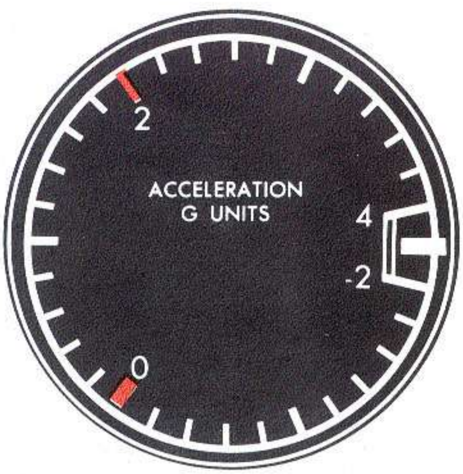
AIRSPEED INDICATOR

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 knots IAS. As altitude is increased, the striped pointer rotates to a lower airspeed which corresponds to the limiting Mach number.

F-325

MACH INDICATOR

0.90 MAXIMUM



ACCELEROMETER

+2g MAXIMUM POSITIVE ACCELERATION

0g MINIMUM ALLOWABLE ACCELERATION

ANGLE OF ATTACK INDICATOR

.85 – .91 CAUTION ZONE
(Approaching buffet)

.91 – 1.10 BUFFET/STALL ZONE

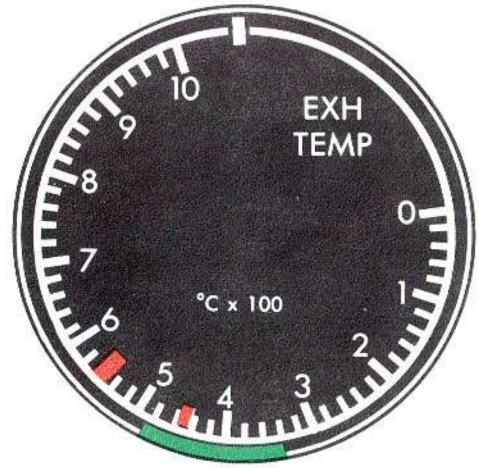
Figure 5-1 (Sheet 1 of 7)

APPLICABLE
TO ALL
FUEL GRADES

F-655

TACHOMETER

Green	58% - 60% RPM	IDLE RANGE
Green	85% - 101% RPM	NORMAL CRUISE RANGE
Red	106% RPM	MAXIMUM ALLOWABLE



F-656

EXHAUST GAS TEMPERATURE

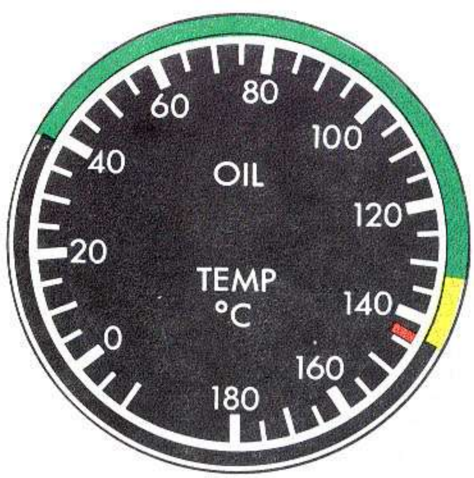
Green	340° - 490°C	CONTINUOUS OPERATION
Red	450°C	MAXIMUM DURING STARTING
Red	555°C	MAXIMUM DURING ACCELERATION AND TAKEOFF

F-658

OIL PRESSURE

Red	35 PSI	MINIMUM FOR FLIGHT
Yellow	35-40 PSI	LIMITED OPERATION
Green	40-60 PSI	CONTINUOUS OPERATION
Red	60 PSI	MAXIMUM FOR FLIGHT

NOTE: Minimum oil pressure for takeoff is 40 psi.



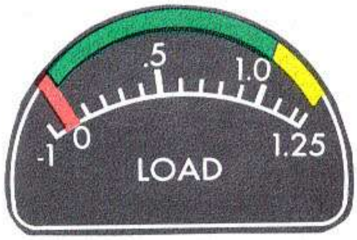
OIL TEMPERATURE

F-657

Green	40° - 132° C	CONTINUOUS OPERATION
Yellow	132° C - 143° C	CAUTION (10 MINUTE DURATION)
Red	143° C	MAXIMUM FOR FLIGHT

Figure 5-1 (Sheet 2 of 7)

instrument markings (cont)



F-331

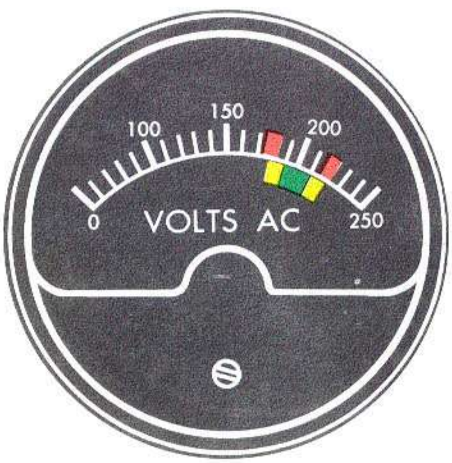
DC AMMETER

0	DANGER
0 - 1	NORMAL
1.0 - 1.25	CAUTION

F-332

AC FREQUENCY METER

380 CYCLES	MINIMUM
380 - 395 CYCLES	CAUTION
395 - 405 CYCLES	NORMAL
405 - 420 CYCLES	CAUTION
420 CYCLES	MAXIMUM



F-334

AC VOLTMETER

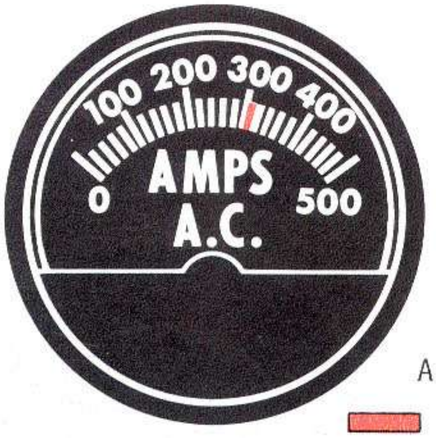
180 VOLTS	MINIMUM
180 - 190 VOLTS	CAUTION
190 - 210 VOLTS	NORMAL
210 - 220 VOLTS	CAUTION
220 VOLTS	MAXIMUM

F-335

DC VOLTMETER

22 VOLTS	MINIMUM
22 - 26 VOLTS	CAUTION
26 - 29 VOLTS	NORMAL
29 - 30 VOLTS	CAUTION

Figure 5-1 (Sheet 3 of 7)



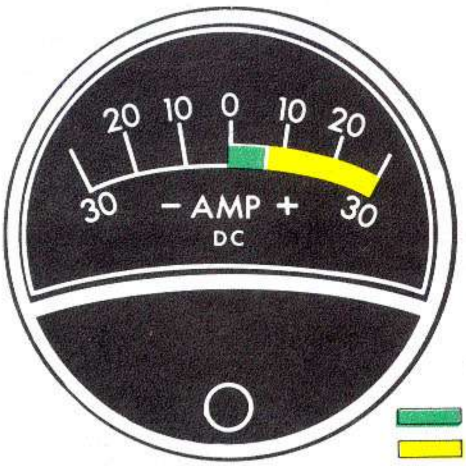
A.C. AMMETER

- 310 AMPS MAXIMUM

FUEL QUANTITY GAGE
FORWARD BODY TANK

- 32,700 LB MANUAL SHUTOFF
- CAUTION
- 37,700 LB TANK CAPACITY*

* AT FUEL DENSITY OF 6.5 LB/GAL.

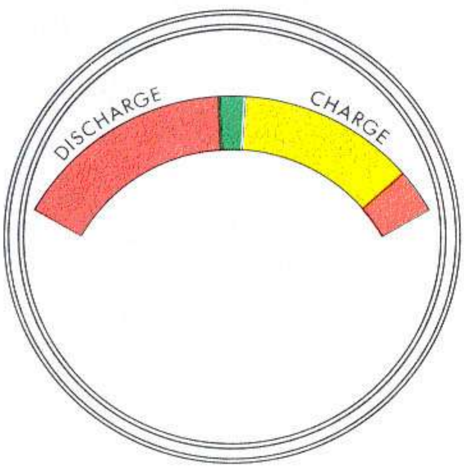


NOTE

See Section VII for state of charge at battery ambient temperatures higher or lower than standard day temperature.

BATTERY CHARGING AMMETER

(green)	0 - 7 AMPS	NORMAL OPERATING RANGE
(yellow)	7 - 30 AMPS	BATTERY CHARGE VERY LOW. CHARGE BATTERY BEFORE TAKEOFF EXCEPT FOR EMERGENCY CONDITIONS.



ALCC BATTERY
CHARGE INDICATOR

- NORMAL
- CAUTION
- DANGER

FUEL QUANTITY GAGE
AFT BODY TANK

- 39,450 LB MANUAL SHUTOFF
- CAUTION
- 41,457 LB TANK CAPACITY*

Figure 5-1 (Sheet 4 of 7)

instrument markings (cont)

F-336

BOOM SIGNAL COIL TEST VOLTMETER

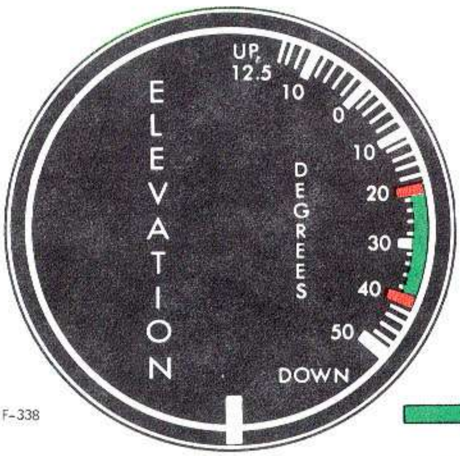
OPEN	BOOM SIGNAL COIL CIRCUIT OPEN
GOOD	BOOM SIGNAL COIL CIRCUIT GOOD
SHORTED	BOOM SIGNAL COIL CIRCUIT SHORTED

The given radar pressure values assume sea level calibration of the system. Actual values will vary with the operating field elevation.

F-343

RADAR PRESSURE

26 - 30 IN HG	MARGINAL OPERATION
30 - 34 IN HG	CONTINUOUS OPERATION
34 - 36 IN HG	MARGINAL OPERATION



F-338

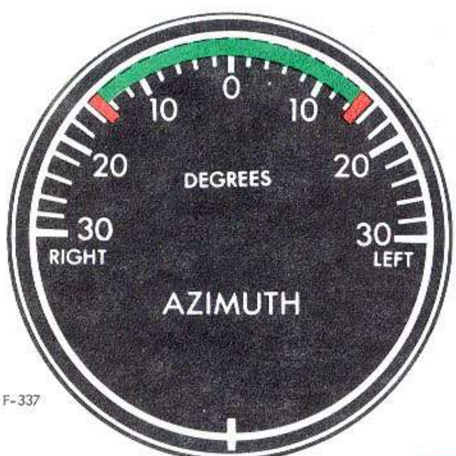
BOOM ELEVATION

20°-40° DOWN	NORMAL ENVELOPE (Automatic Operation)
40° DOWN	MAXIMUM
20° DOWN	MINIMUM

F-339

BOOM TELESCOPE

6 FT MINIMUM	
6 FT - 18 FT	NORMAL ENVELOPE (Automatic Operation)
18 FT MAXIMUM	



F-337

BOOM AZIMUTH

15°L - 15°R	NORMAL ENVELOPE (Automatic Operation)
15°L and 15°R MAXIMUM	

Figure 5-1(Sheet 5 of 7)

F-340

HYDRAULIC PRESSURE

2000 PSI	ACCUMULATOR PRELOAD FOR 70°F (See figure 1-66)
2400-3050 PSI	NORMAL
3050 PSI	MAXIMUM

F-341

PILOT RESERVE BRAKE PRESSURE

1000 PSI	ACCUMULATOR PRELOAD FOR 70°F (See figure 1-66)
1300 PSI	ONE BRAKE APPLICATION AVAILABLE
1300-3050 PSI	NORMAL
3050 PSI	MAXIMUM

NOTE

Because of gage tolerances, hydraulic pressure can read as high as 3200 psi under normal conditions.

F-342

BOOM HYDRAULIC PRESSURE

1500 PSI	ACCUMULATOR PRELOAD FOR 70°F
2400-3050 PSI	NORMAL
3050 PSI	MAXIMUM

RUDDER POWER HYDRAULIC PRESSURE

HIGH RANGE

SPEED = LESS THAN 250 ± 10 KIAS
FLAPS = MORE THAN 5° DOWN

2800-3050 PSI	NORMAL
2400-2800 PSI	CAUTION
3050 PSI	MAXIMUM
2400 PSI	MINIMUM

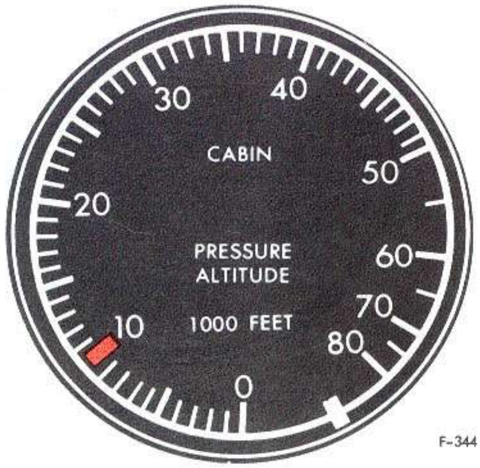
LOW RANGE

SPEED = MORE THAN 250 ± 10 KIAS
FLAPS = LESS THAN 5° DOWN

800-1175 PSI	NORMAL
1175 PSI	MAXIMUM
800 PSI	MINIMUM

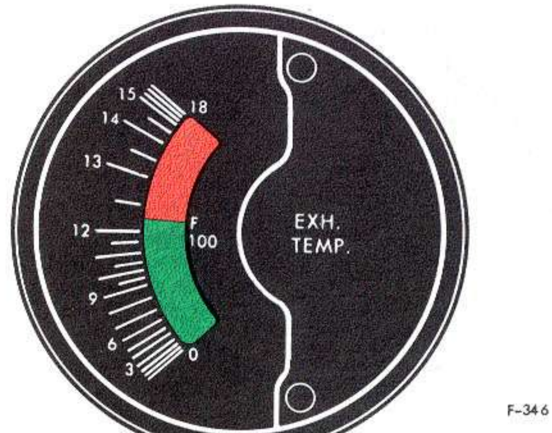
Figure 5-1 (Sheet 6 of 7)

instrument markings (cont)



CABIN PRESSURE

10,000 FT — DANGER (Oxygen required At Cabin altitudes above 10,000 ft)



APU EXHAUST TEMPERATURE

0 TO 1225°F NORMAL OPERATION

ABOVE 1225°F OVERHEAT

Figure 5-1 (Sheet 7 of 7)

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 portions of their checklists are performed.

ENGINE LIMITATIONS

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(E)C-1-1, shall not be exceeded except in an emergency.

Each engine, when installed, is trimmed to proper exhaust pressure to obtain TRT. See THRUST-RPM RELATIONSHIP, Section VII. Takeoff rpm high pressure compressor will be slightly different for each engine and will vary between 95 and 103% rpm. The overspeed limit of 106% rpm should not be exceeded at any time. During ground operation, if engine rpm exceeds 106% or fuel flow rises rapidly toward 15,000 pph, shut down the engine immediately.

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 accessory overheat.

During flight if engine rpm exceed 106% rpm but is less than 109% rpm, consideration should be given to oper-

engine operating limits

OPERATING CONDITION	TIME LIMIT	TEMPERATURE LIMIT
❶ TAKEOFF RATED THRUST (TRT)	5 minutes	555°C
NORMAL RATED THRUST (NRT)	CONTINUOUS	490°C
❷ IDLE	CONTINUOUS	340°C
STARTING (GROUND)	MOMENTARY	450°C
(INFLIGHT)	MOMENTARY	
❸ ACCELERATION (ENGINE)		555°C

❶ To be used for takeoff only.

❷ 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 the temperature limit for Normal Rated Thrust.

❸ 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.

Figure 5-2

ating on reduced power and shutting down the engine as soon as safety of crew and airplane permits. For example, if an engine overspeed between 106 and 109% rpm occurred during a high gross weight takeoff, it would be better to operate the engine at reduced power during climbout rather than shutting down the engine; if the engine were shut down and a go-around were necessary, sufficient power for the gross weight may not be available from the three remaining engines. If an overspeed exceeding 109% rpm occurs, the danger of complete engine failure is more imminent and the engine should be shut down as soon as practical. Engine operating 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 106-109% rpm. Overtemperatures exceeding the following table should be treated the same as an overspeed exceeding the 109% rpm condition.

A. Starting EGT

(1) In excess of 555° C for over 5 seconds

(2) In excess of 565° C for any length of time

B. Inflight EGT - In excess of 565° 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.

NOTE

The amount and time of overspeed, overtemperature and time limits exceeding those listed on figure 5-2 must be noted on Form 781.

EPR limits for the flat rated engines exist during takeoff or other high power operation. See Parts 2 and 4 of the Appendix, T.O. 1C-135(E)C-1-1 for EPR limits and temperature ranges of these limits. Ground operation at maximum power should be held to a minimum. This will forestall sonic structural damage to the airplane.

CAUTION

Prolonged engine operation at EGT and rpm limits will shorten engine life.

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.

Takeoff Rated Thrust (TRT)

Takeoff rated thrust is the highest value of thrust which the engine will deliver 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 chart in Part 2 of the Appendix, T.O. 1C-135(E)C-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(E)C-1-1.

ENGINE OIL LIMITATIONS

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 60 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 60 psi immediately following engine start when the oil is cold. Normal oil pressure for engine operation above idle is 40 to 60 psi. However, oil pressure at idle of 35 to 40 psi is acceptable after ground start and after landing. During flight, pressures between 35 to 40 psi are undesirable and should be tolerated only for the completion of the flight, preferably at reduced throttle setting.

OIL TEMPERATURE LIMITS

Following a reduction in engine thrust settings, for example after a climb, the oil temperature may exceed 132°C. Normally this condition exists only for a brief period. An oil temperature exceeding 132°C but not greater than 143°C is allowed for a maximum of 10 minutes. If the oil temperature exceeds 143°C, the engine should be shut down unless its thrust is necessary to maintain flight. Advancing the throttle will usually reduce oil temperature because of increased fuel flow through the fuel-oil cooler. If it is impossible to use a higher throttle setting or to otherwise maintain the engine oil temperature within limits, either the engine must be shut down or a landing made as soon as possible.

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

CAUTION

- Do not use the GROUND START position of the start switches at any time during flight. Starter shaft damage and overspeed can result.
- 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.
- 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.

CARTRIDGE OPERATION—CARTRIDGE 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 No. 3 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 aircraft 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.

PNEUMATIC OPERATION—BOTH STARTERS

A. Normal Starting Cycle. For normal starting, the duty cycle is 30 seconds maximum on and 60 seconds off.

B. Extended Starting Cycle. For slow starting engines, the duty cycle may be extended to 60 seconds maximum on at speeds up to starter cutout speed and 60 seconds off. The extended duty cycle may be repeated once and then a five minute cooling period must be observed between extended duty cycle starts.

C. Motoring. For motoring the engine with fuel and ignition off the duty cycle is two minutes on and five minutes off.

FUEL GRADE PROPERTIES AND LIMITS

Figure 5-3 lists recommended, alternate and emergency fuel in order of preference. Since this airplane has no provisions for heating or deicing fuel, only those fuels which contain a fuel icing inhibitor additive can be listed as recommended or alternate fuels. Only MIL-J-5624, JP-4 fuel currently contains the additive. JP-4B and Commercial Jet B may be considered as recommended fuels and kerosene types considered as alternate fuels only if icing inhibitor additive MIL-I-27686 is properly mixed with the fuel in quantities of 0.10 to

0.15% by volume. Alternate fuels in this case may be substituted for the recommended fuels and will restrict airplane operation only by their higher freeze points. These alternate fuels will not cause damage to the engines or fuel system.

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 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 a 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. A rapid rate of climb will result in increased flow of fuel vapor through the tank vent system and excessive pressure in the tank. In addition, a range penalty correction 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.

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 and Body Tanks:

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 the fuel, as indicated in above tables, is exceeded. Allow 0.5% loss of aviation gasoline on board for each 1000 feet of additional altitude.

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	LIMITS
RECOMMENDED FUEL	WIDE CUT GASOLINE TYPE	JP-4	F-40	MIL-J-5624		.802-.721	-72	
ALTERNATE FUEL	NONE APPROVED							
EMERGENCY FUEL	WIDE CUT GASOLINE TYPE FUEL	JP-4B	F-40	NONE	DERD 2486	.802-.751	-76	❺
		COMERCIAL JET B	NONE	NONE		.802-.751	-60	❷ ❸ ❺
	KEROSENE	JP-5	F-44	MIL-J-5624		.845-.788	-51	❷ ❺
		JP-5B	F-42	NONE	DERD 2488	.845-.788	-40	❷ ❺
		JP-6	NONE	MIL-J-25656B		.84-.78	-65	❷ ❺
		JP-1B	F-30	NONE	DERD 2482		-40	❷ ❺
			F-34	NONE	DERD 2494		-58	❷ ❺
			F-33	NONE			-40	❷ ❺
		COMMERCIAL JET A-1	NONE	NONE		.829-.775	-54	❷ ❸ ❺
		COMMERCIAL JET A	NONE	NONE		.829-.775	-36	❷ ❸ ❺
	AVIATION GASOLINE (AVGAS) PLUS 3% GRADE 1100 OR 1065 OIL, SPEC. MIL-L-6082	80/87	F-12	MIL-G-5572		❹ .706	-76	❶ ❺
		91/96	NONE	MIL-G-5572		❹ .709	-76	❶ ❺
		100/130	NONE	MIL-G-5572		❹ .702	-76	❶ ❺
		108/135	NONE	NONE		❹ .707	-76	❶ ❺
		115/145	F-22	MIL-G-5572		❹ .706	-76	❶ ❺

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.

❺ Avoid flying at altitudes where indicated OAT is below 0°C. If it is necessary in an emergency to fly where indicated OAT is below 0°C, retain sufficient reserve fuel in relatively warm body fuel tanks to return to above freezing conditions in case of fuel system icing. JP-4B and Commercial Jet B may be used as recommended fuels and kerosene types used as alternate fuel provided icing inhibitor additive MIL-I-27686 is properly mixed with the fuel in quantities of 0.10 to 0.15 percent by volume.

Figure 5-3

When using emergency fuels without icing inhibitor additive, be careful to avoid fuel system icing. The only sure method of doing this is to maintain fuel temperature above 0° C. In flight the fuel in the integral wing tanks cools rapidly and regardless of fuel temperature when loaded, will eventually (in 5 or 6 hours) approach the indicated outside air temperature (OAT). The OAT gage in flight indicates a temperature higher than the static free air temperature due to ram heating. The ram heating effect on the wing fuel tank temperature is much the same as it is on the OAT gage indication. When it is necessary in an emergency to fly where indicated OAT is below 0° C, sufficient reserve fuel should be retained in the relatively warm bladder-cell body tanks, where fuel cooling rate is at a minimum, to permit the airplane to return to above freezing conditions in case of fuel system icing. When using kerosene type fuels with icing inhibitor added the same precautions must be applied except the freeze point of the fuel itself is the critical temperature.

Takeoff when using aviation gasoline 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. This is not meant to imply that takeoffs should be attempted with boost pump inoperative when using JP-4 or kerosene 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 grade fuels are used.

AERODYNAMIC AND STRUCTURAL LIMITS

CAUTION

Airplanes placed on a red dash on the AFTO Form 781A, Maintenance Discrepancy and Work Document, for non-compliance with (TCTO 872) or (TCTO 989) (lower wing surface reskin program) will be flight maneuver restricted to operational load factors vs gross weight as follows:

Load Factor	Gross Weight
1.4g	Above 265,000 pounds
1.5g	210,000 to 265,000 pounds
2.0g	Below 210,000 pounds

In addition, every attempt will be made to avoid known/reported moderate to severe turbulance. If inadvertently encountered in flight, proper corrective action will be initiated. These restrictions will not apply to actual EWO operations.

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 357 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 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.

airspeed and max gross weight limitations

MAXIMUM SPEED

CONDITION	LIMITATION
CLEAN CONFIGURATION	357 KIAS AT SL 362 KIAS 10,000 FT 370 KIAS 20,000 FT 378 KIAS 26,500 FT 369 KIAS 28,000 FT IM = 0.90 ABOVE 29,500 FT
DURING LANDING GEAR EXTENSION OR RETRACTION	270 KIAS BELOW 38,000 FT IM = 0.85 ABOVE 38,000 FT
LANDING GEAR DOWN	320 KIAS BELOW 30,500 FT IM = 0.85 ABOVE 30,500 FT
WING FLAPS 50° 40° 30° 20°	180 KCAS ** 200 KCAS ** 210 KCAS ** 220 KCAS **
DURING TERRAIN LIGHT EXTENSION OR RETRACTION	270 KIAS BELOW 38,000 FT IM = 0.85 ABOVE 38,000 FT
TERRAIN LIGHT DOWN	320 KIAS BELOW 30,500 FT IM = 0.85 ABOVE 30,500 FT
BOOM STOWED SLIPWAY DOORS OPEN	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

MAXIMUM SPEED (Cont)

CONDITION	LIMITATION
HI-SPEED BOOM WITH HI-SPEED RUDDEVATORS	SAME AS CLEAN CONFIGURATION
SPEED BRAKES EXTENDED	SAME AS CLEAN CONFIGURATION
EMERGENCY GEAR EXTENSION, RETRACTION OR GEAR DOWN	SAME AS CLEAN CONFIGURATION

MAXIMUM GROSS WEIGHT*

CONDITION	LIMITATION
GROUND OPERATION	301,600 LB
BRAKE RELEASE	300,500 LB
INFLIGHT FLAPS UP	299,000 LB NORMAL 316,000 LB EMERGENCY
LANDING	297,000 LB

WARNING

Fatigue data is not available in the inflight gross weight range of 299,000 to 316,000 pounds. Therefore these conditions will not be practiced but will be used under extreme emergency conditions only.

* Also see WEIGHT LIMITATIONS, this Section.

** To obtain indicated airspeeds corresponding to the wing flap calibrated airspeed limitation, refer to Part 1 of the Appendix, T.O. 1C-135(E)C-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(E)C-1-1.

Figure 5-4

CG LIMITS

CG limits at gross weights up to 316,000 pounds are 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. The cg can be easily controlled by proper fuel 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.

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.

cg limits

DATE: FEBRUARY 1964
DATA BASIS: ESTIMATED

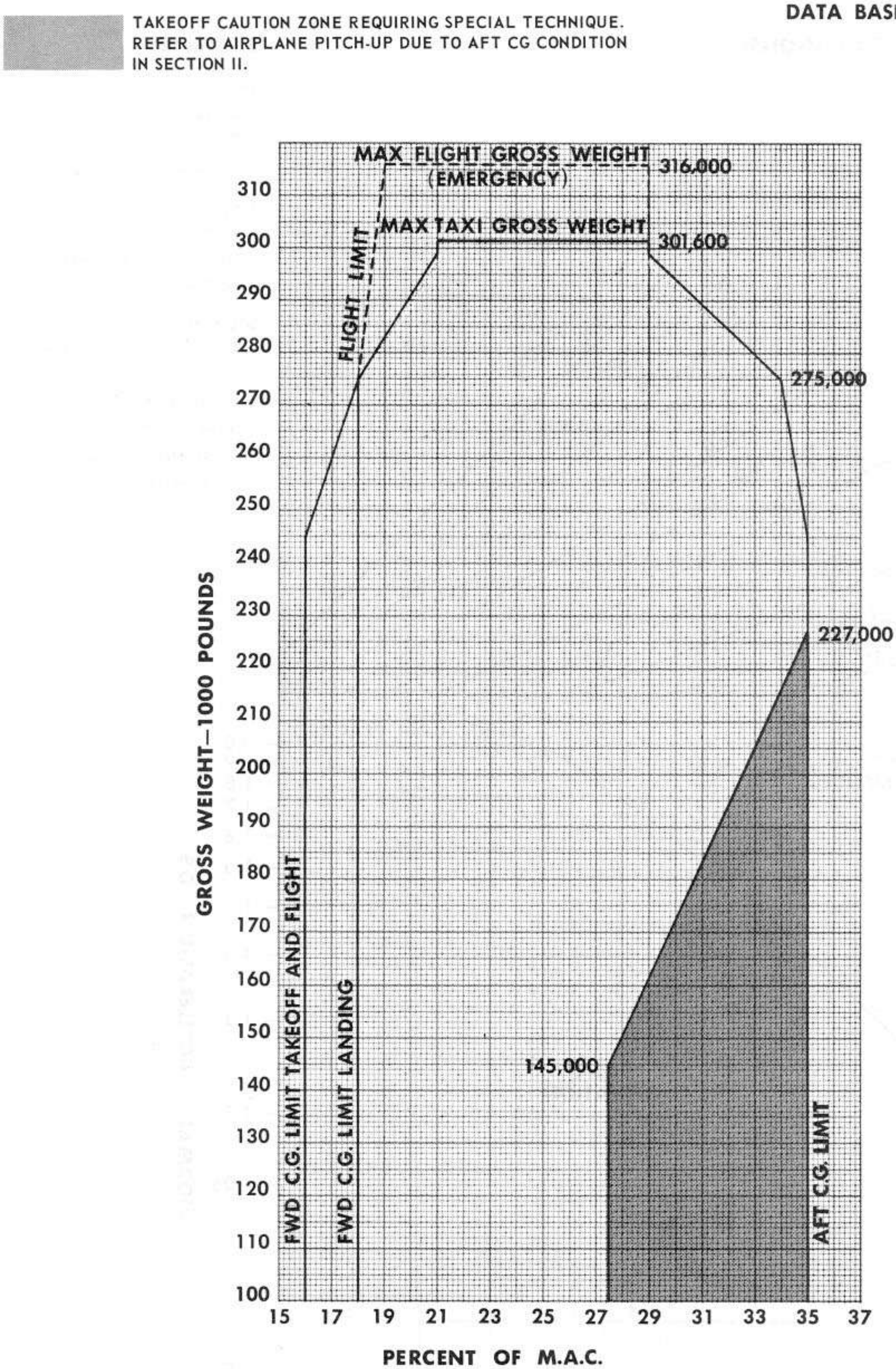


Figure 5-5

maneuver limits - flaps 30°

DATE: FEBRUARY 1964
DATA BASIS: ESTIMATED

CONDITIONS:

FLAPS 30°

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 = 1.68 g's
(b) Maximum bank angle = 53.3°
(2) Go-around speed
(a) Maximum normal accel = 1.49 g's
(b) Maximum bank angle = 48°

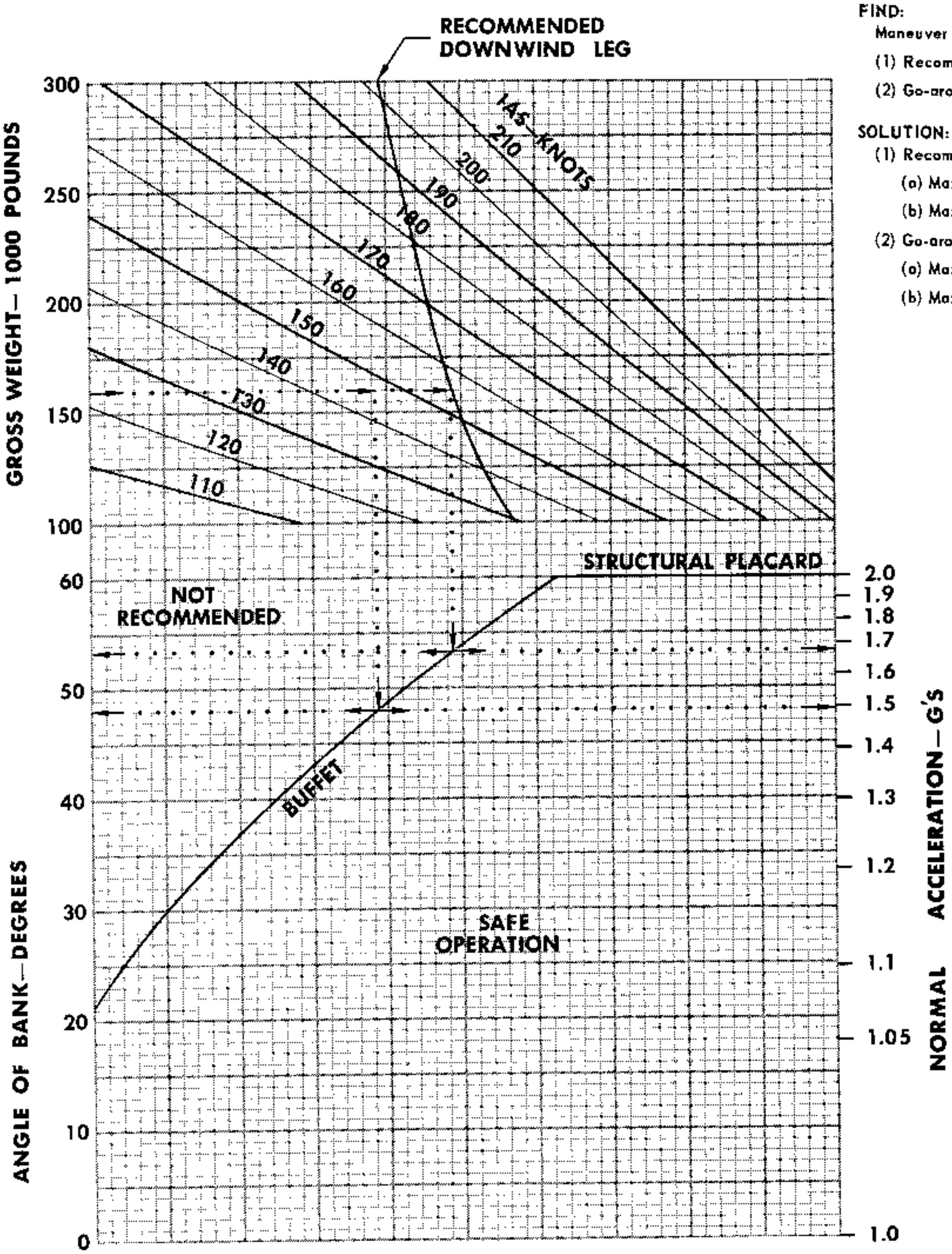


Figure 5-6

maneuver limits - flaps 50°

DATE: FEBRUARY 1964
DATA BASIS: ESTIMATED

CONDITIONS:

FLAPS 50°

SEA LEVEL TO 6000 FT

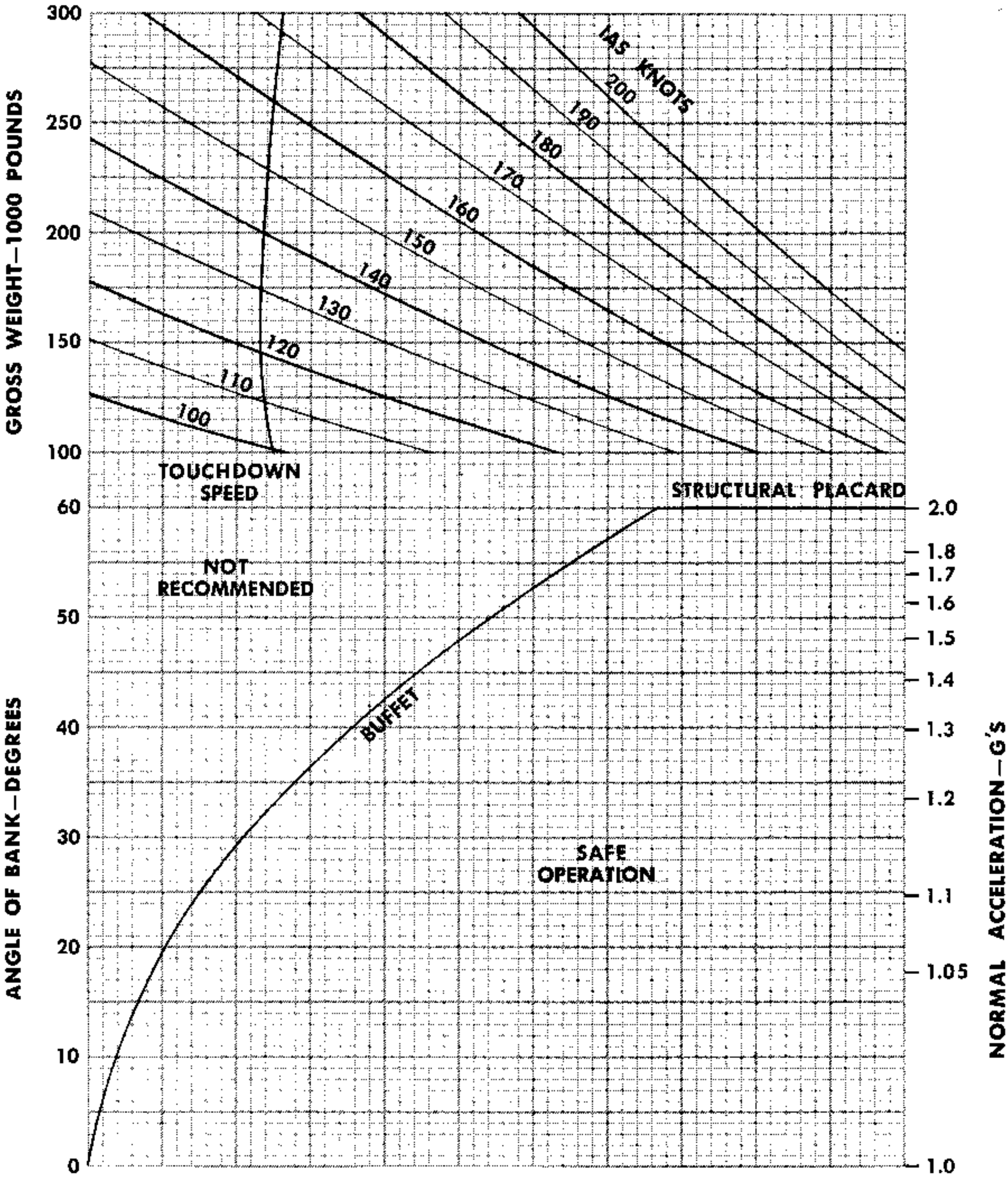


Figure 5-7

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

The airplane should be operated within the range of 0 to +2 g's. 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 pull ups 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.

EXAMPLE PROBLEM 1

LOW ALTITUDE MANEUVER LIMITS

GIVEN:

1. Gross weight = 150,000 pounds
2. Flaps 30 degrees
3. Speed entering traffic pattern = 151 KIAS
4. 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 degree angle of bank or at 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:

1. Gross weight = 180,000 pounds
2. Altitude = 42,300 feet
3. Speed = Mach 0.80

radius of turn at low altitudes

DATE: FEBRUARY 1964
DATA BASIS: FLIGHT TEST

CONDITIONS:

CONSTANT ALTITUDE TURN

NO WIND

REMARKS:

Applicable to any airplane.

Note that speeds are TAS.

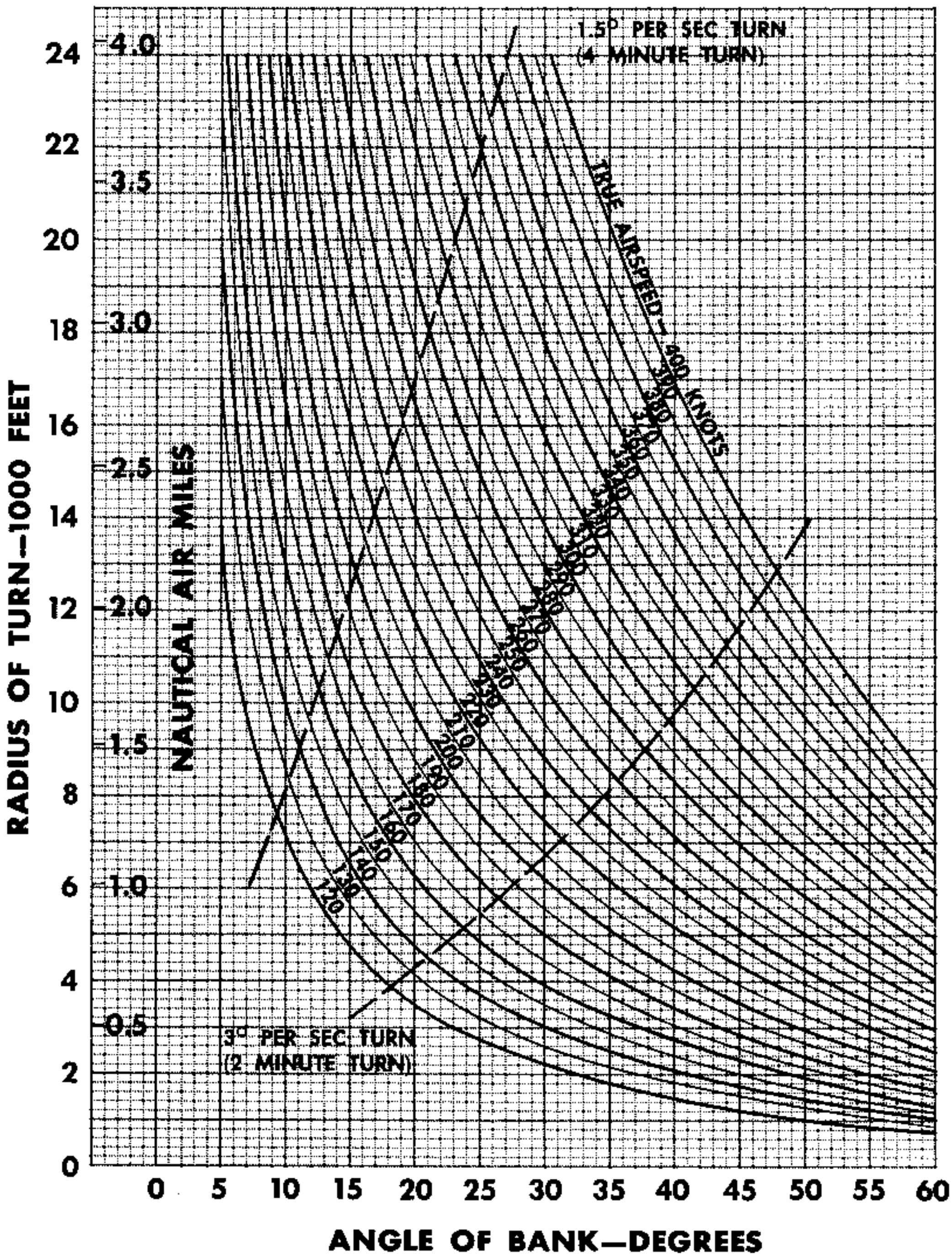


Figure 5-8

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 interrelated 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.

EQUIPMENT LIMITATIONS

APU

The APU is limited in electrical output depending on the ambient inlet air temperature. (See figure 5-13.)

APU STARTER

The duty cycle of the APU 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.

AUXILIARY COOLING SYSTEM

The auxiliary cooling system compressor is designed to operate normally up to 24,000 feet altitude. If operated above 24,000 feet, the compressor may fall off the line or unseat circuit breakers. If the compressor "falls off," it may not reset until airplane altitude is reduced to several thousand feet below the 24,000 foot level.

NOTE

If airflow through the ATC-1 switchboard is insufficient with the auxiliary cooling system OFF, the evaporator fans may be operated with the ATC-1 switchboard cooling doors open to augment the switchboard blowers.

NAVIGATION AND COMMUNICATIONS EQUIPMENT

The 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.

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.

Taxi 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.

Terrain Light

To avoid structural damage, the terrain light should not be extended at airspeeds higher than those shown in figure 5-4.

initial buffet in one-g flight

CONDITIONS:
CLEAN CONFIGURATION

DATE: FEBRUARY 1964
DATA BASIS: ESTIMATED

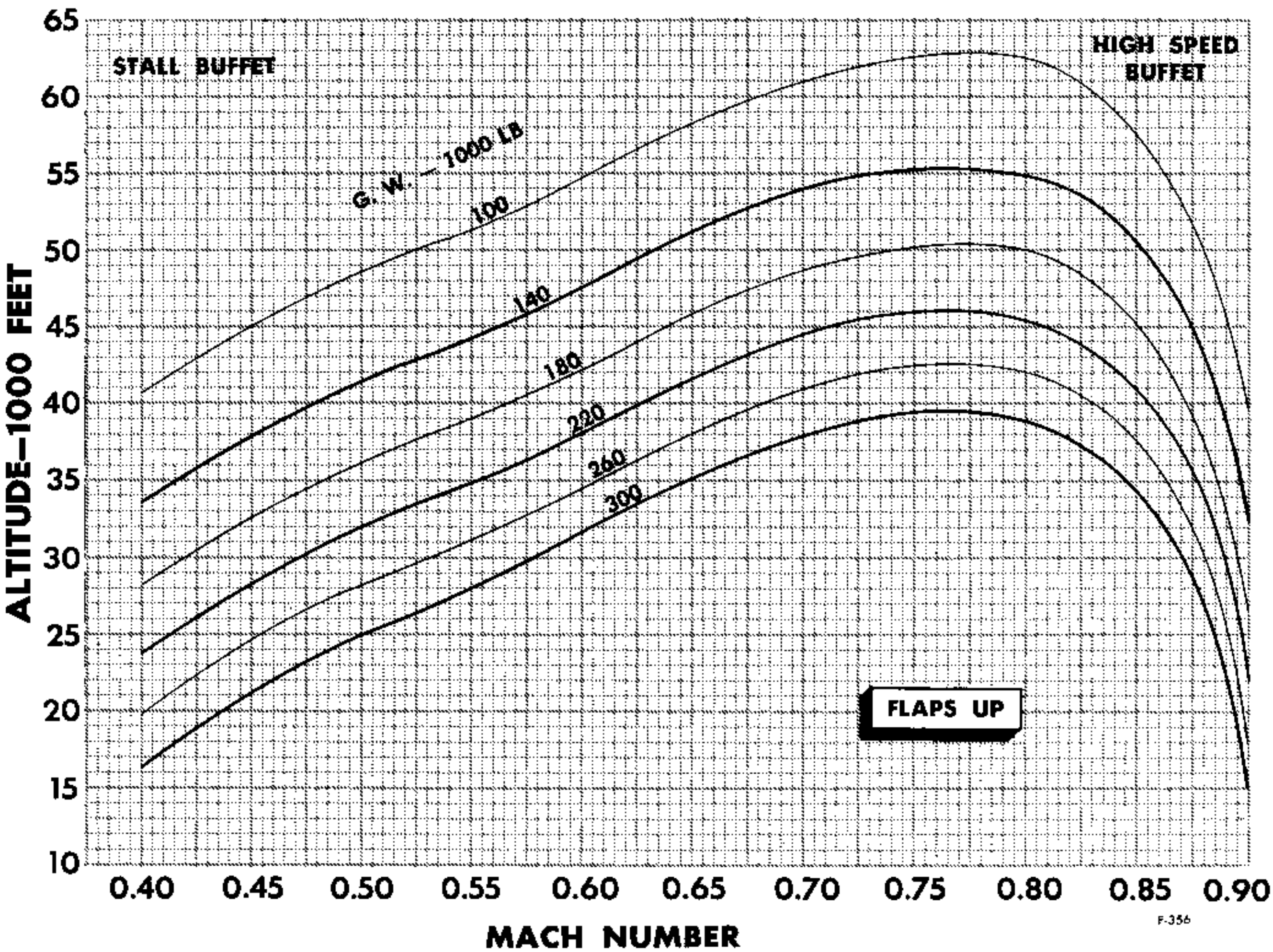


Figure 5-9

normal acceleration at initial buffet

DATE: FEBRUARY 1964
DATA BASIS: ESTIMATED

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

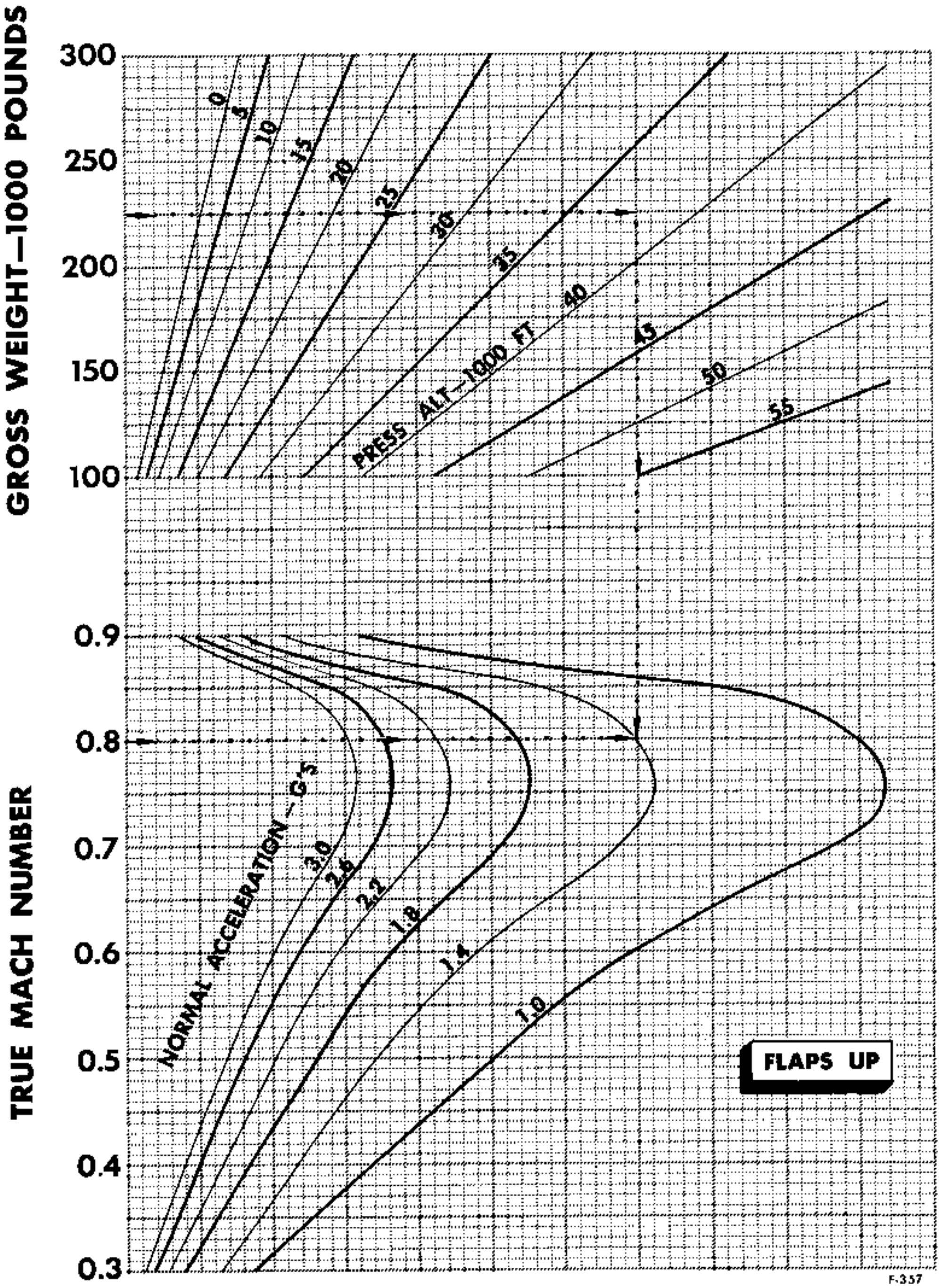


Figure 5-10

radius of turn at high altitudes

DATE: FEBRUARY 1964
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

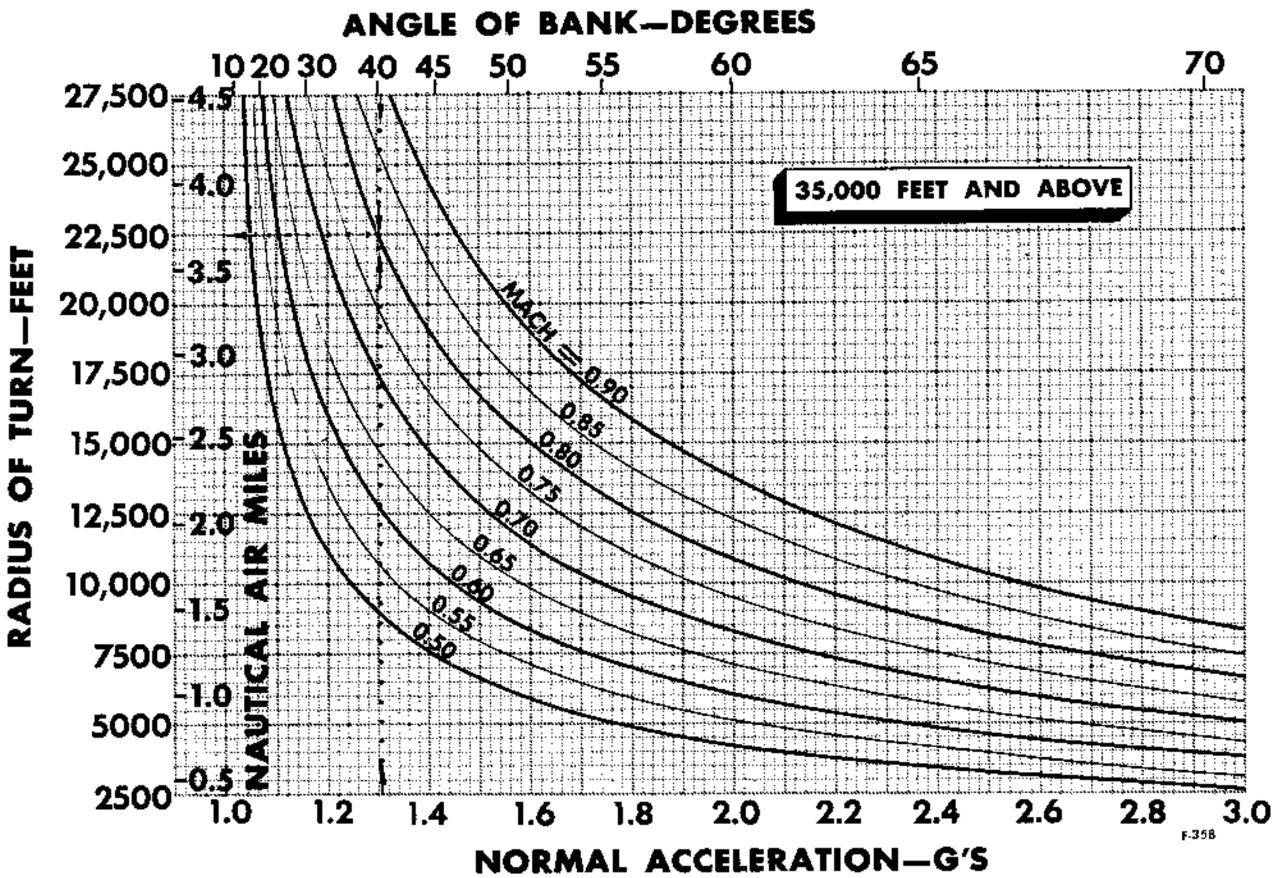


Figure 5-11

turn rate at high altitudes

DATE: FEBRUARY 1964
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

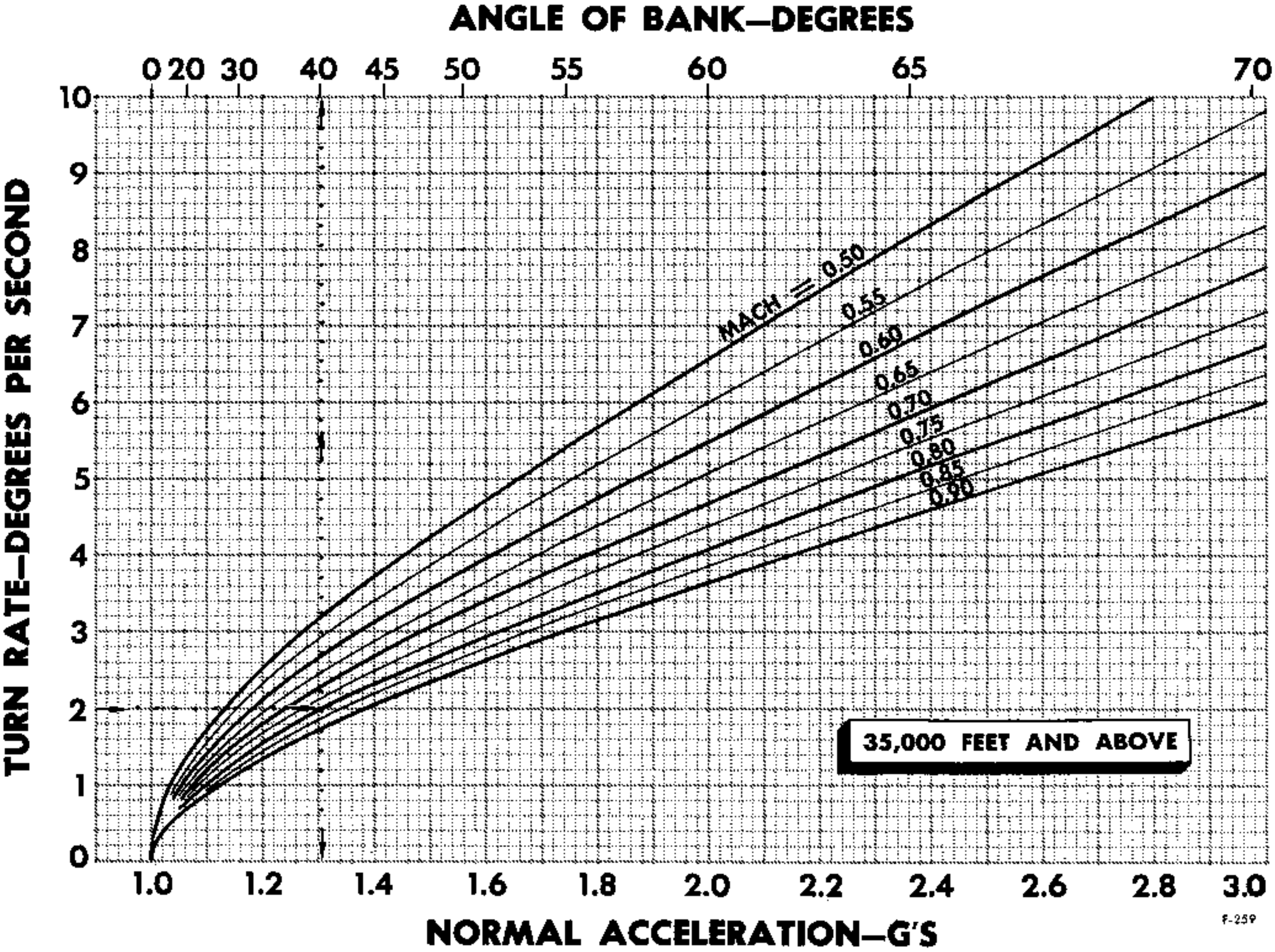
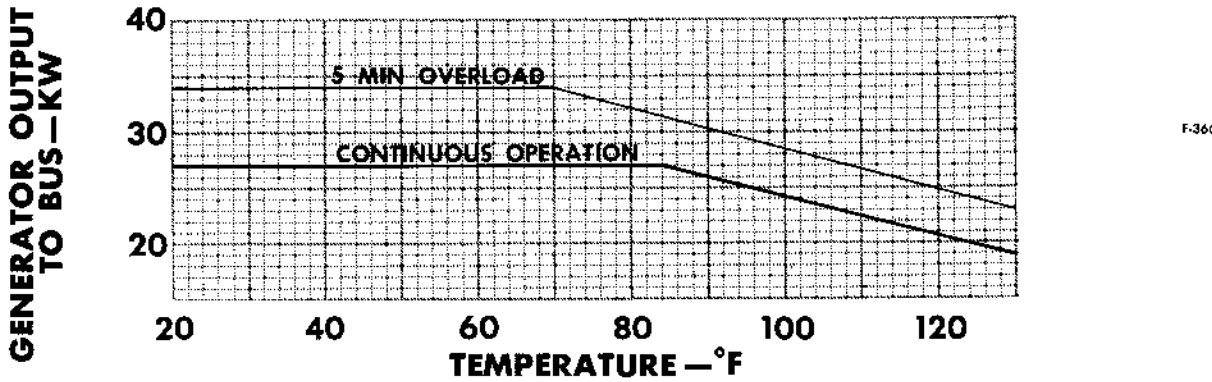


Figure 5-12

apu operating limits

DATE: FEBRUARY 1964
DATA BASIS: ESTIMATED



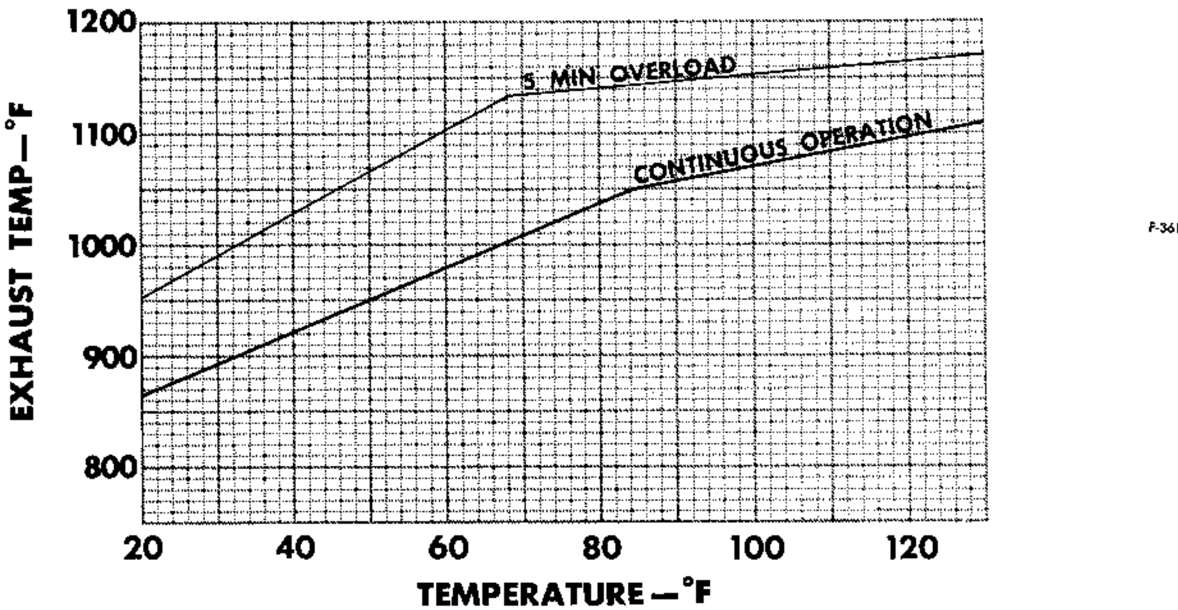


Figure 5-13

Nacelle Illumination Lights

During ground operation of the nacelle illumination lights, try to avoid light operation of more than 15 minutes to prevent distortation of the pressure windows covering the lights.

OXYGEN REGULATOR

The D-2A, CRU-21/A, CRU-52/A, CRU-68/A, and CRU-69 oxygen regulators are 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 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, eg. $\left(\frac{1420 \text{ pounds}}{250 \text{ pounds/man}} = 5.68 \text{ g's}\right)$.

Seats 19 and 20 face forward and do not have shoulder harnesses.

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

The tires are limited to a maximum ground speed of 195 knots and have "195 KNOTS" molded in the sidewall on both sides of the tire. The "195 KNOTS" refers to airplane ground speed; however, the pilot has only the airspeed indicator for speed reference. When the airspeed indicator is corrected for position error, the 195 knots ground speed becomes 199 knots IAS for standard day conditions. Airplane speeds during ground operation shall be limited to 199 knots IAS for standard day conditions. Refer to the TAKEOFF SPEEDS chart in Part 2 or the TOUCHDOWN SPEEDS chart in Part 9 of the Appendix, T.O. 1C-135(E)C-1-1, for corrections to IAS for 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). Refer to 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.

The 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 22 million foot-pounds kinetic energy per brake. 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 20 million foot-pounds or more.

ENERGY ABSORBED DURING TAXI

During light weight operation, some energy will be absorbed by the brakes during taxi because the high idle thrust of the fan engines will cause excessive taxi speeds unless braking is accomplished. At 200,000 lbs or less, as much as 1.5 million foot pounds of energy per mile of taxi can be absorbed by each brake. This energy should be added to that determined from fig. 5-14 to obtain the total energy absorbed by the brakes for a refused takeoff or landing. For higher gross weights little or no brake action should be required during taxi so this effect may be neglected.

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, sheet 1, gives the foot-pounds of kinetic energy required to stop under variables of gross weight, airspeed, pressure altitude, runway OAT and wind. 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. If this, plus the energy absorbed during taxi, does not exceed 6 million foot-pounds per brake another takeoff may be attempted immediately.

NOTE

If low energy stops and associated taxi produce no more than 6 million foot-pounds, the brakes may get hot but the heat will be dissipated more rapidly than it can accumulate between flights. This does not include making a rapid series of such stops in the course of taxiing the airplane.

If the amount of 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 excess of 6 million foot-pounds. When the mission requires 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 two 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; if this 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 Taffeoffs or Braked Landings

Any braking effort between 20 and 28 million foot-pounds 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 28 million foot-pounds will possibly cause damage to the brakes and tire explosion or fire. Braking efforts significantly above 35 million foot-pounds 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.

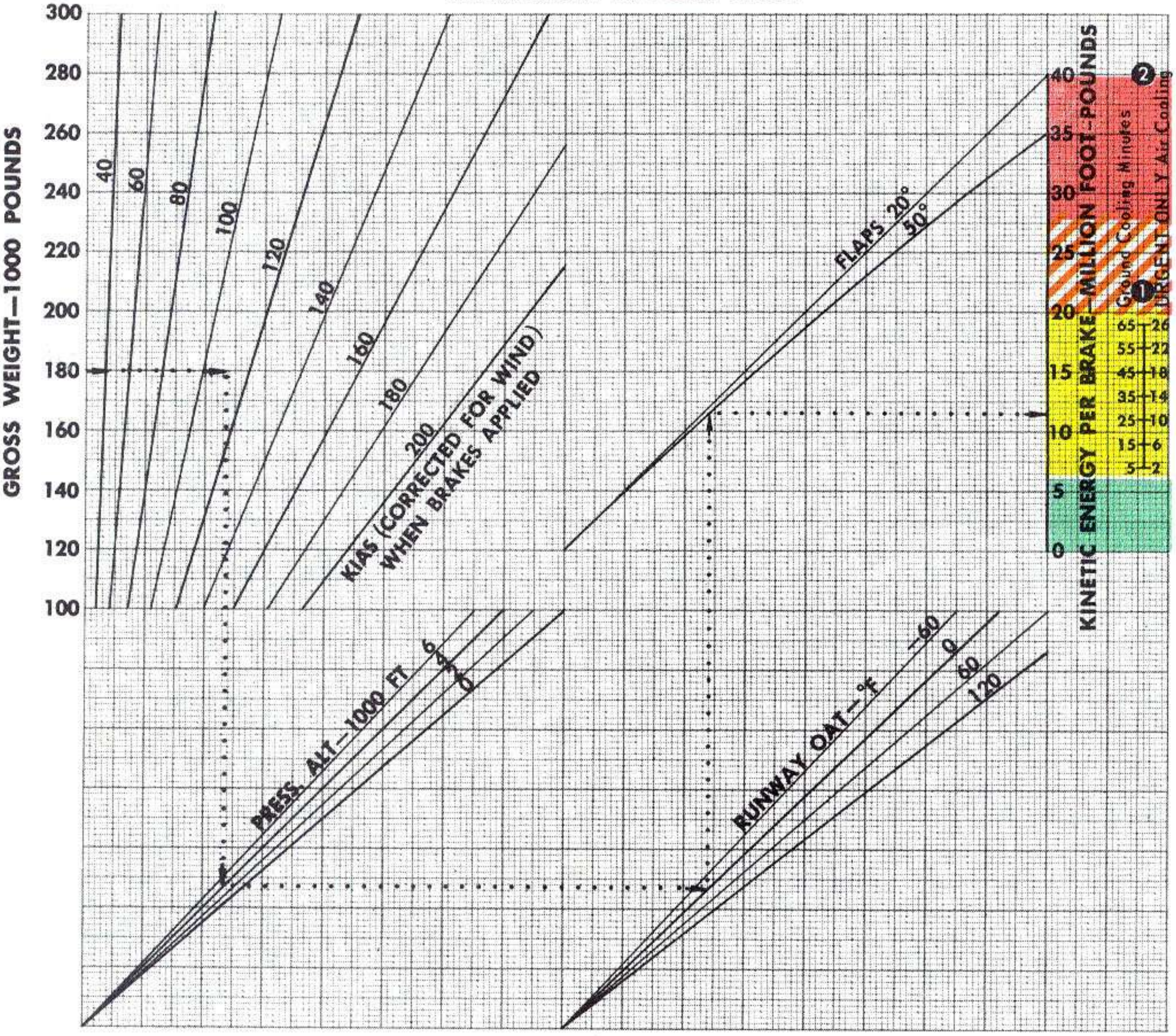
LANDING ROLLOUT STOP

The landing rollout stop is the normal landing. Figure 5-14, sheet 2, gives foot-pounds of kinetic energy required to stop under variables of pressure altitude,

brake limits

DATE: FEBRUARY 1966
DATA BASIS: FLIGHT TEST

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(E)C-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.

Figure 5-14 (Sheet 1 of 2)

NORMAL ZONE - 0 TO 6 MILLION FT-LB

If stop does not exceed 6 million ft-lbs no special procedure is required.

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.

LANDING ROLLOUT STOP

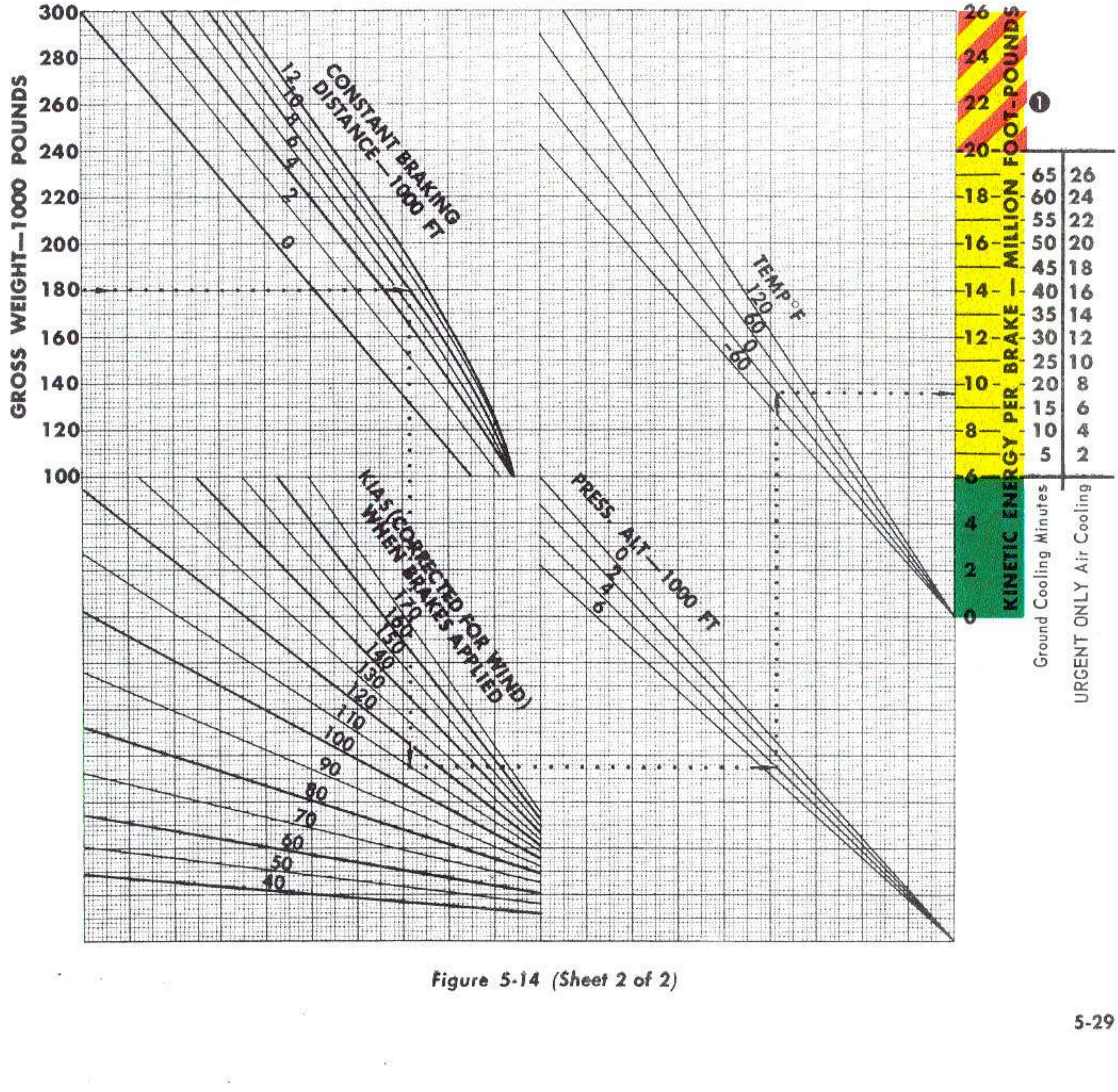


Figure 5-14 (Sheet 2 of 2)

runway OAT, airspeed and gross weight. The limitations on brake energy are the same as for maximum effort stops.

CAUTION

If antiskid cycling occurs during the landing rollout, you are braking too hard; therefore, kinetic energy generated must be determined from the maximum effort stop chart (figure 5-14, sheet 1).

For the correct braking technique in making a landing rollout stop, refer to BRAKE SYSTEM OPERATION in Section VII.

EXAMPLE PROBLEM

GIVEN:

1. Full stop landing (flaps 50 degrees)
2. Gross weight = 180,000 pounds
3. Airspeed when brakes applied = 115 KIAS
4. Reported wind = 10 knot headwind
5. Pressure altitude = 4000 ft
6. Runway OAT = 0°F

FIND:

1. Compare maximum effort stop with landing rollout stop = 8000 ft.

SOLUTION.

1. Following example line on sheet 1, max effort K.E. per brake = 11.5 million foot-pounds. (11.5 - 6) x 5 = 27.5 minutes ground cooling recommended.
2. Following example line on sheet 2, rollout stop K.E. per brake = 9.6 million foot-pounds. (9.6 - 6) x 5 = 18 minutes ground cooling recommended.

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. 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(E)C-1-1.

WARNING

Maximum taxi gross weight is 301,600 pounds. During air refueling (receiver), do not exceed the maximum inflight gross weight limits; see figure 5-4.

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.

WEIGHT LIMITATIONS CHART

The weight limitations chart 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 wing tanks versus the amount of fuel carried in the body tanks. The body tank fuel is regarded as payload in the tanker configuration. Various components of the charts are explained in the following paragraphs.

Body Fuel (Payload)

The body fuel capacity is shown on the horizontal axis of the chart. The body fuel must not exceed 72,150 pounds. A graph adjacent to the body fuel axis of the chart is provided to adjust the operating weights from 120,000 to 140,000 pounds.

Operating Weight

The operating weight range is shown at the top of the chart. 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, crew equipment and oil capacity. Since airplanes vary in operating weight, it will be necessary to determine the operating weight of an individual airplane before using the chart. After the operating weight has been determined, enter at the top of the chart with the body fuel weight and follow the diagonal guide lines to the operating weight of the individual airplane.

Gross Weight

The diagonal gross weight lines are for use in interpolating gross weight with various wing fuel and body fuel combinations. The vertical line on the left of the chart is a limit line beyond which any intersection of body fuel and operating weight should not pass. This vertical line ensures that the maximum taxi weight of 301,600 pounds will not be exceeded. The horizontal line at the bottom of the chart indicates the maximum wing fuel capacity.

EXAMPLE PROBLEM

To demonstrate use of the weight limitations chart, assume 30,000 pounds of body fuel is required to be carried for a tanker mission, and the airplane operating weight is 135,000 pounds. Enter the top of the chart (figure 5-15) at 30,000 pounds of body fuel and follow the diagonal guide line until it intersects with the airplane operating weight of 135,000 pounds. Project vertically down to the start of the gross weight diagonal lines and it will be noticed that the airplane weight less wing fuel is 165,000 pounds. Continue to project vertically down until the horizontal line at the bottom of the chart is reached. This ensures that full wing fuel of 109,500 pounds has been added. The airplane gross weight reads 274,500 pounds.

Should a maximum taxi weight of 301,600 pounds be required, project a horizontal line from the operating weight until it intersects the vertical line on the left of the chart. The point of intersection will give the maximum body fuel for the operating weight being considered. The addition of maximum wing fuel will give the maximum taxi weight.

If it is required to fly a mission without body fuel, project a horizontal line from the operating weight until it intersects the diagonal body fuel line marked zero; then project vertically down until the required amount of wing fuel is reached.

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 also covered in Sections VII and VIII.

CAUTION

- Reserve tank transfer shall not be initiated at inflight gross weight in excess of 293,000 pounds. Since flight with empty reserve tanks has an adverse effect on wing fatigue life, they should be kept full as long as practicable.
- The main wing and reserve tanks shall remain full at inflight gross weights above 301,600 pounds.
- Do not exceed a fuel load of more than 32,700 pounds in the forward body tank and 39,450 pounds in the aft body tank. In an emergency, the aft body tank may be filled to capacity provided the cg limits are not exceeded.

Load Factor

The airplane sturcture 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 maneuver load factor for this airplane is 2.0g and is the load factor above which permanent set can possibly occur. 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. This allowable load factor varies with gross weight. 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.

LANDING WEIGHT

The airplane may be landed at any weight up to a maximum of 297,000 pounds 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. Even 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. For example, if the landing gross weight is 150,000 pounds, the limit contact sinking speed is approximately 600 fpm; if the landing gross weight is 280,000 pounds, the limit contact sinking speed is approximately 440 fpm. 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 this airplane, the weight is 200,000 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 exceeded, or failure to reach charted EPR setting at full throttle

E. Engine surge or stall

F. Taxi turn made away from flat outboard rear tire at weights in excess of 250,000 pounds

G. Elevator forces in excess of 100 pounds

H. Braking limits exceeded

I. Excessive trim required

J. Any system or component defect or malfunction

K. When any hydraulic subsystem is operated with hydraulic fluid quantity at two (2) gallons or less (To be serviced IAW T.O. 1C-135(K)A-2-3, Section VIII)

L. Hydraulic pump isolation time

M. Brute force disconnect/boom mechanical stop exceeded/boom exceeded 20 degrees azimuth

N. Portable oxygen bottles observed to have less than 50 psi pressure; to be purged prior to recharging per 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

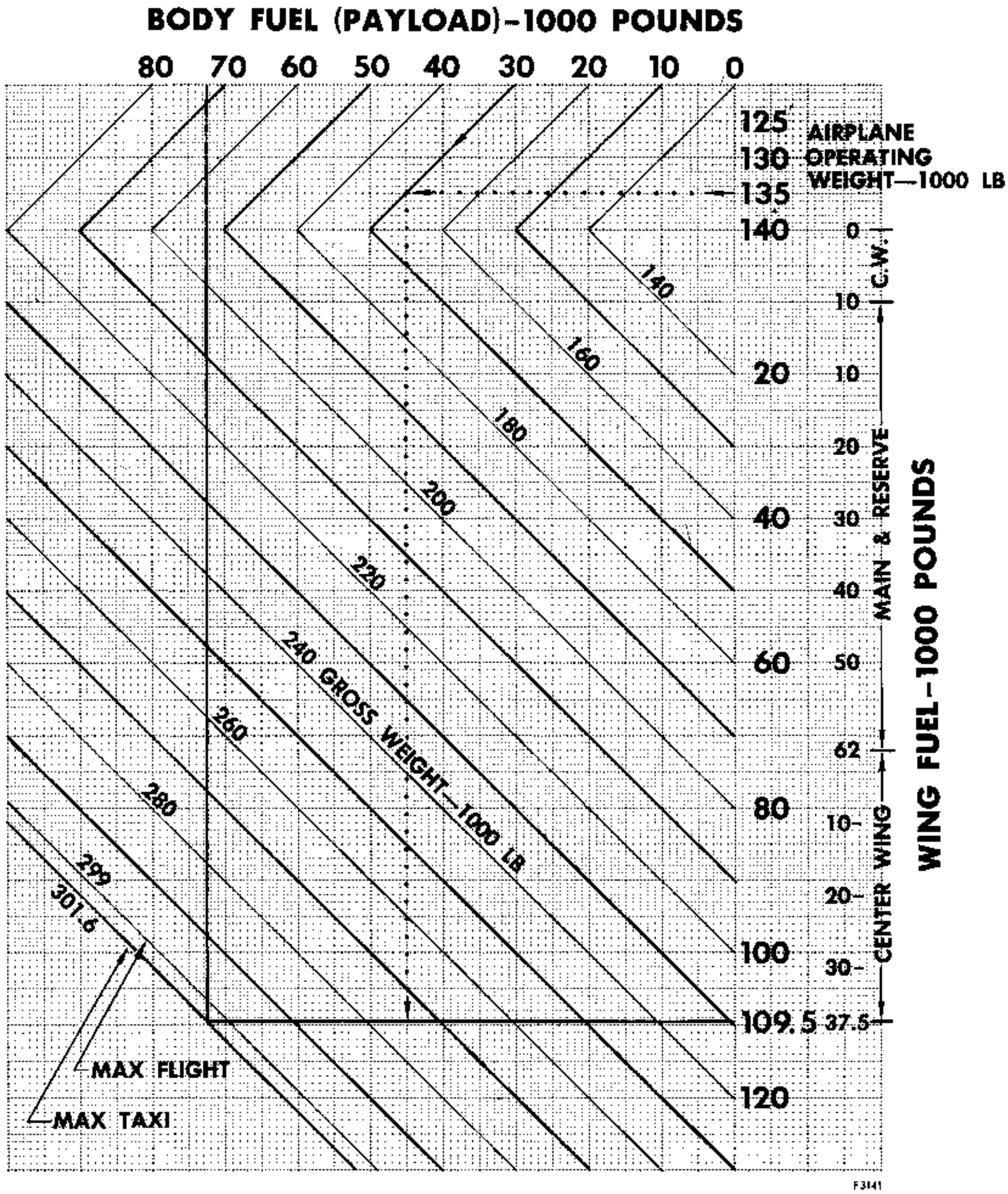
B. Overrotation or Control Force Lightening during Takeoff

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.

weight limitations



NOTE

SEE TEXT FOR EXAMPLE PROBLEM

Figure 5-15

section VI

FLIGHT CHARACTERISTICS

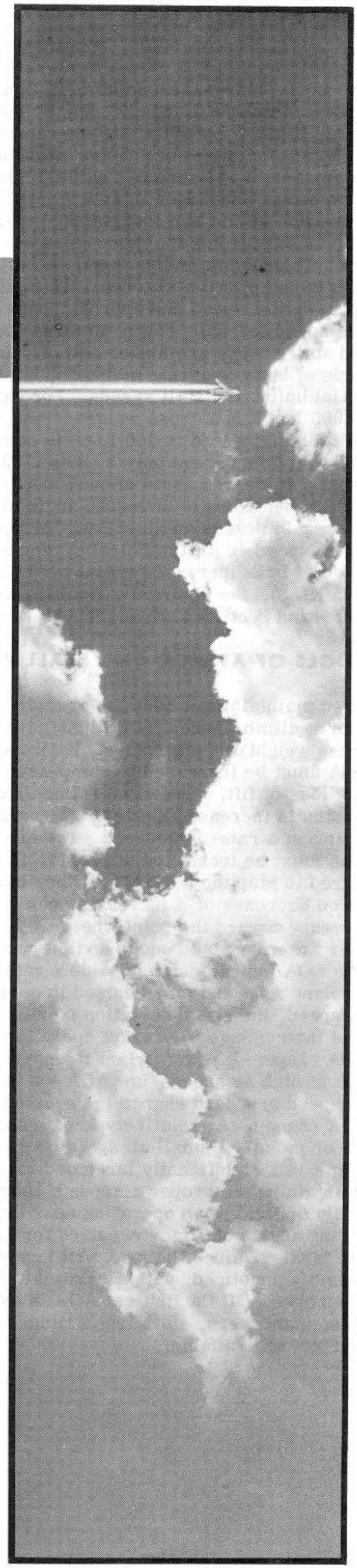


TABLE OF CONTENTS

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 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 to .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.

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. Insure 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 maneuvers, 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 estab lished. 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 crew members 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

initial buffet speeds
(minimum usable flying speeds)

DATE: FEBRUARY 1966

DATA BASIS: FLIGHT TEST

CONDITIONS:

LEADING EDGE FLAPS EXTENDED

NO GROUND EFFECT

SEA LEVEL TO 10,000 FT ALTITUDE

NOTE

REFER TO TEXT FOR DISCUSSION OF STALL WARNING.

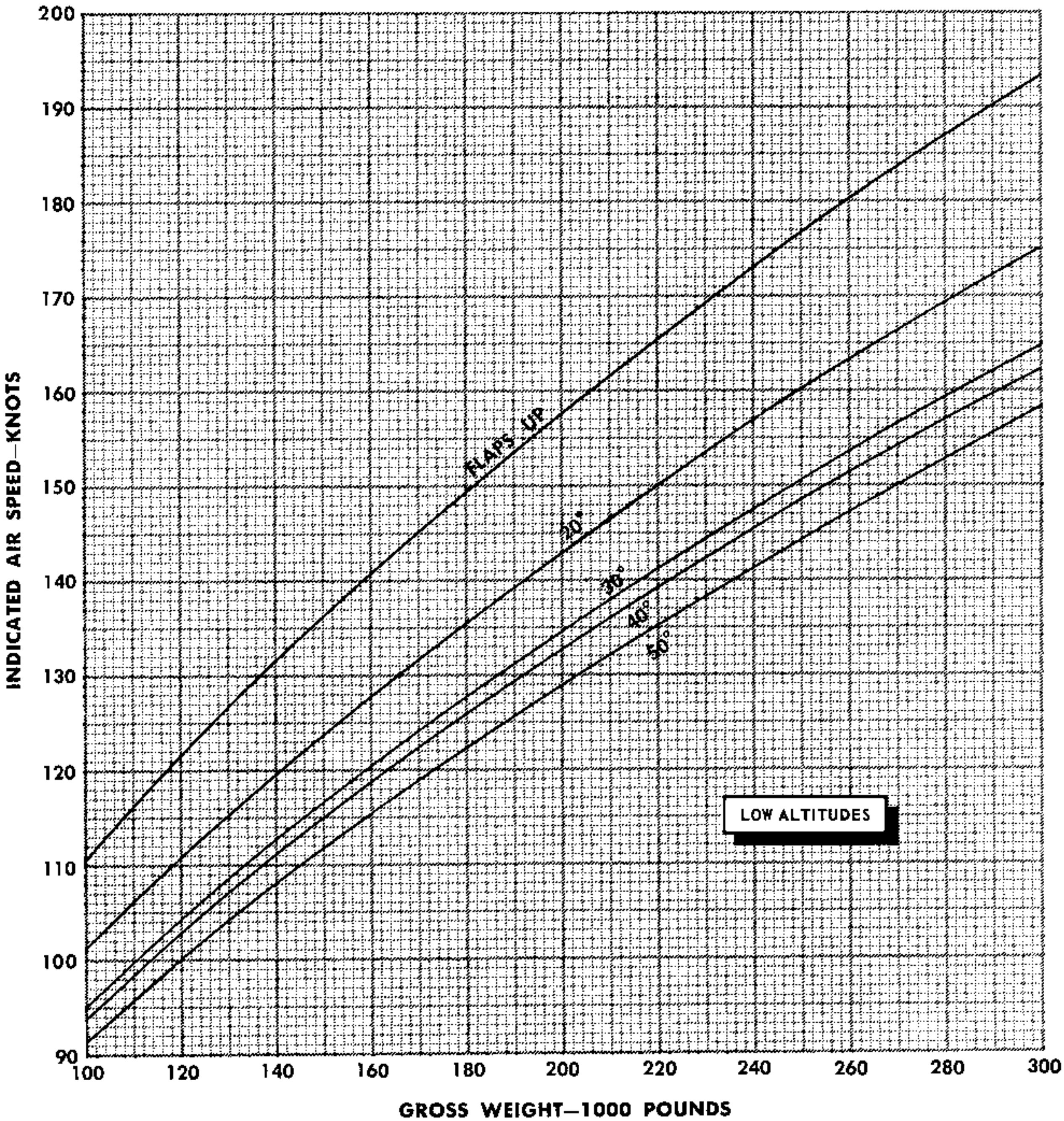


Figure 6-1 (Sheet 1 of 3)

CONDITIONS:

LEADING EDGE FLAPS NOT EXTENDED

NO GROUND EFFECT

SEA LEVEL TO 10,000 FT ALTITUDE

NOTE

REFER TO TEXT FOR DISCUSSION OF STALL WARNING.

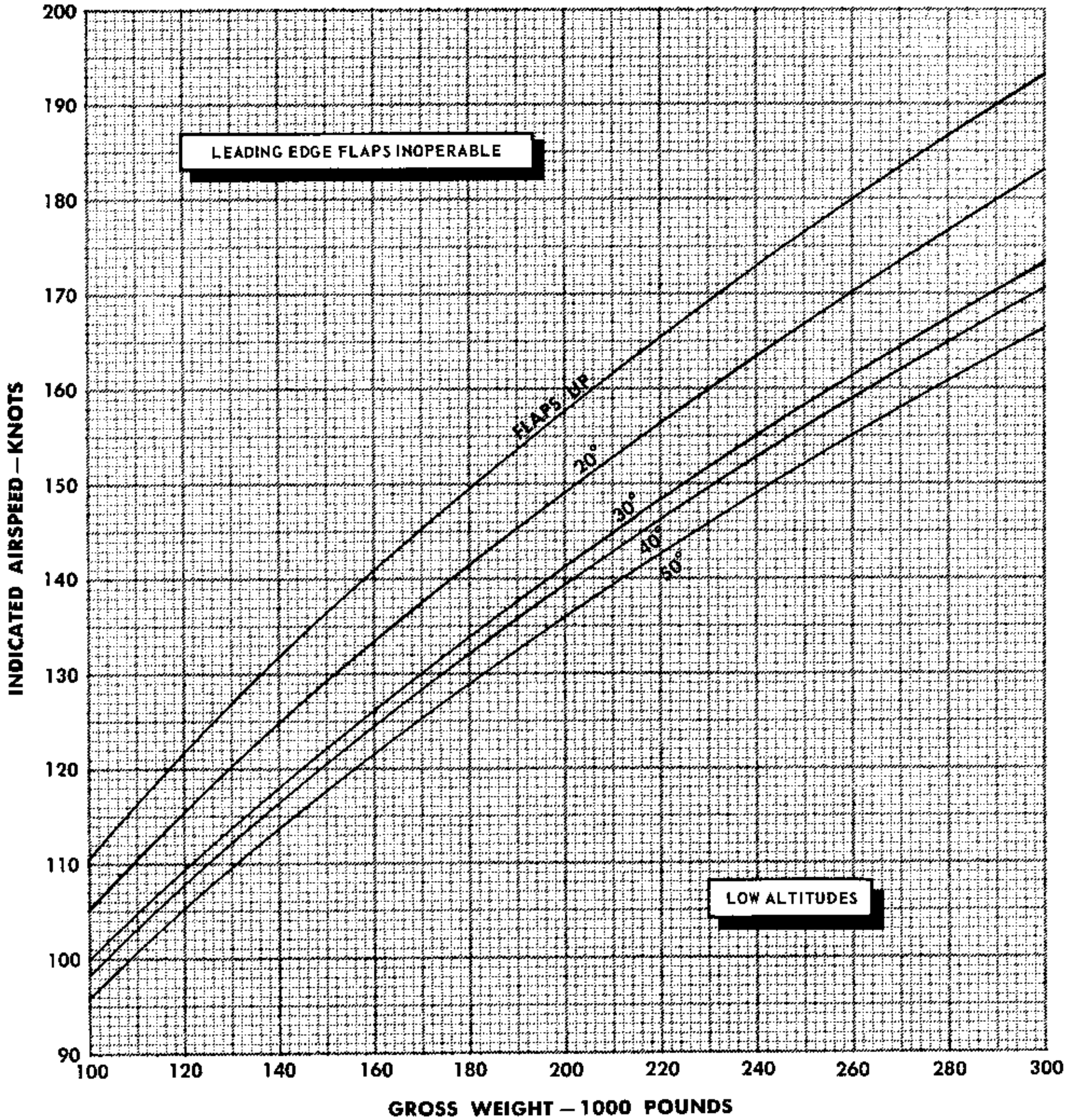


Figure 6-1 (Sheet 2 of 3)

initial buffet speeds (minimum usable flying speeds) (cont)

DATE: FEBRUARY 1966
DATA BASIS: ESTIMATED

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

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

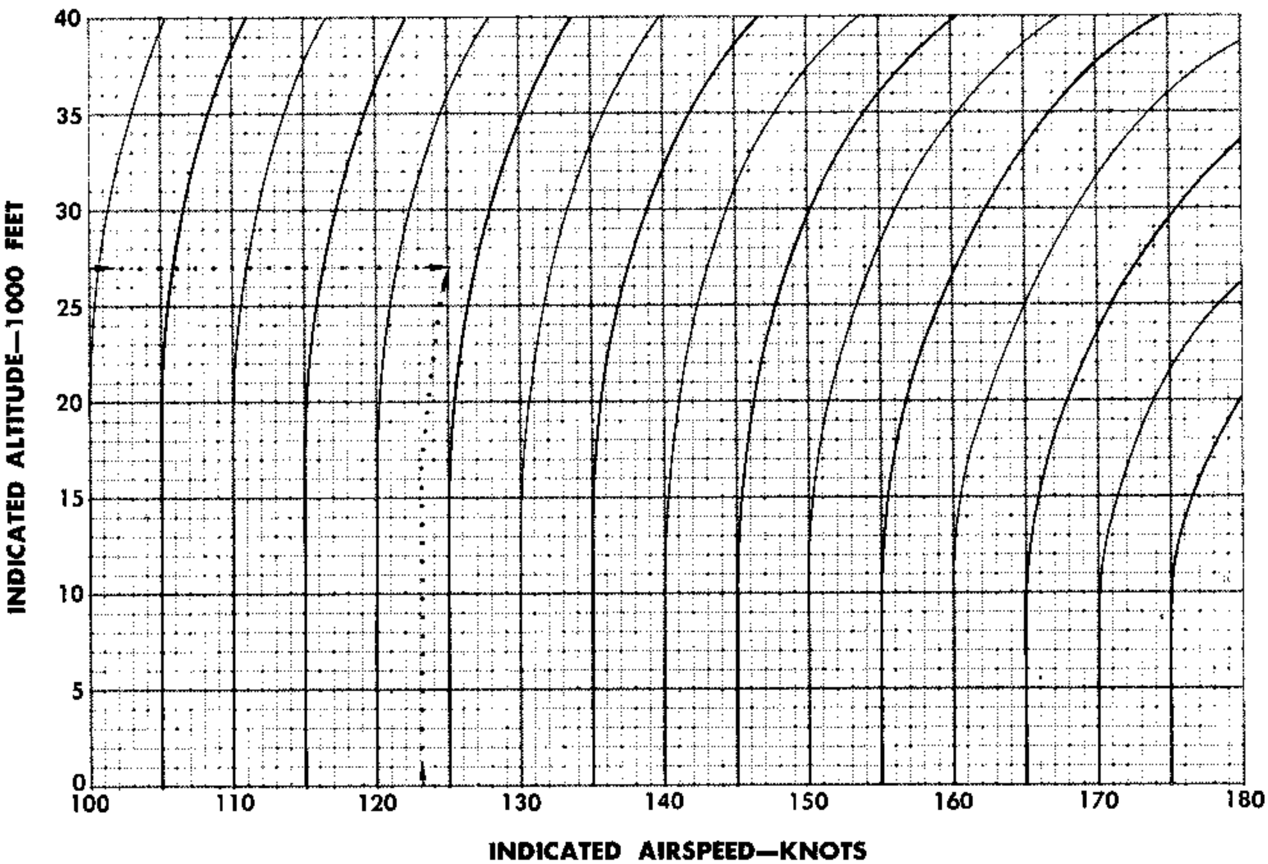


Figure 6-1 **(Sheet 3 of 3)**

will reduce speed buildup during dive recovery after spin rotation stops. In a developed spin, the indicated airspeed is unreliable.

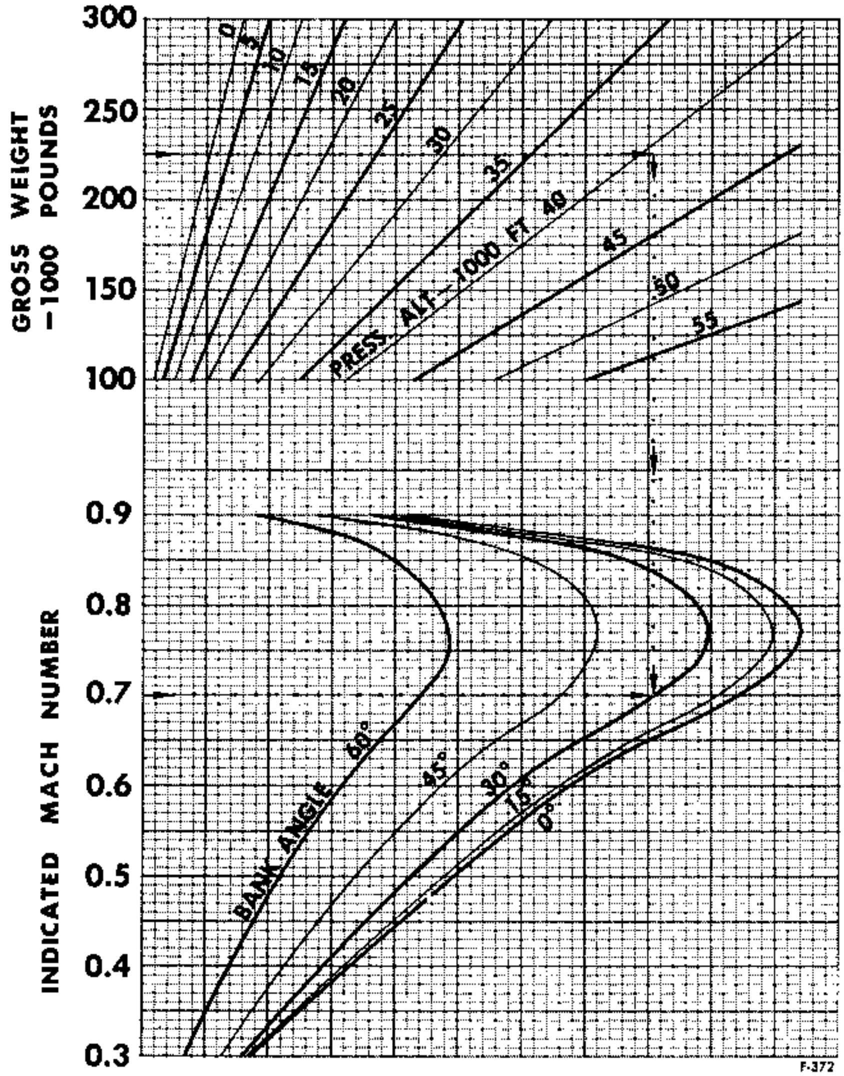
STANDARD SPINS

Intentional spins are prohibited. In case an inadvertent 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, apply 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.

bank angle at initial buffet

DATE: FEBRUARY 1964

DATA BASIS: FLIGHT TEST



NOTE

INDICATED AIRSPEED IS DETERMINED USING PART I OF THE APPENDIX, T.O. 1C-135(E)C-1-1

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

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.

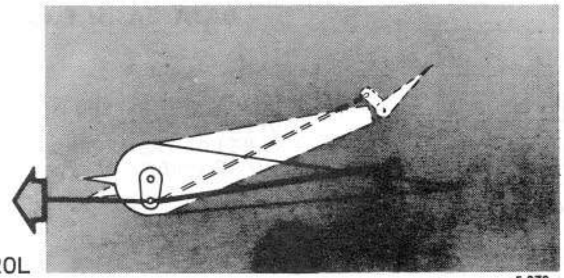
INVERTED SPINS

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.

tab follow-up



ANTI-BALANCE ACTION
(PILOT CONTROL FIXED)
FOLLOW-UP RATIO = + 1.0

Figure 6-3

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.

FLIGHT CONTROL CHARACTERISTICS

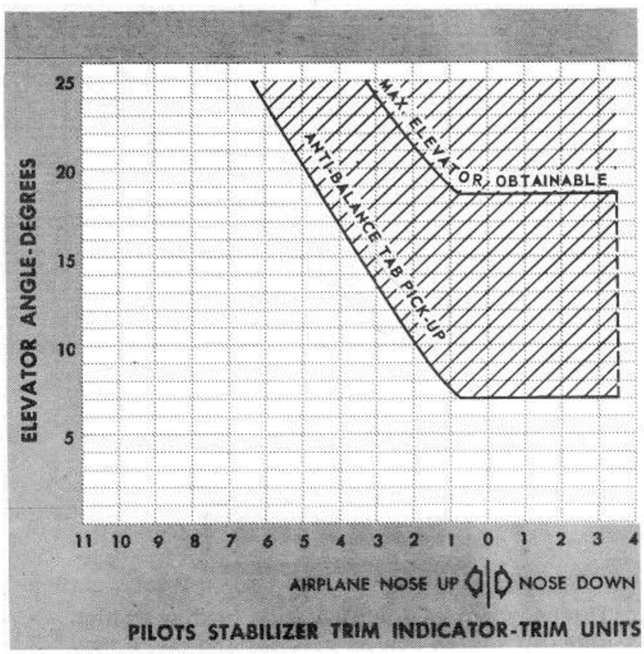
STABILIZER AND ELEVATOR

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 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.

antibalance tab operating envelope



ANTI-BALANCE REGION, MAXIMUM ELEVATOR TRAVEL LIMITED

Figure 6-4 F-177

pitch control systems

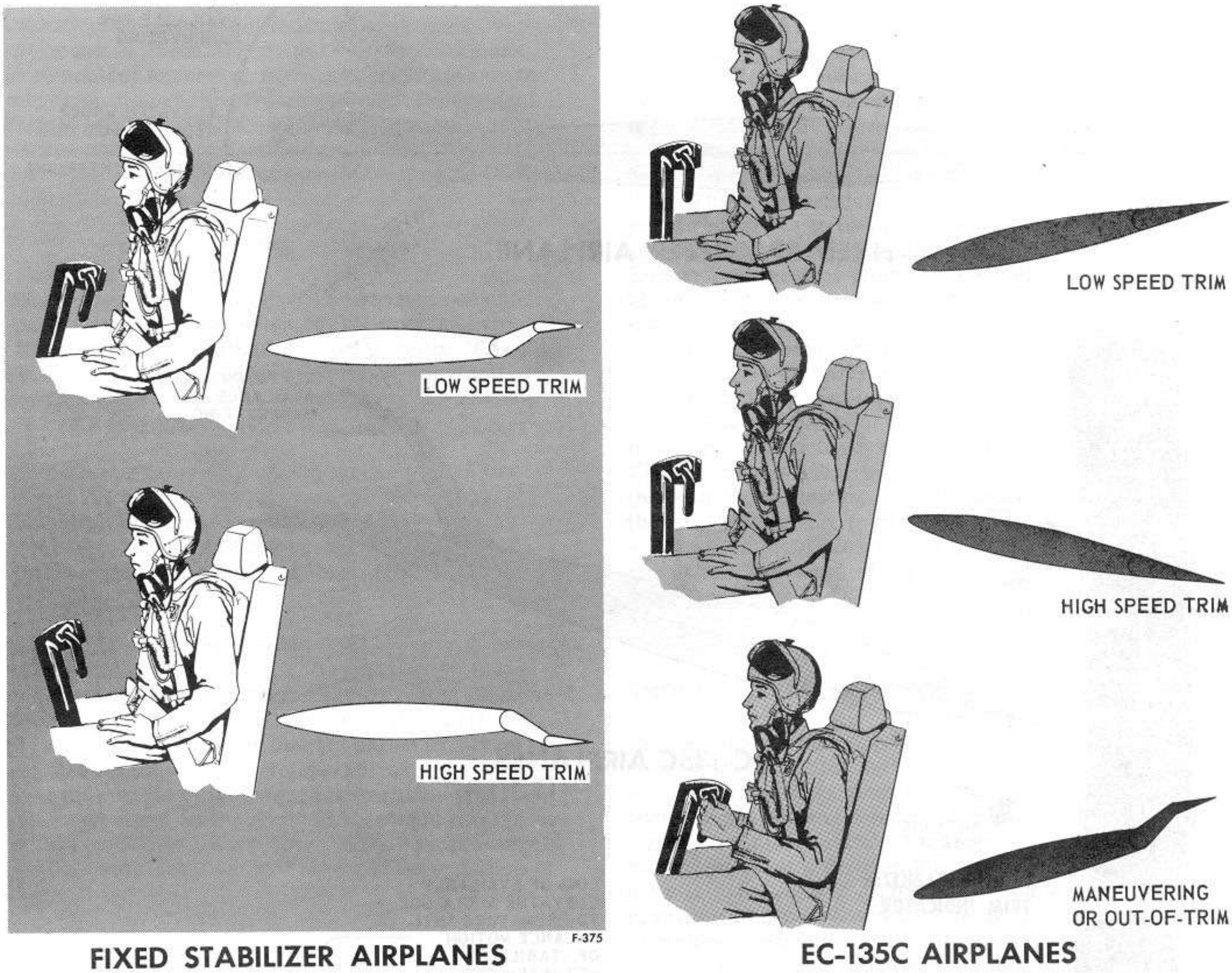


Figure 6-5

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.

effect of stabilizer mistrim

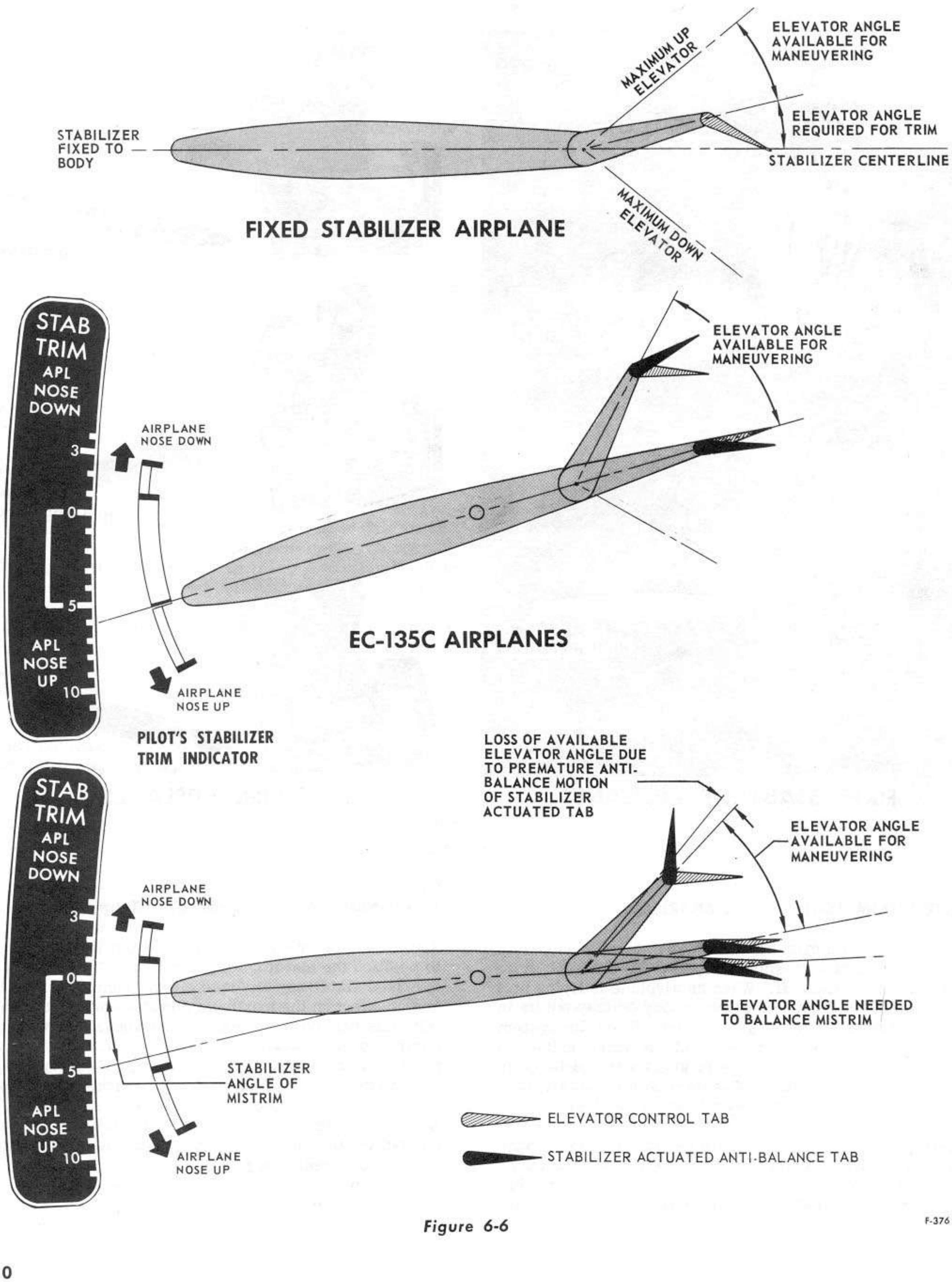


Figure 6-6

Movable Stabilizer

This airplane has a wide range of operational speeds and cg's; therefore, a movable stabilizer is necessary for the increased trim capability. 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 antibalance 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 antibalance 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.

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 super imposed 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 blowdown angles

DATE: FEBRUARY 1964
DATA BASIS: ESTIMATED

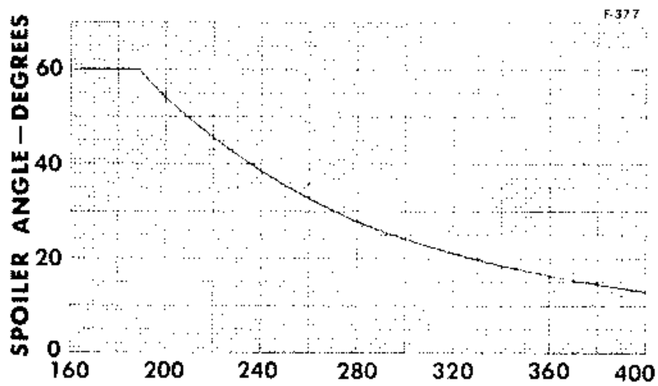


Figure 6-7

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. In-flight 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.

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%.

POWERED RUDDER

The hydraulically powered rudder is effective throughout the speed range of the airplane. At speeds below 250 ± 10 KIAS, hydraulic fluid at 3050 psi is routed to the rudder actuator; above 250 ± 10 KIAS the hydraulic pressure is reduced to approximately 1025 psi. 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 1-42.) 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 6-8 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

In the event that 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

In the event that rudder power is turned ON while pedal force is being applied, the sudden reduction in force required leads to a rapid overcontrolling motion (hardover) of the pedals. Hardover is the reverse situation of false rudder lock.

Pedal Kickback

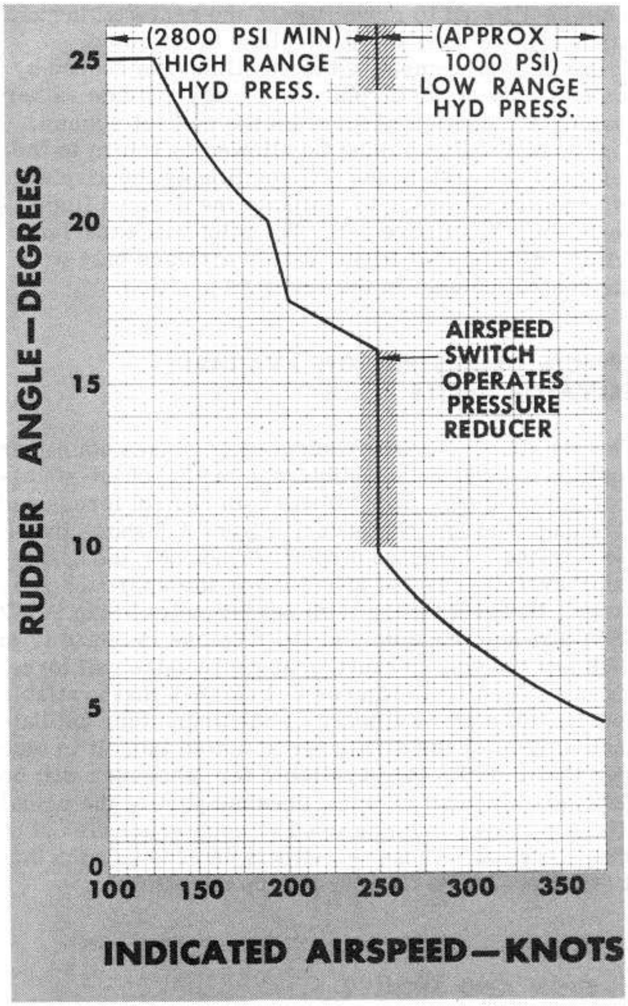
Pedal kickback can occur any time the autopilot is engaged or disengaged or the rudder is changed from either the manual mode or the powered mode. These reactions may not be noticed each time the rudder mode is changed. The most probable cause of pedal kickback is that sustained trim forces are being 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).

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.

rudder angle vs airspeed

DATE: APRIL 1966
DATA BASIS: ESTIMATED
(POWERED RUDDER OPERATIVE)



F-668

Figure 6-8

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. 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 airspeed 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 reponse, 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 6-9 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.

CRUISE CHARACTERISTICS

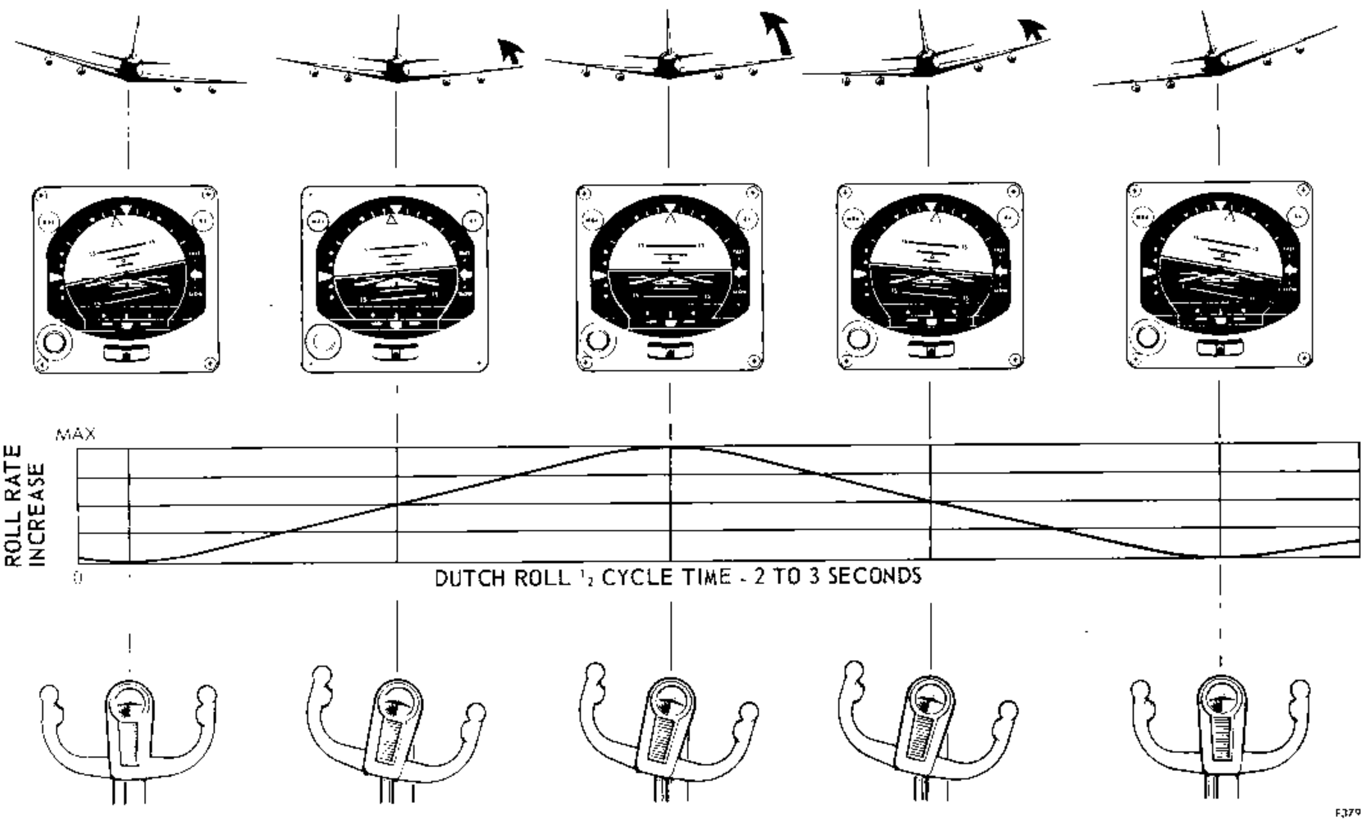
The airplane handling characteristics are good at the recommended speeds and altitudes for cruise flight.

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.

dutch roll damping technique

AIRPLANE MOTION AND INDICATION



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 6-9

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 an EC-135 but the T-33 would experience a strong disturbance from the EC-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 airspeed 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 underrunning an EC-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 EC-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 tend to 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. In the event 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 AS A TANKER

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.

REFUELING AS A RECEIVER

Refer to T.O. 1-1C-1.

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 6-10, 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 6-10). 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 than 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.

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.

buffet boundary limits

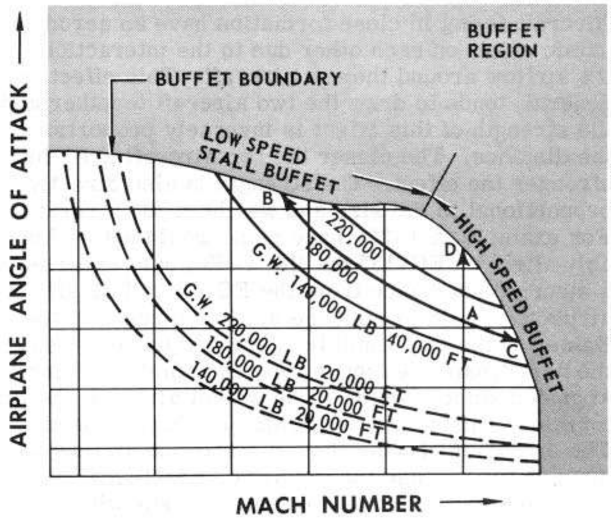


Figure 6-10

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.

section VII

SYSTEMS OPERATION

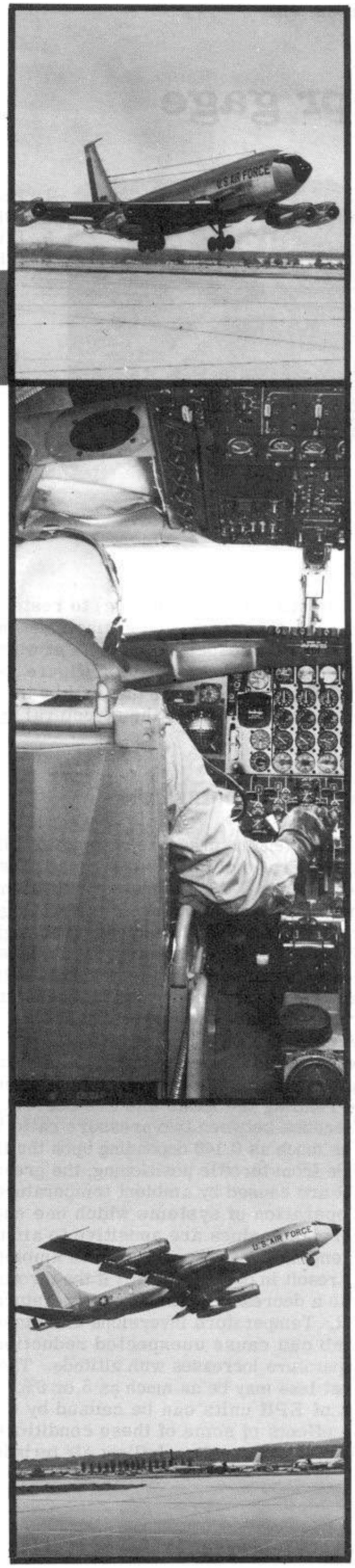


TABLE OF CONTENTS

ENGINE OPERATION

For a description of the engines and components, refer to Section I.

THRUST-RPM RELATIONSHIP

The TF33-P-9 turbofan engine has a split, twin-spool, axial-flow compressor. The compressor section consists of a low-speed, low-pressure rotor unit which includes the fan stages and a 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 TF33 engine, unlike that for other jet engines, is not intended to indicate proper thrust output. During the calibration run of the engine at the factory, high-pressure rotor rpm for a calibrated thrust level 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 %,

epr gage

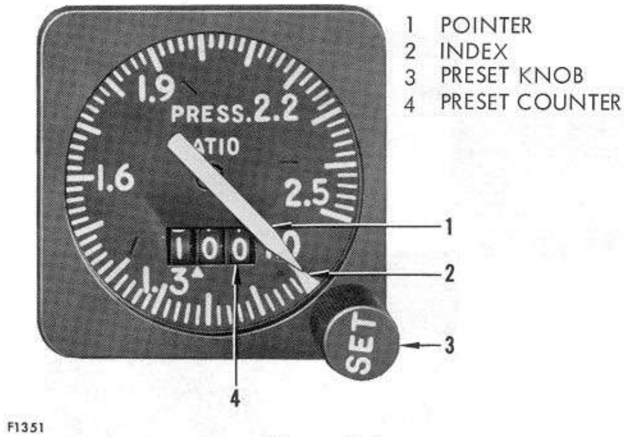


Figure 7-1

by adjustments (retrimming) to restore thrust. It is apparent, then, that each engine must be treated individually with respect to the rpm at which rated thrust is obtained. The tachometer (figure 5-1) has a maximum rpm index of 106% that will be the same for each engine and represents the structural rpm limit of the engine.

EPR SYSTEM OPERATION

The EPR (engine pressure ratio) gage (figure 7-1) indicates the ratio of turbine discharge pressure to engine 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(E)C-1-1, for more information on the EPR gage readings for different conditions of engine operation. Assuming that 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. Aside from throttle positioning, the greatest changes in EPR are caused by ambient temperature variations or by operation of systems which use engine bleed air. Turbofan engines are sensitive to air temperature at the engine inlet. An increase in ambient temperature will result in decreased EPR if the throttle is not moved while a decrease in ambient temperature will increase EPR. Temperature inversions after takeoff and during climb can cause unexpected reduction in EPR when temperature increases with altitude. The accompanying thrust loss may be as much as 5 or 6%. Erratic operation of EPR units can be caused by several factors. The effects of some of these conditions do not justify 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. Actual engine fuel feed fluctuations will cause some fluctuation in the EPR indication. The EPR system is of necessity sensitive and for that reason will reflect subtle changes of ambient temperature, 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. Steady state operation in a gusty crosswind can cause EPR to wander as much as .02 to .03 units at the higher thrust levels. This wandering is caused by the effect of the crosswind on the large air mass flows in the engine inlet.

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 7-2 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.

throttle alignment

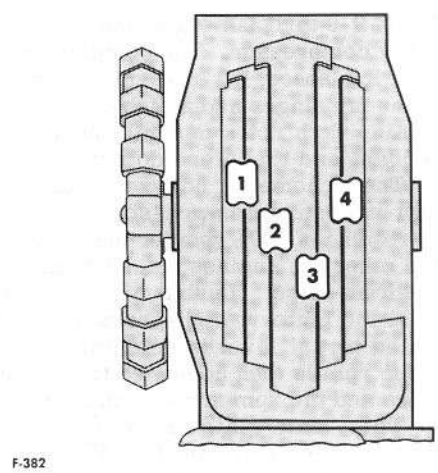
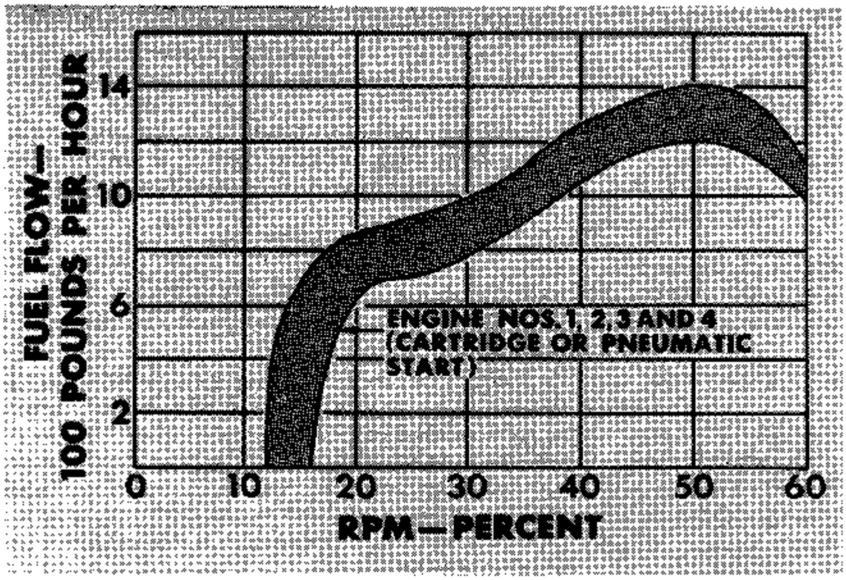


Figure 7-2

fuel flow vs rpm - starting



APPROXIMATE DESIRED FUEL FLOW

NOTE

To obtain a proper start, fuel flow should be within the indicated range

F-383

Figure 7-3

ENGINE STARTING FUEL FLOW INDICATIONS

Figure 7-3 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. Fuel flow cannot be regulated by the throttle within the START range. If abnormally high fuel flow is indicated, move the throttle into **the CUT-OFF position, allow 1 minute for drainage, then investigate.**

ENGINE STARTERS

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 at an engine rpm between 36 and 40%. The pneumatic starters normally cut out at an engine rpm between 32 and 37%. 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. Refer to 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 260°C (450°C maximum temperature limit during starting) and the engine accelerates smoothly to engine idle in 30 to 40 seconds during a pneumatic start on engines 1, 2 and 4, 40 to 50 seconds during a pneumatic start on engine 3, or 20 to 30 seconds during a cartridge start.

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

Engine Cycles

TF-33 engine compressor and turbine disks are subject to low cycle fatigue and therefore must be replaced when cycle limits are exceeded. An accurate record of cycles must be maintained in order to control these life-limited components. Basically, a cycle involves change from one power setting to another and the resulting change in stresses that affects the low cycle fatigue life of rotating parts. For recording engine cycles in the AFTO Form 781H, one cycle is defined as:

1. Any flight, consisting of one takeoff and one landing, regardless of length of flight and whether or not thrust reversers were used on landing.

2. A touch-and-go landing.

3. Inflight thrust changes from idle to NRT or greater and return to idle, e.g. idle for penetration, missed approach, NRT for climbout, and idle for a subsequent penetration (regardless of elapsed time between settings).

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 TF33 turbine blade, the rate of creep is approximately as follows:

EGT - °C	RPM (N_2)	CREEP
450	95%	1 Unit per hour
525	97%	5 Units per hour
555	100%	50 Units per hour
585	101%	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 7-3A shows EGT as related to engine life. It can be readily seen from figure 7-3A 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 7-3A, 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 life vs egt

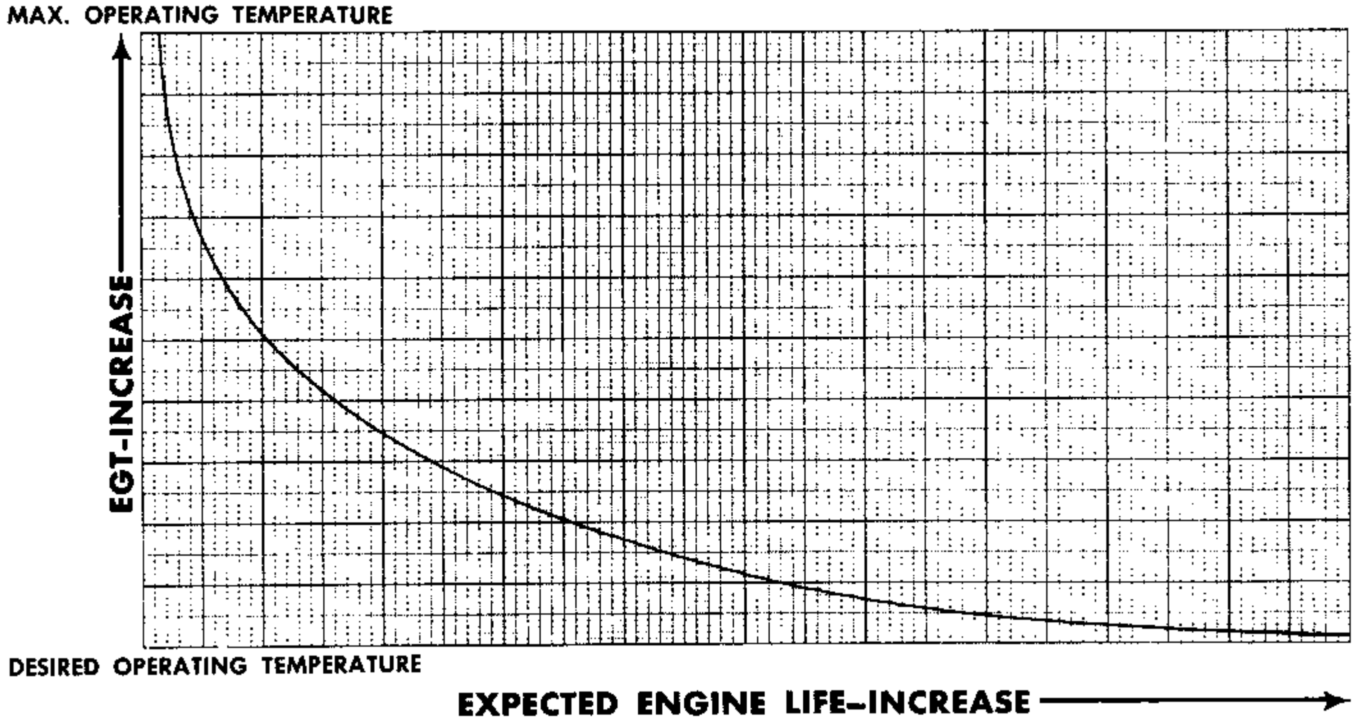


Figure 7-3A

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. Refer to ENGINE STARTERS this Section.

NOTE

When engine acceleration is excessively slow during a pneumatic start it may be suspected that the temperature and alternate pressure control 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(E)C-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 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. Refer to Section V for EGT limits. Whenever allowable temperatures cannot be maintained or controlled, the engine should either be shut down or a landing 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(E)C-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.

ENGINE ACCELERATION CHARACTERISTICS

The acceleration characteristics of the TF33-P-9 engine differ significantly from those of previous turbojet engines. While turbofan engine acceleration times from idle to takeoff thrust are only 1 to 2 seconds longer, the rate of thrust build-up during an acceleration is quite different. During a normal acceleration (6 to 8 seconds with no air bleed) the thrust available at the end of the first 4 or 5 seconds is only 15 to 20% of that available at takeoff. The remaining 75 to 80% is obtained very rapidly during the final 2 to 3 seconds of the acceleration. This acceleration characteristic can cause large yawing moments to be briefly applied to the airplane if acceleration times vary appreciably between engines. Engine acceleration time is adversely affected by air bleed and excessive power extraction (heavy electrical loads on the generator). Occasionally an engine may give a "chug" as it accelerates from IDLE. This is a function of the N_2 compressor stall characteristics and of the fuel control acceleration schedule; however, it is not considered harmful to the engine. Slower throttle movement out of IDLE can minimize this tendency. The turbofan engine, when cool, has a noticeable thrust decay following initial acceleration to takeoff thrust. This decay is caused by increasing temperature which stabilizes the fuel control unit and may result in a decrease of approximately .06 EPR units after 2 minutes at TRT.

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 valve 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. Gusty crosswinds of 15 to 20 knots can cause an audible change in engine noise level as engine parameters wander. Actually the engine is on the verge of a compressor stall due to distortion of air flow at the inlet of the engine. Engine compressor stall may occur when operating statically in gusty crosswinds of more than 15 knots at high thrust levels, usually after approximately 10 to 15 seconds. If compressor stall is encountered, the throttle should be retarded to IDLE until the compressors have become "stable" and decelerated to idle rpm. The throttle should never be advanced deliberately on a surging or "stalled" engine since internal engine parts may be damaged. In a gusty crosswind, engines on the upwind wing will be more susceptible to stall than those on the opposite side of the airplane. If engine surging is encountered and it is repetitive, loss of engine thrust will result.

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. Refer to ENGINE AIR STARTING 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. If erratic engine performance is experienced during acceleration of the aircraft:

1. Retard throttle to IDLE position.
2. Obtain stable operation.
3. Slowly advance throttle to the desired power condition.

STEADY STATE OPERATION. While in a stabilized cruise condition, if erratic engine performance is experienced:

1. Slowly retard or advance throttle to a more stable power range.
2. Reduce altitude.

While in a stabilized climb condition, if erratic engine performance is experienced:

1. Slowly retard or advance throttle to a more stable power range.
2. Increase airspeed by reducing climb.

DECELERATION. During periods of deceleration of the aircraft, if erratic engine performance is experienced:

1. Change the throttle position to obtain stable engine operation.
2. Slowly adjust throttle to the 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.

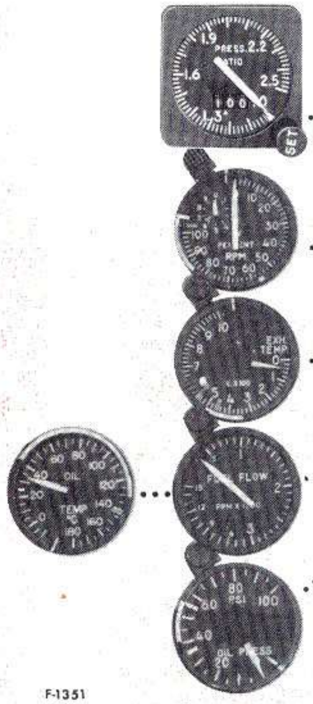
The following guide to engine malfunction symptoms (figure 7-4) represents many (but not necessarily all) of the situations which might conceivably be encountered.

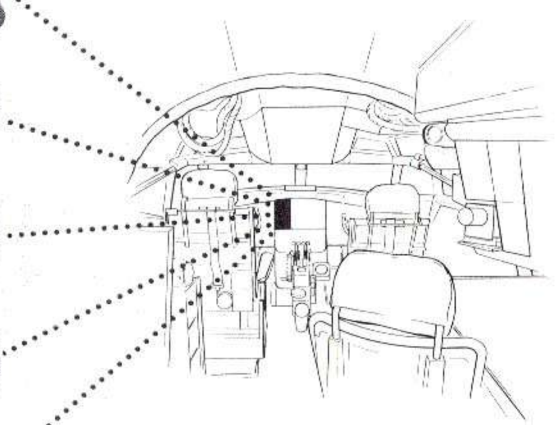
This malfunction analysis guide is not intended to serve as a maintenance trouble shooting chart. The malfunction symptoms which are mentioned are only those which would be apparent to a pilot and his flight crew. Similarly, the action recommended is only that which the flight crew may initiate themselves. 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, carefully 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.

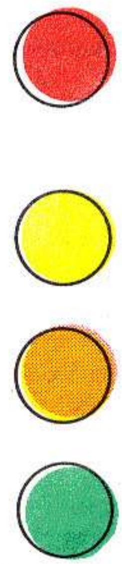
The primary and most important group of engine instruments consists of the exhaust gas temperature (EGT) gage, the high pressure compressor (N_2) tachometer, engine pressure ratio (EPR) gage and the fuel flowmeter. These four instruments should be monitored simultaneously because the interrelationship 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.

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

F-1351
F-384

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)

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 OIL TEMP: 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 7-4 (Sheet 1 of 8)

ENGINE STARTING (GROUND) (CONT)

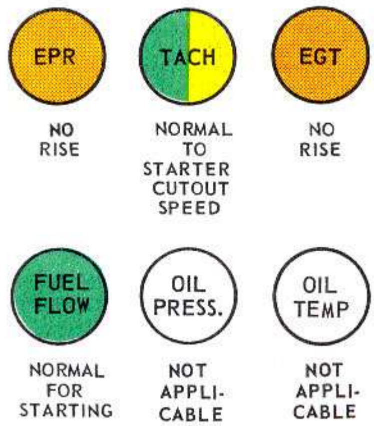
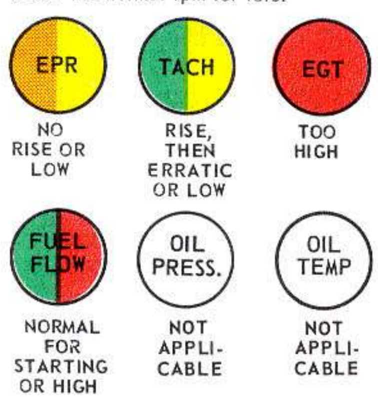
CONDITION	PROBABLE CAUSE	ACTION
No start after engaging the starter. Compressors rotate and normal fuel flow IS observed.  	Malfunctioning engine ignition or airplane relays Malfunctioning pressurizing and dump valve, or weak signal from fuel control to pressurizing and dump valve (unlikely but possible)	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 suspect ignition system malfunction and check the ignition circuit breaker.
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 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 7-4 (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. EPR: TOO LOW TACH: BELOW IDLE RPM EGT: TOO HIGH FUEL FLOW: TOO LOW OIL PRESS.: NOT APPLICABLE OIL TEMP: NOT APPLICABLE	At low ambient temperaures, frozen burner pressure line to fuel control	Discontinue start attempt and apply heat to fuel control.
	Starter misfire or hang-fire, or insufficient air to the starter	Discontinue the starting attempt and investigate.
	Binding rotor assemblies, damaged compressor or turbine blades, damaged accessory gearbox	Suspect possible malfunction of the starter
	Starter improperly adjusted. 'Cuts out below engine self-accelerating speed.	Check compressors for free rotation. Inspect compressor and turbine blades and the accessory gearbox for possible damage.
	In a few cases, one malfunctioning igniter has resulted in almost identical conditions.	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. EPR: NOT APPLICABLE TACH: TOO LOW OR TOO HIGH EGT: NEAR NORMAL FUEL FLOW: TOO LOW OR TOO HIGH OIL PRESS.: NOT APPLICABLE OIL TEMP: NOT APPLICABLE	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 7-4 (Sheet 3 of 8)

TAKEOFF ENGINE CHECK

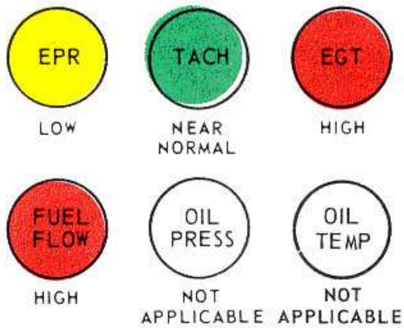
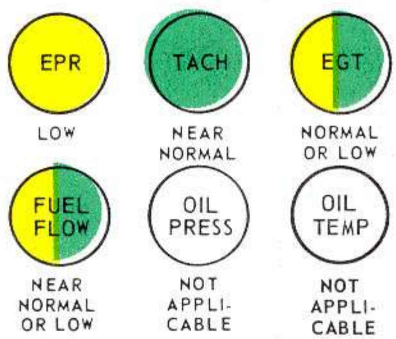
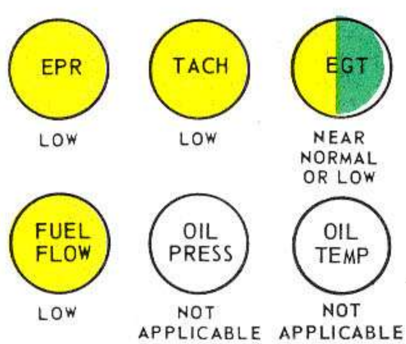
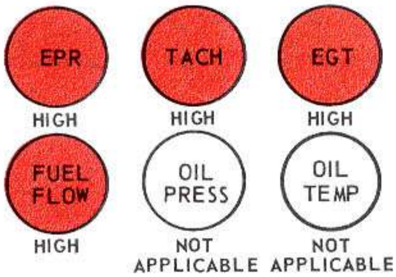
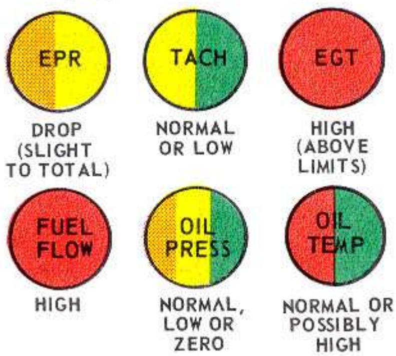
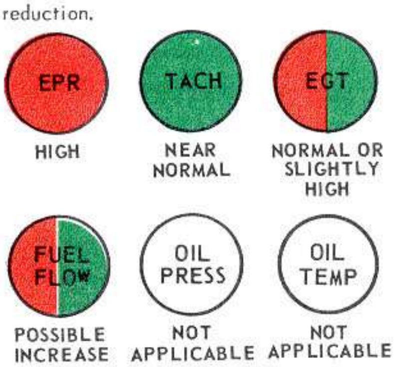
CONDITION	PROBABLE CAUSE	ACTION
EGT high, EPR low and fuel flow high when throttle is adjusted to match the N2 tachometer reading on the engine being checked with the N2 tachometer readings of the other engines.  	Damaged compressors or turbines, or other internal engine damage Possible instrumentation 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 7-4 (Sheet 4 of 8)

engine malfunction analysis (cont)

INFLIGHT

<table>
<tr><th>CONDITION</th><th>PROBABLE CAUSE</th><th>ACTION</th></tr>
<tr><td>Two or more of the four primary instruments indicate abnormally high readings

</td><td>Fuel control malfunction</td><td>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.</td></tr>
<tr><td>Rough engine with possible vibration. Possible compressor stall for no apparent reason. Possibly an audible explosion. Engine may seize. Possible fire warning light.

</td><td>Compressor, turbine or bearing damage or failure</td><td>Shut down engine. Pull engine fire switch. Fuel boost pump switch OFF.</td></tr>
<tr><td>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.

</td><td>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.</td><td>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.

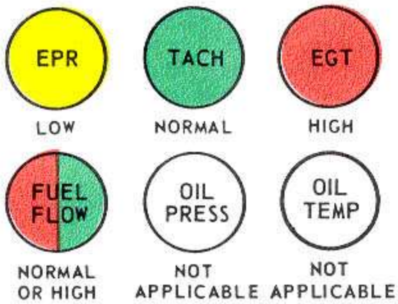
CAUTION

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.</td></tr>
</table>

Figure 7-4 (Sheet 5 of 8)

INFLIGHT (CONT)

<table>
<tr><th>CONDITION</th><th>PROBABLE CAUSE</th><th>ACTION</th></tr>
<tr>
<td>EGT too high, EPR lower than normal, all other instruments approximately normal.

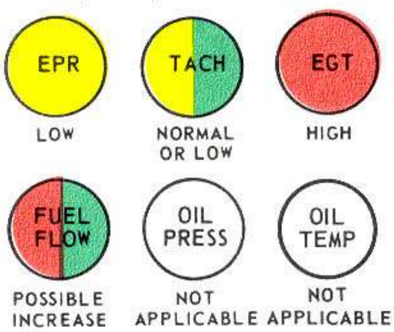

</td>
<td>Excessive airbleed from engine due to:

(1) Overboard airbleed valve stuck open, or

(2) Excessive leakage in the airplane airbleed system.</td>
<td>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.</td>
</tr>
<tr>
<td>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.


</td>
<td>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.

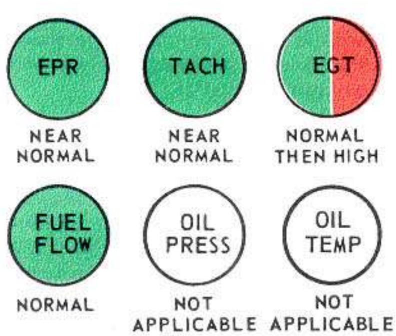
If during or following an acceleration, suspect possible airbleed valve malfunction, particularly if stall disappears after engine has stabilized and instruments return to normal. Possible excessive leakage in the airbleed system.</td>
<td>Reduce throttle setting to maintain EGT within allowable limits.

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.</td>
</tr>
<tr>
<td>Compressor stall during deceleration. Rise in EGT when condition persists.


</td>
<td>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.</td>
<td>Increase airspeed to correct stall condition.

If overtemperaturing cannot be controlled, shut down the engine.</td>
</tr>
</table>

Figure 7-4 (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. EPR: NORMAL OR LOW TACH: NORMAL OR LOW EGT: POSSIBLY HIGH FUEL FLOW: NORMAL OR ERRATIC OIL PRESS: POSSIBLE DROP OIL TEMP: NOT APPLICABLE	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. EPR: DROP TACH: DROP EGT: DROP FUEL FLOW: ZERO OIL PRESS: NOT APPLICABLE OIL TEMP: NOT APPLICABLE	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. EPR: LOW TACH: LOW EGT: NEAR NORMAL OR LOW FUEL FLOW: LOW OIL PRESS: NOT APPLICABLE OIL TEMP: NOT APPLICABLE	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 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, 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. Switching fuel source to a body tank which contains warmer fuel may help. This airplane has no provisions for heating fuel. The usual bypass type of fuel filter will permit fuel to bypass the filter element in the event that the pressure drop increases.

Figure 7-4 (Sheet 7 of 8)

INFLIGHT (CONT)

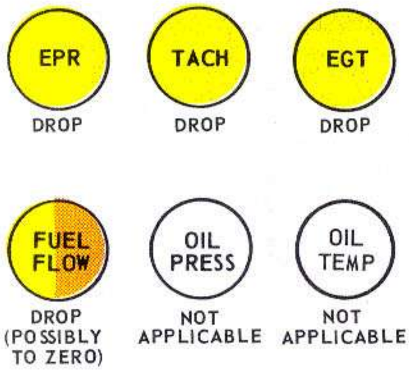
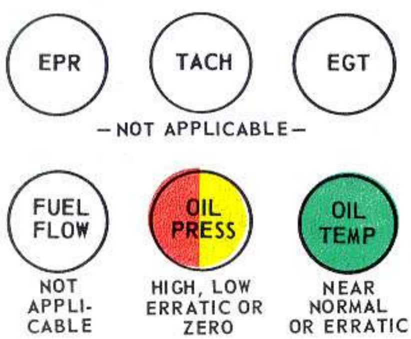
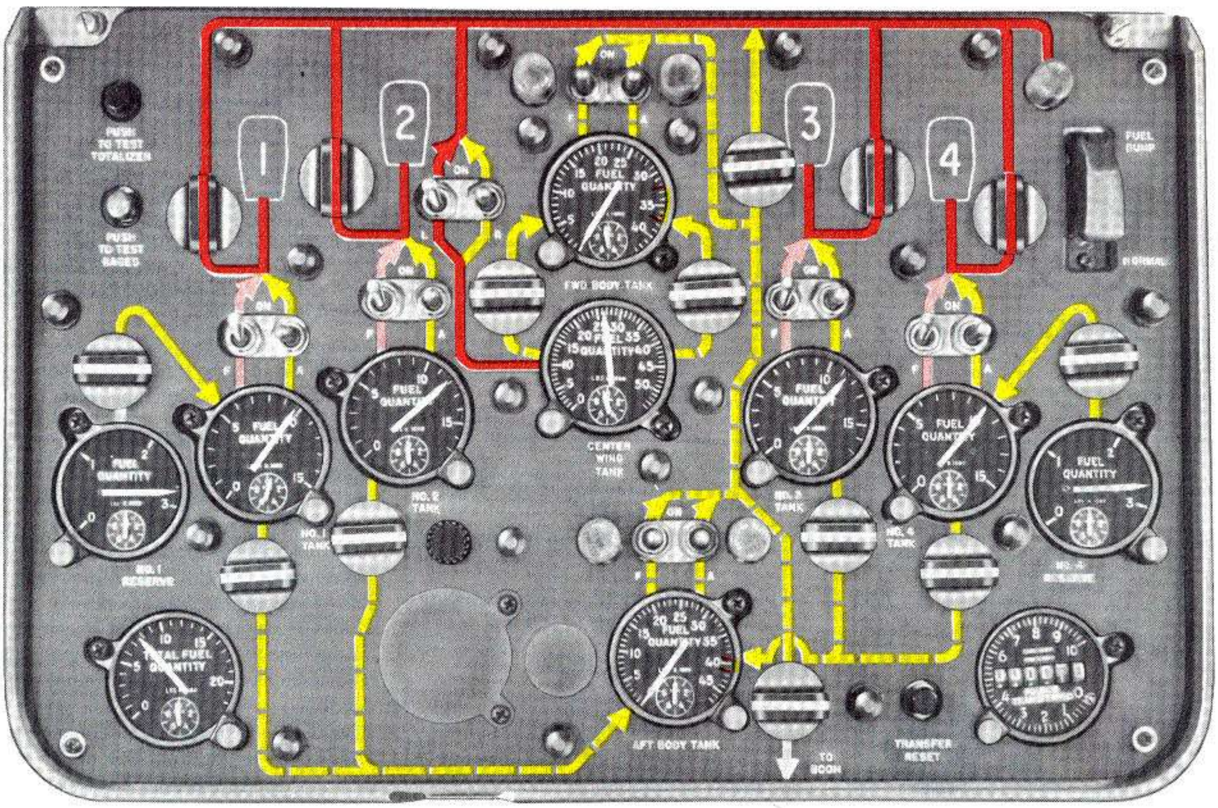
CONDITION	PROBABLE CAUSE	ACTION
Sudden drop in EGT, rpm, EPR and fuel flow. Complete loss of thrust.  	Engine Flameout	Check fuel in tanks. Switch tanks, if necessary. Check position of emergency fuel shut-off valve. Relight the engine. **CAUTION** ***UNLESS THE ENGINE IS URGENTLY NEEDED, DO NOT ATTEMPT 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 WILL BE USED IN CONJUNCTION WITH LOW OIL PRESSURE GAGE READINGS TO VERIFY LOW OR ERRATIC OIL PRESSURE.*	Normal oil pressure is 40 to 60 PSI. Except at idle, oil pressures between 35 and 40 PSI are undesirable and should be tolerated only for the completion of the flight, preferable 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 60 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 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 60 PSI. (PRESSURE VARIATIONS OF 5 PSI ARE PERMISSIBLE PROVIDED THE AVERAGE OF THE FLUCTUATIONS IS NO GREATER THAN 60 PSI.) BLOWN OIL SYSTEM SEALS AND/OR LOSS OF LUBRICATION CAN RESULT. THE CONDITION SHOULD BE CORRECTED BEFORE FLIGHT.*

Figure 7-4 (Sheet 8 of 8)

fuel system operation

PRIMARY FLOW
ALTERNATE SOURCE
NO FLOW



F-1442

Figure 7-5

FUEL SYSTEM OPERATION AND MANAGEMENT

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.

MAIN TANKS TO ENGINES

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 10,500 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. engines 1 and 4 from an outboard tank or engines 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.

NOTE

It is possible to transfer fuel inflight between the forward and aft body tanks and from the body tanks to the reserve, main and center wing tanks by pressurizing the A/R manifold and opening the appropriate fuel level control valve. However, inflight internal transfer of fuel by use of an A/R pump is considered an emergency procedure and should be avoided whenever possible. Refer to FUEL SYSTEM EMERGENCY OPERATION in Section III.

BODY TANKS 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

- 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 low pressure warning lights will not indicate tanks empty when the engines are being fed from either body tank.
- Fuel flowmeter fluctuation or a temporary drop in fuel flow at the start of fuel feed from body or center wing tanks can be expected. Air temporarily trapped in the fuel flow transmitter upstream of the engine driven fuel pump causes this phenomenon which will cease in a few seconds.

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.

fuel remaining in main tanks

DATE: FEBRUARY 1964
DATA BASIS: ESTIMATED

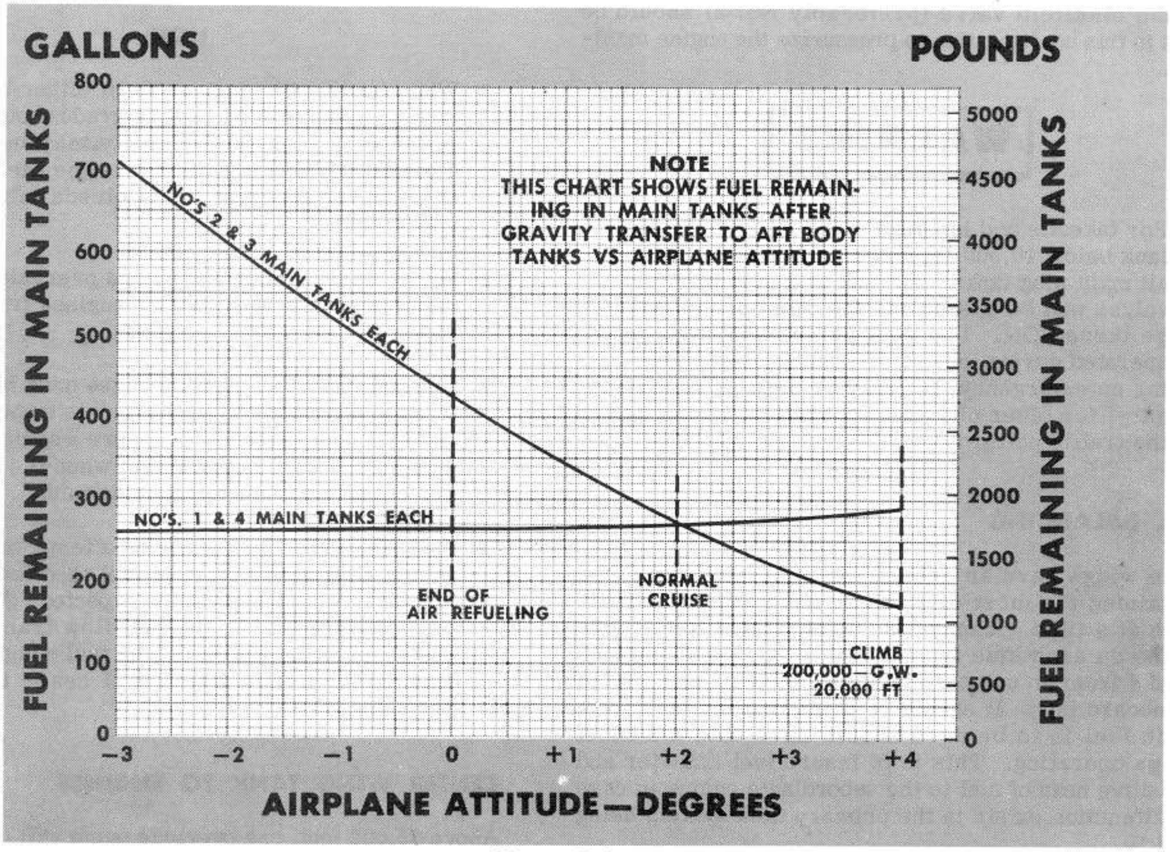


Figure 7-6

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. 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.

B. In event of override pump failure in center wing tank.

C. During ground operation, to provide fuel for the APU.

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. See figure 7-6 for fuel remaining in main tanks after gravity transfer to aft body tank.

CAUTION

The maximum gross weight at which the outboard reserve tanks may be empty is 293,000 pounds provided the main wing tanks are full. However, since flight with empty reserve tanks has an adverse effect on wing fatigue life, they should be kept full as long as practicable.

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, it is necessary to lower the quantity of fuel in main tanks 1 and 4 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 over-filling.
- 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 7-6A.

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.
- 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 85,000	85,000 to 115,000	115,000 or Greater		
1	1	1	Start Engines Taxi Takeoff	Mains 1, 2, 3, & 4
	2	2	En route Climb & Cruise	Center Wing Use down to 18,000 lbs.
2			↓	Center Wing Use until empty
		3	Cruise	Aft Body Use 11,000 lbs.
3	3			Aft Body Use until empty
4	4			Forward Body Use until empty [1]
	5	4		Center Wing Use until empty
		5		Aft Body & Fwd Body: Use in equal amts. not to exceed 6000 lbs. until empty starting with the Aft body tank [1]
5	6	6	↓	Mains 1, 2, 3, &4 Use down to 9000 lbs. each in Mains 1 & 4
6	7	7	Cruise	Drain Reserves 1 & 4
7	8	8	Landing	Mains 1, 2, 3, & 4 Use until mission completed

[1] Retaining some forward body fuel may be required for cg control

Figure 7-6A

FUEL TRANSFER FOR APU OPERATION

The APU will become inoperative with less than approximately 2000 pounds of fuel in the forward body tank. Center wing tank fuel can be gravity transferred to the forward body tank. If there is insufficient fuel in the forward body tank or center wing tank for APU operation, the following procedures will be used:

CAUTION

Do not exceed airplane cg limits.

A. Condition I: Forward body and center wing tank empty

Fuel available in aft body tank.

Procedure:

1. Park airplane - Set parking brakes; check reserve brake pressure
2. Engines 1, 3 and 4 - Shut down
3. Operate Engine 2, Tank to Engine - No. 2 tank to No. 2 engine
4. Air Refueling to Engine Manifold Valve Switch - OPEN
5. Master Refuel Switch - ON
6. Fuel Level Control Valve Switch, Forward Body Tank - OPEN
7. Forward A/R Pump Switch, Aft Body Tank - ON
8. Forward A/R Pump Switch, Aft Body Tank - OFF

   Turn off after desired transfer has been obtained.
9. Fuel Level Control Valve Switch, Forward Body Tank - CLOSED
10. Manifold Valves Switch - Check in WING REFUEL position
11. Master Refuel Switch - OFF
12. APU - Start
13. ENG 2 Generator - Trip

    If power is also required on ENG 1 and ENG 4 generator load buses, trip the generator switches to close the bus tie breakers.
14. External Power Switch - CLOSE
15. No. 2 Engine - Shut down

B. Condition II: Forward body and center wing tank empty

Fuel available in main wing tanks

Procedure:

1. Park airplane - Set parking brakes; check reserve brake pressure
2. Engines 1, 3 and 4 - Shut down
3. Operate Engine 2, Tank to Engine - No. 2 tank to No. 2 engine
4. Manual Defueling Valve - OPEN
5. Master Refuel Switch - ON
6. Manifold Valves Switch - Check in WING REFUEL position
7. Tank to Engine Manifold Valve Switch - As required
8. Fuel Level Control Valve Switch, Forward Body Tank - OPEN
9. Boost Pump Switches - ON

   Turn on boost pumps in main wing tanks (tanks 1, 3 and 4) as desired for fuel transfer.

   NOTE

   If necessary, transfer from No. 2 tank last in order to avoid fuel starvation of No. 2 engine.
10. Boost Pump Switches - OFF

    Turn off boost pumps after desired transfer has been obtained.

fuel tank location

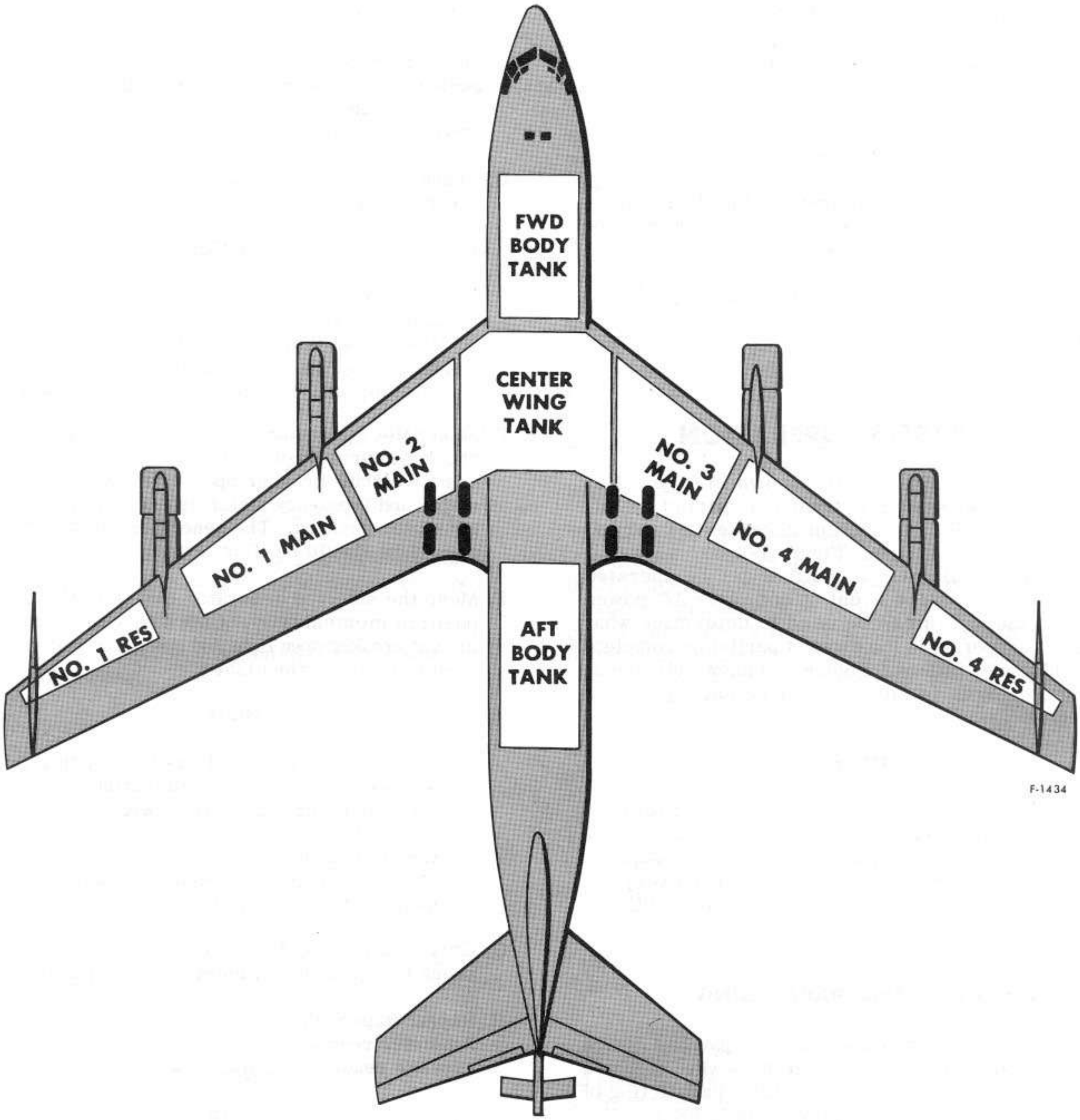


Figure 7-7

11. Tank to Engine Manifold Valve Switches - CLOSED
12. Fuel Level Control Valve Switch, Forward Body Tank - CLOSED
13. Master Refuel Switch - OFF
14. Manual Defueling Valve - CLOSED
15. APU - Start
16. ENG 2 Generator - Trip

    If power is also required on Eng 1 and Eng 4 generator load buses trip the generator switches to close the bus tie breakers.

17. External Power Switch - CLOSE
18. No. 2 Engine - Shut down

ELECTRICAL SYSTEM OPERATION

Major AC electrical loads are shown in figure 7-8. The DC electrical system is treated as part of the AC system load as the DC system receives all normal power from the AC system. Figure 7-8 also shows all DC electrical equipment loads that can be operated from the battery in the 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 operational loads for different airplane operating conditions.

NOTE

To prevent overcharging of the APU battery and resulting loss of the electrolyte, do not exceed 200 volts, as indicated 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 3 cps of each other. Automatic paralleling of the generators can be accomplished as follows:

NOTE

The AC system is not equipped for manual paralleling of the generators.

A. Before engine start check that the generator circuit breaker open light is illuminated. The bus tie circuit breaker open light receives power from the SWITCHED DC BUS. Move battery power switch to EMERGENCY to check position of bus tie circuit breaker's if ground power is not available. (On shutdown, the bus tie circuit breakers are normally closed and the generator circuit breakers are normally tripped.)

B. After the engine(s) with a generator is (are) started, move the voltmeter and frequency meter selector to the selected generator position.

C. Move the selected generator switch to the CLOSE position momentarily. Check that the generator circuit breaker open light and bus tie circuit breaker open light are extinguished.

D. Check voltage and frequency within limits, and check the generator ammeter within limits.

NOTE

If generator voltage does not build up, the bus tie circuit breaker should trip within 2 seconds. Wait at least 15 seconds before attempting to reset, to allow time delays to complete cycling and restore power.

E. Select the generator for the next engine started, check generator circuit breaker open light and bus tie circuit breaker open light. Move the voltmeter and frequency meter selector to the selected generator position. The generator circuit breaker open light should be illuminated.

F. Move the selected generator switch to the CLOSE position momentarily. Check that the generator circuit breaker open light and bus tie circuit breaker open light are extinguished.

NOTE

The generator circuit breaker open light will extinguish and remain extinguished if the generators have paralleled properly. It may be necessary to slightly move the throttles of the engines just started to provide the proper frequency to enable the generators to parallel.

G. Check voltage and frequency within limits, and check the generator ammeter within limits.

H. Repeat steps E, F, and G for the remaining generator. Ammeter readings should agree within 40 amps of average reading on paralleled system.

NOTE

Pointer oscillation of ± 30 amps (60 amps total excursion) on airplane ammeters, resulting from load shuffle between paralleled generators, is normal.

J. Check voltage on T-R No. 1 and T-R No. 2.

COMM CENTER AIRPLANE POWER

If AC power from the airplane power buses is desired for the communication center, place the comm ctr airplane power switch on the electrical control panel to ON position. If comm ctr external power is on the communication center bus, airplane power may be placed on the bus without power interruption. See COMMUNICATION CENTER EXTERNAL/AIRPLANE POWER TRANSFER, this section.

NOTE

While operating the communication center on airplane power, moving the battery switch can cause loss of power to the communication center. The communication center airplane power switch will return to OFF, requiring reconnection of comm center power by placing the comm center airplane power switch to ON.

electrical equipment loads

MAJOR AC ELECTRICAL LOADS			
EQUIPMENT (AIRPLANE SYSTEMS)	NO. UNITS	RATED VOLT AMPS	CONNECTED LOADS VOLT AMPS
ANTI-ICING			
Windows P3, P4, P5	1	318	318
Windows P1, CP2	1	2850	2850
Windows P2, CP1	1	2850	2850
Windows CP3, CP4, CP5	1	318	318
AUTOPILOT			
Autopilot	1	300	300
ELECTRICAL POWER			
APU Battery Charge	1	465	465
A/R Control Panel	1	1586	1586
Battery Charge	1	1030	1030
Transformer Rectifier No. 1, 2	2	3684	7368
28V Transformer (Gen 1-AØ)	1	572	572
28V Transformer (Gen 1-BØ)	1	285	285
28V Transformer (Gen 2-AØ)	1	750	491
28V Transformer (Gen 4-AØ)	1	750	603
28V Transformer (Gen 4-CØ)	1	750	298
ELECTRONICS			
Doppler Radar AN/APN-81	1	1891	1891
Liaison Radio No. 1 AN/ARC-58	1		
Transmit		1463	1463
Receive		382	382
Navigation Computer AN/ASN-7	1	465	465
Pressurizing Kit C-1173/ASQ	1	530	530
Radar Altimeter AN/APN-133	1	150	150
Radar Beacon AN/APN-69	1	600	600
Search Radar AN/APN-59	1	1380	1380
TACAN AN/ARN-21	1	60	60
Transponder AN/APX-25	1	300	300
UHF-ADF Antenna Heater	1	230	230
ENGINES AND FUEL			
Boost Pump	8	720	5760
Override Pump	2	1530	3060

Figure 7-8 (Sheet 1 of 9)

electrical equipment loads (cont)

MAJOR AC ELECTRICAL LOADS (CONT)			
EQUIPMENT (AIRPLANE SYSTEMS)			
FLIGHT CONTROLS			
Emergency Flap Drives	2	600	1200
Stabilizer Trim	1	3460	3460
LIGHTING			
Nose Landing Light	1	600	600
Wing Landing Light	1	1200	1200
MISC HEATING AND VENTING			
Aft Galley Power	1	17,200	17,200
Doppler Radar Blower	1	300	300
Drain Line Heaters	1	174	174
Drain Mast Heater	1	326	326
Electronic Cabinet Cooling	1	1675	1675
Q-Inlet Heater	1	200	200
AUXILIARY COOLING SYSTEM			
Evaporator Fans	2	5,000	10,000
Condenser Fans	2	1,200	2,400
Compressor	2	13,000	13,000
EQUIPMENT (CONT)			
ELECTRICAL POWER			
Transformer Rectifier No. 3, 4	2	3684	7368
Transformer Rectifier 10V	1	305	305
28V Transformer No. 1	1		541
28V Transformer No. 2	1		572
28V Transformer No. 3	1		249
28V Transformer No. 4	1		489
28V Transformer No. 5	1		526
28V Transformer No. 6	1		343
28V Transformer No. 7	1		579
28V Transformer No. 8	1		369
ELECTRONICS			
HF Equipment Blower "A," "B"	2	1110	2220
HF Receiver No. 1, 2, 3, 4 R-1149/ARC-58	4	792	3168

Figure 7-8 (Sheet 2 of 9)

EQUIPMENT (COMM CENTER) (CONT)	NO. UNITS	RATED VOLT AMPS	CONNECTED LOADS VOLT AMPS
ELECTRONICS (Cont)			
UHF Equipment Blower "A," "B"	2	1730	3460
UHF No. 1 Transmitter Blower	1	690	690
UHF Transmitter No. 1, 2, 3, 4, 5 AN/ART-47	5	4500	22,500
UHF Receiver No. 1, 2, 3, 4, 5 AN/ARR-71 (and APM Monitor Receiver)	6	470	2820
Liaison Radio No. 2, 3, 4 AN/ARC-58	3		
Transmit		1463	4389
Receiver		382	1146
ALCC			
Power Supply	1	4485	4485
Batt Chg (Code Retained Power Unit)	1	5175	5175
Tape Recorder Blower	1	345	345
Teletype and Crypto	1	1230	1230
SATCOM Amplifier-Mixer	1	4025	4025
SATCOM Modem	2	150	300
ARC-96 L.F. Transmitters No. 1, 2	2	14,433	28,866
ARC-96 L.F. Transmitter Blower	1	3996	3996
ARC-96 L.F. Receiver	1	1622	1622
HEATING AND VENTILATING			
Boom Operator's Fan	1	690	690
MISCELLANEOUS			
Aft Toilets	2	277	277
Overhead Projector	1	1075	1075
Sig. Dist. SWBD	1	890	890

DC ELECTRICAL LOADS (TR BUS NO. 1)

EQUIPMENT	NO. UNITS	AMPS PER UNIT	AVERAGE LOAD
FLIGHT CONTROLS			
Autopilot	1	8.0	8.0
Emerg Flap Drive Control, Inbd	1	1.55	Neg
Stabilizer Trim	1	2.6	Mom
ELECTRONICS			
ILS 51V-4A	2	0.1	0.1
Radar Beacon APN/69	1	1.0	1.0
Search Radar AN/APN-59	1	6.0	6.0
TACAN	1	1.8	1.8
Test Power		Ground loads only	
Transponder AN/APX-25	1	2.0	2.0

Figure 7-8 (Sheet 3 of 9)

electrical equipment loads (cont)

DC ELECTRICAL LOADS (TR BUS NO. 1) (CONT)			
EQUIPMENT	[illegible]	[illegible]	[illegible]
ELECTRONICS (Cont)			
UHF Command No. 2 (AN/ARC-34 WITHOUT TCTO 1044)	1		
Transmit		18.0	4.5
Receive		13.5	13.5
UHF Command No. 2 (AN/ARC-164 WITH TCTO 1044)	1		
Transmit		4.1	4.1
Receive		1.4	1.4
ENGINES AND FUEL			
Fuel Boost Control	4	0.35	1.4
Fuel Quantity Indicator	6	0.015	0.10
Reserve No. 1 to Tank No. 1 Valve	1	2.0	Neg
HEATING AND VENTILATING			
Copilot's Window Anti-ice Control	1	0.40	0.4
Engine Anti-ice Control	1	0.40	0.4
Engine No. 2, 4 Anti-ice Valve	4	1.8	Neg
Main Compt Air Conditioning	1	1.7	Mom
HYDRAULICS			
L.H. Hydraulic Pump	1	53	53
LANDING GEAR			
Landing Gear Lever Lock	1	0.45	0.45
LIGHTING			
Emerg Exit Light	5	0.05	0.3
Light Dimming Control	4	0.6	2.6
Nav. Light Flasher	1	1.0	1.0
Retractable Ldg Light Control	1	1.0	1.0
Taxi and Landing Light Control			
Taxi	1	2.6	2.6
Landing	1	0.6	0.6
WARNING			
Troop Oxygen Warning	1	0.04	Neg

Figure 7-8 (Sheet 4 of 9)

DC ELECTRICAL LOADS (TR BUS NO. 2)			
EQUIPMENT	**NO. UNITS**	**AMPS PER UNIT**	**AVERAGE LOAD**
FLIGHT CONTROLS			
Emerg. Flap Drive Control Outbd	1	1.55	Emerg
Spoiler Hyd. Press. Inbd, Outbd	4	1.20	Neg
ELECTRONICS			
Doppler Radar AN/APN-81	1	1.1	1.1
Liaison Radio No. 1 AN/ARC-58	1	1.0	Neg
Marker Beacon AN/ARN-32	1	0.5	0.5
N-1 Compass & Pilot Attitude Director Indicator	1	1.4	1.4
Nav Computer AN/ASN-7	1	0.2	0.2
UHF Homing AN/ARA-25	1	2.8	2.8
VHF Radio Nav 51R-6	2	5.7	5.7
ENGINES AND FUEL			
Fuel Boost Control	4	.35	1.4
Override Pumps	2	.35	0.7
Res No. 4 to Tank No. 4	1	2.0	Neg
HEATING AND VENTILATING			
A/C Control Cabin	2	.23	Neg
Anti-ice, Engine No. 1, No. 3	4	1.8	Neg
Auxiliary Cooling System Control	1	2.5	2.5
Pilot Window Anti-ice Control	1	0.40	0.4
INSTRUMENTS			
Cabin Temperature Indicator	1	0.1	0.1
Engine Oil Temperature Ind	1	0.6	0.6
Free Air Temperature Indicator	2	0.1	0.2
Fuel Quantity Indicator	4	0.015	0.1
Hydraulic Oil Quantity Ind	1	0.2	0.2
LANDING GEAR			
Antiskid	2	1.7	3.4
Safety Switch Relay	2	.35	0.35
LIGHTING			
Boarding Light Control	1	.23	.2
MISCELLANEOUS			
Copilot's Flight Instruments	1	6.9	Emerg
Hyd Pump Control (R.H.)	1	0.6	Emerg
WARNING			
Door Warning	1	0.17	Neg
Q-Inlet Heater Warning	1	0.4	Neg
Troop Oxygen Warning Signs	1	3.2	Neg

Figure 7-8 (Sheet 5 of 9)

electrical equipment loads (cont)

DC ELECTRICAL LOADS (TR BUS NO. 3 AND 4)			
EQUIPMENT (COMM CENTER)	NO. UNITS	AMPS PER UNIT	AVERAGE LOAD
COMMUNICATION CENTER			
APM			
Baseband Signal Attenuator	1	1.3	1.3
Electronics Unit	1	1.3	1.3
Receiver AGC Monitor	1	1.07	1.07
RF Power Monitor	5	0.53	2.65
Squelch-Alarm Cont Indicator	1	0.93	0.93
Squelch-Alarm Indicator Monitor	1	0.64	0.64
Low Power Indicator	1	0.32	0.32
Selector Panel	1	0.23	0.23
Audio Amplifier	1	1.78	1.78
SATCOM Receiver	1	5.3	5.3
Compt. 3 Panel Lights	11	0.04	0.4
Compt. 4 Overhead Light Control	1	0.35	0.4
Interphone AN/AIC-18	1	1.2	1.2
R.O. & Crypto Console	1	4.3	4.3
Private Interphone	1	3.0	3.0
Liaison Radio, 2, 3, 4 AN/ARC-58	3	1.0	Mom
HF Receiver 1, 2, 3, 4 AN/ARC-58	4	1.0	Mom
HF Receiver Muting Relay	1	1.2	1.2
Press to Test	3	0.04	Neg
UHF Receiver 1, 2, 3, 4, 5 AN/ARR-71 (and APM monitor receiver)	6	3.5	3.5 each
UHF Transmitter 1, 2, 3, 4, 5 AN/ART-47	5	3.5	3.5 each
AM Dropout	1	0.08	0.1
Broadcast Receiver DFA-73A	1	1.0	1.0
Tape Recorder AR-200	1	10.0	10.0
Tape Recorder Heater	1	10.0	10.0
LF Coax Pressure AN/ARC-96	1	0.04	Neg
VHF FM			
Receiver-Transmitter	4	7.0	
Control	1	0.7	8.0
Ant. Switch	1	0.25	
Teletype and Crypto			
Test Power		Ground load only	
Multiplex ACC-3	1	10.7	10.7
Sig. Dist. SWBD SB2059/ATC-1	1	1.0	1.0
DI, DM & DOPL Consoles	1	6.4	
DI, Console	1	2.2	
DM Console	1	2.2	
DOPL Console	1	2.2	24.0
AEAO & Controllers Console	1	4.7	
Controllers Console	1	3.7	
AEAO Console	1	2.6	
Signalling Relay RE-760/ARC-1	1	0.6	0.6
UHF Blowers A & B	2	0.35	0.7
UHF Overheat Warning	5	0.04	Mom
UHF Blower Temp Ind	2	0.05	0.1
HF Blower Warning	2	0.35	0.7
UHF Rec. Ant. Cont	1	0.5	0.5
Radio Opr. Panel Lights	149	0.05	6.1
Radio Opr. Console Lights	7	0.65	4.6

Figure 7-8 (Sheet 6 of 9)

DC ELECTRICAL LOADS (TR BUS NO. 3 AND 4) (CONT)			
EQUIPMENT (COMM CENTER)	**NO. UNITS**	**AMPS PER UNIT**	**AVERAGE LOAD**
COMMUNICATION CENTER (Cont)			
Radio Opr. Table Lights	5	0.65	3.3
Crypto Opr. Panel Lights	9	0.04	0.4
Crypto Opr. Console Lights	5	0.90	4.5
Compt 4 Steward Sta Lights	16	0.65	6.7
ALCC Panel Lights			
Controllers Console Panel Lights	4	0.04	0.16
AEAO (Left Console) Panel Lights	2	0.04	0.08
(Right Console) Panel Lights	6	0.04	0.24
Launch Control Panel Lights	20	0.04	0.80
494L Control Panel Lights	9	0.04	0.36
Launch Monitor Panel Lights	12	0.04	0.48
ARC-96			
L.F. Blower Control	1	1.5	1.5
L.F. Power Control	1	2.1	2.1

Figure 7-8 (Sheet 6A of 9)

* This chart lists all equipment that can be operated from the battery by placing the battery switch to EMERGENCY; the battery will then supply the following units through the hot battery bus, battery bus and switched DC bus. Other DC equipment will operate only under normal operation of the T-R units.

DC ELECTRICAL LOADS *			
EQUIPMENT	**NO. UNITS**	**AMPS PER UNIT**	**AVERAGE LOAD**
A-R			
A/R Manf to Eng Manf	1	2.0	Neg
A/R Manf Line Valve	1	2.0	Neg
ARR			
Alt. Slipway Door	1	1.35	Neg
ARR Bus Control	1	0.6	0.6
ARR Manual Control	1	2.0	Neg
ARR Signal Amplifier	1	6.8	5.0
ARR Valve	1	0.6	0.6
Fuel Level Checkout	1	0.23	Mom
Fuel Tank Level Control Valves	9	2.0	18.0
Manifold Valve	1	2.0	Mom
Manual Disconnect	1	0.28	Mom
Normal Slipway Door	1	1.35	1.3
Scavenge Valve	1	3.0	Neg
Valve Not In Flight Position Lt.	1	0.04	Neg
Wing Refuel Ind Light	1	0.04	Neg
BOOM OPERATOR'S PANEL			
A/R Control	1	5.0	5.0
Boom Nozzle Light	1	2.7	2.7
Boom Position Indicator	6	0.06	0.2
Spot and Press To Test Light	2	0.2	0.2
Underwing Illumination	2	1.8	3.6
Window Defrost	1	0.35	0.35
ELECTRONICS			
Interphone	1	1.2	1.2
L.F. Antenna Cable Cutter	1	Emergency only	
UHF Command No. 1 (AN/ARC-34 WITHOUT TCTO 1044)	1		
Receive		13.5	13.5
Transmit		18.0	4.5
UHF Command No. 1 (AN/ARC-164 WITH TCTO 1044)	1		
Receive		1.4	1.4
Transmit		4.1	4.1
ENGINES			
Engine Ignition	4	7.0	28.0
Engine Starter	4	1.0	1.0

Figure 7-8 (Sheet 7 of 9)

electrical equipment loads (cont)

DC ELECTRICAL LOADS * (CONT)

EQUIPMENT	NO. UNITS	AMPS PER UNIT	AVERAGE LOAD
FUEL AND OIL			
Fuel Dump Valve	1	1.6	1.6
Fuel Flowmeter Power Supply	1	0.45	0.45
Fuel Pressure Warn.	1	0.04	Neg
Fuel Valves			
Center Wing	2	5.0	Neg
Fire Shutoff	4	2.0	Neg
Tank to Engine Manifold	4	2.0	Neg
Wing to Aft Tank	4	2.0	Neg
Refuel Pump Control	4	1.0	4.0
HEATING AND VENTILATING			
Air Cond Shutoff	1	1.75	Neg
Alt. Press. & Aux Heat	2	2.23	Neg
Crossover Valve	1	1.5	Neg
Engine Bleed Air Shutoff	4	2.5	Neg
Ground Air Eject.	1	2.5	Neg
Ram Air	1	2.5	Neg
HYDRAULIC OIL			
Engine Hydraulic Oil Fire Shutoff	4	1.9	Neg
Hydraulic System Pressure	1	3.0	Neg
L.H. Auxiliary Hydraulic Pump	1	53.0	53.0
L.H. Hydraulic Pump Control	2	0.45	0.1
Rudder Power Control	1	1.2	1.2 (SW OFF)
Rudder Power Pressure Control	1	1.43	1.2
LIGHTING			
Boarding Lights	4	0.65	2.6
Emergency Exit Light Control	5	0.04	Neg
Entry Door Light	1	0.17	0.17
Magnetic Compass Light	1	0.04	0.04
Pilot's Spot Light	2	0.17	0.34
MISCELLANEOUS			
Windshield Wiper	2	4.86	9.72
POWER CONTROL			
Battery Charge	1	28.0	28.0 MAX
Comm Center AC Control	3	0.6	1.8
Comm Center DC System Tie	1	0.5	Neg
External Power & Bus Tie Isolate	1	0.40	0.40

Figure 7-8 (Sheet 8 of 9)

DC ELECTRICAL LOADS * (CONT)			
EQUIPMENT	NO. UNITS	AMPS PER UNIT	AVERAGE LOAD
POWER CONTROL (Cont)			
Generator Control	3	14.0	Neg
Ground Test	1	Neg	Neg
WARNING			
Alarm Bell	7	0.6	Emergency
BTB Open Indicator	3	0.04	Neg
Cabin Pressure Warning	1	0.17	Neg
Engine Fire Detector	4	0.17	Neg
Engine No. 3 Oil Pressure Warn.	1	.04	Neg
Generator Trip Indicator	6	0.04	Neg
Hydraulic Low Pressure Warn.	4	.04	Neg
Landing Gear Position and Warn.	3	0.27	0.8
Landing Gear Warn. Light	1	0.17	Neg
Switched Bus Failure Light	1	0.23	0.2
Warning Horn	1	5.5	5.5

Figure 7-8 (Sheet 9 of 9)

ISOLATION OF ONE OR MORE GENERATORS

Momentarily push the bus tie isolate switch. All three bus tie circuit breaker lights will illuminate, indicating that three generators are isolated. Reparallel generators as desired.

PARALLELING ISOLATED GENERATORS

If a generator has been isolated and parallel operation is desired, close the bus tie circuit breaker by moving the selected generator switch to CLOSE and hold until the bus tie circuit breaker light goes out. The generator switch should not be held in the CLOSE position longer than 10 seconds for automatic paralleling. It may be necessary to adjust throttle slightly to obtain proper frequency for paralleling.

GENERATOR SHUTDOWN

Move generator switch momentarily to the TRIP position; the generator circuit breaker light will illuminate. If the bus tie circuit breaker was open, an automatic reclose feature will close the bus tie circuit breaker. To override the automatic reclose, push the bus tie isolate switch while tripping the generator.

NOTE

On engine shutdown the generator drive underspeed switch will trip the generator circuit breaker at approximately 310 cps.

MAIN 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 reversed phase external power be subsequently applied.

NOTE

The APU generator is automatically tripped from the system when the external power receptacle cover is opened.

electrical operational loads

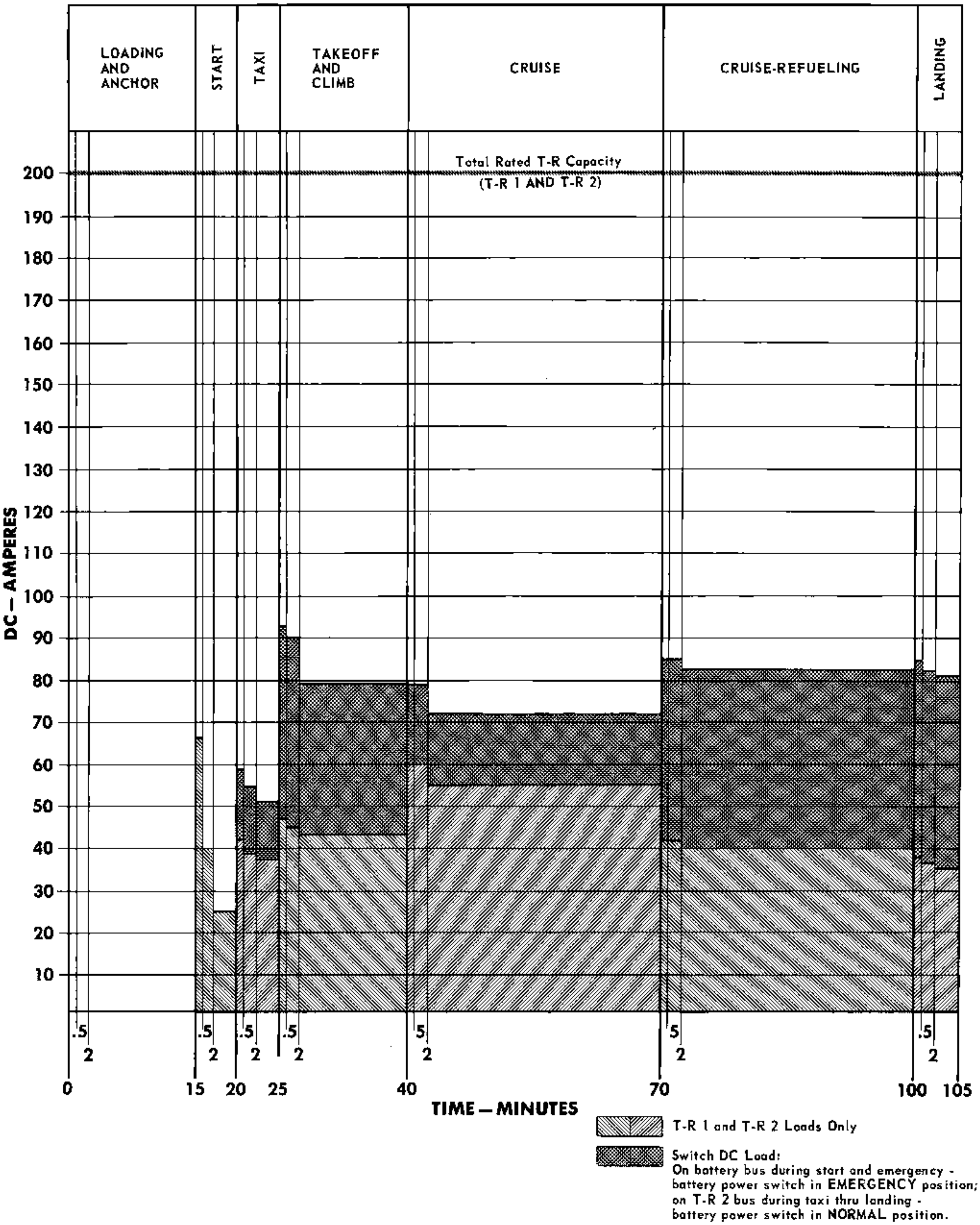


Figure 7-9 (Sheet 1 of 3)

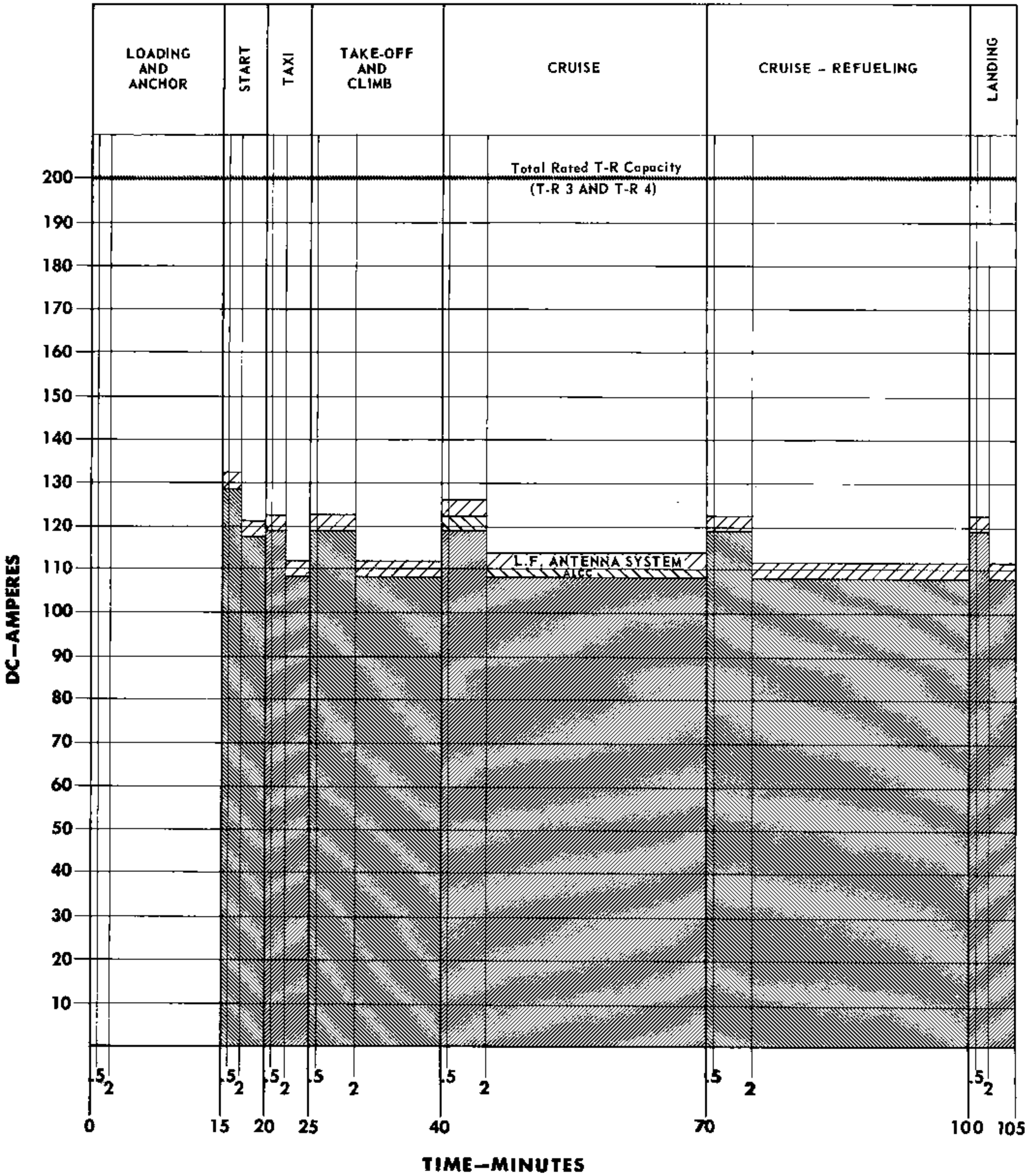


Figure 7-9 (Sheet 2 of 3)

electrical operational loads (cont)

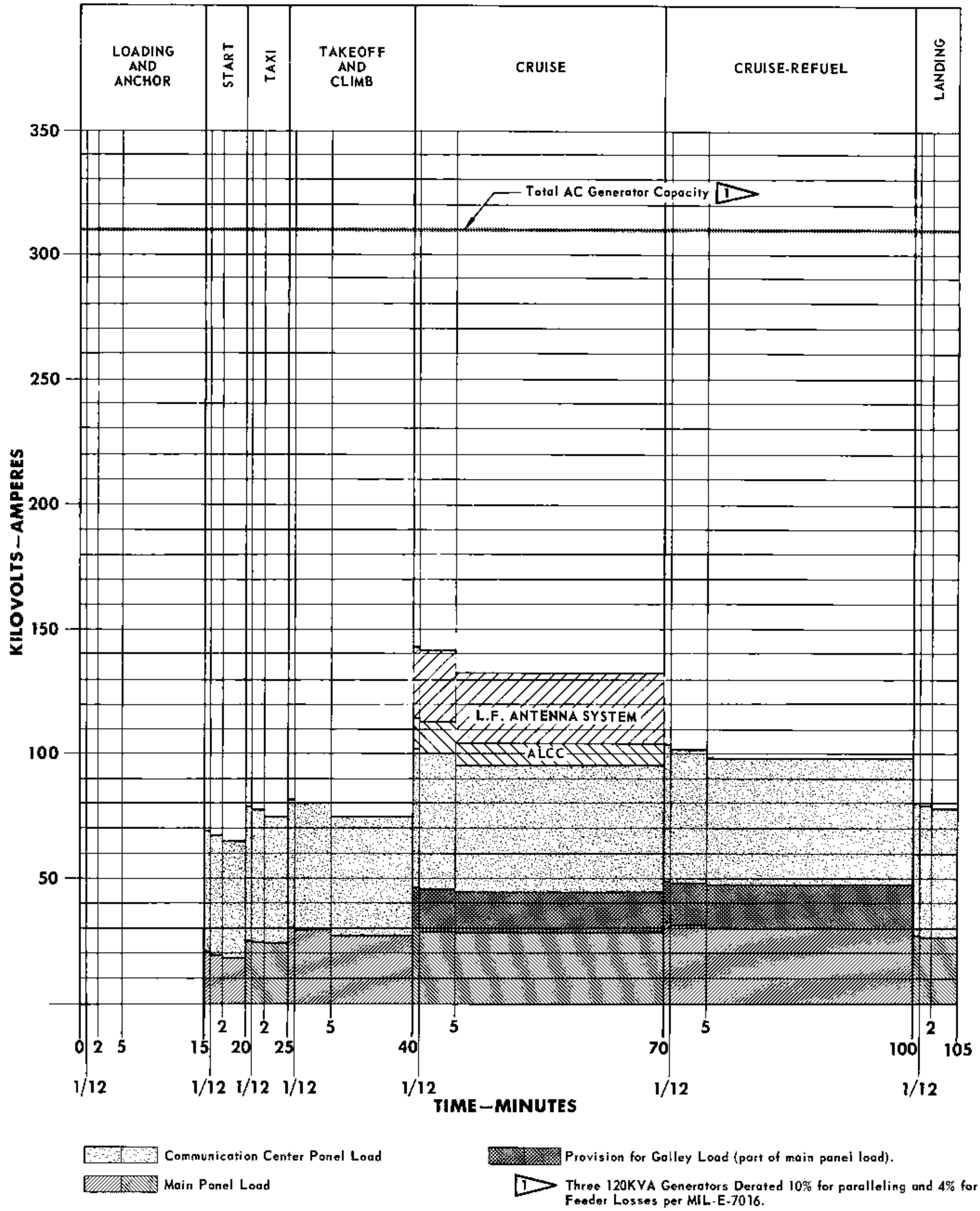


Figure 7-9 (Sheet 3 of 3)

A. Move battery power switch to the EMERGENCY position and check bus tie circuit open lights extinguished and generator circuit breaker open lights illuminated.

1. If any bus tie circuit open light is illuminated, move its generator switch momentarily to the TRIP position and if any generator breaker circuit open light is extinguished, move its generator switch to the TRIP position.

NOTE

If generator switch is moved to CLOSE with generator dead, the bus tie circuit breaker will close, then automatically trip within 2 seconds and then automatically reclose within 9 seconds of moving the switch.

B. Check power source.

1. If external power used, insert power plug into the forward external power receptacle.
2. If APU power used, check external power receptacle door is closed.

WARNING

A power plug with 28 volts DC on pin E and with pin F open, must be used to provide ground power to the airplane. If a power plug with pins E and F jumpered is used the normal interlocks in the airplane can override to permit airplane generators to be paralleled with ground power cart resulting in danger to personnel and damage to equipment.

C. Turn voltmeter and frequency meter selector on electrical control panel to EXT PWR and check voltage and frequency.

D. Move main 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 trips the main external power breaker.

To also power the communication center through the main external power receptacle:

H. Move the comm ctr airplane power switch to ON position.

NOTE

Changing battery switch positions can cause loss of power to the communication center bus while the comm center is powered from the main external power receptacle. The communication center airplane power switch will return to OFF, requiring reconnection of comm center power by placing the communication center airplane power switch to ON.

J. Check for voltage on T-R No. 3 and T-R No. 4.

COMM CENTER EXTERNAL POWER

External power may be used to operate the communication center electrical systems. The following procedure should be used when connecting external power to communication center (aft) external power receptacle.

NOTE

External power cannot be supplied to the main airplane busses through the communication center external power receptacle.

A. Check that the comm ctr external power switch (on the electrical control panel) is in the OFF position.

B. Turn the voltmeter and frequency meter selector on the electrical control panel to COMM CTR EXT PWR position.

C. Insert the power plug from the external power cart into the aft external power receptacle.

NOTE

A power plug with 28 volts DC on pin E must be used to provide ground power to the communication center loads through the communication center external power receptacle.

D. Using the voltmeter and frequency meter on the electrical control panel, check that the voltage and frequency are within limits.

E. Move the comm ctr external power switch on the electrical control panel to ON position.

F. Check for voltage on T-R No. 3 and T-R No. 4 using the ammeter and voltmeter selector on the electrical control panel at the TR 3 and TR 4 positions.

COMMUNICATION CENTER EXTERNAL/AIRPLANE POWER TRANSFER

Power for the communication center buses can be automatically transferred from comm center external power to airplane system power (and vice versa) with momentary paralleling, without power interruption during the switching operation. The following procedure must be followed when transferring electrical power.

CAUTION

When airplane generators are operating, do not attempt a power transfer unless all generators are operating in parallel or unless one generator is supplying power to all airplane buses through the bus tie breakers. If generators are isolated, damage to power system equipment may result due to paralleling out of phase on generators 2 and 4.

A. Transfer from comm center external power to airplane power on communication center buses with momentary paralleling:

1. Apply external power to the communication center buses per procedure under COMM CENTER EXTERNAL POWER, this section.
2. Operate all three generators in parallel or only one generator ON with bus tie circuit breakers closed.
3. Place the comm center airplane power switch to ON and hold until the comm center external power switch automatically moves to OFF. Power transfer is then complete.

NOTE

If transfer of power is not complete within approximately 10 seconds, release the comm center airplane power switch. Switch should return to OFF. The comm center airplane power and external power switches should never remain in the ON position at the same time.

B. Transfer from airplane power to comm center external power on the communication center buses with momentary paralleling:

1. With all three generators operating in parallel or one generator ON with all bus tie circuit breakers closed, apply airplane power to the communication center buses by placing the comm center airplane power switch to ON.
2. With the external power connected to the communication center external power receptacle, place the comm center external power switch to ON and hold until the comm center airplane power switch toggle automatically moves to OFF. Power transfer is then complete.

NOTE

If transfer of power is not complete within approximately 10 seconds, release the comm center external power switch. Switch should return to OFF. The comm center airplane power and external power switches should never remain in the ON position at the same time.

C. Power transfer can be accomplished as indicated in paragraphs A and B above with external power connected to the main (FWD) external power receptacle instead of generators operating.

battery charge status

(NICKEL-CADMIUM BATTERY)

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.

CHARGING VOLTAGE = 31.5V
CHARGING VOLTAGE = 30.0V
CHARGING VOLTAGE = 28.5V
CHARGING VOLTAGE = 27.0V
CHARGING VOLTAGE = 26.0V

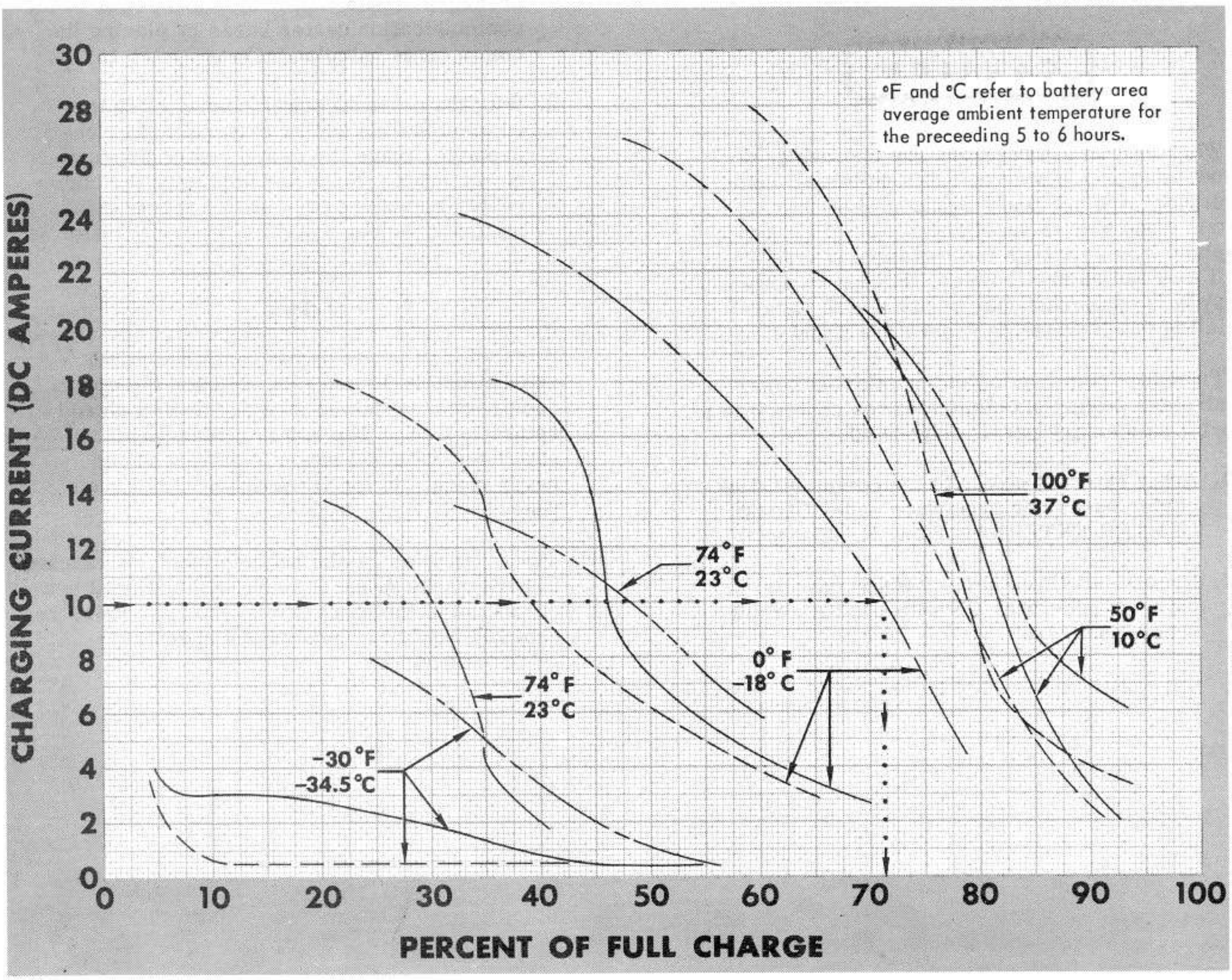


Figure 7-10

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:

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, the APU is operating or external power is connected. 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 nickel-cadmium battery for the APU 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 the circuit breakers on the ENG 2 GENERATOR section of the MCBP marked APU BATTERY CHARGE. When the battery charging ammeter reading is 4 amp or less during ground operation of the 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 APU 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. Refer also to APU OPERATION 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.

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. Therefore braking action is the most important 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(E)C-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 Section V.

D. With the modulated antiskid system, pilot technique is not a factor in obtaining maximum braking capability of the brakes. 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. 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, 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. The pilot should apply full brake pedal to obtain minimum stopping distance under any runway condition. The BRAKE LIMITS Chart, figure 5-14, sheet 1 is designed to be used for all maximum effort stops.

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. 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 antiskid 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 is:

A. Apply full brake pedal to obtain minimum stopping distance under any runway condition.

B. If directional control becomes difficult, release pressure to both brakes, level wings and reinitiate braking cycle.

ANTISKID 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 pressure should be kept to a 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.

section VIII

CREW DUTIES

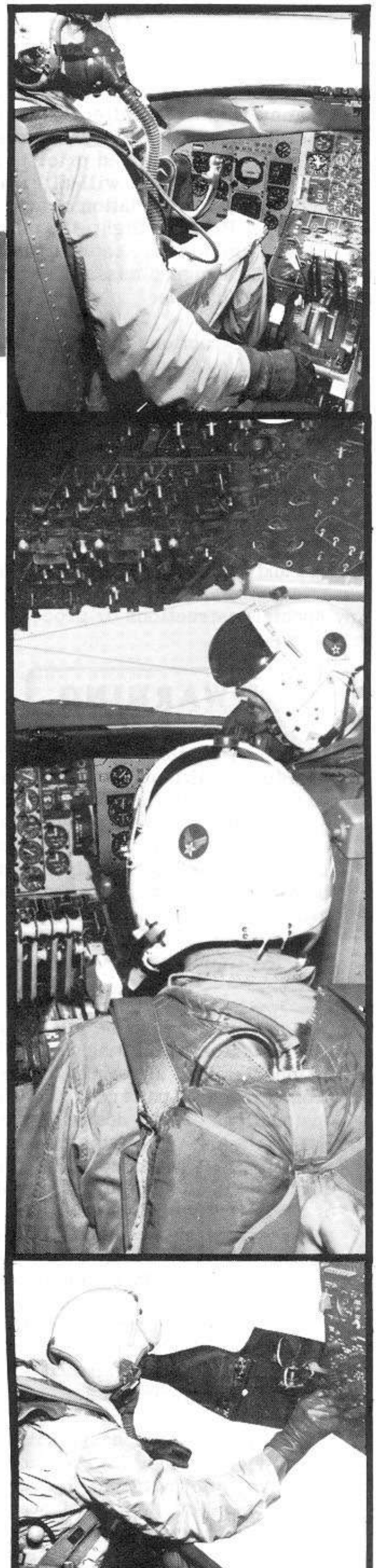


TABLE OF CONTENTS

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 crewmember must be constantly on the alert and will notify the responsible crew member 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 crew members. Prior to flight, the pilot must insure that all crew members 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.

WARNING

The pilot, copilot and navigator will monitor all altitudes being flown to ensure there are no deviations from air traffic clearances and that sufficient terrain clearance is provided. If descent is inadvertently continued below an assigned/published level-off altitude, immediately notify the pilot of the deviation over interphone using the CALL function if necessary.

NOTE

- 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 on or off oxygen.

E. Any electrical power source is changed.

F It is necessary for the pilot flying the airplane to transfer control of the airplane to the other pilot when he is required to do something which will divert his attention from flying, such as checking oxygen, tuning radios, changing fuel panel settings, etc.

WARNING

Pilots shall not exchange seats during flight if only two pilots are aboard.

7. The pilot intends to perform any critical maneuver, at which time all crew members will be secured in their respective positions.

All applicable crewmembers will acknowledge that the intended course of action is understood prior to actual accomplishment and will conduct themselves accordingly. All applicable crew positions, when practical, should monitor all communications outside the airplane by use of 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 will ascertain 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 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 jet 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 of a scale and projection to suit the requirements of the mission, and plot the required routes including departure route to be flown if a SID is to be flown or if 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 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

2. IFF Control Panel:

   a. Master Switch - OFF

   b. Mode 4 Code Switch - A or B (as applicable)

   c. Mode Enabling Switches - OUT

   d. Mode 4 ON/OUT Switch - ON

   e. Mode 3/A Code Selectors - Set

   Insure that all four Mode 3/A selectors are set to zero.

3. ASN-7 Mode Selector Switch - OFF

4. Auto-Nav Radar Control Panel:

   a. System Power Switch - OFF

b. System Monitor Switch - NORMAL

c. Radar Silence Switch - SILENT

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

Set heading select control to 360 -East Variation / +West Variation

i. Scan - OFF

j. Test Meter Switch - MAG

k. Range - 3-30/S

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 width switch as required.

8. Electronic Cabinet Cooling Switch - ON

9. Search Radar Indicator:

a. Range Delay Switch - OFF (down)

b. Intensity - CCW

c. Range 3/30 Control - CW

10. Interphone Selector - INTER

11. Liaison Radio - OFF

12. Radio Altimeter - OFF

12A. Parachute Preflight - Complete, if required

a. Inspection Record - Inspection and repack date checked

b. Personal Locator Beacon Lanyard - Snapped/Unsnapped (as required)

For peacetime operations, the personal locator beacon lanyard must be configured for automatic operation. When mission requirements dictate the necessity to avoid detection, the lanyard must be configured for non-automatic (manual) operation.

c. Bailout Bottle Pressure and Hose Connector - Checked

d. Personnel Lowering Device - Check condition (if attached)

e. Canopy Release, Ripcord and Arming Knob - Checked for defects and security

f. Pack and Harness - General condition checked

g. Parachute Straps - Adjusted (as required)

13. Crew Assembly - Complete

The assembly is conducted as outlined in INTERIOR INSPECTION, Section II.

14. Portable Oxygen Bottle - Checked

Insure the portable oxygen bottle at the crewmember's station is serviced and that the altitude selector knob is set to the NORMAL position.

15. Oxygen System - Check

See Section IV detailed oxygen check.

16. 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

5. ASN-7 Mode Selector Switch - STBY

6. ASN-7 Control Panel:

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/grivation setting in the variation window. If mission requirements dictate the use of manual variation, verify that manual values can be inserted into the computer.

d. ASN-7 Mode Selector Switch - OFF

7. 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.

8. 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. Master Switch - OFF

h. Mode enabling Switches - ON, as briefed

i. Modes 1 and 3/A - Set codes as briefed

Mode 1 code will be set. Mode 3/A code may be set upon receipt.

j. Audio/Light Switch - As desired

Insure switch is in AUDIO for EWO and alert cocking.

9. Altimeter - Set and checked

The copilot will obtain and relay the altimeter setting during his radio check. Insure that all 3 pointers are correctly positioned. See figure 1-59.

10. Liaison Radio:

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).

a. Time Hack - Obtain (if necessary)

Accomplish the following steps only if it is necessary to obtain a time hack:

(1) Mode Selector Switch - Briefed mode

(2) Reception - Check and obtain time hack

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

11. Navigator's Clock - Wind and set

12. Radio Altimeter - Checked

a. Rec Gain Knob - ON

b. Scale Switch - Times one

c. Rec Gain and Circle Size - Adjust

A 3 minute warmup is required.

d. Times One Zero Adjustment Knob - Adjust

e. Scale Switch - Times ten

f. Times Ten Function - Checked

g. Scale Switch - Times one

h. Rec Gain Knob - OFF

NOTE

Sequence of steps 9, 10, 11, and 12 may be varied to best suit mission requirements.

13. Celestial Observation Windows Thermal Radiation Curtains - Stowed or installed (as 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. ASN-7 Mode Selector Switch - STBY

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. Warning and Indicator Lights - Press to test

9. 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.

10. Command Radio - Monitor

TAXIING

1. Radio Altimeter - ON and set, if required

For missions that require the use of pressure pattern, it is permissible to delay turning the set to ON until just 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.

2. 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 4-20.)

b. Intensity Control - Rotate CW for faint trace

c. Focus Control - Adjusted

d. Scan Switch - As desired

e. Stab Switch - STAB (up)

f. 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. ASN-7 Mode Selector Switch - 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

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 values in the latitude and longitude display windows on the ASN-7 control panel will be set to grid coordinates while grid navigation is being performed, unless mission requirements prohibit use of 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, set DG mode, 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 set the J-4 to DG mode and set the present grid heading under the lubber line.

5. Search Radar Heading Select Control - As required

   Adjust the radar heading marker to the present grid heading.

6. ASN-7 Mode Selector Switch - PP RST or STBY
7. ASN-7 Variation - As required
8. Latitude and Longitude - Set
9. ASN-7 Mode Selector Switch - RUN

NOTE

- Steps 5, 6, and 7 may be accomplished prior to entry.
- Sequence of steps 4, 5, 6, 7, and 8 may be varied to best suit mission requirements.
- Omit steps 6, 7, and 8 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 degrees 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 set MAG mode (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) will be resolved by accomplishing a celestial heading check.

4. Search Radar Heading Select Control - Set to local variation

5. ASN-7 Variation - As required

6. ASN-7 Mode Selector Switch - PP RST or STBY

7. Latitude and Longitude - Set

8. ASN-7 Mode Selector Switch - 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

The navigator's primary responsibility during descent, penetration and approach is the close monitoring of airplane position and altitude relative to route and clearance. This will necessarily entail his undivided attention and scrutiny to provide timely and effective crew coordination. Mission paperwork and other extraneous actions not directly relating to descent and approach shall cease.

1. Latitude and Longitude - Corrected

2. ASN-7 Variation - As required

3. Review Penetration and Approach - Accomplished (P, CP, N)

   Prior to starting penetration or letdown, the pilot will insure 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 and subsequent approaches with copilot and navigator with particular emphasis on any intermediate altitude restrictions, minimum altitude and visibility for the type of approach, and missed approach procedure.

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. Altitude Calls - Report, as required (N, P, CP)

   The navigator will call off altitudes to the pilot passing each multiple of 5000 feet down to level-off altitude by stating over interphone, "Passing ____ feet for ____ feet." He will continue altitude calls passing 2000 feet and 1000 feet above any assigned or published level-off altitude by stating, "Passing ____ feet for ____ feet." In addition, he will alert the pilot 100 feet above level-off altitude and the applicable DH or MDA.

WARNING

The pilot, copilot and navigator will monitor all altitudes being flown to ensure there are no deviations from air traffic clearances and that sufficient terrain clearance is provided. If descent is inadvertently continued below an assigned/published level-off altitude, immediately notify the pilot of the deviation over interphone, using the CALL function if necessary.

7. Search Radar Heading Select Control - Set

8. Safety Belt and Shoulder Harness - Fastened

NOTE

Sequence of steps may be varied to best suit mission requirements.

AIRBORNE RADAR DIRECTED/MONITORED PENETRATIONS AND APPROACHES

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.

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 and 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 directions 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 1-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.

For multiple approaches, when conditions allow, the navigator may elect to act as a safety observer by visually checking for aircraft and other hazards. He must continue to alert the pilots as minimums are approached and be prepared to return to radar monitoring if the need arises.

AFTER LANDING

After the final landing has been completed, the following items will be completed as soon as practical.

1. Mode 4 Code Switch - As required

   If it is desired to retain the mode 4 code, momentarily place the mode 4 code switch to the HOLD position.

   NOTE

   When utilized after landing, 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.

1A. Mode 4 ON/OUT Switch - OUT

2. IFF Master Switch - OFF
3. ASN-7 Mode Selector Switch - OFF
4. Radar Silence Switch - SILENT
5. 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.

6. Radar/Rendezvous Beacon - OFF, if not previously accomplished
7. Liaison Radio Control Switch - OFF
8. Radio Altimeter Receiver Gain Knob - OFF
9. Oxygen System:
   a. Oxygen Supply Shutoff Lever - OFF
   b. Diluter Lever - 100% OXYGEN, and bleed pressure
10. Auto Nav System Power Switch - OFF, after airplane parked
11. Interphone Selector Switch - INTER

MULTIPLE FULL STOP LANDINGS

After Landing

1. IFF Master Switch - STBY
2. GPI - STBY
3. Radar Silence Switch - SILENT

4. Search Radar Function Switch - STBY, if required

The radar may be left in SEARCH if the energy beam will not create a hazard along the taxi route.

WARNING

Avoid directing the energy beam toward inhabited structures, personnel groupings, or areas where airplanes are being serviced with fuel. (See figure 4-20).

5. ASN-7 Control Panel - Latitude and longitude values set

Before Takeoff

1. Radio Call - Monitor
2. Search Radar Function Switch - SEARCH
3. Heading Select - Set

Takeoff and Climb

Accomplish normal TAKEOFF and AFTER TAKEOFF - CLIMB checklists.

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 4/5

COCKING (POSTURE 4/5)

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 4/5.

1. Radio Altimeter Receiver Gain Control - OFF
2. Liaison Radio Control Switch - OFF
3. Search Radar - Turn off (N, CP)
   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.

4. ASN-7 Mode Selector Switch - OFF
5. Auto Nav System Power Switch - OFF, after airplane parked

NOTE

The navigator's normal procedures also appear in T.O. 1C-135(E)C-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 or 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.

* 2. Portable Oxygen Bottle - Checked

Ensure the portable oxygen bottle at the boom operator's station is serviced and that the altitude selector knob is set to the NORMAL position.

3. Parachute Preflight - Complete (if required)

NOTE

In addition to preflighting his own parachute, the boom operator will preflight the spare parachute(s). Spare parachute(s) will be unbuckled and stowed in an easily accessible location.

a. Inspection Record - Inspection and repack date checked

b. Personal Locator Beacon Lanyard - Snapped/Unsnapped (as required)

For peacetime operations, the personal locator beacon lanyard must be configured for automatic operation. When mission requirements dictate the necessity to avoid detection, the lanyard must be configured for non-automatic (manual) operation.

c. Bailout Bottle Pressure and Hose Connector - Checked

d. Personnel Lowering Device - Check condition (if attached)

e. Canopy Release, Ripcord and Arming Knob - Checked for defects and security

f. Pack and Harness - General condition checked

g. Parachute Straps - Adjusted (as required)

* 4. Ground Safety Locks - Stow

* 5. Crew Assembly - Complete (P, CO)

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.

* 6. Boom Operator's Forward Station:

a. Interphone - Connect

b. Oxygen System - Check

Check oxygen equipment as outlined in Section IV.

* 7. 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.

Main Cabin

1. Main Cabin Temperature Control Switch - OFF

* 2. 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.

3. Main Cabin Oxygen Panels - OFF, 100% OXYGEN

* 4. 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.

5. Aft Scanning Station Interphone Panel - Check operation

6. Galley Vent Manual Valve - Closed

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

Turn light controls to full intensity.

11. Sighting Door - Check open

Visually check that sighting door has opened.

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. Check the illumination of the counters, bubble, and the dial lights.

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 two minute time period, at which time the shutter should fall. Some sextant averagers are set for one minute operation.

d. Alignment - Check

Set azimuth counter to 0 degrees, check security of projection lens lock nut, 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 mistakingly 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 degrees azimuth error could 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, and any change to limitations.

5. Cargo Compartment and Boom Pod Thermal Radiation Curtains and Eye Protective Devices - Stowed and sealed or installed (as applicable)

See ALERT PROCEDURES, Section II.

* 6. Equipment - Secure

Securing the flightcrew's equipment may be delayed until the ladder is stowed.

* 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. Switchboard/Cabin Cooling Valve - As required

This valve must be in CABIN AIRFLOW position when the APU is used for cabin heating, and must be in SWITCHBOARD COOLING position and locked when the air conditioning system is operating or when maximum cooling is required for electronics equipment. Intermediate positions of the valve allow auxiliary cooling system to be used for cabin cooling.

CAUTION

APU heat can damage electronics equipment if switchboard/cabin cooling valve is not in CABIN AIRFLOW position when APU is used for cabin heating.

2. Flow Divider Valve - As required

In CABIN HEAT position this valve directs APU heat and auxiliary cooling system air to the control cabin. The valve must be in NORMAL position for simultaneous operation of the air conditioning system and the auxiliary cooling system.

CAUTION

Operation of the air conditioning system with the flow divider valve in other than NORMAL position can result in damage to the auxiliary cooling system.

3. APU - Start (if applicable)

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 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. Boom Operator's Compartment Window Heat Switch - ON

9. Passengers and Extra Crewmembers - Notify to prepare 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. 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.

12. **MCBP BATTERY CHARGE Circuit Breakers - Pull (as applicable)**

Pull the three APU BATTERY CHARGE circuit breakers on the ENG 2 GENERATOR section of the MCBP.

13. 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.

14. Electrical Control Panel - Monitor

Boom operator will monitor the electrical control panel during taxi and takeoff.

BEFORE TAKEOFF

1. Nacelle Illumination Lights - ON

1A. Air Refueling Line Valve - OPEN

Insure the line valve override handle is positioned inboard toward the fuel manifold.

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. Switchboard/Cabin Cooling Valve - SWITCHBOARD COOLING, locked (if applicable)

5. Circuit Breakers - Check

Check the SBCBP, CIPP, MCBP (including BATTERY CHARGE CB's pulled), main AC power panel, and battery CB panel to insure that all circuit breakers are set.

6. 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.

7. 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.

8. Oxygen - ON and 100%

9. Safety Belt and Shoulder Harness - Fasten and lock

10. 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. Air Conditioning Master Switch - COND AIR

3. Sextant - Install (if applicable)

If additional height is needed to install the sextant, the navigator's sighting stool will be properly installed and utilized.

4. Main Cabin Temperature Control Switch - ON, Temperature Control - AUTOMATIC (set to desired temperature)

5. Main Cabin - Check

Check main cabin for fuel fumes and general condition. Check APU inlet and exhaust valves closed.

6. Boom - Check (drogue installed)

Check that boom is fully retracted (possibility that boom will extend when towing the drogue adapter).

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)

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. Main Cabin 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

TOUCH AND GO LANDING

1. Extra Crewmembers - Notify to prepare for touch and go landing(s) (as required)
2. Circuit Breakers - Set

   Check circuit breakers on MCBP and SBCBP when airplane turns downwind.

3. 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. Main Cabin Temperature Control 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.

6. Boarding Light Switch - OFF

   Turn OFF boarding light switch on main cabin temperature control panel.

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 Switch - ON
4. Primer Switch - ON
5. Start-Stop Switch - ON (momentarily)
6. Tachometer - Check (100 plus or minus 0.5%)
7. Primer Switch - OFF
8. AC Power Control Switch - RESET (momentarily) then ON

Heating Main Cabin

1. Main Cabin Temperature Control Switch - OFF
2. Air Conditioning Master Switch (Control Cabin) - RAM
3. Switchboard/Cabin Cooling Valve - CABIN AIRFLOW

CAUTION

APU heat can damage electronics equipment if switchboard/cabin cooling valve is not in CABIN AIRFLOW position.

4. Flow Divider Valve - As desired for control cabin heating
5. Boom Operator's Compartment Air Outlet Doors - Close

   Close emergency defrost slide prior to closing doors.

6. Main Cabin Distribution Duct Diffusers - As desired
7. Cabin Air Switch - ON
8. 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 Switch - OFF
2. AC Power Control Switch - OFF
3. Start-Stop Switch - OFF (momentarily)
4. Master 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. Switchboard/Cabin Cooling Valve - SWITCHBOARD COOLING, locked (if applicable)
7. APU Circuit Breakers - Open (if applicable)

   Open the battery charging circuit breakers on the APU.

8. Flow Divider Valve - NORMAL (if applicable)

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.

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. APU - START (if applicable)

2. Preflight - Assist, as required

3. APU - STOP (if applicable) (BO, CP)

Insure that CP has tripped external power switch prior to placing the AC Power Control Switch to the OFF position.

4. Battery Charge Circuit Breakers - Open (prior to departing the airplane)

Open the BATTERY CHARGE circuit breakers on the APU, and the three circuit breakers marked APU BATTERY CHARGE on the ENG 2 GENERATOR section of the MCBP.

5. 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. Nacelle Illumination Lights - OFF

4. APU - START (if applicable)

5. BO Window Heat Switch - OFF

6. APU - STOP

7. Entry Door Light - OFF

BOOM OPERATOR'S POSTURE 4/5 AND REPOSITIONED ALERT

COCKING (POSTURE 4/5 AND REPOSITIONED ALERT)

All checklists through the BEFORE TAKEOFF Checklist must have been completed prior to starting the Repositioned Alert Checklist.

1. APU - START (Prior to engine shutdown)

2. Oxygen Regulator - OFF, 100%

3. No. 3 Engine Starter CB - Open, close (CP, BO)

The No. 3 engine starter circuit breaker will be opened prior to cartridge insertion. The circuit breaker will be closed after cartridge insertion is complete.

SCRAMBLE (REPOSITIONED ALERT)

1. APU - OFF (After one generator is on the line)

2. APU Inlet and Exhaust Valves (3) - CLOSED

   Close cabin air inlet, compressor inlet, and turbine exhaust valves.

3. Flow Divider Valve - NORMAL

4. Switchboard/Cabin Cooling Valve - SWITCHBOARD COOLING, locked (if applicable)

NOTE

The boom operator's normal procedures appear in T. O. 1C-135(E)C-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.

RADIO OPERATOR

See T.O. 1C-135(E)C-1-2.

GROUND CREW

GROUND CREW CHECKLIST

NOTE

The abbreviated ground crew checklist is contained in the GC pages of the pilots checklist.

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 closed, ground wires, chocks, pitot covers, 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 through 25,000 feet - every 15 minutes
- Above 25,000 feet - every 5 minutes

When copilot calls for oxygen check, the crew members 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:

a. Copilot will make periodic checks of the oxygen quantity whenever airplane altitude is above 25,000 feet.

b. Passengers normally will not be carried during training flights.

c. 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:

a. All ground operation (including engine starts) except when accomplishing crew duties that preclude use of interphone.

b. During rendezvous and air refueling

c. During flight under weather conditions

d. Formation flying

e. During all takeoffs and landings

B. Whenever personnel are occupying main cabin 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 crew member 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, crew members 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 access covers and receptacle areas should be kept clear and the covers closed. The entry panel for covering the boom operator's compartment should be open and properly stowed, except on a passenger flight during which time it 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

NOTE

A computer flight plan may be used in lieu of Form 200. Crewmembers are responsible for the accuracy of the computer flight plan.

Form 200 is folded for planning so that the sheet with Fuel Flight Plan (pilot's copy) is on the bottom. Carbon paper is used by the navigator so as to duplicate the columns from the left of the form over 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

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 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 - Extend flights over water or over desolate areas. 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 against 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.

Jet 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 is determined by using 1500 pounds from brake release to flaps up speed.

Item B. CLIMB. Information is taken from the NRT Climb charts in Part 4 of the Appendix, T.O. 1C-135(E)C-1-1. For the sample, an NRT 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(E)C-1-1. During cruise, a fuel remaining entry is needed at approximately one hour intervals or prior to mission of procedures directed below:

profile changes (such as air refueling, changes in mission altitudes, etc.) to allow for a continuous crosscheck 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 1A7-6. Sufficient fuel should be on board to allow for 15 minutes additional orbit time to accommodate late receivers.

Item E. REFUELING. Fuel consumption figures for air refueling are found in T. O. 1C-135(E)C-1-1, pages 1A7-2 and 1A7-3. As a tanker with the boom down, use 200 pounds per minute, and as a receiver use 250 pounds per minute.

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 practice 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(E)C-1-1. Multiple departures can be computed from Part 5 of the Appendix, T.O. 1C-135(E)C-1-1. Low approaches and go-arounds or touch and go landings require fuel at an approximate rate of 8% of the airplane gross weight, e.g., airplane gross weight - 150,000 pounds, fuel consumption - 14,400 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.

Takeoff Computation Flight Progress, Form 201

NOTE

Use of this form is optional.

Takeoff Computations

Entries on this portion of the form are obtained from Form 365F and applicable parts of the Appendix, T.O. 1C-135(E)C-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 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 (± 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 the 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 the tactical 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.

sample mission flight plan

MISSION FLIGHT PLAN

SQ	WING	CREW NO	ACFT TYPE	ACFT SERIAL NO
5 ACCS	8 BW	S-181P	EC-135C	623585

PILOT (Name & Grade)	CO-PILOT (Name & Grade)	NAVIGATOR (Name & Grade)	RADAR NAVIGATOR (Name & Grade)	EW OFFICER (Name & Grade)	~~GUNNER OR~~ BOOM OPR (Name & Grade)	DATE OF TAKEOFF
BELL, LT COL	THIEMAN, MAJ	MOORE, MAJ			MOORE, MSGT	8 AUG 72

ENGINE START	TAKEOFF TIME	LANDING TIME	DURATION OF FLT

FROM BARKSDALE AFB ROUTE LA	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 0100	ATA	REMARKS
SETTOAC							DEV ° 0° M				10 10	:03 :03	10 10	0103		
DISANTE #2 TXK L/O	↗	302	180/30 -4	298	-7	291	↓		(360)	375	78 88	:12 :15	72 82	0115		
ARCP TUL 204/51	→	316	270/50 -5	311	-8	303	-36° 26.0 M	.695	417	380	162 250	:26 :41	181	0141		
ORBIT	↓	251 071	✓ +2/-2	253 069	-8	245 061		275	397			:19 1:00		ARCT 0200		
AR EXIT PT ARG 282/74	↓	073	✓ -2	071	-7	064	↓	275	397	445	200 450	:27 1:27	179	0227		
OFFLOAD				10,000#												
ST NAV ARG 005/41	→	076	270/50 -2	074	-5	069	-42° 29.0 M	.730	433	482	80 530	:10 1:37	72	0237		
EVV 194/40		078	✓ -1	077	-4	073					138 668	:17 1:54	123	0254		
LOU 103/74		080	✓ -1	079	-1	078	↓	↓	↓	↓	192 860	:24 2:18	173	0318		
EVV 137/36		259	✓ +1	260	0	260	-46 31.0 M	.725	425	378	168 1028	:27 2:45	191	0345		
END NAV ARG 010/47		257	✓ +1	258	-3	255					168 1196	:27 3:12	191	0412		
ARIP ARG 282/74		255	✓ +2	257	-5	252					85 1281	:14 3:26	99	0426		
ST. DESC	↓	254	✓ +2	256	-6	250	↓	↓	↓	↓	18 1299	:03 3:29	21	0429		
ARCP FYV 212/19	↘	254	✓ +2	256	-6	250	-34° 25.0 M	310	436	390	80 1379	:12 3:41	88	ARCT 0441		
AR EXIT PT OKC 205/40	→	251	✓ +2	253	-8	245	-36° 26.0 M	275	397	350	201 1580	:35 4:16	230	0516		
ONLOAD				10,000#												
TXK 246/55	→	121	270/50 +3	124	-8	116	-42° 29.0 M	.710	421	462	190 1770	:25 4:41	175	0541		
EMG	↓	122	✓ +3	125	-7	118	↓	↓	↓	↓	93 1863	:12 4:53	84	0553		
AIRWORK, PENETRATION AND LANDINGS												* 2:07 7:00		0800		

* THIS ENTRY MAY BE BROKEN DOWN INTO SEPARATE TIME ELEMENTS FOR EACH TYPE OF ACTIVITY AT THE CONVENIENCE OF THE CREW.

SAC FORM 200 MAR 66 — REPLACES PREVIOUS EDITION AND SAC FORMS 1, 1A & 201, WHICH ARE OBSOLETE.

Navigator's Copy

PAGE 1 OF 4 PAGES

Figure 8-1 (Sheet 1 of 2)

F-393

MISSION FLIGHT PLAN	SQ 5 ACCS	WING 8 BW	CREW NO S-181P	ACFT TYPE EC-135C	ACFT SERIAL NO 623585

PILOT (Name & Grade)	CO-PILOT (Name & Grade)	NAVIGATOR (Name & Grade)	RADAR NAVIGATOR (Name & Grade)	EW OFFICER (Name & Grade)	~~GUNNER OR~~ BOOM OPR (Name & Grade)	NOTES
BELL, LT COL	THIEMAN, MAJ	MOORE, MAJ			MOORE, MSGT	

FROM: BARKSDALE AFB ROUTE: LA	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
														0100	120.0	257.0
SETTOAC							DEV 0°				10 10	:03 :03	10 10	0103	3.2 116.8	3.2 253.8
DISANTE # 2 TKK L/O	↗	302	180/30 -4	298	-7	291	↓		(360)	375	78 88	:12 :15	72 82	0115	4.9 111.9	4.9 248.9
ARCP TUL 204/51	→	316	270/50 -5	311	-8	303	-36° 26.0	.695	417	380	162 250	:26 :41	181	0141	4.7 107.2	4.7 244.2
ORBIT	↓	251 071	✓ +2/-2	253 069	-8	245 061	↓	275	397			:19 1:00		ARCT 0200	3.5 103.7	3.5 240.7
AR EXIT PT ARG 282/74	↓	073	✓ -2	071	-7	064	↓	275	397	445	200 450	:27 1:27	179	0227	5.4 98.3	5.4 235.3
OFFLOAD				10,000 #											10.0 88.3	10.0 225.3
ST NAV ARG 005/41	→	076	270/50 -2	074	-5	069	-42° 29.0	.730	433	482	80 530	:10 1:37	72	0237	1.7 86.6	1.7 223.6
EVV 194/40	↓	078	✓ -1	077	-4	073	↓	↓	↓	↓	138 668	:17 1:54	123	0254	2.9 83.7	2.9 220.7
LOU 103/74	↓	080	✓ -1	079	-1	078	↓	↓	↓	↓	192 860	:24 2:18	173	0318	4.0 79.7	4.0 216.7
EVV 137/36	↓	259	✓ +1	260	0	260	-46° 31.0	.725	425	378	168 1028	:27 2:45	191	0345	4.4 75.3	4.4 212.3
END NAV ARG 010/47	↓	257	✓ +1	258	-3	255	↓	↓	↓	↓	168 1196	:27 3:12	191	0412	4.3 71.0	4.3 208.0
ARIP ARG 282/74	↓	255	✓ +2	257	-5	252	↓	↓	↓	↓	85 1281	:14 3:26	99	0426	2.2 68.8	2.2 205.8
ST. DESC	↓	254	✓ +2	256	-6	250	↓	↓	↓	↓	18 1299	:03 3:29	21	0429	↓	↓
ARCP FYV 212/19	↘	254	✓ +2	256	-6	250	-34° 25.0	310	438	390	80 1379	:12 3:41	88	ARCT 0441	2.7 66.1	2.7 203.1
AR EXIT PT OKC 205/40	→	251	✓ +2	253	-8	245	-36° 26.0	275	397	350	201 1580	:35 4:16	230	0516	8.8 57.3	8.8 194.3
ONLOAD				10,000 #											10.0 67.3	10.0 204.3
TKK 246/55	→	121	270/50 +3	124	-8	116	-42° 29.0	.710	421	462	190 1770	:25 4:41	175	0541	3.9 63.4	3.9 200.4
EMG	↓	122	✓ +3	125	-7	118	↓	↓	↓	↓	93 1863	:12 4:53	84	0553	1.8 61.6	1.8 198.6
AIRWORK, PENETRATION AND LANDINGS											*	2:07 7:00		0800	27.8 33.8	27.8 170.8

*THIS ENTRY MAY BE BROKEN DOWN INTO SEPARATE TIME ELEMENTS FOR EACH TYPE OF ACTIVITY AT THE CONVENIENCE OF THE CREW.

SAC FORM 200 MAR 68 — Pilot's Copy — PAGE 3 OF 4 PAGES

F-394

Figure 8-1 (Sheet 2 of 2)

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/C	BAR	EAR	BAR	EAR	CR I	B/DSC	RAMP			
TIME				0409	0425	0530	0545	0618	0733	0840	1052			
ALTITUDE				290	260	270	270	270	350	350				
IAS				300	275	275	275	255	268	268				
OAT (Gage)				-20	-24	-20	-20	-25	-34	-34				
MACH				.77	.665	.68	.68	.63	.78	.78				
FUEL														
NO 1 RES	2.8	2.8			2.8	2.8	2.8	2.8	2.8					
NO 1	13.4	13.4			11.3	7.3	7.3	5.6	5.6					
NO 2	14.8	14.8			12.7	8.6	8.6	7.0	7.0					
FWD BODY	1.6	1.6			1.6	6.6	6.6	3.0	3.0					
CTR WG	47.5	47.5			44.4	44.4	41.5	31.7	15.9					
AFT BODY	11.6	11.6			11.6	16.6	16.6	—	—					
NO 3	14.8	14.8			12.7	8.6	8.6	7.0	7.0					
NO 4	13.4	13.4			11.2	7.2	7.2	5.5	5.5					
NO 4 RES	2.8	2.8			2.8	2.8	2.8	2.8	2.8					
TOTAL	122.7	122.7			111.1	104.9	102.0	65.4	49.6					
TOTALIZER		122.7	120.7	114.2	111.1	104.9	102.0	65.4	49.6	44.3	9.5			
CONDITION														
TIME														
ALTITUDE														
IAS														
OAT (Gage)														
MACH														
FUEL														
TOTAL														
TOTALIZER														

F-395

Figure 8-2

sample pilot flight progress chart

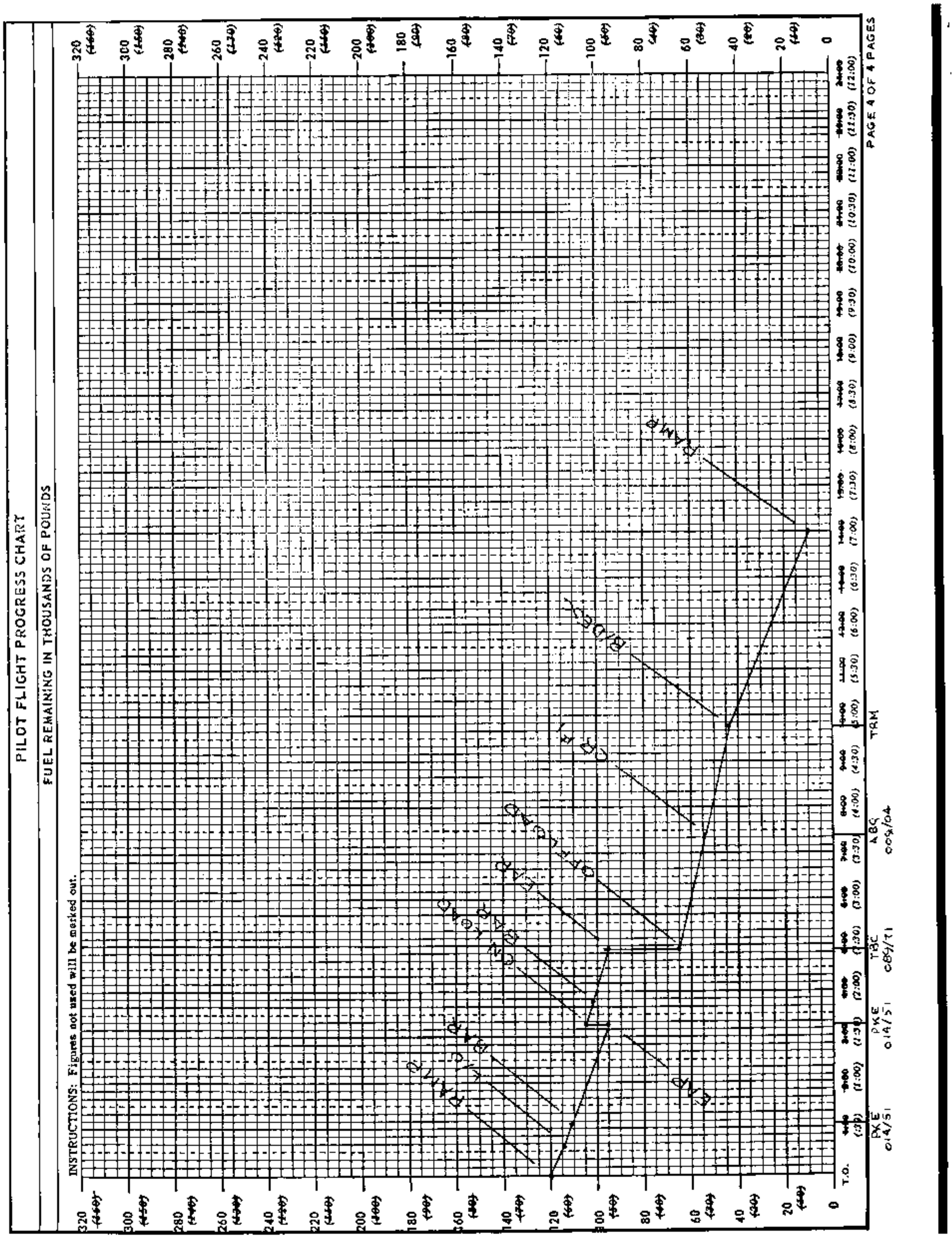


Figure 8-3

F-396

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-1165 computer plate was used to complete figure 8-4.

The following list of mission planning factors will be used for all missions when the actual weight of individual items are not available.

20 man life raft	-- 155 pounds each
1 man life raft	-- 20 pounds each
Life vest or RI 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
Air refueling drogue	-- 120 pounds each (Index change + 0.6 installed)
Crewmember with professional equipment	-- 250 pounds each

Loading Data Form 365F (Tactical)

The following information refers to figure 8-4.

A. FORM HEADING: Enter necessary identifying information at top of form.

B. BASIC AIRPLANE: (Ref 1) Enter the basic weight and index.

C. OIL: (Ref 2) Enter the weight of engine oil, 376 pounds. (Ref 2, line 2) When appropriate, enter weight and index of drogue.

D. DISTRIBUTION OF LOAD: (Ref 3) Enter by compartment and appropriate column, all crewmembers, extra crewmembers, and additional items, including emergency equipment and passengers.

E. OPERATING WEIGHT. (Ref 4) The operating weight entry will be the sum of the weights entered above in references 1 thru 3.

F. 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.

G. FUEL: (Ref 7) Enter weight and index of the planned fuel loading.

H. TAKEOFF CONDITION: (Uncorrected) (Ref 10) This entry will be the total of all weights entered in references 4 and 7.

I. 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.

J. 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.

K. 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, 16, and permissible C.G. for landing in the limitations block need not be computed prior to flight if the planned gross weight for landing does not exceed 200,000 pounds.

L. LESS EXPENDABLES: (Ref 14) Indicate fuel expended by weight and index.

M. ESTIMATED LANDING CONDITION: (Ref 15) Subtract total of reference 14 from takeoff condition.

N. 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.

O. LIMITATIONS: Enter the permissible gross weight and permissible cg for takeoff and landing.

USE OF AFTO FORM 7

AFTO Form 7 is the aircraft refueling, defeuling and distribution log. There are two 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 Block 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.

form 365F (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: 16 JULY 65	AIRCRAFT TYPE: EC-135C	FROM: BARKSDALE AFB, LA.	HOME STATION: BARKSDALE AFB, LA.
MISSION/TRIP/FLIGHT/NO.: AR/NAV	SERIAL NO.: AF 62-3584	TO: BARKSDALE AFB, LA.	PILOT: BANKS, R.K.

REMARKS: FUEL

	PLANNED	ACTUAL
R	5.6	5.5
O	26.8	26.6
I	29.5	29.0
C	47.5	47.2
A	28.4	28.6
F	12.2	12.1
Tot	150.0	149.0
Tx	- 2.0	- 2.0
Tot	148.0	147.0

COMPUTER PLATE NO. *(If used)*: E-1165

REF	ITEM	WEIGHT	[1] INDEX OR ~~MOM~~
1	BASIC AIRCRAFT *(From Chart C)*	129160	516
2	OIL (Gal.)	376	516
3	DISTRIBUTION OF LOAD		

COMPT.	CREW NO.	CREW WEIGHT	BAGGAGE	CARGO AND MISC.	WEIGHT	[1] INDEX OR ~~MOM~~
B	4	1000			1000	488
C				500	500	480
D	3	750		850	1600	471
E	8	2000		800	2800	490
F	2	500		450	950	501

REF	ITEM		WEIGHT	[1] INDEX OR ~~MOM~~
4	OPERATING WEIGHT		136386	501
5	AMMUNITION	COMPT. / ROUNDS / CALIBER		
6	BOMBS, ROCKETS, ETC.	FORWARD		
		AFT		
		EXTERNAL		
		ROCKETS		
7	FUEL	BUILT IN (Gal.)	148000	428
		BOMB BAY (Gal.)		
		EXTERNAL (Gal.)		
8	WATER INJ. FLUID (Gal.)			
9	JATO OR RATO			
10	TAKEOFF CONDITION *(Uncorrected)*		284386	428
11	CORRECTIONS *(If required)*		-850	434
12	TAKEOFF CONDITION *(Corrected)*		283436	434
13	TAKEOFF C. G. IN % M. A. C. ~~OR IN.~~		~~25.8~~ 26.0	
14	LESS EXPENDABLES	JATO OR RATO		
		BOMBS		
		AMMUNITION		
		FUEL		
15	ESTIMATED LANDING CONDITION			
16	ESTIMATED LANDING C. G. IN % M. A. C. ~~OR IN.~~			

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	[1] INDEX OR ~~MOM~~
	FUEL	-1000	43.5
	EXTRA EQUIP	+150	43.4
	TOTAL WEIGHT REMOVED	-1000	-
	TOTAL WEIGHT ADDED	+150	+
	NET DIFFERENCE *(Ref. 11)*	-850	43.4

sample

LIMITATIONS

[2] GROSS WT. TAKEOFF *(lb.)*: 299,000	[2] GROSS WT. LANDING *(lb.)*: 297,000	
[3] PERMISSIBLE C. G. TAKEOFF	FROM: 19.2	TO (% M. A. C.): 31.9
[4] PERMISSIBLE C. G. LANDING	FROM:	TO (% M. A. C.):

COMPUTED BY *(Signature)*: /S/ JOE G. ROSS, SMSGT.

WEIGHT AND BALANCE AUTHORITY *(Signature)*:

PILOT *(Signature)*: /S/ ROBERT K. BANKS, MAJ., USAF

[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).*

DD FORM 1 SEPT 54 365F

Figure 8-4

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
1	50000	2734	8000	8000	8000	8000	2734	2000	10332	200
2	55000		9000	9000	9000	9000		2000	11332	200
3	60000		10000	10000	10000	10000		2000	12332	200
4	65000		10500	10500	10500	10500		2000	15332	200
5	70000		11500	11500	11500	11500		2000	16332	200
6	75000		12750	12750	12750	12750		2000	16332	200
7	80000		12991	14333	14333	12991		2000	17684	200
8	85000							2000	20384	2500
9	90000							2000	23384	4500
10	95000							2000	26384	6500
11	100000							3000	28884	8000
12	105000							3000	31884	10000
13	110000							4000	34384	11500
14	115000							5000	36384	13500
15	120000	FULL	FULL	FULL	FULL	FULL	FULL	6500	38084	15300
16	125000							6500	42084	16300
17	130000							7000	44084	18800
18	135000							8000	46028	20856
19	140000							9500		24356
20	145000							12000		26856
21	150000							14000		29856
22	155000							16000	FULL	32856
23	160000							18000		35856
24	165000							20000		38856
25	170000							23675		40181
26	175000							28675		FULL
27	180000	2734	12991	14333	14333	12991	2734	33675	46028	40181

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 8-5 (Sheet 1 of 3)

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
1	50000	2778	8000	8000	8000	8000	2778	2000	10244	200
2	55000		9000	9000	9000	9000		2000	11244	200
3	60000		10000	10000	10000	10000		2000	12244	200
4	65000		10500	10500	10500	10500		2000	15244	200
5	70000		11500	11500	11500	11500		2000	16244	200
6	75000		12750	12750	12750	12750		2000	16244	200
7	80000		13197	14560	14560	13197		2000	16730	200
8	85000							2000	19930	2000
9	90000							2000	22930	4000
10	95000							2000	25930	6000
11	100000							3000	28430	7500
12	105000							3000	31430	9500
13	110000							4000	33930	11000
14	115000							5000	35930	13000
15	120000	FULL	FULL	FULL	FULL	FULL	FULL	6500	37630	14800
16	125000							6500	41630	15800
17	130000							7000	43630	18300
18	135000							8000	45630	20300
19	140000							8500	46758	23672
20	145000							11000		26172
21	150000							13000		29172
22	155000							15000		32172
23	160000							17000	FULL	35172
24	165000							19000		38172
25	170000							21353		40819
26	175000							26353		FULL
27	180000	2778	13197	14560	14560	13197	2778	31353	46758	40819

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 8-5 (Sheet 2 of 3)

standard fuel loads (cont)

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
1	50000	2821	8000	8000	8000	8000	2821	2000	10158	200
2	55000		9000	9000	9000	9000		2000	11158	200
3	60000		10000	10000	10000	10000		2000	12158	200
4	65000		10500	10500	10500	10500		2000	15158	200
5	70000		11500	11500	11500	11500		2000	16158	200
6	75000		12750	12750	12750	12750		2000	16158	200
7	80000		13403	14288	14288	13403		2000	16776	200
8	85000			14788	14788			2000	19276	1700
9	90000							2000	22276	3700
10	95000							2000	25276	5700
11	100000							3000	27776	7200
12	105000							3000	30776	9200
13	110000							4000	33276	10700
14	115000							5000	35276	12700
15	120000	FULL	FULL	FULL	FULL	FULL	FULL	6500	36976	14500
16	125000							6500	40976	15500
17	130000							7000	42976	18000
18	135000							8000	44976	20000
19	140000							8000	47489	22487
20	145000							10500		24987
21	150000							12500		27987
22	155000							14500		30987
23	160000							16500	FULL	33987
24	165000							18500		36987
25	170000							20500		39987
26	175000							24030		41457
27	180000	2821	13403	14788	14788	13403	2821	29030	47489	FULL

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 8-5 (Sheet 3 of 3)

section IX

ALL WEATHER OPERATION

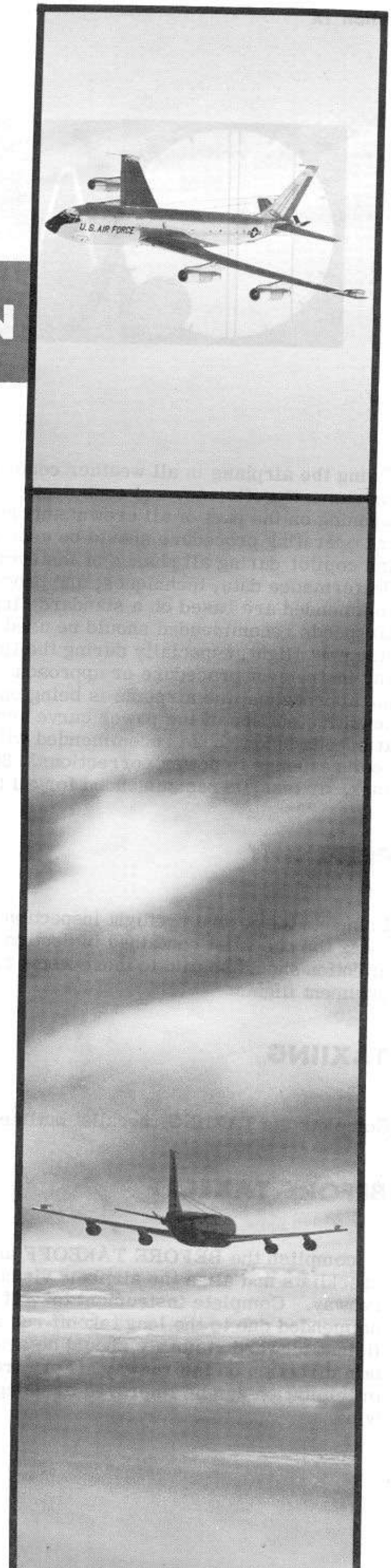
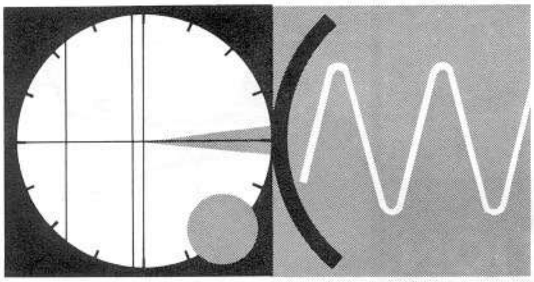


TABLE OF CONTENTS

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 used 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. 30 degrees of bank, or less, is recommended for all turns.

PREFLIGHT

Complete the normal preflight inspection of the airplane using 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. Complete instrument takeoffs are not recommended due to the long takeoff run required. Sufficient forward visibility should be available to maintain direction on the runway. Forward visibility in precipitation can be improved by using the 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 anticollision 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(E)C-1-1.

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

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 systems.

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 4-17A. Heading reference signals for VOR 1 and TACAN come from the N-1 compass, and for VOR 2 from the J-4 compass.

HOLDING

The airspeed to be maintained in the holding pattern is obtained from the HOLDING SPEED chart in T.O. 1C-135(E)C-1CL-1.

NOTE

Holding speed is approximately 10 knots greater than endurance speed; therefore, add 3% to the fuel consumption values derived from the chart in Part 6 of the Appendix T.O. 1C-135(E)C-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(E)C-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

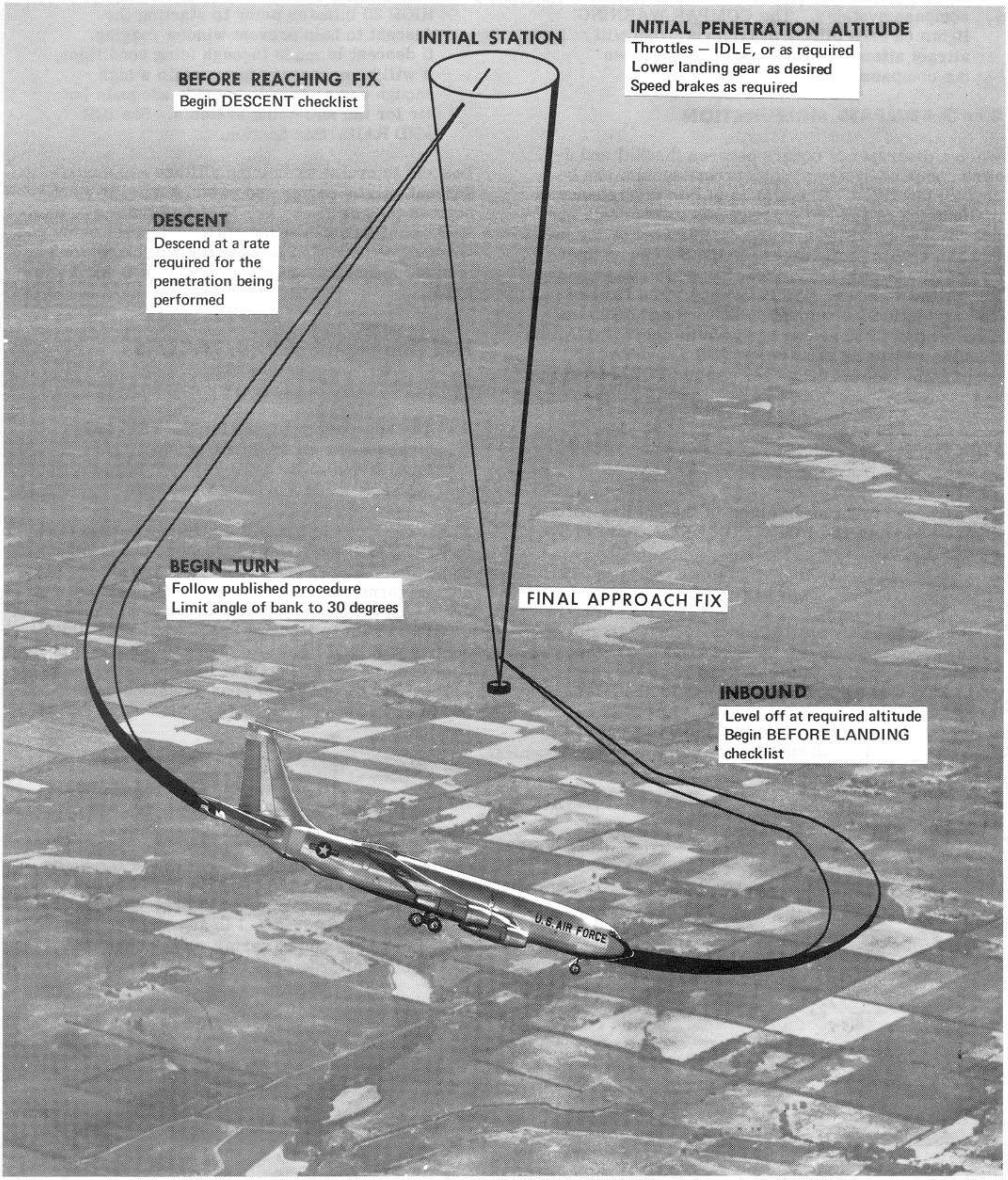
The approach category for the EC-135C airplane and all modified versions thereof, is as stated in the DOD FLIGHT INFORMATION PUBLICATION PLANNING.

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(E)C-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.

typical jet penetration



F-1412
F-690

Figure 9-1A

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.

WARNING

Speed brakes shall not be used at any time below 1000 feet above field elevation during the final approach phase.

NOTE

Approaches with less than 50 degrees flaps will be flown at the appropriate approach speed.

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 degrees flap pattern speed until turning base or final, then use visual techniques and procedures.

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 described 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, 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 the 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. 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 inboard 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.

typical FD/RGA system ILS approach

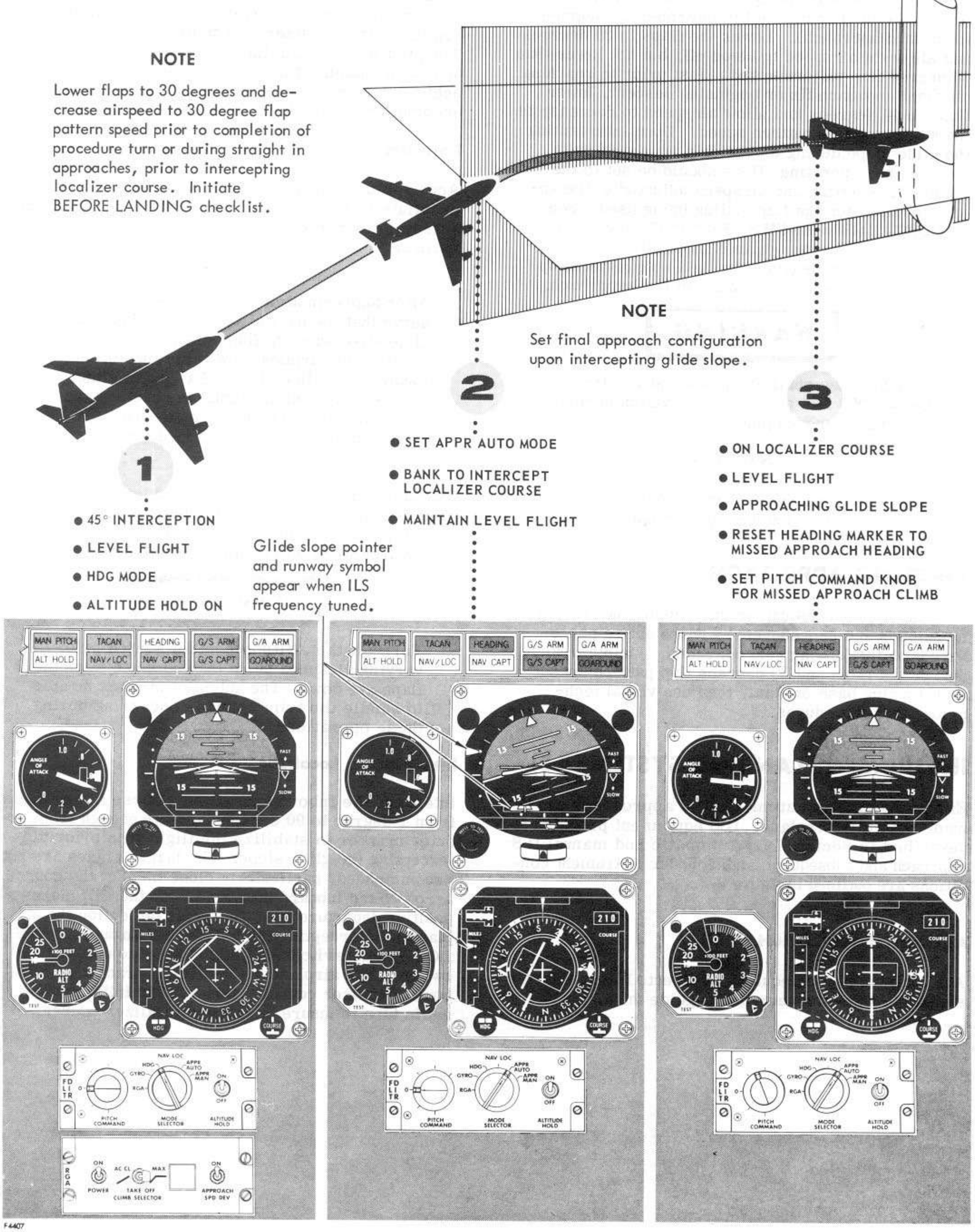


Figure 9-2 (Sheet 1 of 2)

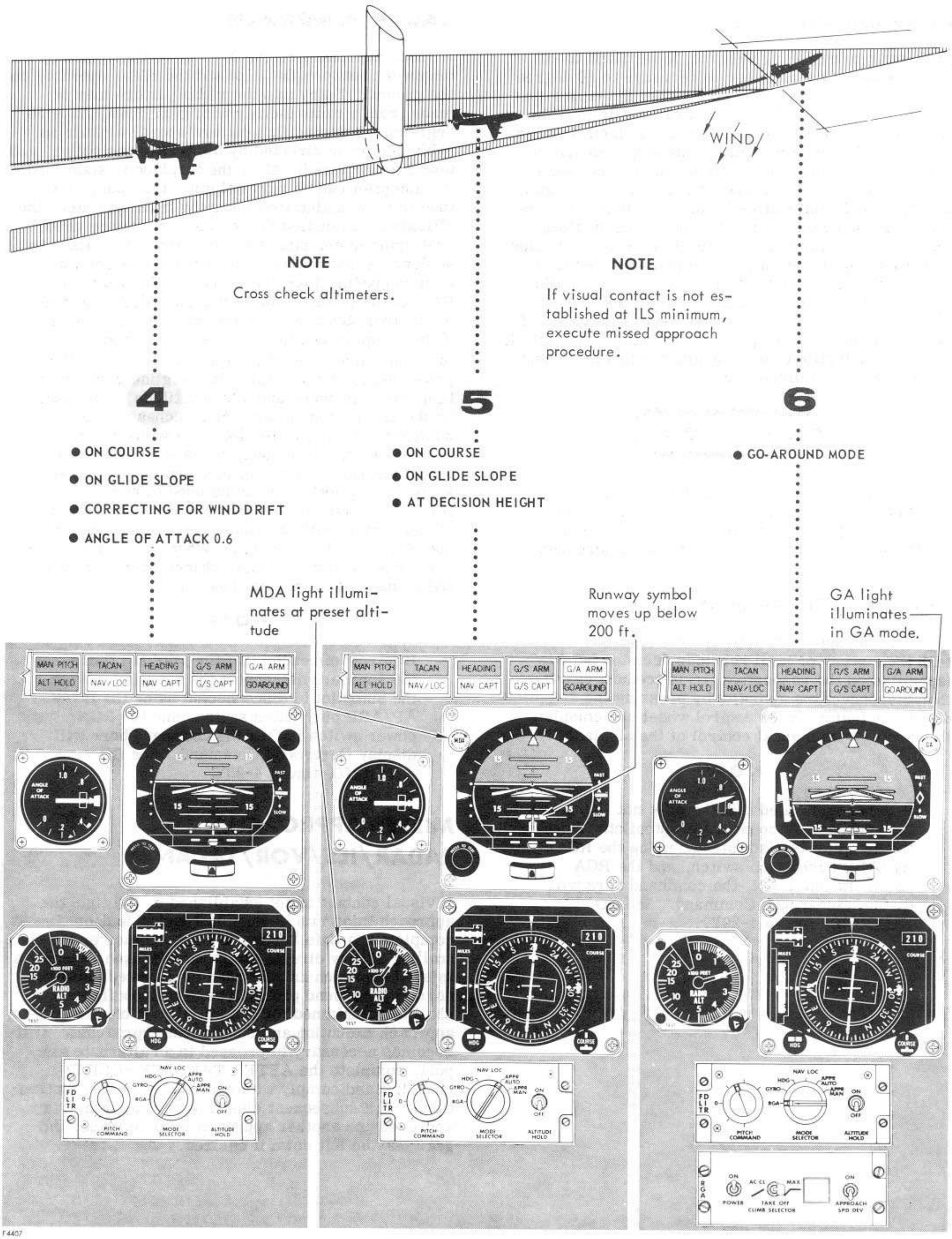


Figure 9-2 (Sheet 2 of 2)

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 the 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 disengage 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/ARR pushbutton switch, and the RGA power switch is ON, the command bars will display Go-around Command. See GO-AROUND, figure 4-29Y.

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, the altitude hold function of the autopilot may be used. Just prior to entering 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 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/ARR pushbutton switch, and the RGA power switch is ON, the command bars will display Go-around Command. See GO-AROUND, figure 4-29Y.

MISSED APPROACH, RADAR/ILS/VOR/TACAN

If visual contact is not established by the time the approach minimum altitude is reached and/or time is completed, a safe landing is not possible, or the controlling agency directs a missed approach, execute a missed approach as published or directed using the normal go-around procedures. This configuration shall be maintained for the initial part of missed approach execution and subsequent approaches. If it becomes necessary to proceed to an alternate airport, complete 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 if desired.

radar approach

ENTRY

Gear Down
Flaps 30 Degrees
30 Degree Flap Pattern Speed
Power as required

FINAL

Just prior to entering glide path lower flaps to 40 degrees. Reduce airspeed to 40° 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.

GLIDE PATH

Maintain airspeed.

MISSED APPROACH

Actuate RGA switch
Throttles – as required (not to exceed NRT)
Speed brakes retracted
Establish climb attitude
Flaps to 30 degrees on retraction schedule
Landing gear up
30 degree flap pattern speed

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 the airplane is established in a climb, contact the controlling agency and state intentions.

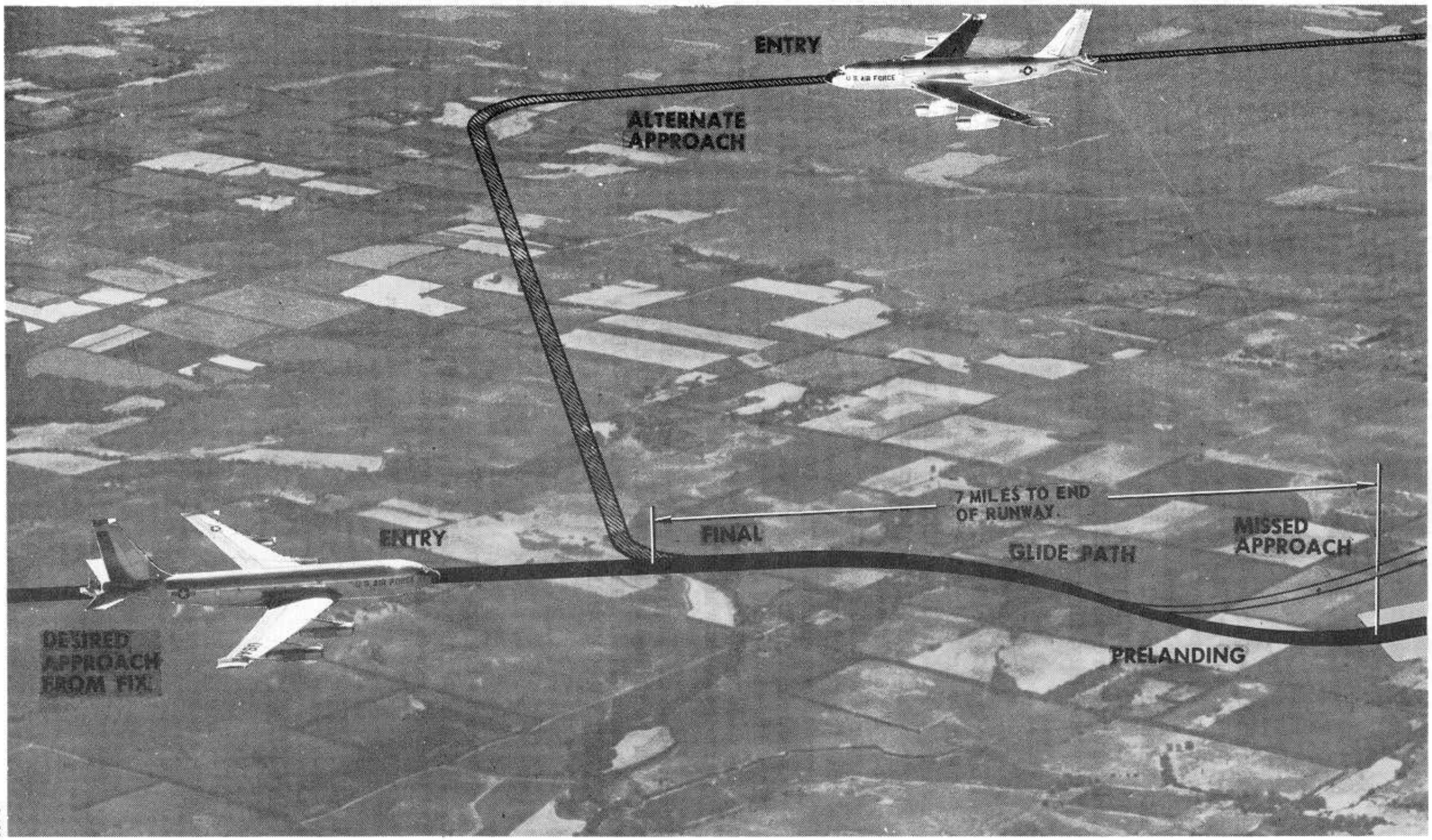


Figure 9-3

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 runback 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.

The airplane can be protected from ice and rain while on the ground 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, pitot, and Q-inlet anti-icing systems should be turned on before entering the condition. These are designed as anti-icing systems rather than deicing systems; therefore during potential icing conditions the anti-icing systems must be used before ice buildups can occur.

NOTE

Because of the temperature rise resulting from the ram air effect, ice will not form on the airplane at high airspeeds until the true ambient temperature is considerably below 0° C. For example, at 375 knots ice does not form above -6.7° C (20° F) OAT (True). The engine and nacelle anti-icing system will be more effective in most encounters at the lower speeds and higher thrust settings. During flight in light or moderate icing conditions, ice can collect on the engine nose at any setting up to and including 90% rpm. Sustained flight in light or moderate icing conditions should be avoided. Ascent or descent through icing conditions should be made as expeditiously as possible. Refer also to FUEL SYSTEM 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 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 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. 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 over-temperature.

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, freeze. This phenomenon may occur during ground and takeoff operations, when the airplane velocity is low and engines are operated at high thrust settings.

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

Should inlet icing conditions be encountered prior to activating the anti-icing system, set throttles to NRT or below and place ignition and start switches to FLIGHT START prior to turning on the anti-icing system. This will preclude the possibility of engine flameout due to inlet ice ingestion. As soon as the engines have stabilized, 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 dome 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 dome 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 mechanical failure or introduction of foreign matter into the systems.

Q-INLET ICING

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 feel 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. When 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 30 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 form 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 OAT is between 47°F (8°C) and 0°F (-18 C) and visible atmospheric moisture is present, the engine anti-icing should be turned on during taxi. Engine inlet components are susceptible to icing during ground operation even when the OAT is above freezing under certain atmospheric conditions. 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. No takeoff thrust penalty is involved when the anti-icing system is operating.

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. At speeds above 280 knots TAS, icing can occur only if visible atmospheric moisture is present and the true OAT is 0°C (32° F) or below.

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 touchdown 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 the nose wheel touches down and use wheel brakes as necessary. 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. The pilot should apply full brake pedal to obtain minimum stopping distance under any runway condition. Brake control should be through the pilot's brake pedals. 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 anti-skid, 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 may 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(R)C-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(R)C-1-1.

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 flight. Retention of fuel in the reserve tanks until its use is required, or until the last portion of the mission will enhance wing strength if turbulence is encountered.

NOTE

Visual sighting, when possible, and correct use of the search radar for early detection of thunderstorm activity is essential for determining a course of action in order to circumnavigate detected disturbances. As the thunderstorm is approached, variations in function, range, antenna tilt, and radar beam pattern may be necessary for optimum radar scope presentation.

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.

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 overcontrolling or overstressing 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 overcontrolling, 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 flight through severe turbulence.

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 sweptwing 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 penetrations. 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 lever 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 TRIM - Maintain control of the airplane with the elevators.

CAUTION

After establishing the trim setting for penetration speed, DO NOT CHANGE 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 troop and crew safety belts are fastened.

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

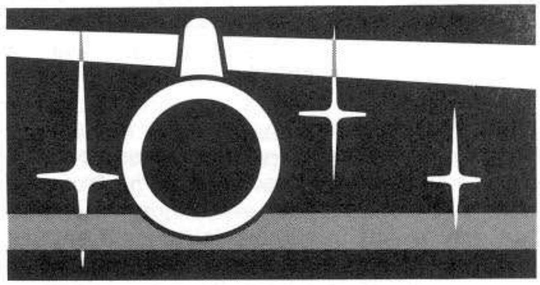
The recommended procedures for planned penetration are identical to those described above, except that penetration should be planned for an altitude of 10,000 feet OR MORE below maximum range cruise altitude at an airspeed of 280 KIAS.

turbulence penetration thrust settings- % N_2 rpm

120	84.7	85.3	86.2	88.4
160	85.8	86.1	87.4	92.3
200	86.5	87.1	89.2	
240	87.3	88.5	91.5	
280	88.8	90.1	94.7	

Figure 9-4

NIGHT FLYING

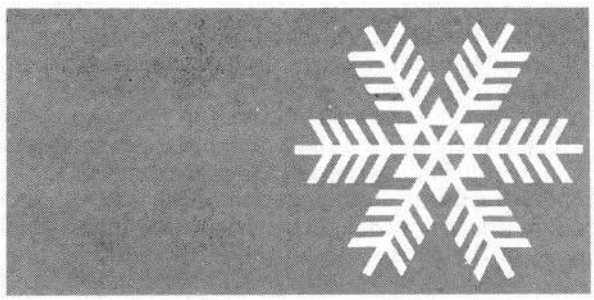


On entering the airplane, turn on interior lighting and adjust light rheostats to provide illumination of all necessary controls and panels. Lights should be as dim as possible so the crewmembers' ability to see at night will not be greatly affected or limited. Before taxiing at night, turn taxi lights ON, and retractable terrain light as required. Before takeoff, turn off all unnecessary interior lights, and turn landing lights ON. After takeoff, landing lights will remain ON and will not be turned off until passing appropriate altitude unless reflections cause pilot distractions while operating in instrument flight conditions. The nacelle illumination lights will be turned ON by the boom operator prior to takeoff and will be left on at all times during 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



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, static ports and EPR (P_{t2} pressure pickup) for ice; remove if present. Inspect the nose cowl auxiliary air inlet doors and cavities for ice or snow accumulations. Any restriction to door travel can seriously affect engine airflow, especially at takeoff thrust settings.

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.

WARNING

- Remove snow from the top of the 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.
- 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 the 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 the 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, manually applying deicing fluid or using portable ground heaters, be sure that the 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. This will prevent the runoff from the deicing operation from seeping into the balance bay areas and refreezing. (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 the deicing rig in position in order to grasp the trailing edge of each control surface 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.

control surface deicing

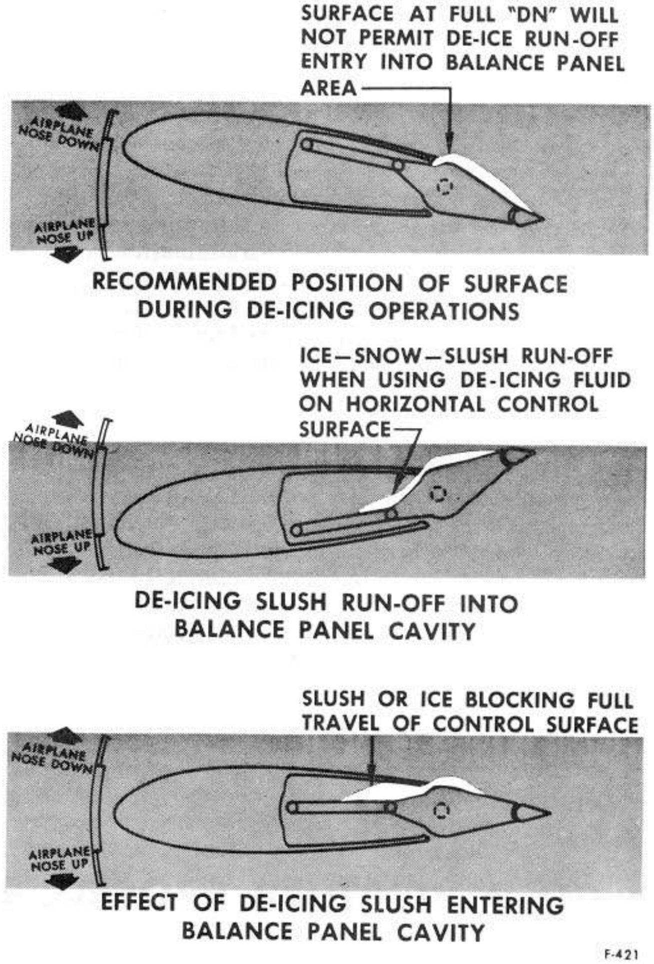


Figure 9-5

WARNING

- Snow and ice accumulation in any significant degree must be removed from the upper airplane 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 antiexposure 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 the 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 the 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 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 the 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 30 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 form 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 the engines in normal manner. If true ambient temperature is below -22°F (-30°C), idle the engine 2 minutes before changing throttle position. If the 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 IDLE 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. Engine oil pressure is rpm sensitive, increasing by approximately 9 psig between IDLE and takeoff thrust settings.

NOTE

During cold weather starts, oil pressure might temporarily exceed maximum limits until the oil warms slightly. The throttle should remain in IDLE until the oil pressure is within limits.

WARMUP AND GROUND TESTS

Inspect the 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 the 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 3-1/2 minutes may be allowed for the indicated oil pressure to reach the minimum limit.
- No warmup is required if the oil pressure remains below 60 psi at takeoff EPR. A temporary high pressure above 60 psi at temperatures below 0° F (-18° C) is not dangerous, but takeoff should be delayed until the pressure drops below 60 psi.
- Do not turn on unnecessary electrical equipment until generators show output.

TAXIING INSTRUCTIONS

If snow or slush conditions exist on taxi strips, maintain throttles at IDLE; thrust settings above IDLE on inboard engines may blow snow and slush back on the 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 areas. 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 obtain approximately 1.2 EPR on all engines. If the airplane starts to slide on ice or snow, release brakes immediately and begin the takeoff run. Continue engine check and runup during early part of the takeoff run. If the takeoff cannot be accomplished due to engine malfunctions, retard throttles to IDLE and bring the airplane to a normal stop. Consult Part 2 of the Appendix, T.O. 1C-135(E)C-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 wheel steering and the possibility of nose wheel 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 semi-liquid 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%. At depths greater than 1/2 inch, substantial damage can occur due to impingement on fuselage, inboard wing surfaces, flap surfaces, air conditioning ducts, equipment bay and wheel well doors, etc.

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, be careful not to exceed the flap placard speeds during flap retraction.

If windshield anti-icing is not adequate with the switch in NORMAL, place the switch in HIGH. Watch closely for ice formation on critical areas; position the engine 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(E)C-1-1.

Adjust the 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 the cabin temperature control full WARMER (if operating under manual temperature control, hold the cabin temperature control in WARMER). After the cabin has cleared, reposition the cabin temperature control (if operating under manual temperature control, move the cabin temperature control to COOLER) to obtain cabin air temperature sufficiently higher than original to prevent recurrence of the fog condition. If a comfortable temperature cannot be maintained without fogging, reduce the cabin pressure until an area with more favorable atmospheric conditions is entered.

DESCENT

Refer to 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 the horizontal stabilizer to 3 units airplane nose down. Install wheel chocks so the parking brakes can be released; if moisture has entered the brake assembly around brake shoes, releasing the parking brakes will forestall the possibility of brakes freezing in position. Service the airplane with fuel and oil and drain all sumps before condensates reach the freezing point. Install engine protective covers and intake and tailpipe plugs. Install wing, empennage, and pitot tube covers if there is the slightest possibility of blowing or drifting snow; install both main landing gear wheel well covers, air conditioning intake, and exhaust plugs. Remove ice and dirt from shock struts. If a layover of several days is anticipated, remove the nicad battery from the airplane 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 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. The aft toilets should be serviced with anti-freeze solution. Refer to T.O. 1C-135(K)A-2-2 for servicing procedures.

HOT WEATHER AND DESERT OPERATION

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 the most successful operation. Examine the Appendix, T.O. 1C-135(E)C-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 tires and shock struts more closely 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. Position the airplane to avoid sand-blasting other equipment during engine 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. Expect the engines to accelerate to idle more slowly than on a normal or cold day because the air is less dense.

NOTE

> To prevent accessory overheat, engine ground operation shall be limited to a maximum of 5 minutes at 90% rpm or above when the engine is fully cowled.

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(E)C-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(E)C-1-1.

DURING FLIGHT

To prevent damage to the engines avoid flying through dust or sand storms. To determine the effects of temperature on range and endurance, refer to Parts 5 and 6 of the Appendix, T.O. 1C-135(E)C-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, carefully 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. Install wheel chocks 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

Install all protective plugs and covers. 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 dust-proof 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.

ALPHABETICAL INDEX

* DENOTES ILLUSTRATION

A

B

C

E

G

H

I

M

P

S

T

U

V

W

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