USAF SERIES

A-7D FLIGHT MANUAL

AIRCRAFT

LTV AEROSPACE CORPORATION
N00019-67-C-0143
N00019-71-C-0470

THIS PUBLICATION IS INCOMPLETE WITHOUT T.O. 1A-7D-1A SUPPLEMENT FLIGHT MANUAL.

THIS CHANGE SUPERSEDES OPERATIONAL SUPPLEMENT -52. REFER TO SAFETY SUPPLEMENT INDEX T.O. 0-1-1-5 FOR THE CURRENT STATUS OF FLIGHT MANUALS, SAFETY/ OPERATIONAL SUPPLEMENTS AND FLIGHT CREW CHECKLISTS.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS PUBLICATION TO THE ATTENTION OF ALL AFFECTED PERSONNEL.

Each transmittal of this document outside the Department of Defense must have approval of the issuing Service.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE.

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15 NOVEMBER 1971
Change 5 — 20 September 1972

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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 DESTROY SUPERSEDED PAGES.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. Changes to illustrations are indicated by miniature pointing hands.

Dates of Issue for original and changed pages are:

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*A	5	1-31	0	1-78B Blank	1	1-129	3
*B	5	1-32	1	1-79	0	1-130	0
C Blank	1	1-33	2	1-80	1	1-131	0
i thru v	0	1-34	0	1-81 thru 1-86	0	1-132	3
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vii	0	1-36	0	1-88	0	1-134 Blank	0
viii	3	1-37 thru 1-40	2	1-88A	3	1-135 thru 1-141	0
*ix	5	1-40A	2	1-88B	3	1-142 Blank	0
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1-1	3	1-41	2	1-93 thru 1-97	0	1-144	0
1-2 Blank	0	1-42	0	1-98	3	1-145	3
1-3 thru 1-5	0	1-43	3	1-99	3	1-146 Blank	0
1-6 Blank	0	1-44 Blank	0	1-100 Blank	0	1-147 thru 1-164	0
1-7 thru 1-9	0	1-45	0	1-101	0	1-165	3
1-10 Blank	0	1-46	0	1-102	0	1-166 thru 1-183	0
1-11	0	1-47	2	1-103	3	1-184 Blank	0
1-12	1	1-48 Blank	0	1-104	0	1-185 thru 1-189	0
1-13	0	1-49	0	1-105	3	1-190 Blank	0
1-14	0	1-50	0	1-106	3	1-191 thru 1-199	0
1-15	3	1-51	2	1-107	0	1-200	3
1-16 thru 1-19	0	1-52	2	1-108	0	1-201	3
1-20	3	1-53 thru 1-56	0	1-109	3	1-202 Blank	0
1-21	0	1-57	1	1-110	3	1-203 thru 1-216	0
1-22	3	1-58 thru 1-62	0	1-111 thru 1-116	0	1-217	1
1-23	1	1-63	1	1-117	3	1-218 Blank	0
1-24 Blank	0	1-64 thru 1-70	0	1-118 thru 1-124	0	1-219 thru 1-229	0
1-25 thru 1-27	0	1-71	3	1-125	1	1-230 Blank	0
1-28 Blank	0	1-72 thru 1-77	0	1-126	0	1-231 thru 1-235	0
1-29	0	1-78	1	1-127	0	1-236 Blank	0

CURRENT FLIGHT CREW CHECKLIST

T.O. 1A-7D-1CL-1
15 Nov 1971

Change 1 – 1 Jan 1972
Change 2 – 10 Mar 1972
Change 3 – 1 Jun 1972
Change 4 – 28 Aug 1972
Change 5 – 20 Sep 1972

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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1-240	3	3-13	0	*5-20B Blank	5	A3-2 thru A3-6	0
1-241 thru 1-247	0	3-14	1	5-21	3	A4-1	3
1-248 Blank	0	3-15	0	5-22	4	A4-2 thru A4-5	0
1-249 thru 1-257	0	3-16	2	5-23	4	A4-6	3
1-258 Blank	0	3-16A	2	5-24	3	A4-7	0
1-259 thru 1-262	0	3-16B Blank	2	*5-24A	5	A4-8	3
1-263	3	3-17	0	5-24B	4	A4-9	0
1-264 Blank	0	3-18	3	*5-25	5	A4-10	3
2-1	0	3-19	3	5-26 thru 5-28	3	A4-11	0
2-2 Blank	0	3-20	2	5-28A	4	A4-12	3
2-3	3	3-20A	3	5-28B	4	A4-13	0
2-4	0	3-20B Blank	3	5-29	4	A4-14	3
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2-6	3	*3-27	5	5-31	3	A4-16	3
*2-7	5	3-28 thru 3-31	0	5-32	4	A4-17	0
2-8	3	3-32 thru 3-38	3	5-33	3	A4-18	3
2-9	3	3-38A	3	*5-34	5	A4-19	0
2-10 thru 2-15	0	3-38B Blank	3	5-35	4	A4-20	3
2-16	3	3-39	0	*5-36 thru 5-49	5	A4-21	0
2-17	3	*3-40	5	*5-50 Blank	5	A4-22	3
2-18 thru 2-20	0	*3-41	5	6-1 thru 6-21	3	A4-23	0
2-21	3	3-42	0	6-22 Blank	3	A4-24	3
2-22	0	*3-43	5	7-1	0	A4-25 thru A4-27	0
2-23	0	3-44 thru 3-46	3	7-2	3	A4-28 Blank	0
2-24	1	3-47 thru 3-49	0	7-3 thru 7-5	0	A5-1	0
2-25	0	3-50	2	7-6	3	A5-2	3
2-26	3	3-51	2	7-7 thru 7-9	0	A5-3	0
2-27	0	3-52 Blank	0	7-10 Blank	0	A5-4	0
2-28	0	4-1	0	A-1 thru A-3	0	A5-5	3
2-28A	3	4-2 Blank	0	A-4 Blank	0	A5-6	0
2-28B Blank	3	5-1 thru 5-3	0	A1-1 thru A1-5	0	A6-1 thru A6-3	0
2-29 thru 2-32	3	5-4	3	A1-6	4	A6-4 Blank	0
2-33	0	5-5	0	*A1-7	5	A7-1	3
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2-35	3	5-6A	3	*A1-8A	5	A7-3	3
2-36	0	5-6B Blank	3	*A1-8B	5	A7-4 Blank	3
2-37	0	5-7	2	*A1-9	5	A7-5	0
2-38	3	5-8 thru 5-10	0	A1-10 thru A1-21	0	A7-6	0
2-39	0	*5-11	5	A1-22 Blank	0	A7-7	3
2-40	0	5-12	0	A2-1	3	A7-8 Blank	3
3-1 thru 3-4	3	*5-13	5	A2-2	0	A8-1 thru A8-9	0
3-4A	3	*5-14	5	A2-3	3	A8-10 Blank	0
3-4B Blank	3	*5-14A	5	A2-4 Blank	3	A9-1 thru A9-4	0
3-5	3	*5-14B Blank	5	A2-5	3	Index-1 thru Index-3	3
3-6	0	*5-15	5	A2-6 thru A2-9	0	*Index-4	5
3-7	3	*5-16	5	A2-10 thru A2-12	3	Index-5	0
3-8 thru 3-10	0	5-17 thru 5-19	3	A2-13 Deleted	3	Index-6 thru Index-9	3
3-11	2	*5-20	5	A2-14 Deleted	3	Index-10 Blank	0

TABLE OF CONTENTS

Don't turn your back on this page...

THIS INFORMATION IS IMPORTANT!

SCOPE.

This manual contains the necessary information for safe and efficient operation of the A-7D. These instructions provide you with a general knowledge of the aircraft, its characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized; therefore, basic flight principles are avoided.

SOUND JUDGMENT.

Instructions in this manual are for a crew inexperienced in the operation of this aircraft. This manual provides the best possible operating instructions under most circumstances, but it is not intended to be used as a substitute for sound judgment. Multiple emergencies, adverse weather, terrain, or extenuating circumstances may require modification of any procedure(s) presented in this manual.

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 Major Command (with information to the flight manual manager) before any questionable operation is attempted which is not specifically permitted in this manual.

HOW TO BE ASSURED OF HAVING LATEST DATA.

Refer to the latest Flight Manual and Supplement Status page for the current status of Flight Manuals, Safety Supplements, Operational Supplements, and Checklists. This status page accompanies the latest Safety/Operational Supplement, manual change, or revision, and assures an accurate, up-to-date listing of these publications. If you have any doubts concerning the status of your flight manual, check with your flight manual distribution officer.

ARRANGEMENT.

The manual is divided into seven fairly independent sections, an Appendix, and an Alphabetical Index, to simplify reading it straight through or using it as a reference manual.

SAFETY SUPPLEMENTS.

Information involving safety will be promptly forwarded to you by Safety Supplement. Supplements covering loss of life will get to you within 48 hours by TWX, and those covering serious damage to equipment within 10 days by mail. The title page of the Flight Manual and the title block of each Safety Supplement should be checked to determine the effect they may have on existing supplements. You must remain constantly aware of the status of all supplements. Current supplements must be complied with, but there is no point in restricting your operation by complying with a replaced or rescinded supplement.

OPERATIONAL SUPPLEMENT.

Information involving changes to operating procedures will be forwarded to you by Operational Supplements. The procedure for handling Operational Supplements is the same as for Safety Supplements. Operational Supplements are issued as an expeditious means of reflecting information when mission essential operational deficiencies are involved.

NUMBERING OF SUPPLEMENTS.

Safety and operational supplements to the flight manual publications will be numbered consecutively regardless of the type of supplement issued. For example, the first supplement issued will be numbered SS-1 or S-1 dependent upon whether it is safety or operational and the second supplement issued will be numbered -2 regardless of whether it is safety or operational.

CHECKLISTS.

The flight manual contains only simplified normal and emergency procedures. Checklists have been issued as separate technical orders. See the Flight Manual and Supplement Status page, which follows, for T.O. number and date of your latest checklist. Line items in the flight manual and checklist are identical with respect to arrangement and item number. Whenever a safety supplement 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. This will keep handwritten entries of safety supplement information in your checklist to a minimum. In all cases, the information contained in the flight manual and its supplements takes precedence over that contained in the checklist.

CHANGE SYMBOL.

The change symbol, as illustrated by the black line in the margin of this paragraph, indicates text changes made to the current revision. Changes to illustrations are indicated with a miniature hand.

WARNINGS. CAUTIONS, AND NOTES.

The following definitions apply to Warnings, Cautions, and Notes found throughout the manual.

WARNING

An operating procedure, practice, etc, which, if not correctly followed, could result in personal injury or loss of life.

CAUTION

An operating procedure, practice, etc, which, if not strictly observed, could result in damage to, or destruction of, equipment.

Note

An operating procedure, condition, etc, which it is essential to highlight.

USE OF WORDS SHALL, WILL, SHOULD, AND MAY.

The words "shall" or "will" are to be used to indicate a mandatory requirement. The word "should" is to be used to indicate a nonmandatory desire or preferred method of accomplishment. The word "may" is to indicate an acceptable or suggested means of accomplishment.

YOUR RESPONSIBILITY – TO LET US KNOW.

Every effort is made to keep the Flight Manual current. Review conferences with operating personnel and a constant review of accident and flight test reports assure inclusion of the latest data in the manual. However, we cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual or any phase of the Flight Manual program are welcomed. These should be forwarded on AF Form 847 through your Aircrew Standardization/Evaluation channels to Navair System Command Headquarters, PMA-235B, Washington D.C.

PUBLICATION DATE.

The date appearing on the title page of this manual represents the currency of material in the manual. (The publication date is not the printing or distribution date.) When referring to the manual, use the publication date plus the date of the latest change.

AIRCRAFT DESIGNATION CODES.

Changes to the aircraft which affect manual descriptions, illustrations or procedures are indicated by a coding system. The coding system assigns symbols which represent the tail numbers of individual aircraft. For example, [17] [27] → means "aircraft AF69-6189, AF69-6197, and subsequent." Symbols which read, "→ [16] [18] → [26] after T.O. 1A-7D-505" mean "aircraft through AF69-6196, except AF69-6189, after modification by T.O. 1A-7D-505."

Codes are as follows:

[1]	AF67-14582	[20]	AF69-6190
[2]	AF67-14583	[21]	AF69-6191
[3]	AF67-14584	[22]	AF69-6192
[4]	AF68-8220	[23]	AF69-6193
[5]	AF67-14586	[24]	AF69-6194
[6]	AF67-14585	[25]	AF69-6195
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TECHNICAL ORDER SUMMARY

This summary contains only those modifications affecting safe or efficient operation of the aircraft or its systems. Upon completion of the modification, or incorporation of the TCTO in all applicable aircraft, the modification will be withdrawn from the list and information pertaining to the unmodified configuration deleted from the manual.

TECHNICAL ORDER	ECP NO.	TITLE/DESCRIPTION	PRODUCTION EFFECTIVITY	RETROFIT EFFECTIVITY
1A-7D-503	155	Installation of APR-36/37 ECM Provisions	[17] [27] →	→ [16] [18] → [26]
1A-7D-505	140	Installation of Automatic Direction Finder (ADF) Guard Frequency Operation Capability	[17] [27] →	→ [16] [18] → [26]
1A-7D-519	214	Addition of Residual Fuel Tanks for Temporary Storage	[17] [27] →	→ [16] [18] → [26]
1A-7D-521	216	Modification of Console Lighting to Provide NWDC Panel Dimming	[17] [20] →	[4] → [6] [8] → [16] [18] [19]
1A-7D-524	221	Modification of Nose Gear Steering System	[17] [27] →	→ [16] [18] → [26]
1A-7D-544	253	Installation of Ceramic Armor	[51] →	[17] [27] → [50]
1A-7D-545	219	Modification of Cockpit Lighting	[115] →	→ [114]
1A-7D-547		Remove and Replace Radio Receiving Set AN/ARR-69		[1] → [66]
1A-7D-563	292	Airframe Wiring Change to Provide Capability to Activate Double Datum through Weight-on-Gear Switch	[74] →	→ [73]
2J-TF41-513	292	Installation of Engine Double Datum Amplifier	[74] →	→ [73]
1A-7D-570	239	Modification of HUD	[51] →	[4] → [6] [8] → [50]
1A-7D-575	330	Modification of IMS	[17] [27] →	[4] → [16] [18] → [26]
1A-7D-578	348	Installation of Projected Map Display Set (PMDS)	[115] →	[17] [27] → [114]
1A-7D-581	308	Installation of Surge Tank, Air Conditioning System	[50] →	[4] → [6] [8] → [16] [18] → [49]

TECHNICAL ORDER SUMMARY (Continued)

TECHNICAL ORDER	ECP NO.	TITLE/DESCRIPTION	PRODUCTION EFFECTIVITY	RETROFIT EFFECTIVITY
1A-7D-595	345	Incorporation of UHF Remote Channel Indicator	[203] →	[11] → [202]
1A-7D-596	359	Manual Differential Braking System	[203] →	[17] [27] → [202]
1A-7D-597		Modification of: (a) Aerial Refueling Relay and (b) Ejector Air Valve Control Units	(a) [115] → (b) [115] →	[17] [27] → [114] [4] → [114]
1A-7D-619	355-3	Installation of Canopy Breaker Tool	[115] →	→ [114]
1A-7D-625	355-1	Improvement of Pilot Restraint System	[203] →	→ [202]
1A-7D-626	369	Installation of Night Filter, AN/APQ-126 Radar	[175] →	[4] → [6] [8] → [174]
1A-7D-628	152	Change to Gun Gas Purge Door Closure Rate	[184] →	→ [183]
1A-7D-647		Sidetone Provision Hot MIC Position	[159] →	[4] → [158]
1A-7D-652	423	Modification of Fuel Bypass Valve Wiring	[282] →	[17] [27] → [281]
1A-7D-685		Manual Differential Braking System		→ [16] [18] → [26]

FLIGHT MANUAL AND SUPPLEMENT STATUS

This page will be published with each Safety Supplement, Operational Supplement, Flight Manual Change, and Flight Manual Revision. It provides a listing of the current Flight Manual and Safety and Operational Supplements. The supplements received should follow in sequence. If one listed on this page is missing, see the Publications Distribution Officer and get a copy. The latest Safety/Operational supplement index should be checked periodically to make sure you have the latest basic manuals, checklist, and supplements.

CURRENT FLIGHT MANUAL	DATE	CHANGED
T.O. 1A-7D-1	15 November 1971	20 September 1972
T.O. 1A-7D-1A (Conf.)	1 August 1970	1 June 1972

CURRENT FLIGHT CREW CHECKLIST	DATE	CHANGED
T.O. 1A-7D-1CL-1	15 November 1971	20 September 1972

SUMMARY OF SAFETY SUPPLEMENTS INCORPORATED IN THIS CHANGE

Number	Date	Short Title	Flight Manual Pages Affected

OUTSTANDING SAFETY SUPPLEMENTS

PREVIOUSLY INCORPORATED, RESCINDED OR REPLACED

-2 (Interim); -4 (Interim); -5 (Interim); -6 (Interim); -8; -12; -13; -14 (Interim); -24; -49 (Interim)

SUMMARY OF OPERATIONAL SUPPLEMENTS INCORPORATED IN THIS CHANGE

Number	Date	Short Title	Flight Manual Pages Affected
52 (Interim)	19 September 1972	Correction to External Stores Limitations Charts	5–25

OUTSTANDING OPERATIONAL SUPPLEMENTS

-23	1 December 1970	Avionic System Operational Anomalies	
-32	29 March 1971	OFP Tape Characteristics and Anomalies	
-48	17 May 1972	Engine Restrictions T.C.T.O. 1A-7D-676 and 2J-TF41-573	

PREVIOUSLY INCORPORATED, RESCINDED OR REPLACED

-1 (Interim); -3; -7; -9; -10; -11; -15 (Interim); -16 (Interim); -17 (Interim); -18 (Interim); -19; -20 (Interim); -21; -22 (Interim); -25 (Interim); -26 (Interim); -27, -28 (Interim); -29; -30; -31; -33 (Interim); -34 (Interim); -35 (Interim); -36; -37 (Interim); -38 (Interim); -39 (Interim); -40 (Interim); -41 (Interim); -42 (Interim); -43 (Interim); -44 (Interim); -45; -46 (Interim); -47 (Interim); -50 (Interim); -51 (Interim)

GLOSSARY

A

ADC	Air Data Computer.
ADI	Attitude Director Indicator.
Advisory lights	All advisory lights are grouped on the right console. Illumination of one of these lights calls attention to a malfunction not serious enough to warrant caution light illumination.
AFCS	Automatic Flight Control System.
AGR	Air-to-Ground Ranging.
AIMS	Automatic altitude reporting system used with AAU-19/A altimeter. Reports corrected pressure altitude during IFF Mode C interrogations. Altitude information supplied by Air Data Computer.
Air Refueling Probe	Rigid-tube type air refueling receptacle. Hydraulically extended and retracted from the right forward side of the fuselage.
ALT	Altitude.
AOA	Angle of attack.
Approach Indexer	An indicator on the left side of the center windshield panel which indicates attitude changes required for optimum approach angle of attack. Illumination of the donut in the center of the instrument indicates optimum approach angle of attack.
ASCU	Armament Station Control Unit.

B

BITE	Built-In Test Equipment.
Bleed air	High-pressure and low-pressure air tapped from the compressor sections of the engine.

C

Caution lights	A group of lights on the right console. Illumination of one of these lights indicates a condition less serious than a warning light condition, but more serious than advisory light illumination.
CSD	Hydromechanical constant speed drive unit between engine accessory gearcase and the master generator. Maintains constant frequency output of master generator over a large engine speed range.

D

DART	Directional Automatic Realignment of Trajectory System. Used to keep ejection seat upright during ejection seat rocket burn.
Designation	An action that ground stabilizes the HUD aiming symbol or radar cursors on the selected aiming point and records the aiming point location in the computer. Designation is accomplished by pressing the designate switch or armament release switch on the stick grip. Designation also used in conjunction with update procedures.
Donut	Two lighted arcs forming an approximate circle in the center of the approach indexer. When lighted, the donut indicates angle of attack is optimum for landing approach.
DPLR	Doppler.

E

Engine motoring	Use of the jet fuel starter to rotate the engine without fuel or ignition.

F

FDC	Flight Director Computer. Used to provide steering fly-to commands.
FLR	AN/APQ-126 Forward Looking Radar.

G

Gyrocompassing	The method used to align the Inertial Measurement Set platform to true North.

H

HUD	Head-Up Display.

I

IMS	Inertial Measurement Set.
Incremental velocity	Change in velocity, or Delta (Δ) velocity. The Inertial Measurement Set measures acceleration, and by applying the variable of time provides incremental velocity to the NAV WD Computer for aircraft speed and distance solutions.
Isolated utilities	Hydraulic utilities which become isolated from the PC 2 hydraulic system when the flap handle is placed in ISO UTILITY. Isolated utilities are nosewheel steering, wheel brakes, wingfold, landing gear, wing flaps, and arresting hook.

J

Jet ejector pump	The equivalent of fuel transfer pumps, or fuel boost pumps, in most aircraft. Pumps operate on the venturi principle when supplied with motive flow fuel.
Jet fuel starter	A turbine power unit, actually a small jet engine, mounted on the engine accessory section. Provides torque for engine rotation during engine starting or motoring.

L

Lateral steering error	The difference between actual ground track and desired ground track. Cockpit indications become centered when on course.

M

MAC	Mean Aerodynamic Chord.
Master Generator	Prime source of electrical power for the aircraft. An engine-driven ac alternator.
MER	Multiple Ejector Rack.
Motive flow	A portion of the output of the fuel boost pump No. 2 utilized for operation of the jet ejector pumps.

N

NAV WD	Navigation/Weapon Delivery. The control panel on the right console is labeled NAV WD. The nameplate on the computer box in the avionic bay reads CP-952/ASN-91(V). The computer is sometimes referred to as the Tactical Computer.

O

OAP	Offset Aiming Point, used for offset bombing.
OFP	Operational Flight Program. The OFP is a computer program which is a resident in the NAV WD computer and accomplishes the functions of the navigation/weapon delivery system.

P

PC 1	Power control system 1 (hydraulic, flight controls).
PC 2	Power control system 2 (hydraulic, flight controls and utilities).
PC 3	Power control system 3 (hydraulic, flight controls).
Permanent magnetic generator (PMG)	A small engine-driven ac generator supplying power for engine ignition.
PMDS	Projected Map Display Set.
PPI	Plan Position Indicator. Plan presentation of ground map display. Seen on the radar scope on the instrument panel.

R

Radar pencil beam	A tightly focused radar beam.
Radar range cursor	An internal electronic radar signal recurringly generated at some specific time after each radar pulse transmission, appearing on the scope as a solid arc representing a specific slant range.
Radar range sweep	The motion of the electron beam in a cathode ray tube that permits target blips and range cursors to be distributed across the face of a tube in proportion to their slant ranges.
RAT	Ram Air Turbine. Also referred to as Emergency Power Package, or EPP.
RCR	Runway Condition Reading.
Reflective target	An area that presents prominent returns for radar scope interpretation.

S

Slant range	Line-of-sight distance from the aircraft to the target.
Spoiler-deflector	Hydraulically operated surfaces on top and bottom of each wing forward of the trailing edge flaps. Operate in conjunction with ailerons to improve roll characteristics. Deflector mechanically connected to the spoiler and deflects as the spoiler rises. Spoilers decrease lift. Deflectors direct air over the wing to prevent boundary separation caused by spoilers.
Steering command	A fly-to indication to center the bank steering bar, pitch steering bar, or the flight director symbol on the HUD to achieve proper pitch and azimuth flight corrections.

T

TER	Triple Ejector Rack.
Thermistor	A switching device that is sensitive to wet and dry fuel tank conditions. Used to switch control circuitry to fuel selector valves, determining route of motive flow.
TOP	Turbine Outlet Pressure.
TOT	Turbine Outlet Temperature
Transducer	As used in this manual, an electromechanical device that converts motion or force into electrical signals. Example — An angle-of-attack (AOA) transducer on the side of the aircraft measures AOA to drive the cockpit-mounted AOA indicator.
Transformer-rectifier	An electrical device for converting ac, produced by the master generator, to dc.

V

Viscous Damper	A self-contained hydraulic unit utilized to damp stick movement. Two of these units are installed in the pitch axis, one in the roll axis.

W

Warning lights	All of these lights are located on the instrument panel or above the glareshield. Illumination of one of the lights alerts the pilot to a hazardous condition requiring his immediate attention.

75D048-08-70

DESCRIPTION AND OPERATION

SECTION I

TABLE OF CONTENTS.

THE AIRCRAFT.

The A-7D is a single-engine, single-place, transonic, light attack aircraft built by the Vought Aeronautics Division of LTV Aerospace Corporation, Dallas, Texas. Equipped with the latest radar, navigational, communications, and weapon systems, the A-7D has an all-weather combat capability. The engine is a nonafterburner turbofan of Rolls Royce design manufactured by the Allison Division of General Motors. Principal recognition features include a shoulder-mounted wing with a marked degree of negative dihedral, an all-moving horizontal stabilizer, a low profile fuselage, a rounded nose radome mounted above the inlet duct, and a fuselage-retracting tricycle landing gear with a steerable nosewheel. The wings are equipped with two-position leading edge flaps and variable-position trailing edge flaps. Spoiler-deflectors are installed to improve the rolling moment provided by the conventional ailerons. A wingfold capability is included. A single, large speed brake is mounted on the bottom side of the fuselage. An arresting hook retracts under the fuselage aft section. Stability, control augmentation, trim and autopilot functions are provided by an Automatic Flight Control System. On aircraft → [16] [18] → [26], flight control power is provided by two redundant hydraulic systems, PC 1 and PC 2. On aircraft [17] [27] →, flight control power is provided by three redundant hydraulic systems, PC 1, PC 2, and PC 3. All aircraft utilities, such as the landing gear, speed brake, and flaps, are hydraulically actuated by the PC 2 system. Aircraft fuel tanks are located in the wing and fuselage, and external drop tanks can be carried from wing pylons. The fuel system incorporates both inflight and single point ground refueling capabilities and gravity refueling capability through filler caps on top of the fuselage. The aircraft armament system includes a single, nose-mounted M61 gun, six wing-mounted store pylons, and two fuselage-mounted store pylons. A variety of missiles, bombs, and rockets can be carried and released in manual or automatic modes. A Navigation/Weapon Delivery System integrates many of the aircraft's avionic subsystems to provide for navigation to the target, computed run on target, computed weapon release, and return navigation. A Head-Up Display (HUD) System is provided to put all steering and attack displays between the pilot's eyes and the windshield. See figure 1–1 for the aircraft general arrangement.

AIRCRAFT DIMENSIONS.

The overall dimensions of the aircraft under normal conditions of gross weight, tire, and strut inflation are as follows:

Length	46.13 ft
Wing span, extended	38.73 ft
Wing span, folded	23.77 ft
Height to top of vertical fin	16.06 ft
Horizontal stabilizer span	18.14 ft

Refer to Section II for minimum turning radius and ground clearance dimensions.

AIRCRAFT GROSS WEIGHT.

The approximate aircraft empty weight is 22,000 pounds. (For aircraft → [16] [18] → [26], the approximate empty weight is 20,500 pounds.) This weight includes pilot, engine oil, unusable fuel, six wing pylons with single ejector racks, two fuselage pylons with launchers, and special equipment. Gross weight limitations are presented in Section V. For exact aircraft weight, refer to the current Form 365F for the aircraft to be flown.

ARMOR PLATE PROTECTION.

On aircraft [17] [27] →, armor plate protection is provided for the pilot by two steel plates installed in the nose bulkhead. Armored panels (or external armor) are also installed on the midsection, aft fuselage, and vertical tail for protection of the rudder actuator control valve, cylinder assemblies, feel isolation actuator, and horizontal stabilizer feel and control mechanism. On aircraft [51] → and aircraft [17] [27] → [50] after T.O. 1A-7D-544, additional armor plate protection is provided by the installation of ceramic armor plates in the cockpit, fuselage midsection, and engine bay areas.

INSTRUMENT PANEL AND CONSOLES.

The instrument panel, cowl area, and consoles are illustrated in figures 1–2 through 1–8. These illustrations are provided for general cockpit familiarization.

TF41 ENGINE.

The Allison TF41-A-1 is a twin spool, axial flow, turbofan engine. It has a three-stage low-pressure compressor (fan), two-stage intermediate compressor, 11-stage high-pressure compressor, 10-chamber combustion section, and a four-stage turbine with an overall compression ratio of 20:1. Bypass ratio is 0.76:1.

The air inlet section consists of an air inlet extension that directs incoming air into the engine. The inlet section contains probes that sense engine air inlet temperature for engine fuel control and airflow control regulator/actuator limiters.

Air enters the engine and is compressed through three stages of the low-pressure compressor (fan). The air is discharged into two flow paths. The outer layer of air is ducted around the intermediate and high-pressure compressors and subsequently to the exhaust bypass mixer where it is mixed with combustion exhaust gas. The inner core of air flows through the intermediate compressor and enters the high-pressure compressor section through a variable geometry guide vane system where it is further compressed. This compressed air then flows through the diffuser into ten axial-flow canannular combustors where it is mixed with fuel and the mixture ignited. The hot gas is then directed through the high-pressure and low-pressure turbine rotors. The turbine rotors drive the compressors and accessory gearbox through the internal drive shafts. The turbine exhaust gas mixes with ducted bypass air and is jetted through the tailpipe nozzle to produce thrust. The engine is illustrated in figure 1–9.

GENERAL ARRANGEMENT

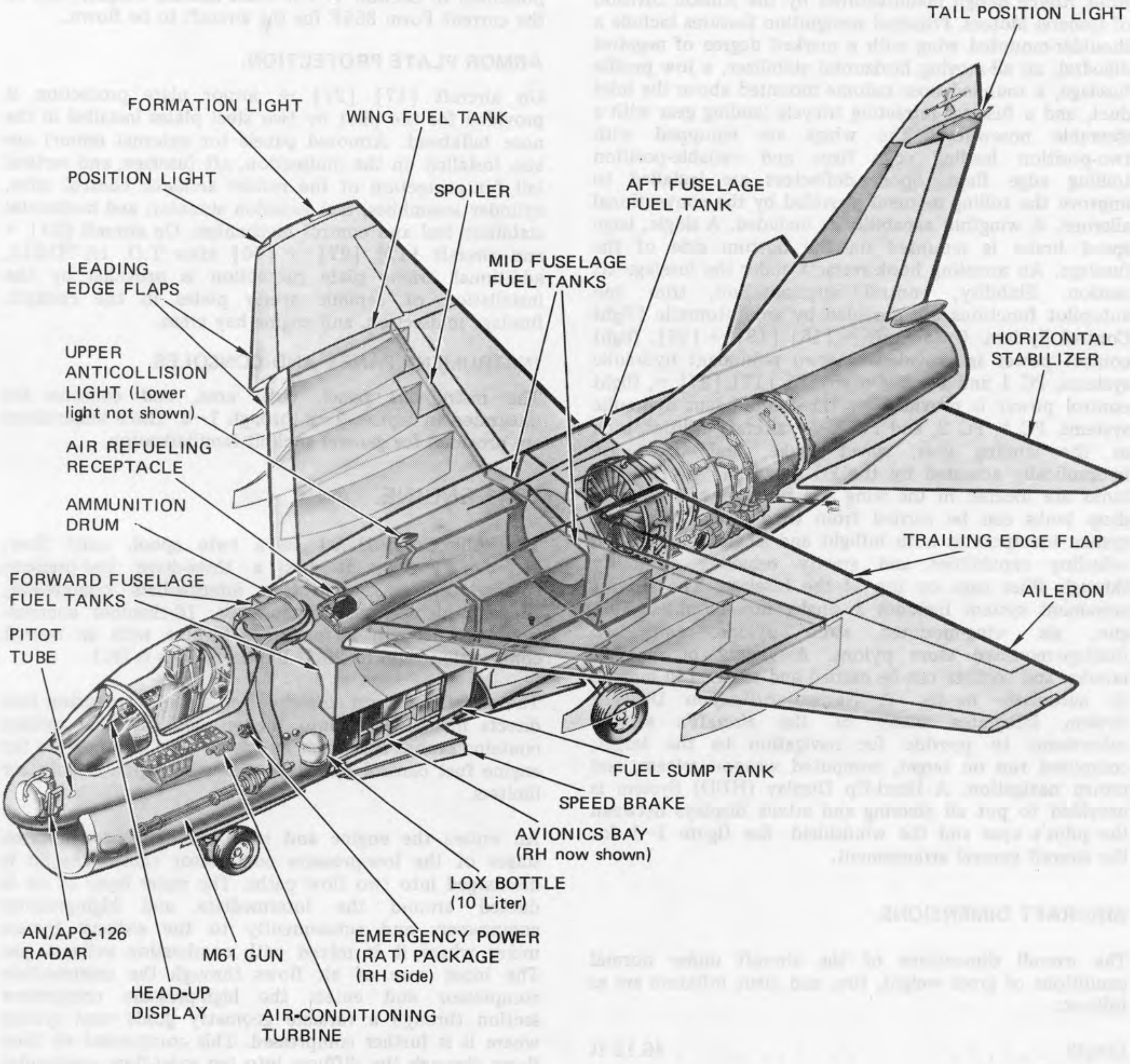
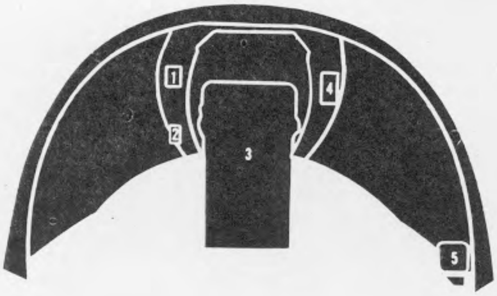


Figure 1–1

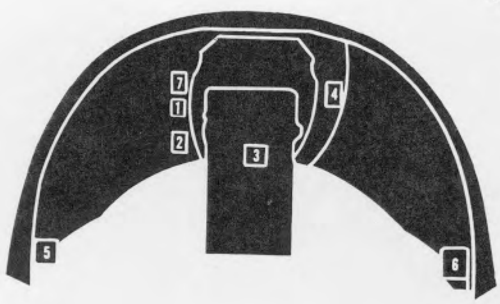
INSTRUMENT COWL AREA (TYPICAL)

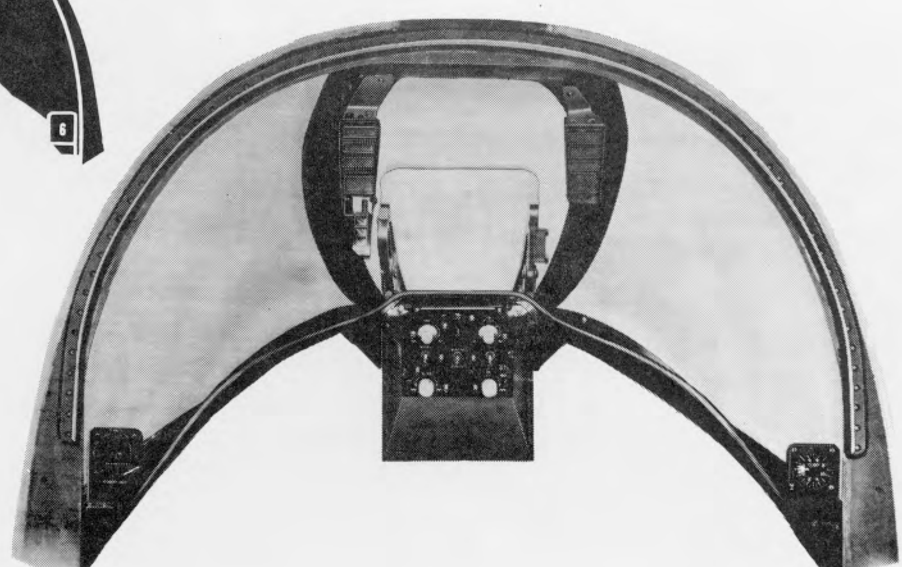
AIRCRAFT → [16] [18] → [26]



1. WHEELS/FLAPS warning lights
2. Angle-of-attack approach indexer
3. Head-up display and controls
4. Threat lights
5. Standby compass

AIRCRAFT [17] [27] →





1. WHEELS/FLAPS warning lights
2. Angle-of-attack approach indexer
3. Head-up display and controls
4. Threat lights
5. Standby compass
6. Accelerometer
7. Air refueling lights

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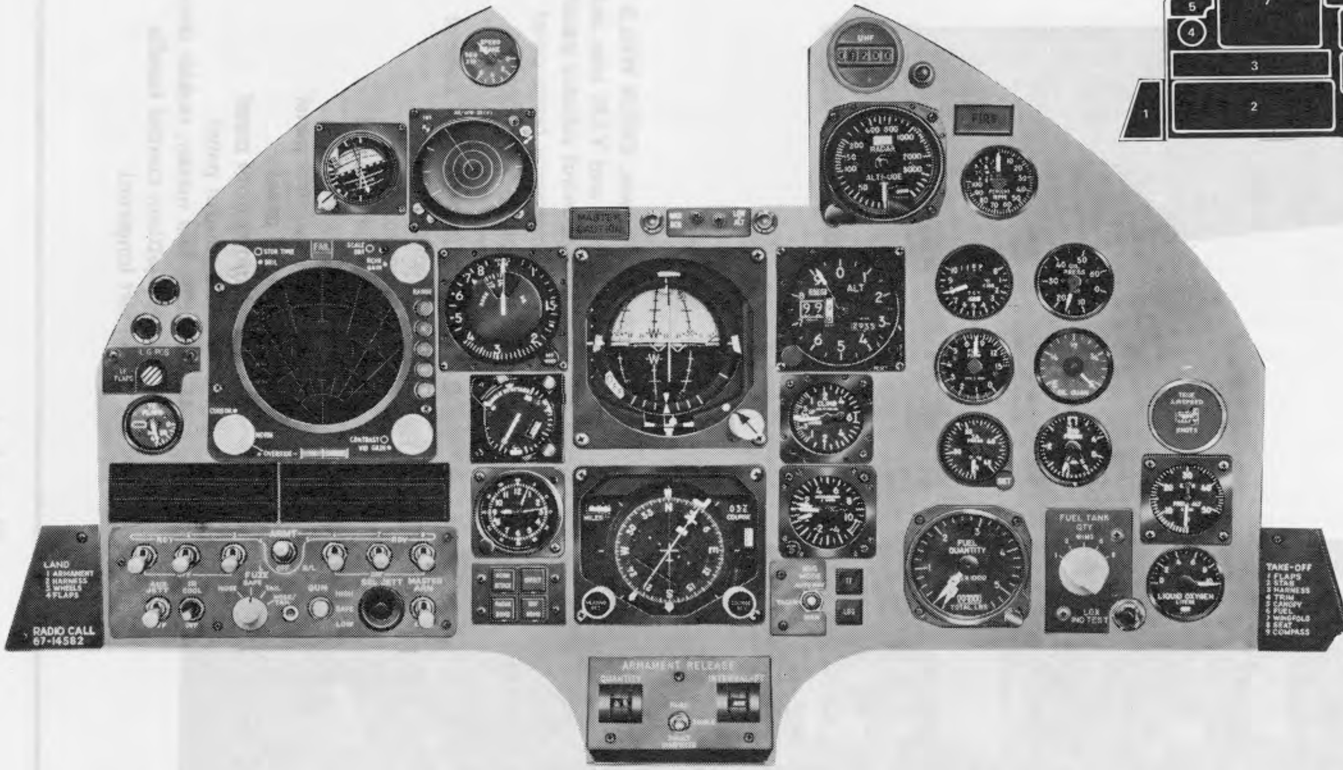
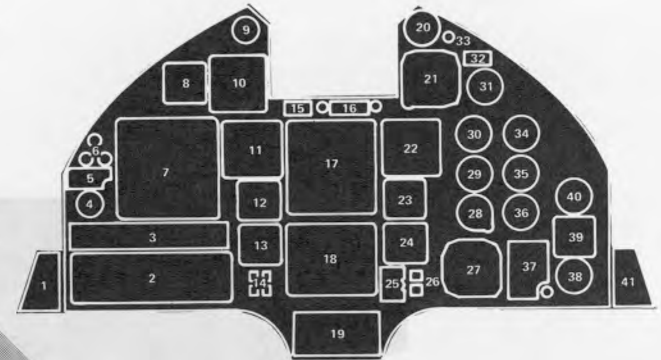
Figure 1–2

INSTRUMENT PANEL (TYPICAL) → [16] [18] → [26]





1. LAND checklist
2. ARMT select panel
3. Armament advisory light panel
4. Flap position indicator
5. LE FLAPS indicator
6. LG POS lights (3)
7. Forward looking radar
8. Standby attitude indicator
9. Speed brake indicator
10. APR-36 threat analyzer
11. Mach-airspeed indicator
12. Angle-of-attack indicator
13. Clock
14. Attack master function switches (4)
15. MASTER CAUTION light
16. MKR BCN, LOW ALT lights
17. Attitude director indicator
18. Horizontal situation indicator
19. ARMAMENT RELEASE panel
20. UHF frequency remote indicator
21. Radar altimeter
22. Barometric altimeter
23. Vertical velocity indicator
24. Accelerometer
25. HDG MODE switch
26. TF and LDG master function switches
27. Fuel quantity indicator
28. Turbine outlet pressure indicator
29. Fuel flow indicator
30. Turbine outlet temperature indicator
31. Tachometer
32. FIRE warning light
33. Fire warning switch
34. Oil pressure indicator
35. Oil quantity indicator
36. Hydraulic pressure indicator
37. FUEL TANK QTY indicator
38. LIQUID OXYGEN indicator
39. Cockpit pressure altimeter
40. TRUE AIRSPEED indicator
41. TAKE OFF check list

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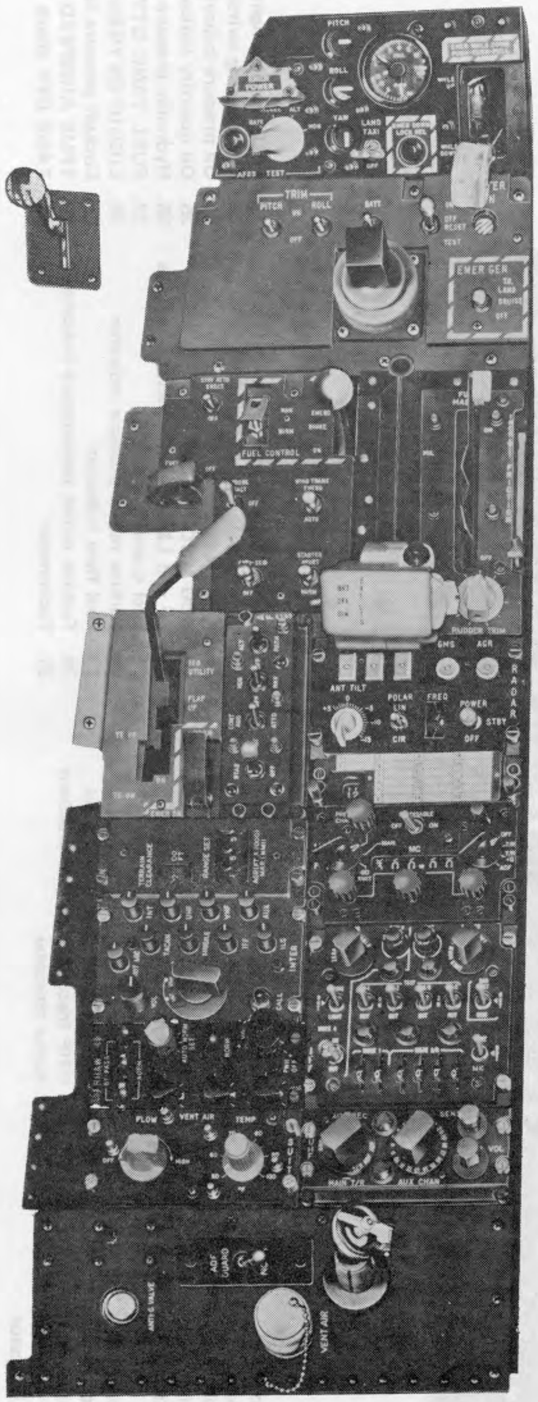
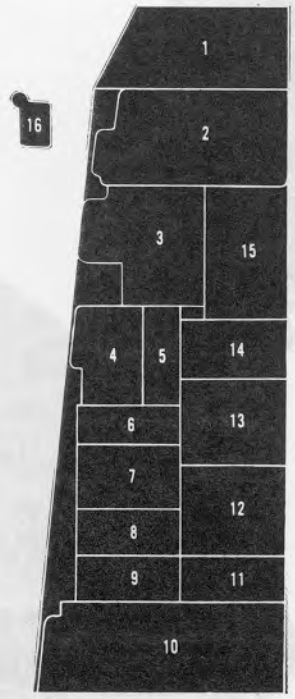
Figure 1–3

LEFT CONSOLE → [16] [18] → [26]



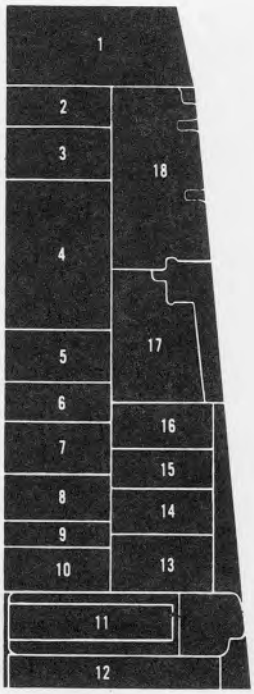


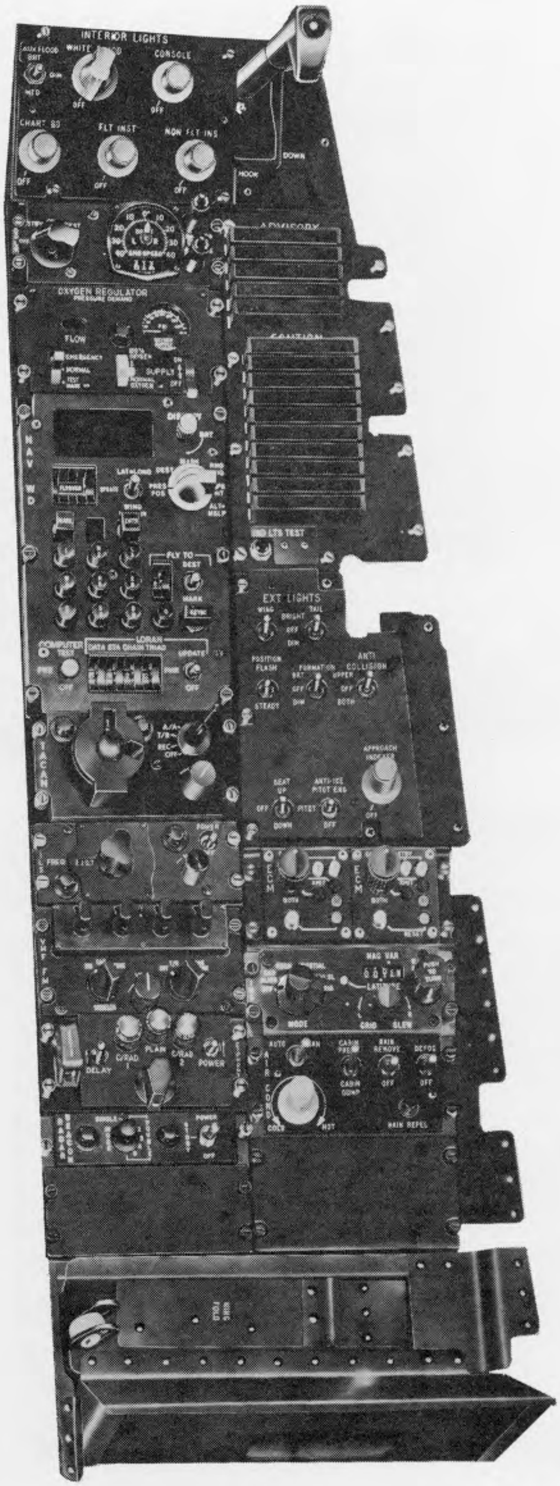
1. Emergency power, EMER WHLS DN, PITCH, ROLL and YAW trim indicators
2. Generators, control selector panel
3. Fuel and emergency brake panel
4. Flap control
5. AFCS control panel
6. TER CLR/RANGE SET control
7. INTER control panel
8. RHAW control panel
9. Suit temperature panel
10. Pilot services panel
11. ADF radio control panel
12. IFF control panel
13. UHF radio control panel
14. RADAR control panel
15. Throttle, fuel master, rudder trim panel
16. Canopy jettison control handle (on left longeron)

75D195-12-70

Figure 1-4

RIGHT CONSOLE → [16] [18] → [26]





1. INTERIOR LIGHTS control panel
2. DPLR control panel
3. OXYGEN REGULATOR
4. NAV WD control panel
5. TACAN control panel
6. ILS control panel
7. VHF FM control panel
8. Speech security control panel
9. RADAR BEACON control panel
10. Blank panel
11. WINGFOLD
12. Map case
13. Blank panel
14. AIR COND control panel
15. IMS control panel
16. ECM pod control panel
17. EXT LIGHTS controls
18. ADVISORY and CAUTION light panels

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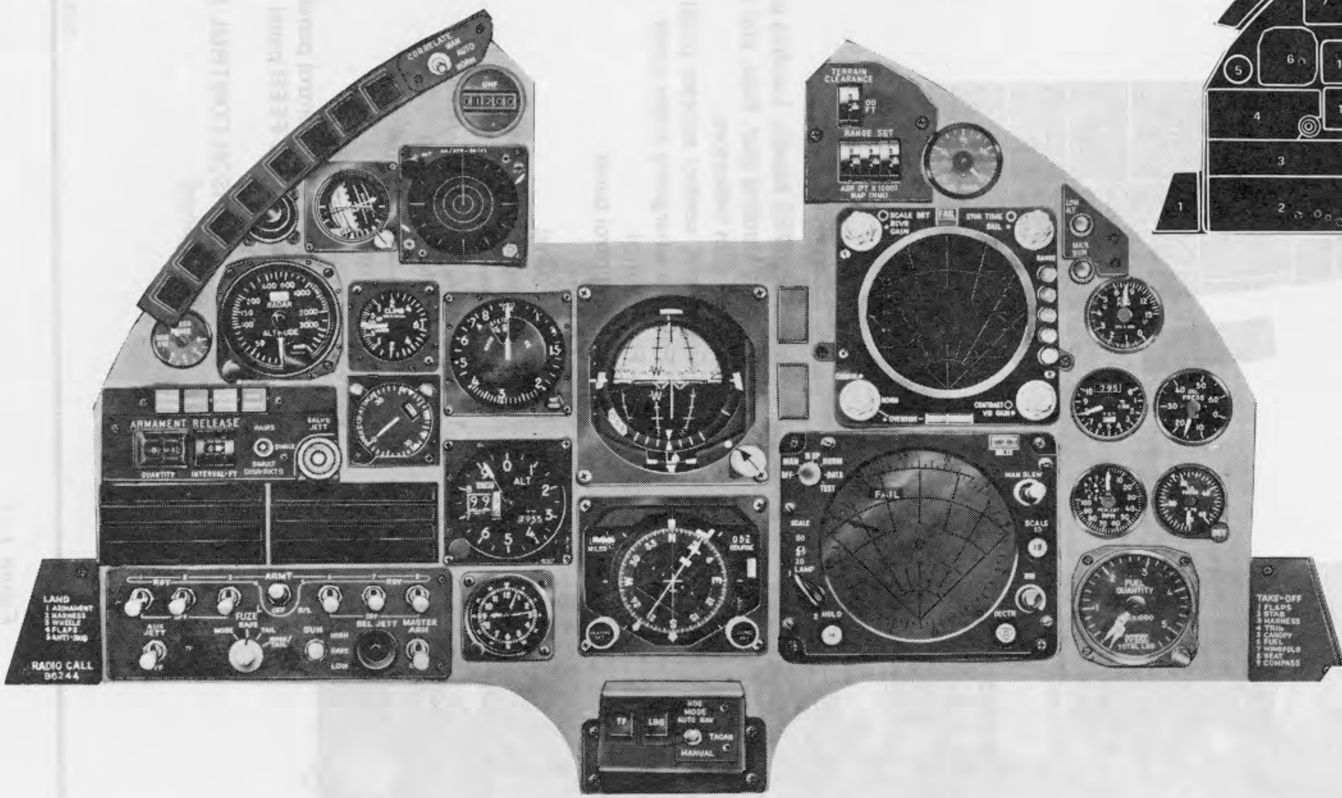
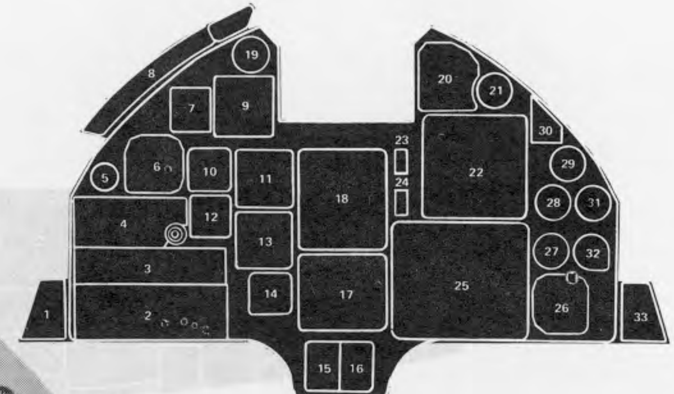
Figure 1—5

INSTRUMENT PANEL (TYPICAL) [17] [27] →





1. LAND checklist
2. ARMT select panel
3. Armament advisory light panel
4. ARMAMENT RELEASE panel
5. Speed brake indicator
6. Radar altimeter
7. Standby attitude indicator
8. RHAW lights indicator and CORRELATE switch
9. APR-36 threat analyzer
10. Vertical velocity indicator
11. Mach-airspeed indicator
12. Angle-of-attack indicator
13. Barometric altimeter
14. Clock
15. TF and LDG master function switches
16. HDG MODE switch
17. Horizontal situation indicator
18. Attitude director indicator
19. UHF Frequency remote indicator
20. TERRAIN CLEARANCE and RANGE SET control
21. OIL QUAN indicator
22. Forward looking radar
23. FIRE warning light
24. MASTER CAUTION light
25. Projected map display
26. FUEL QUANTITY indicator
27. Tachometer
28. Turbine outlet temperature indicator
29. Fuel low indicator
30. LOW ALT, MKR BCN lights
31. Oil pressure indicator
32. Turbine outlet pressure indicator
33. TAKE-OFF checklist

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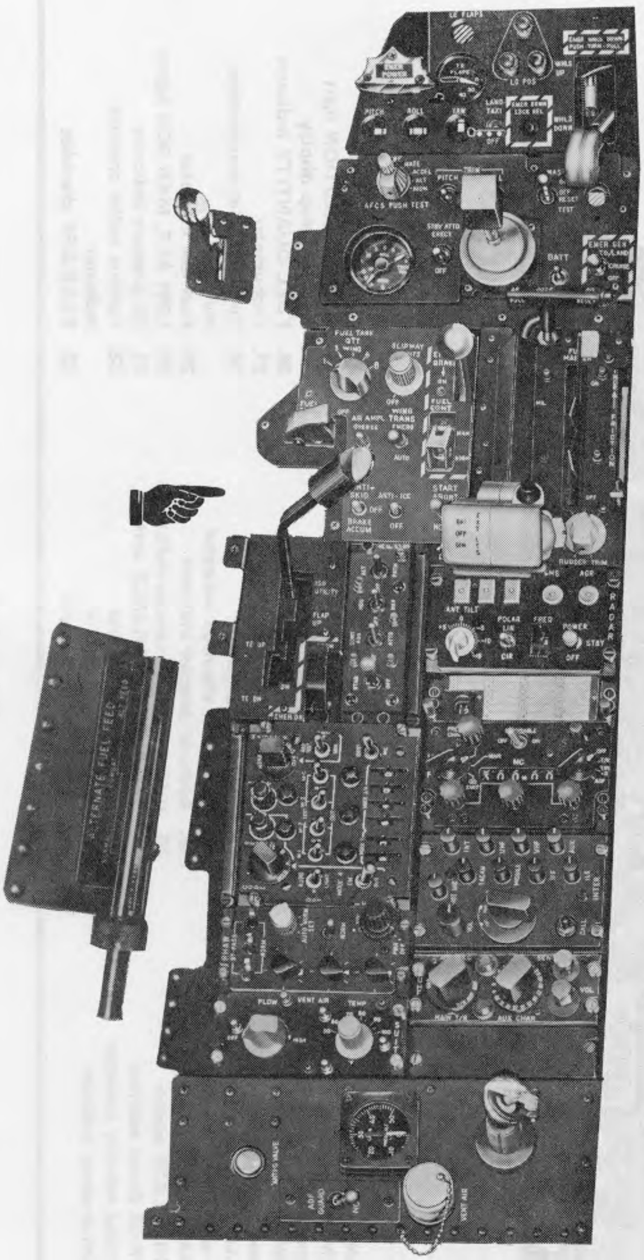
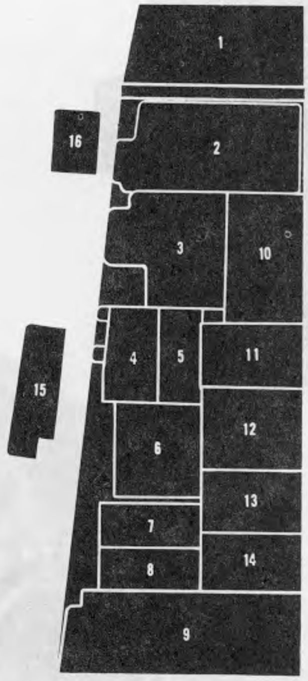
Figure 1–6

LEFT CONSOLE [17] [27] →





1. EMER POWER handle, Landing gear controls, Landing gear, flaps, and pitch and roll trim indicators.
2. Generators, control selector panel
3. Fuel and emergency brake panel
4. Flap control
5. AFCS control panel
6. IFF panel
7. RHAW panel
8. Suit temperature panel
9. Pilot services panel
10. Throttle, fuel master, AR door, and rudder trim panel
11. RADAR control panel
12. UHF control panel
13. INTER control panel
14. ADF/Auxiliary UHF control panel
15. ALTERNATE FUEL FEED panel (on left longeron)
16. CANOPY JETTISON CONTROL HANDLE (on left longeron)

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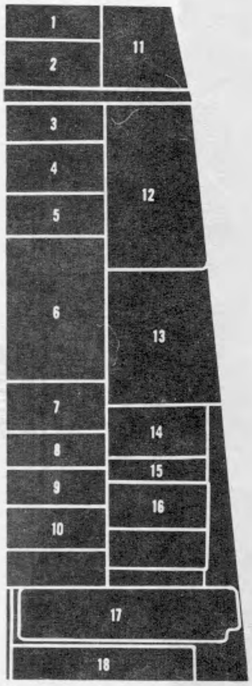
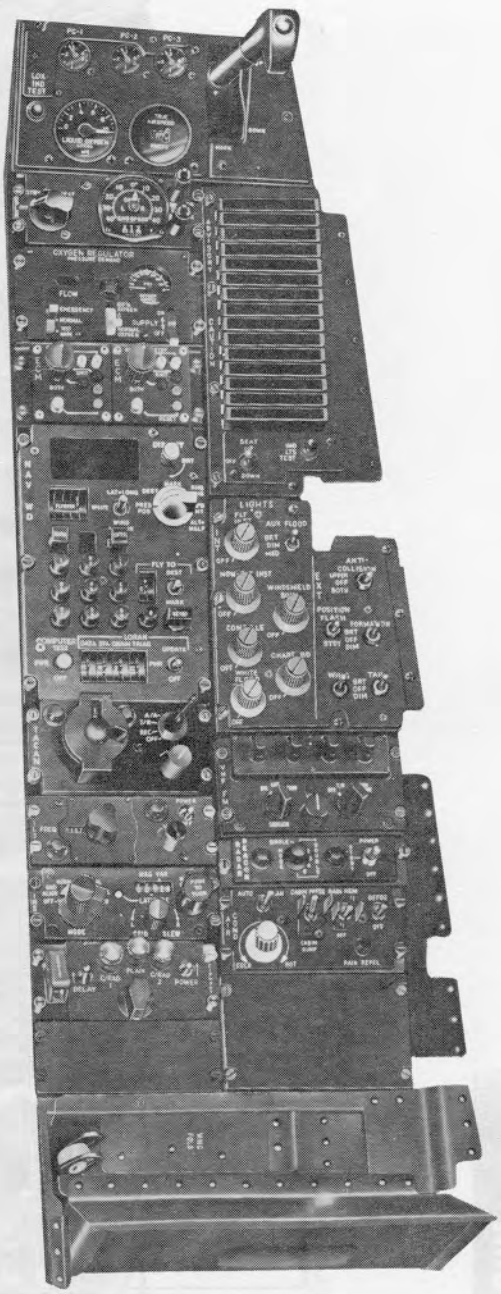
Figure 1–7

RIGHT CONSOLE [17] [27] →





1. Hydraulic pressures indicators
2. Oxygen pressure and TRUE AIRSPEED indicators
3. DPLR control panel
4. OXYGEN REGULATOR
5. ECM pod control panel
6. NAV WD control panel
7. TACAN control panel
8. ILS control panel
9. IMS control panel
10. Speech security control panel
11. HOOK control panel
12. ADVISORY and CAUTION lights panel
13. INT and EXT lights control panel
14. VHF FM control panel
15. RADAR BEACON control panel
16. AIR COND control panel
17. WINGFOLD
18. MAP CASE

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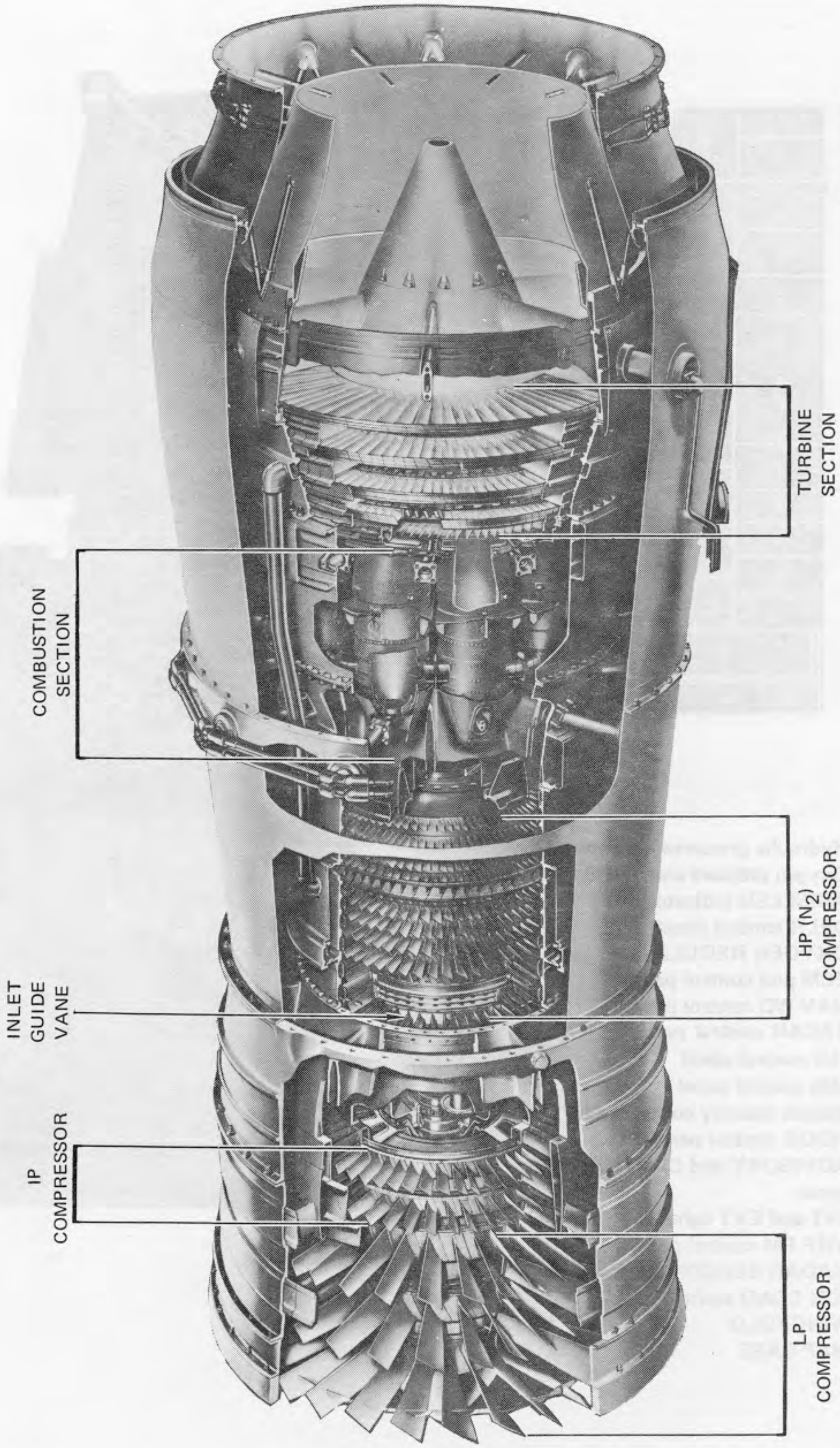
Figure 1–8

TF41-A-1 ENGINE



NOTE

Engine shown without accessories.

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Figure 1-9

The engine control system provides cockpit control of the normal and manual fuel system, manually operated fuel shutoff valve, and throttle for selecting desired engine speed throughout the operating range.

High-pressure engine bleed air is used for cockpit air-conditioning and pressurization and electronic equipment cooling. Low-pressure bleed air supplies the rain removal, external fuel tank pressurization, gun gas purge, and engine anti-ice systems.

Engine thrust ratings are as follows:

Uninstalled . . . . 14,250 lb (sea level, static)

Installed . . . . 13,390 lb (sea level, static, air-conditioning system operating)

STARTING SYSTEM.

The jet fuel starter is a self-sufficient gas turbine engine that provides starting torque. It is started by a dc electric motor that is powered by the aircraft battery or external 28-volt dc aircraft battery or two 12-volt auto batteries in series. Starting torque is transmitted to the N_2 (high pressure) compressor through reduction gearing and an overrunning clutch. A starter abort switch on the left console shuts off fuel to the starter.

Note

The FUEL MASTER handle must be in the ON position for starter operation.

The STARTER ABORT switch must remain in the ABORT position for a minimum of 5 seconds to terminate starter operation and prevent starter damage due to an inadvertent starter relight.

IGNITION SYSTEM.

The engine ignition system is independent of the aircraft electrical system. The electrical power required for ignition is provided by a permanent magnet generator (PMG) which is engine-driven through the high speed gearbox. The PMG also contains a dc system for power supply to certain engine electrical systems. At engine speeds greater than 10 percent, the output of the PMG is sufficient to provide ignition at the rate of 60 discharges per minute. The igniters are located in combustion cans No. 4 and No. 8.

Ignition is initiated in any of the following ways:

Manually with the throttle lever during the ground start sequence.

Automatically following engine flameout through the automatic relight feature.

Manually following engine flameout through an AIR IGNITE switch on the throttle grip.

During the normal ground start sequence, ignition is activated by holding the throttle lever outboard. A switch at the base of the throttle lever closes to activate ignition. If at any time the engine flames out, an automatic relight system instantly activates the ignition system. The flameout causes a rapid loss of compressor discharge pressure which activates a pressure-rate sensitive switch, completing the ignition circuit. Another means for activating engine ignition is depressing the AIR IGNITE switch on the throttle grip. This switch is provided as a backup for the automatic relight feature.

CAUTION

To prevent igniter damage due to prolonged activation, move the throttle inboard to IDLE position as soon as idle rpm is established.

ENGINE FUEL SYSTEM.

The engine fuel system is supplied fuel from the fuselage sump tank through a shutoff valve to fuel boost pump No. 1. The shutoff valve is mechanically operated by a FUEL MASTER handle. The OFF position of the FUEL MASTER handle closes the fuel shutoff valve and opens a switch in the cranking circuit to prevent engine cranking. The path of fuel through the various pumps and controls is illustrated in figure 1–10.

CAUTION

Do not use the FUEL MASTER handle to obtain engine shutdown; damage to the main fuel pump may result. Placing the handle in OFF during engine operation is permissible only in the event of engine fire or failure of the throttle shutoff valve.

After placing the FUEL MASTER handle in the ON position, pull aft on the handle to check that the spring-loaded latch has locked the handle in position.

Note

A spring-loaded latch engages to lock the FUEL MASTER handle in the ON or OFF position. The latch must be released (moved outboard) to initiate movement of the handle.

Fuel Pumps.

Two boost pumps (No. 1 and 2) and one high-pressure (dual element) main pump are provided. On aircraft → [16] [18] → [26], all fuel pumps are engine driven. On aircraft [17] [27] →, boost pump No. 2 and the main fuel pump are engine driven; boost pump No. 1 is hydraulically driven by PC 3 power. Each boost pump has its own internal bypass system.

ENGINE FUEL SYSTEM

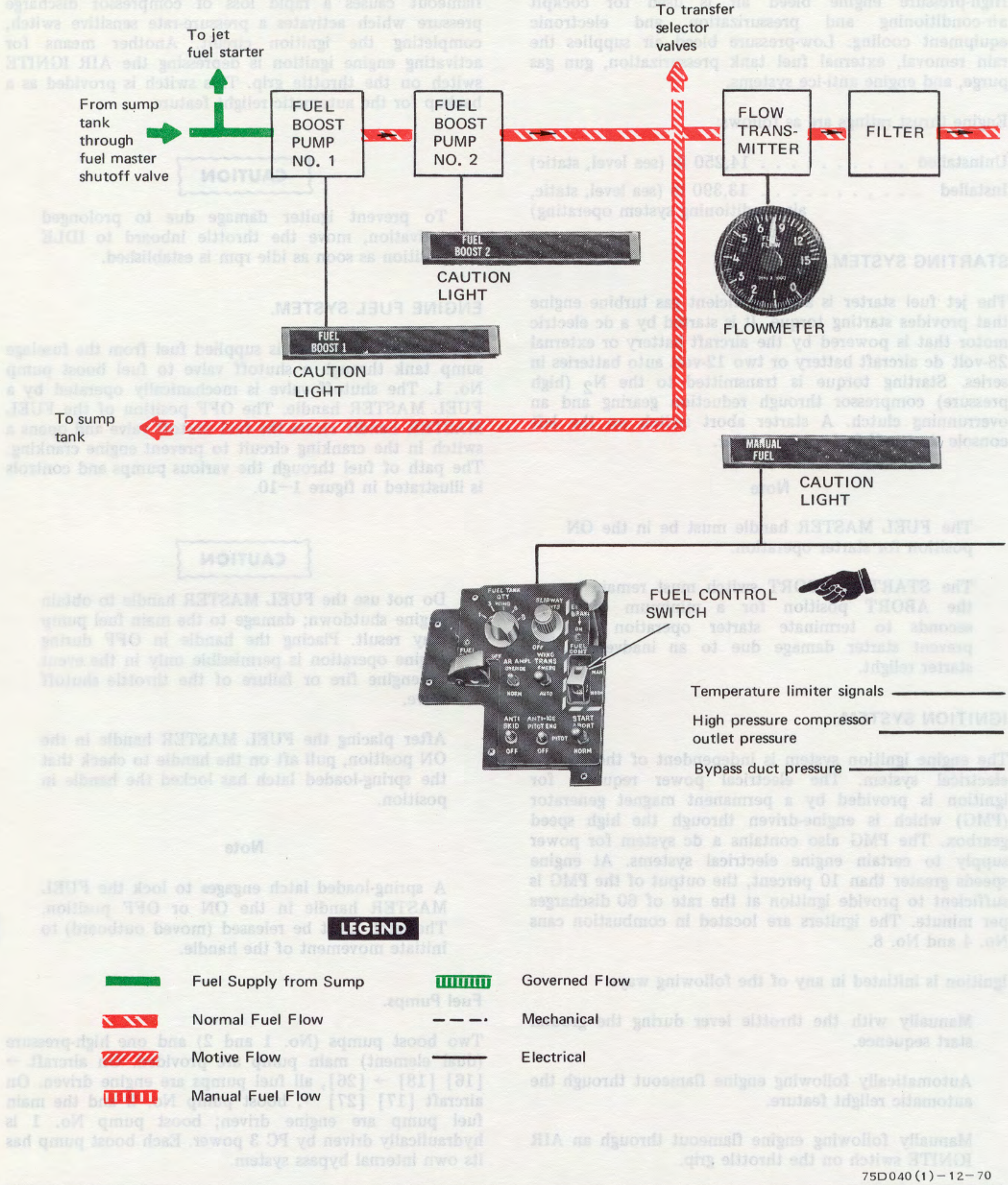

Figure 1-10 (Sheet 1)

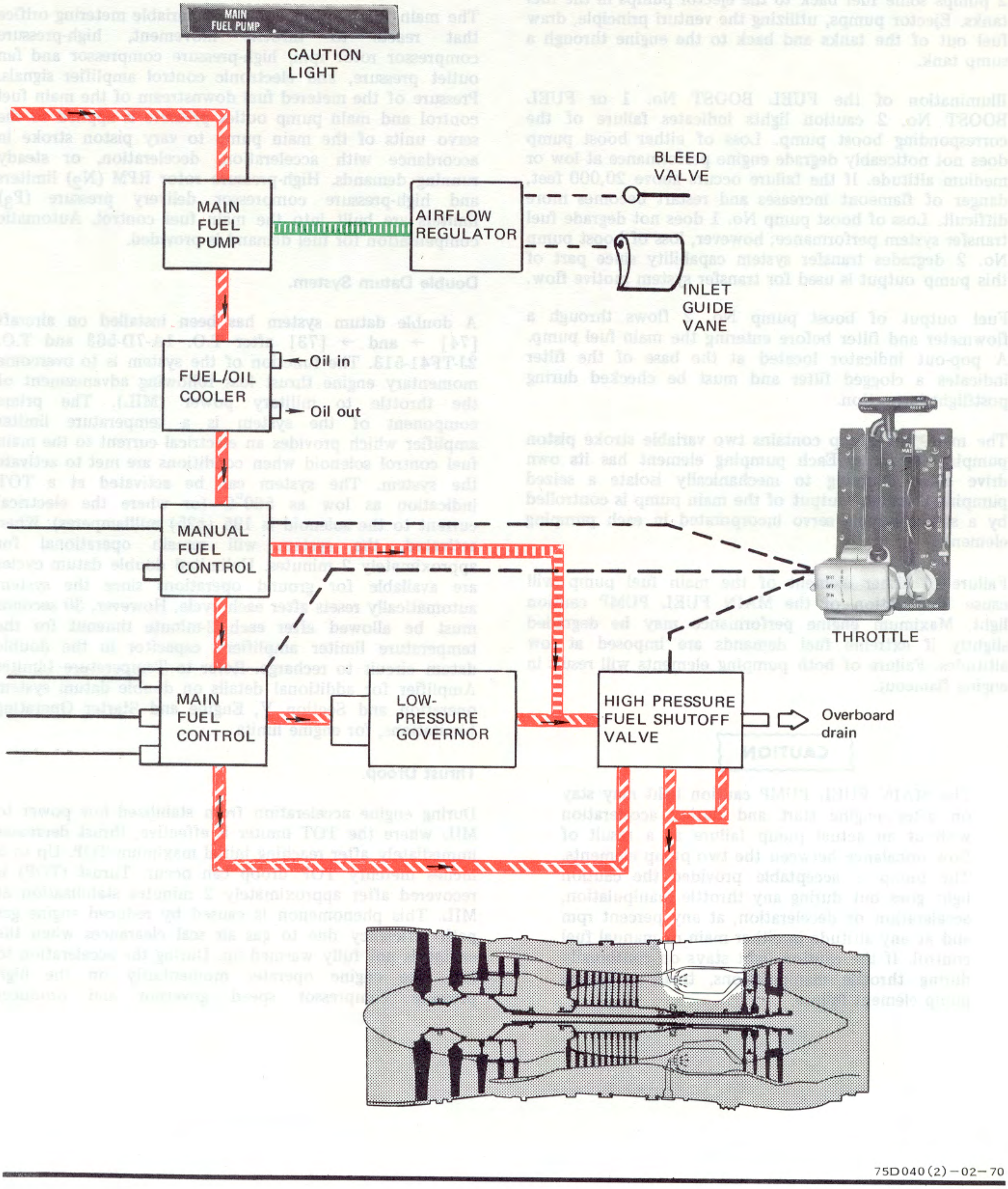

Figure 1-10 (Sheet 2)

Output of boost pump No. 1 is delivered to boost pump No. 2, which supplies fuel to the variable displacement, dual element main fuel pump, and also to the fuel tank ejector pumps. The ejector pumps in this aircraft serve the same purpose as boost pumps in other aircraft; they move fuel from fuel tanks to the engine. Boost pump No. 2 pumps some fuel back to the ejector pumps in the fuel tanks. Ejector pumps, utilizing the venturi principle, draw fuel out of the tanks and back to the engine through a sump tank.

Illumination of the FUEL BOOST No. 1 or FUEL BOOST No. 2 caution lights indicates failure of the corresponding boost pump. Loss of either boost pump does not noticeably degrade engine performance at low or medium altitude. If the failure occurs above 20,000 feet, danger of flameout increases and restart becomes more difficult. Loss of boost pump No. 1 does not degrade fuel transfer system performance; however, loss of boost pump No. 2 degrades transfer system capability since part of this pump output is used for transfer system motive flow.

Fuel output of boost pump No. 2 flows through a flowmeter and filter before entering the main fuel pump. A pop-out indicator located at the base of the filter indicates a clogged filter and must be checked during postflight inspection.

The main fuel pump contains two variable stroke piston pumping elements. Each pumping element has its own drive shear coupling to mechanically isolate a seized pumping element. Output of the main pump is controlled by a stroke-varying servo incorporated in each pumping element.

Failure of either element of the main fuel pump will cause illumination of the MAIN FUEL PUMP caution light. Maximum engine performance may be degraded slightly if extreme fuel demands are imposed at low altitudes. Failure of both pumping elements will result in engine flameout.

CAUTION

The MAIN FUEL PUMP caution light may stay on after engine start and during acceleration without an actual pump failure as a result of flow imbalance between the two pump elements. The pump is acceptable provided the caution light goes out during any throttle manipulation, acceleration or deceleration, at any percent rpm and at any altitude in either main or manual fuel control. If the caution light stays on continually during throttle manipulations, treat as a fuel pump element failure.

Main Fuel Control.

After fuel leaves the main fuel pump, it passes through a fuel filter, a fuel-cooled oil cooler, and a transfer valve of the manual fuel control before reaching the main fuel control.

The main fuel control contains a variable metering orifice that reacts to throttle movement, high-pressure compressor rotor rpm, high-pressure compressor and fan outlet pressure, and electronic control amplifier signals. Pressure of the metered fuel downstream of the main fuel control and main pump outlet pressure is applied to the servo units of the main pump to vary piston stroke in accordance with acceleration, deceleration, or steady running demands. High-pressure rotor RPM (N_2) limiters and high-pressure compressor delivery pressure (P_3) limiters are built into the main fuel control. Automatic compensation for fuel demand is provided.

Double Datum System.

A double datum system has been installed on aircraft [74] → and → [73] after T.O. 1A-7D-563 and T.O. 2J-TF41-513. The function of the system is to overcome momentary engine thrust loss following advancement of the throttle to military power (MIL). The prime component of the system is a temperature limiter amplifier which provides an electrical current to the main fuel control solenoid when conditions are met to activate the system. The system can be activated at a TOT indication as low as 560°C (or where the electrical current to the solenoid is 195 (±25) milliamperes). When activated, the system will remain operational for approximately 2 minutes. Unlimited double datum cycles are available for ground operations since the system automatically resets after each cycle. However, 30 seconds must be allowed after each 2-minute timeout for the temperature limiter amplifier's capacitor in the double datum circuit to recharge. Refer to Temperature Limiter Amplifier for additional details on double datum system operation and Section V, Engine and Starter Operating Limitations, for engine limits.

Thrust Droop.

During engine acceleration from stabilized low power to MIL where the TOT limiter is effective, thrust decreases immediately after reaching initial maximum TOP. Up to 5 inches mercury TOP droop can occur. Thrust (TOP) is recovered after approximately 2 minutes stabilization at MIL. This phenomenon is caused by reduced engine gas path efficiency due to gas air seal clearances when the engine is not fully warmed up. During the acceleration to MIL the engine operates momentarily on the high pressure compressor speed governor and produces maximum TOP. As the TOT limiter begins to reduce fuel flow to hold maximum TOT, a lower compressor speed results. This action, in combination with the reduced engine efficiency, results in a thrust decrease. Seal clearances decrease as engine operating temperature is stabilized and TOP (thrust) is restored.

Thrust Check Data charts for takeoff, Section II, Normal Procedures, are established based on maximum droop, which occurs after the TOP has peaked. The power check minimum TOP should be checked when the engine is in the fully drooped condition, that is, at the bottom of the droop after initial maximum TOP.

TOP System.

The cockpit TOP indicator is connected through a transmitter directly to the engine turbine outlet pressure manifold. TOP is the most direct measurement of thrust available that can be read in the cockpit and is used for power check prior to takeoff. The TOP indicator has a 25- to 45-inch mercury range. TOP values obtained from Thrust Check Data charts are used to determine the acceptable condition of the engine. These values include allowances for the TOP droop phenomenon and thrust degradation due to total operating time and are based on minimum engine performance.

Certain conditions of high ambient temperature combined with high pressure altitude result in indicated TOP values during engine power check that are less than 25 inches mercury. To allow actual TOP to be read in the cockpit when target TOP is less than 25 inches mercury, the air-conditioning shall be turned OFF. Two inches mercury shall be added to the TOP reading obtained from the Thrust Check Data charts, which will provide an accurate air-conditioning-off TOP power check. The air-conditioning-off procedure shall be used for engines with and without double datum TOT systems, when the value during engine power check is less than 25 inches mercury.

Temperature Limiter Amplifier.

The temperature limiter amplifier is a solid state device powered from the primary dc bus. Its function is to monitor engine operating parameters and send an electrical signal to the fuel control to maintain the engine within operating limits. It receives signals from the T_1 (engine inlet) thermocouple, the low-pressure rotor tachometer generator (N_1 rpm), two T_3 (high-pressure compressor discharge air) thermocouples, and nine average T_5 (TOT) thermocouples. The two parameters N_1 and T_1 are combined within the amplifier into the function proportional to mass airflow corrected for engine inlet temperature and engine rpm. Thus the amplifier monitors three engine operating limits; TOT, T_3 (high-pressure compressor discharge air temperature) and corrected mass airflow. A monitoring circuit continuously examines each of the three limits and as any one limit is approached, generates an appropriate output signal which is fed to the main fuel control limiting solenoid. The monitoring circuit ensures that the limit that results in the lowest fuel flow at any time is the one in control.

The TOT limiter is in control during the TOP droop phenomenon and normally controls the engine TOT to a single datum. To reduce the magnitude of the droop, a second TOT datum 19° (±4°)C above the single datum is incorporated into the amplifier, hence double datum. The higher datum is available for approximately 2 minutes with TOT rising sharply to a maximum and then slowly decreasing back to single datum limits during the 2-minute cycle. This increase in TOT allows a higher engine speed and therefore higher thrust during the time period when the thrust droop phenomenon occurs. Approximately 40% (2.0 inches mercury) of lost thrust is recovered when the double datum system is operating.

To prevent unnecessary reduction in turbine life due to the increased operating temperature, the double datum is made available only for takeoff when the aircraft has weight on the gear. After initial weight off gear occurs, the double datum circuit in the amplifier is locked out and cannot be reactivated in flight.

An interim configuration is installed on some aircraft that utilizes the leading edge flap switch to arm the double datum on the ground (leading edge flaps down) and lock it out after takeoff (leading edge flaps up). However, with this configuration the higher TOT datum can also be obtained in flight any time the leading edge flaps are extended and the engine is operating on the TOT limiter, such as during a go-around when the power is advanced to MIL. If this condition occurs, the throttle should be manipulated to maintain TOT within inflight limits. Refer to Section V, Engine and Starter Operating Limitations, for engine limits during flight.

Manual Fuel Control.

If a malfunction of the main fuel control should occur, the MAN position of the FUEL CONTROL switch selects the manual control, and fuel is directed through the metering section of the transfer metering valve. This valve is positioned by the throttle lever.

CAUTION

Throttle advancements should be made slowly to avoid compressor stalls and excessive TOT.

Low-Pressure Governor.

Engine overspeed in the event of normal limiter failure is prevented by an engine-driven low-pressure governor that receives fuel flow from the main fuel control. At a predetermined engine speed, a metering valve in the governor begins to restrict fuel flow to the engine, limiting engine speed.

Fuel Shutoff Valve.

The fuel supply to the fuel nozzles is terminated by a fuel shutoff valve located downstream of the low-pressure governor. Placing the throttle lever in OFF closes this valve and vents fuel supply lines overboard.

ENGINE FUEL DRAIN HOLDING TANK.

Aircraft |17| |27| → and aircraft → |16| |18| → |26| after T.O. 1A-7D-519 have a fuel drain holding tank installed. The tank is used to catch fuel which vents from the engine and supply lines when the throttle lever is placed in OFF. The 2-liter tank is large enough to hold fuel from three consecutive engine shutdowns. When the aircraft is airborne at speeds above 140 KTAS, the tank drains through the fuel system vent mast. If desired, ground personnel can drain the tank by means of a manual drain cock.

CAUTION

Three consecutive engine shutdowns, including the one following a previous flight, will fill the holding tank. The tank should be drained before starting the engine again as a fourth engine shutdown without aircraft flight will overflow the tank. Once overflow has started, a siphon effect will drain all fuel in the tank, creating a possible fire hazard.

ENGINE OIL SYSTEM.

The main oil pumping unit consists of one pressure pump and six scavenge pumps in the same housing and driven by the accessory section. Oil from the pressure pump flows through the fuel cooled oil cooler and a main oil filter to the engine bearings and accessory drive gears. A system relief valve at the pump outlet prevents excessive pressure when the oil is cold. A bypass valve on the oil cooler bypasses oil if restricted flow raises pressure differential above acceptable limits. Scavenge oil from engine bearings and accessory drives is returned to the oil tank by the six scavenge pumps. Oil leakage through engine bearing seals is prevented by pressurizing the seals with engine bleed air. Air that passes the seals is separated from the oil supply and vented overboard. Maximum allowable oil consumption rate is 0.12 gallon per hour. The engine oil system is illustrated in figure 1–11.

Tank Quantity And Expansion Space.

Total oil tank capacity is 2.49 gallons, including 0.69 gallons expansion space. Of the 1.80 gallons normally in the tank, 1.20 gallons is usable.

Quantity Indicating.

An oil quantity gage is mounted on the instrument panel indicating oil quantity remaining (graduated in sixteenths of a tank).

Note

If an electrical failure occurs, the indicator needle deflects to a position approximately 15 degrees past the full mark, which is the same position assumed with power off.

Oil Pressure Indicating System.

An oil pressure transmitter senses the differential between gearbox pressure and pump discharge pressure and transmits an electrical signal, equivalent to the sensed pressure, to an oil pressure indicator in the cockpit. When differential pressure decreases to approximately 11 psi differential, a pressure switch completes a circuit to the ENG OIL caution light causing it to come on.

Note

Engine oil pressure fluctuations may occur when full rudder deflection sideslip maneuvers are performed.

ENG OIL Caution Light.

An ENG OIL caution light is provided to warn the pilot that

1. Oil quantity has fallen to 3/16 full or less.
2. Oil pressure is low (11 psi (±1)).

Quantity and pressure indicators must be observed to determine the malfunction.

Note

Steep dive angles for long durations will cause oil to be trapped in the high speed gear case which will cause the ENG OIL caution light to come on. Negative g conditions may cause oil pressure drop and resultant caution light illumination. Positive g will restore proper oil level and the ENG OIL caution light will go off.

ACCESSORIES AND ACCESSORY DRIVE.

External Gearboxes.

Engine-mounted accessories requiring power are mounted externally on two gearboxes. A high speed gearbox on the underside of the engine is driven by a shaft geared to the high-pressure compressor. A low speed gearbox on the left side of the engine receives its torque from the low-pressure compressor.

High Speed Gearbox.

The high speed gearbox drives the constant speed drive (CSD), the two power control hydraulic pumps (PC 1 and 2), the two fuel boost pumps (boost pumps No. 1 and 2), the high-pressure compressor (N_2) tachometer, centrifugal breather, main fuel pump, oil pump, main fuel control, and permanent magnet generator. The jet fuel starter supplies starting torque to the engine through the high speed gearbox.

ENGINE OIL SYSTEM

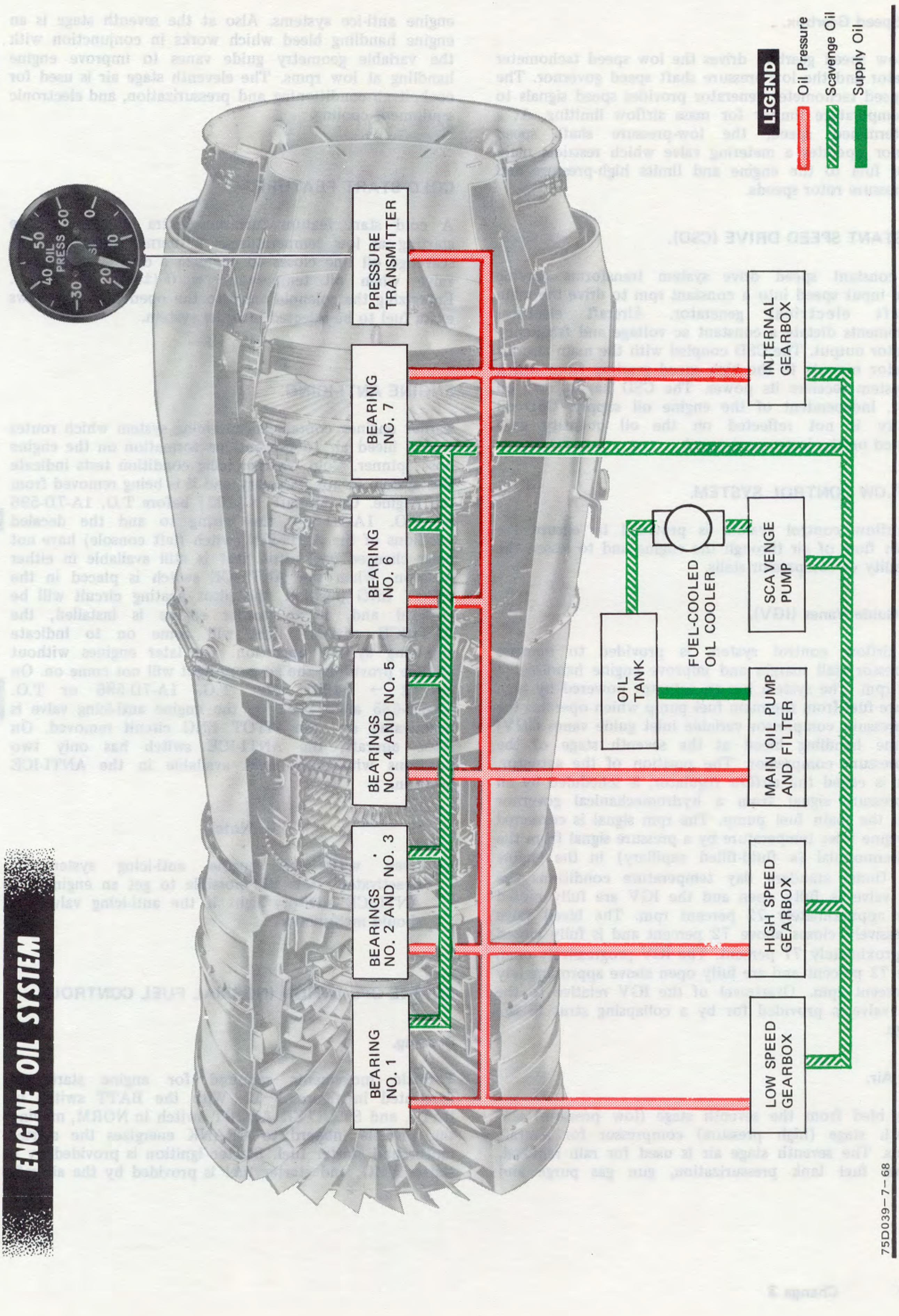

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Figure 1-11

Low Speed Gearbox.

The low speed gearbox drives the low speed tachometer generator and the low-pressure shaft speed governor. The low speed tachometer generator provides speed signals to the temperature limiter for mass airflow limiting. At a predetermined speed, the low-pressure shaft speed governor operates a metering valve which restricts main burner fuel to the engine and limits high-pressure and low-pressure rotor speeds.

CONSTANT SPEED DRIVE (CSD).

The constant speed drive system transforms varying engine input speed into a constant rpm to drive the main aircraft electrical generator. Aircraft electrical requirements dictate a constant ac voltage and frequency generator output. The CSD coupled with the main aircraft generator mounts to the high speed gearbox from which the system receives its power. The CSD has its own oil supply, independent of the engine oil supply. CSD oil quantity is not reflected on the oil quantity gage mounted on the instrument panel.

AIRFLOW CONTROL SYSTEM.

An airflow control system is provided to ensure the smooth flow of air through the engine and to lessen the possibility of compressor stalls.

Inlet Guide Vanes (IGV).

The airflow control system is provided to increase compressor stall margin and improve engine handling at lower rpm. The system has an actuator powered by high pressure fuel from the main fuel pump which operates the high-pressure compressor variable inlet guide vanes (IGV) and the handling bleed at the seventh stage of the high-pressure compressor. The position of the actuator, which is called the airflow regulator, is scheduled by an rpm/pressure signal from a hydromechanical governor within the main fuel pump. The rpm signal is corrected for engine inlet temperature by a pressure signal from the T_1 thermophial (a fluid-filled capillary) in the engine inlet. Under standard day temperature conditions the bleed valve is fully open and the IGV are fully closed below approximately 72 percent rpm. The bleed valve progressively closes above 72 percent and is fully closed at approximately 77 percent. The IGV progressively open above 72 percent and are fully open above approximately 90 percent rpm. Overtravel of the IGV relative to the bleed valve is provided for by a collapsing strut in the linkage.

Bleed Air.

Air is bled from the seventh stage (low pressure) and eleventh stage (high pressure) compressor for aircraft systems. The seventh stage air is used for rain removal, external fuel tank pressurization, gun gas purge and engine anti-ice systems. Also at the seventh stage is an engine handling bleed which works in conjunction with the variable geometry guide vanes to improve engine handling at low rpms. The eleventh stage air is used for cockpit air-conditioning and pressurization, and electronic equipment cooling.

COLD START FEATURE.

A cold start feature furnishes extra fuel for engine starting at low temperatures. A thermal switch in the scavenge oil line closes to energize a cold start solenoid valve when oil temperature is $0^{\circ}(\pm 3^{\circ})$C or colder. Energizing the solenoid valve to the open position allows extra fuel to be injected into the system.

ENGINE ANTI-ICING.

Earlier engines contain an anti-icing system which routes engine bleed air to prevent ice formation on the engine nose spinner. Cold weather icing condition tests indicate this system is not necessary and it is being removed from the engine. On aircraft → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685, the wiring to and the decaled positions of the ANTI-ICE switch (left console) have not been changed and pitot heat is still available in either position. When the ANTI-ICE switch is placed in the PITOT ENG position, the pitot heating circuit will be engaged and, if an earlier engine is installed, the ANTI-ICE advisory light will come on to indicate anti-icing system operation. On later engines without anti-ice provisions the advisory light will not come on. On aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →, the engine anti-icing valve is deactivated and the PITOT ENG circuit removed. On these aircraft, the ANTI-ICE switch has only two positions with pitot heat available in the ANTI-ICE position.

Note

> Even with the engine anti-icing system deactivated, it is still possible to get an engine ANTI-ICE advisory light if the anti-icing valve should malfunction.

ENGINE OPERATION (NORMAL FUEL CONTROL).

Starting.

Throttle movements required for engine start are illustrated in figure 1–12. With the BATT switch in BATT, and STARTER ABORT switch in NORM, moving the throttle inboard to CRANK energizes the starter motor and starter fuel. Starter ignition is provided by a starter PMG, and starter fuel is provided by the aircraft

THROTTLE POSITIONS

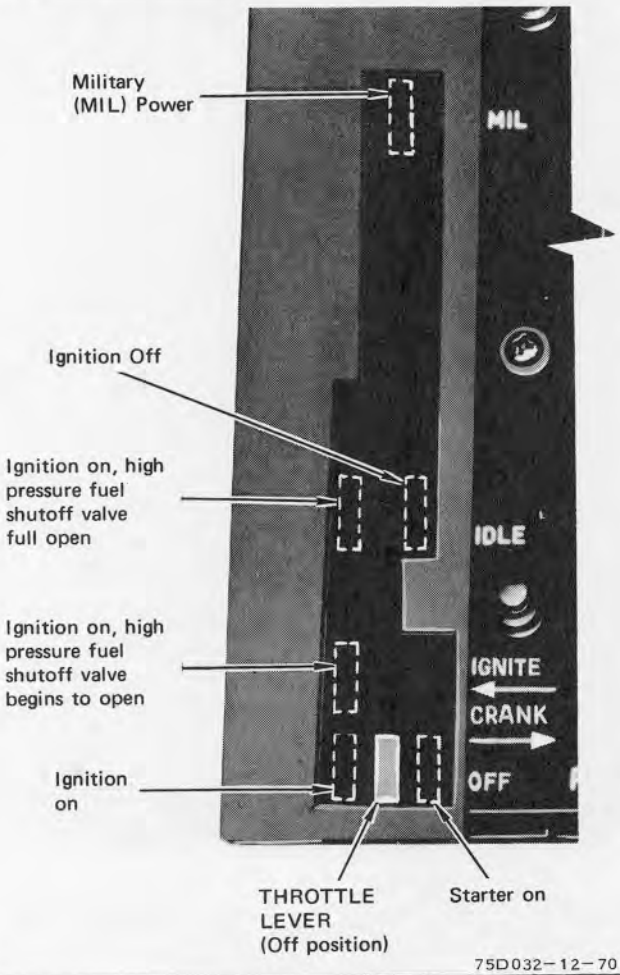


Figure 1–12

fuel system. The throttle should be held inboard in CRANK until engine rotation is indicated. Within 4 seconds, the starter turbine reaches a self-sustaining speed and the starter motor circuit deenergizes. Placing the throttle to IGNITE at 5 percent rpm initiates engine PMG ignition for engine starting. At 15 percent engine rpm, advancing the throttle to outboard of IDLE initiates starting fuel. When idle rpm (52 to 56 percent) is reached, moving the throttle inboard to the IDLE detent position terminates the ignition cycle and selects the automatic relight circuit. Refer to Engine and Starter Operation Limitations, Section V, for starter limitations.

Note

During throttle manipulation, avoid exerting outboard force on the throttle when operating in the idle range. This practice can force the throttle into the engine shutdown range. Subsequent attempts to move the throttle forward or aft can cause either a stuck throttle indication or an inadvertent engine shutdown.

Starter Shutoff.

The jet fuel starter is equipped with two automatic cutout switches and if both of these fail, the STARTER ABORT switch can be used to shut down the starter. Normally, shutoff occurs automatically at 41 to 44 percent engine rpm when the centrifugally-actuated primary cutout switch opens, causing shutoff of the fuel supply to the starter and dumping of starter fuel. If the primary cutout switch fails, a secondary cutout switch shuts down the starter as an overspeed backup when engine rpm reaches 45 to 50 percent rpm.

Note

Shutdown of the jet fuel starter can be confirmed by a ground crewman observing the cessation of jet starter exhaust.

Starter shutdown above 45 percent indicates failure of the primary cutout switch and actuation of the secondary cutout switch. Normally, the cause of primary cutout switch failure shall be corrected prior to the next start attempt. Primary cutout switch failure can be confirmed by ground personnel observing the starter overspeed "roll-over" indicator located inside the engine oil filler door. The indicator will show FAIL.

Note

In the event of operational necessity, one start is permitted following starter overspeed shutdown (primary cutout switch failure). However, the reset button on the lower portion of the starter, near the exhaust, must be pressed before the start can be attempted. This is necessary because the secondary cutout switch is a reset type switch.

If starter shutoff has not occurred at idle, it shall be shut down manually by placing the STARTER ABORT switch in ABORT. In the event of a starter turbine failure, most fragments are contained within the starter. Any fragments that fall from the exhaust contain no destructive energy.

Engine Motoring.

The engine can be motored without fuel by placing the FUEL MASTER handle ON, the throttle inboard to CRANK until engine rpm indication is observed. The throttle is then released and remains in OFF during motoring mode. The starter will motor the engine to 20 to 25 percent. Motoring is terminated by actuation of the STARTER ABORT switch to stop fuel flow to the starter. Refer to Engine Limitations, Section V, for engine motoring limitations.

The STARTER caution light will come on if starter overtemperature occurs. Illumination of the STARTER caution light is cause for an immediate abort of the ground start. If the aircraft engine has started, the aircraft may be flown. Termination of the start cycle at less than 30 to 35 percent rpm on a ground start may cause a hot engine start.

The jet fuel starter can be used in flight below 10,000 feet MSL to motor the engine to provide hydraulic pressure for flight controls if fuel is available and the aircraft engine is not seized. Normally, during such motoring, the STARTER caution light will come on between 5 and 15 seconds after starter operation is initiated. Motoring the engine in flight will result in an engine rpm of approximately 26 percent at airspeeds between 175 and 210 KIAS.

If the starter is being used for an air start, illumination of the STARTER caution light should be anticipated. However, the starter should not be shut down (by placing the starter switch to the ABORT position) until engine rpm has increased above 12 percent, throttle has been advanced, and engine TOT is increasing. Normal engine relights can be accomplished without using the jet fuel starter at any time in flight when engine rpm is above 12 percent.

ENGINE OPERATION (MANUAL FUEL CONTROL).

If the main fuel control malfunctions (indicated by thrust loss, excessive and/or erratic turbine outlet temperature, or engine rpm), the manual fuel control can be selected. Selection is accomplished by placing the FUEL CONTROL switch in MAN. Refer to Engine and Starter Operating Limitations in Section V for restrictions related to selection or deselection of manual fuel control.

CAUTION

If engine speed decreases below 48% rpm during ground checkout, shut down the engine immediately. Any attempt to accelerate the engine below 48% may result in severe engine damage.

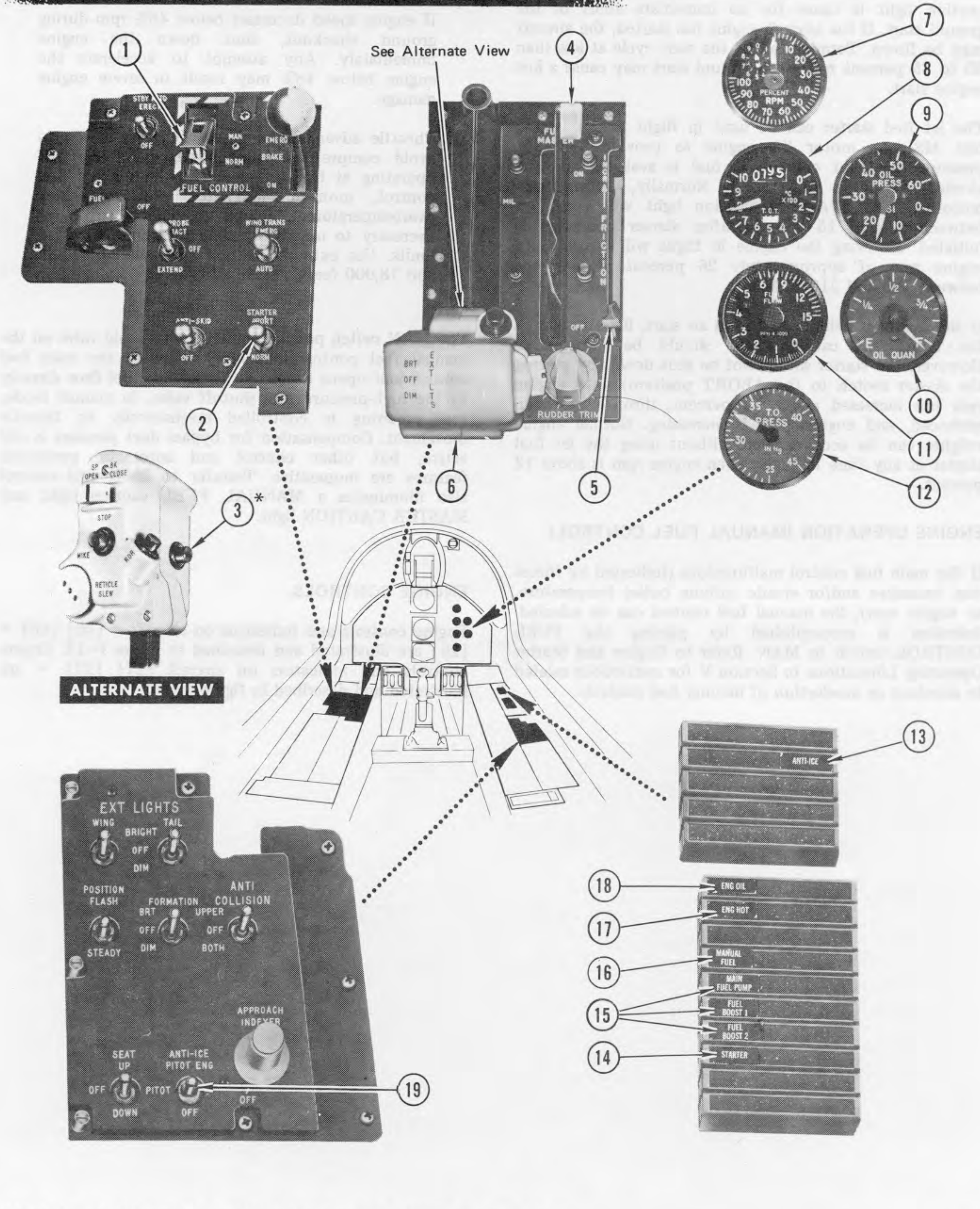
Throttle advancement should be made slowly to avoid compressor stalls and excessive TOT. If operating at high-power settings in manual fuel control, monitor TOT for possible engine overtemperature. Manipulate the throttle as necessary to maintain engine temperature within limits. Use extreme caution between 6,000 feet and 18,000 feet pressure altitude.

The MAN switch position actuates a solenoid valve on the manual fuel control that blocks flow to the main fuel control and opens a passage for manual fuel flow directly to the high-pressure fuel shutoff valve. In manual mode, fuel metering is controlled mechanically by throttle movement. Compensation for bypass duct pressure is still active, but other control and automatic protective features are inoperative. Transfer to MAN fuel control also illuminates a MANUAL FUEL caution light and MASTER CAUTION light.

ENGINE CONTROLS.

Engine controls and indicators on aircraft → [16] [18] → [26] are illustrated and described in figure 1–13. Engine controls and indicators on aircraft [17] [27] → are illustrated and described in figure 1–14.

ENGINE CONTROLS → [16] [18] → [26]



*Air ignite switch located on outboard side of throttle grip on aircraft → [10]

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Figure 1–13 (Sheet 1)

ENGINE CONTROLS — [16] [18] — [26]

Nomenclature	Function
1. FUEL CONTROL switch	MAN — switches engine fuel control to emergency metering. Throttle directly controls engine fuel flow. Energizes manual fuel caution light. NORM — selects normal operation of engine fuel control, providing automatic control of engine fuel flow.
2. STARTER ABORT switch	ABORT — deenergizes a solenoid operated valve to shut off fuel supply to the jet fuel starter. NORM — start cycle is not interrupted.
3. Air ignite switch	Depressed — activates engine ignition circuit when throttle is in any position. Switch is spring-loaded to off and ignition stops when it is released.
4. FUEL MASTER handle	ON — opens manual fuel shutoff valve in engine and jet fuel starter fuel feed lines to allow normal fuel flow; closes switch in starting circuit to permit engine cranking. OFF — closes manual fuel shutoff valve to stop fuel flow through the engine fuel feed line; opens switch in starting circuit to stop or prevent cranking.
5. Throttle friction handle	Adjusts throttle friction.
6. Throttle	OFF — interrupts or prevents engine ignition and fuel flow. CRANK — and held, energizes the start motor of the jet fuel starter. IGNITE — initiates engine ignition. Must be held outboard to maintain ignition. IDLE — operates engine at idle rpm. Below IDLE, closes high pressure fuel shutoff valve and allows residual fuel to dump. MIL — operates engine at military power.
7. Tachometer indicator	Indicates engine high rotor (N_2) speed in percent rpm.
8. Turbine outlet temperature indicator	Indicates turbine outlet temperature in degrees centigrade (pointer and digital readouts).
9. Engine oil pressure indicator	Indicates engine oil system pressure in psi.
10. Oil quantity indicator	Indicates quantity of oil in engine oil tank in fractions of tank capacity.
11. Fuel flow indicator	Indicates rate of fuel flow to engine combustion chambers in pounds per hour.
12. Turbine outlet pressure indicator	Indicates engine performance. Calibrated in inches of mercury (Hg).
13. Engine anti-icing advisory light	On (ANTI-ICE) — if anti-icing system is not removed, indicates satisfactory operation of engine anti-icing system if engine speed is above 75% rpm and ANTI-ICE switch is in PITOT ENG position provided light will go off when switch is placed in PITOT or OFF. Satisfactory operation if ANTI-ICE switch is in PITOT or OFF and aircraft is at high airspeed provided light will go off at lower airspeed. Unsatisfactory operation of engine anti-icing system if ANTI-ICE switch is in PITOT or OFF position and aircraft is static or at low airspeed.

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Figure 1–13 (Sheet 2)

ENGINE CONTROLS — [16] [18] — [26]

Nomenclature	Function
14. Starter overtemperature caution light	On (STARTER) – indicates an overtemperature condition of the jet fuel starter.
15. Fuel boost caution lights	On (FUEL BOOST 1) – indicates failure of engine-driven fuel boost pump No. 1. On (FUEL BOOST 2) – indicates failure of engine-driven fuel boost pump No. 2. On (MAIN FUEL PUMP) – indicates failure of an element of the engine-driven main fuel pump.
16. Manual fuel control indicator light	On (MANUAL FUEL) – indicates FUEL CONTROL switch is in MAN position.
17. Engine overtemperature light	On (ENG HOT) – indicates engine temperature exceeding 620° (–0°, +5°).
18. Engine oil caution light	On (ENG OIL) – indicates low engine oil quantity (3/16 tank), or low engine oil pressure (11 psi).
19. ANTI-ICE switch	PITOT – energizes pitot heating circuit. PITOT ENG – on aircraft with anti-icing system still installed, turns on engine anti-icing airflow and energizes pitot heating circuit. OFF – shuts off engine anti-icing airflow if applicable, and de-energizes pitot heating circuit.

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Figure 1–13 (Sheet 3)

ENGINE CONTROLS [17] [27] →

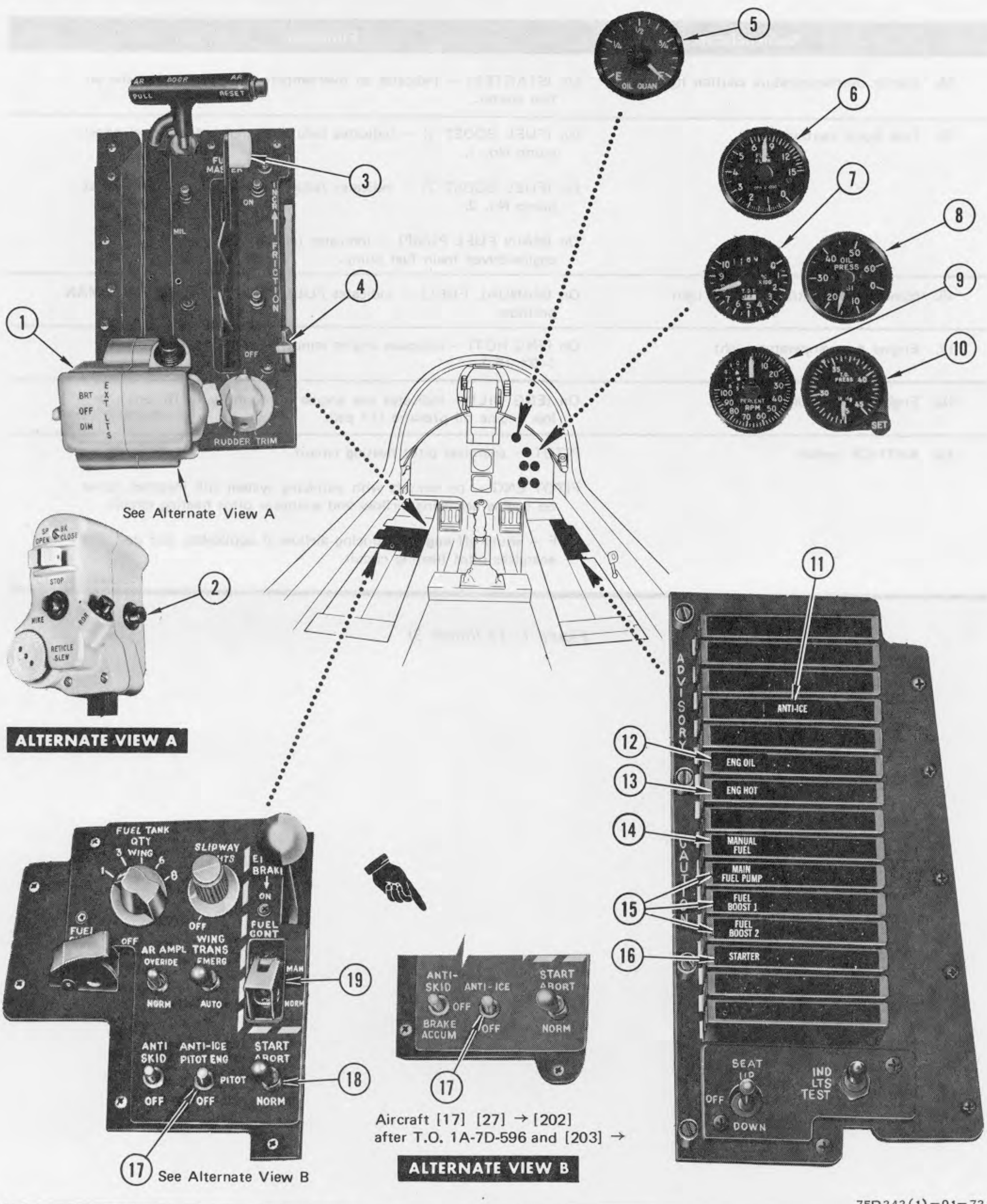

Figure 1–14 (Sheet 1)

ENGINE CONTROLS [17] [27] →

Nomenclature	Function
1. Throttle	OFF – interrupts or prevents engine ignition and fuel flow. CRANK – and held, energizes the start motor of the jet fuel starter. IGNITE – initiates engine ignition. Must be held outboard to maintain ignition. IDLE – operates engine at idle rpm. Below IDLE, closes high presure fuel shutoff valve and allows residual fuel to dump. MIL – operates engine at military power.
2. Air ignite switch	Depressed – activates engine ignition circuit when throttle is in any position. Switch is spring-loaded to off and ignition stops when it is released.
3. FUEL MASTER handle	ON – opens manual fuel shutoff valve in engine and jet fuel starter fuel feed lines to allow normal fuel flow; closes switch in starting circuit to permit engine cranking. OFF – closes manual fuel shutoff valve to stop fuel flow through the engine fuel feed line; opens switch in starting circuit to discontinue or prevent cranking.
4. Throttle friction handle	Adjusts throttle friction.
5. Oil quantity indicator	Indicates quantity of oil in engine oil tank in fractions of tank capacity.
6. Fuel flow indicator	Indicates rate of fuel flow to engine combustion chambers in pounds per hour.
7. Turbine outlet temperature indicator	Indicates turbine outlet temperature in degrees centigrade. (Pointer and digital readout).
8. Engine oil pressure indicator	Indicates engine oil system pressure in psi.
9. Tachometer indicator	Indicates engine high rotor (N_2) speed in percent rpm.
10. Turbine outlet pressure indicator	Indicates engine performance. Calibrated in inches of mercury (Hg).
11. Engine anti-icing advisory light	On (ANTI-ICE) – if anti-icing system is not removed, indicates satisfactory operation of engine anti-icing system if engine speed is above 75% rpm and ANTI-ICE switch is in PITOT ENG position provided light will go off when switch is placed in PITOT or OFF. Satisfactory operation of engine anti-icing system if ANTI-ICE switch is in PITOT or OFF and aircraft is at high airspeed provided light will go off at lower airspeed. Unsatisfactory operation of engine anti-icing system if ANTI-ICE switch is in PITOT or OFF position and aircraft is static or at low airspeed.
12. Engine oil caution light	On (ENG OIL) – indicates low engine oil quantity (3/16 tank), or low engine oil pressure (11 psi).
13. Engine overtemperature light	On (ENG HOT) – indicates engine temperature exceeding 620°C (-0° +5°).
14. Manual fuel control indicator light	On (MANUAL FUEL) – indicates FUEL CONTROL switch is in MAN position.

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Figure 1–14 (Sheet 2)

ENGINE CONTROLS [17] [27] →

	Nomenclature	Function
15.	Fuel boost caution lights	On (FUEL BOOST 1) – indicates failure of engine-driven fuel boost pump No. 1. On (FUEL BOOST 2) – indicates failure of engine-driven fuel boost pump No. 2. On (MAIN FUEL PUMP) – indicates failure of an element of the engine-driven main fuel pump.
16.	Starter overtemperature caution light	On (STARTER) – indicates an overtemperature condition of the jet fuel starter.
17.	ANTI-ICE switch [17] [27] → [202] before T.O. 1A-7D-596	PITOT – energizes pitot heating circuit. PITOT ENG – on aircraft with anti-icing system still installed, turns on engine anti-icing airflow and energizes pitot heating circuit. OFF – shuts off engine anti-icing airflow if applicable, and de-energizes pitot heating circuit.
	ANTI-ICE switch [17] [27] → [202] after T.O. 1A-7D-596 and [203] →	ANTI-ICE – energizes pitot heating circuit. OFF – deenergizes pitot heating circuit.
18.	STARTER ABORT switch	ABORT – deenergizes a solenoid operated valve to shut off fuel supply to the jet fuel starter.
19.	FUEL CONTROL switch	MAN – switches engine fuel control to emergency metering. Throttle directly controls engine fuel flow. Energizes manual fuel caution light. NORM – selects normal operaton of engine fuel control, providing automatic control of engine fuel flow.

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Figure 1–14 (Sheet 3)

AIRCRAFT FUEL SUPPLY SYSTEM.

The fuel supply system consists of the following subsystems:

- Main Fuel System
- Transfer Fuel System
- Alternate Fuel Feed System [17] [27] →
- Air Refueling System
- Fuel Vent and Pressurization System
- Fuel Quantity Indicating System
- Fuel Dumping System

The main fuel system consists of all fuselage fuel tanks. The transfer system consists of wing and external tanks.

The basic principle of the fuel supply system is that all fuel supply tanks feed a sump tank, which feeds the engine. Fuel is moved from the supply tanks to the sump tank by means of ejector pumps and gravity flow. An ejector pump in the sump tank supplies fuel and maintains a positive inlet pressure to engine boost pump No. 1. The fuel from boost pump No. 1 is directed to boost pump No. 2. Part of the output from boost pump No. 2 is used as motive flow and the remainder is directed to a main fuel pump after passing through a flowmeter and filter. The main fuel pump is a dual element high-pressure pump. The flow of fuel from the main fuel pump through the fuel control to the engine is described in detail under Engine Fuel System.

Ejector pumps operate when supplied with a high speed stream of fuel produced by engine-driven boost pumps No. 1 and No. 2. The high speed stream of fuel is called motive flow. As the motive flow fuel jets from the ejector pump nozzle, it draws stagnant fuel from the fuel tank. The stagnant fuel mixes with the motive flow fuel in the throat of the ejector pump. The fuel is then decelerated in the diffuser before discharge at a relatively low pressure. Figure 1–15 illustrates a typical ejector pump.

Provisions are included for aerial refueling of internal and external tanks from a tanker aircraft. The system is capable of receiving fuel without adverse effects from fueling facilities that do not exceed 55 psi nozzle pressure while flowing, and at 120 psi maximum surges for any

TYPICAL EJECTOR PUMP

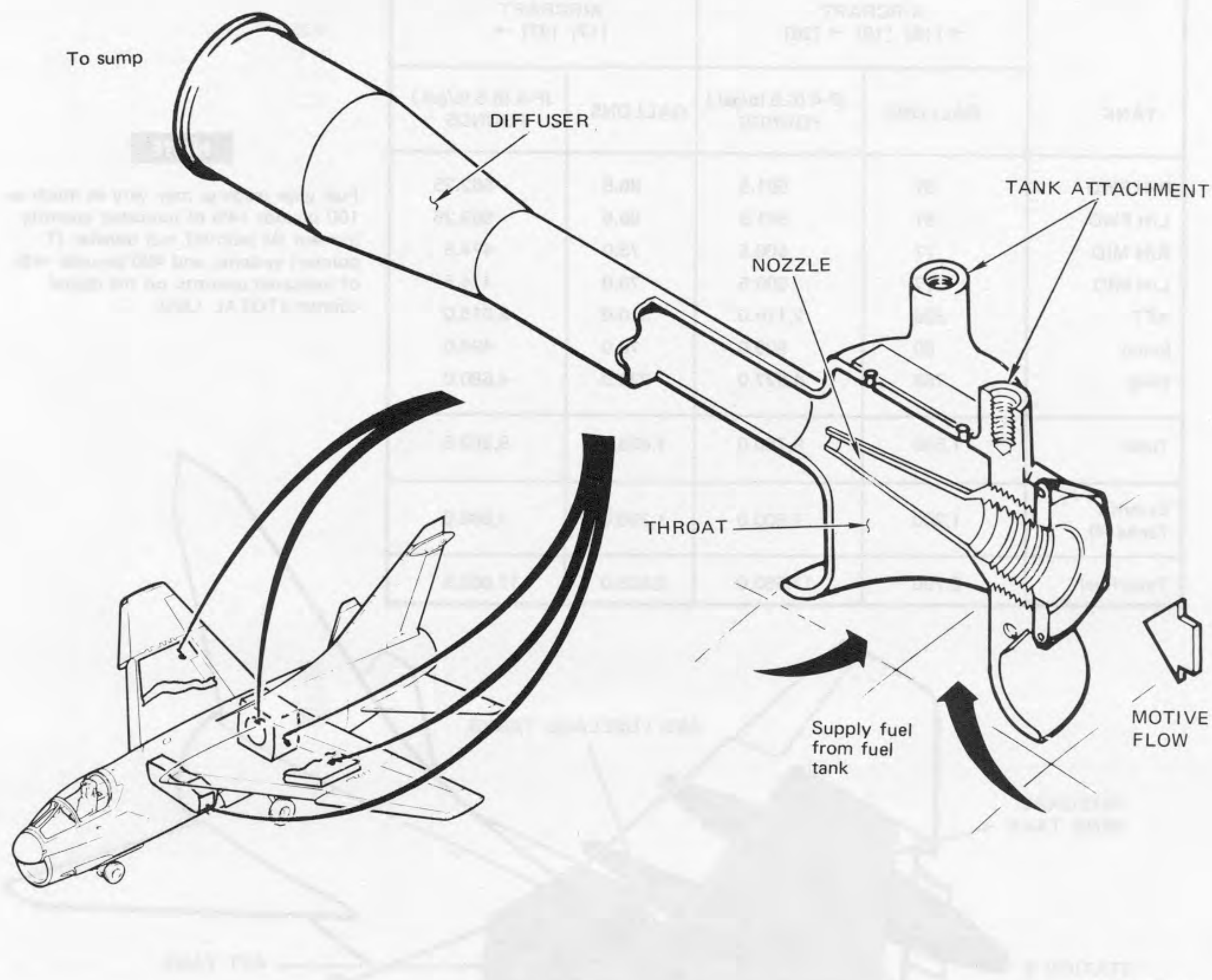


Figure 1–15

shutoff condition. Aircraft → [16] [18] → [26] are refueled from tanker aircraft equipped with a MA-2 hose drogue adapter kit. These aircraft receive fuel at a rate of 1,200 to 1,600 pounds per minute (190 to 250 gallons per minute). Aircraft [17] [27] → are refueled from a tanker equipped with a flying boom and receive fuel at 1,700 to 2,900 pounds per minute (260 to 450 gallons per minute).

Single point pressure ground fueling is accomplished through a pressure fueling receptacle in the left wheel well. The aircraft can be gravity fueled through receptacles on top of the fuselage and on top of the wing center section. Aircraft [17] [27] → have polyurethane foam baffles installed in all internal fuel tanks. The baffles fill all voids except those required around inlet or outlet openings for fuel flow and are included to reduce the threat of fire and/or explosion if hit by a foreign object. Installation of the baffles reduces the fuel capacity by a small percentage. Fuel tank capacities and locations are shown in figure 1–16.

MAIN AND TRANSFER FUEL SYSTEMS.

The main fuel system consists of the six fuselage tanks. The sump tank and the lower 120 gallons of the aft fuselage tank are self-sealing. The transfer system consists of the integral wing tank and external fuel tanks. Under

FUEL TANK LOCATIONS AND CAPACITIES

USABLE FUEL – GROUND ATTITUDE

TANK	AIRCRAFT → [16] [18] → [26] GALLONS	AIRCRAFT → [16] [18] → [26] JP-4 (6.5 lb/gal.) POUNDS	AIRCRAFT [17] [27] → GALLONS	AIRCRAFT [17] [27] → JP-4 (6.5 lb/gal.) POUNDS
R/H FWD	91	591.5	86.5	562.25
L/H FWD	91	591.5	86.5	562.25
R/H MID	77	500.5	73.0	474.5
L/H MID	77	500.5	73.0	474.5
AFT	326	2,119.0	310.0	2,015.0
Sump	80	520.0	76.0	494.0
Wing	758	4,927.0	720.0	4,680.0
Total	1,500	9,750.0	1,425.0	9,262.5
External Tanks (4)	1,200	7,800.0	1,200.0	7,800.0
Total Fuel	2,700	17,550.0	2,625.0	17,062.5

NOTE

Fuel gage readings may vary as much as 100 pounds +4% of indicated quantity in main (M pointer) and transfer (T pointer) systems; and 400 pounds +4% of indicated quantity on the digital counter (TOTAL LBS).

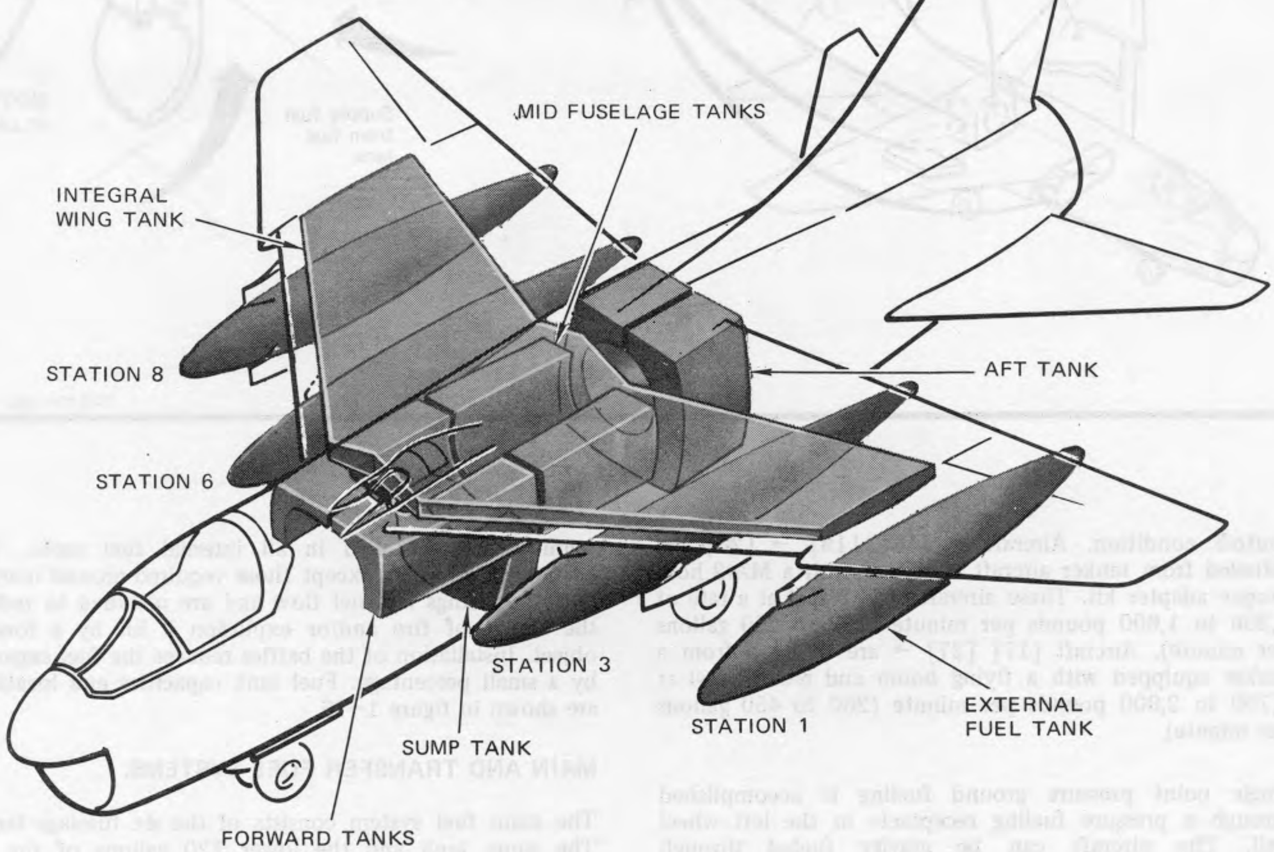


Figure 1–16

normal conditions, all fuel supplied to the engine is from the sump tank. Fuel in the forward fuselage tanks transfers to the sump tank by gravity flow. On aircraft → [16] [18] → [26], fuel in both midfuselage tanks also transfers to the sump tank by gravity flow. On aircraft [17] [27] →, fuel in the right midfuselage tank transfers to the aft tank by gravity flow and fuel in the left midfuselage tank transfers to the sump tank by gravity flow. Fuel in the wing and aft tanks is transferred to the sump tank by ejector pumps (two in the wing tank and two in the aft tank).

Fuel transfer is automatically sequenced to maintain optimum CG. Transfer sequence is as follows: external tanks (if installed), wing tank, aft fuselage tank, forward and midfuselage tanks.

Alternate Fuel Feed System [17] [27] →

The alternate fuel feed system consists of a cockpit mounted control handle, two manually operated valves, and electrical circuitry to reposition motive flow selector valves. The NORMAL position of the ALTERNATE FUEL FEED control handle allows normal fuel transfer sequencing. Selection of the COMBAT position closes the sump tank motive flow shutoff valve to depressurize fuel feed lines from the sump tank to the engine when in a combat area. The ALT FEED position of the control handle allows the pilot to select an alternate route for fuel feed to the engine. With the system in the ALT FEED position, the alternate feed selector valve is mechanically positioned to route fuel from the right midfuselage and aft tanks directly to the engine, bypassing the sump tank. Selection of ALT FEED also electrically repositions the wing fuel selector valve to the aft tank position, and on aircraft [17] [27] → [281] after T.O. 1A-7D-652 and [282] → repositions the bypass selector valve to the bypass position. This feature allows for correction of several fuel transfer system failures which may otherwise result in trapped aft tank fuel. Because the motive flow selector valves are repositioned when ALT FEED is selected, the WING TRANS switch must be placed in EMERG to transfer wing fuel. Wing fuel, when transferred in this manner, will also bypass the sump tank. The WING TRANS switch should be returned to AUTO when transfer is complete. With ALT FEED selected, fuel from the sump, left midfuselage, and forward tanks is available to the engine by gravity feed after other tanks are empty when the WING TRANS switch is in AUTO. The rate of gravity feed is limited, and fuel boost caution lights may come on or engine flameout may occur if at high altitude, high power settings, or nose low attitudes.

External Fuel System.

External tanks of 300-gallon capacity may be mounted on wing stations 1, 3, 6, or 8. Pressurization for transfer of fuel to the main fuel system is provided by engine bleed air. The external tanks can be either salvo or select jettisoned, if necessary.

Ground fueling of the external tanks may be accomplished during single point pressure fueling operations. As each tank fills, a pressure shutoff valve automatically closes to stop flow into the tank. External tanks may also be gravity fueled through a receptacle on the top forward side of each tank.

Dumping from external tanks is accomplished indirectly. External fuel is transferred to the fuselage tanks where it overflows to the wing tank and gravity flows overboard through the dump valves. External fuel and dump systems are illustrated in figure 1–17.

FUEL QUANTITY INDICATING SYSTEM.

The fuel quantity indicating system measures fuel quantity (by weight) for cockpit display. The system consists of probes for measuring quantity, density monitors to compensate for density changes, a quantity indicator on the instrument panel, a fuel low-level caution light, and on aircraft [17] [27] →, a SUMP LOW caution light. Main fuel quantity (fuselage tanks) is indicated by an (M) pointer. Transfer fuel quantity (wing and external tanks) is indicated by a (T) pointer. Wing quantity and individual external tank quantity is selected by a FUEL TANK QTY monitoring switch. A counter is provided to show total fuel aboard the aircraft. A press-to-test switch in the lower right corner of the indicator provides the capability to test for accurate pointer and digital counter indications.

FUEL VENT AND PRESSURIZATION SYSTEM.

All fuel tanks are connected by vent lines that lead to a vent mast on the lower portion of the aft fuselage. This venting prevents negative or excessive positive pressures that could cause structural damage to the tanks. During all ground pressure fueling operations of internal fuel tanks, air should be flowing from the vent mast.

During flight, a small positive pressure is maintained in the tanks (relative to ambient pressure) by ram air through the vent mast.

Cooled engine bleed air, regulated to about 12 psi, is used to transfer fuel from the external tanks into the internal aircraft fuel system. Pressurization of external tanks begins when the landing gear is retracted and vents when the gear is extended, or the air refueling probe (or receptacle door) is extended. No pilot-operated switch is used for selecting external fuel tank transfer. No other fuel system in the aircraft uses pressurization for moving fuel.

AIR REFUELING SYSTEM.

The air refueling system permits aerial refueling of all tanks, including external tanks, if installed. There are two different air refueling systems used on the aircraft.

Aircraft → [16] [18] → [26] are configured for refueling from a tanker equipped with an MA-2 drogue. The system consists of a hydraulically actuated refueling probe, a probe floodlight, a PROBE advisory light, and a PROBE switch. With the PROBE switch in the EXTEND position and the probe engaged with the tanker drogue, refueling of the aircraft fuel system and external tanks is

EXTERNAL FUEL AND DUMP SYSTEMS

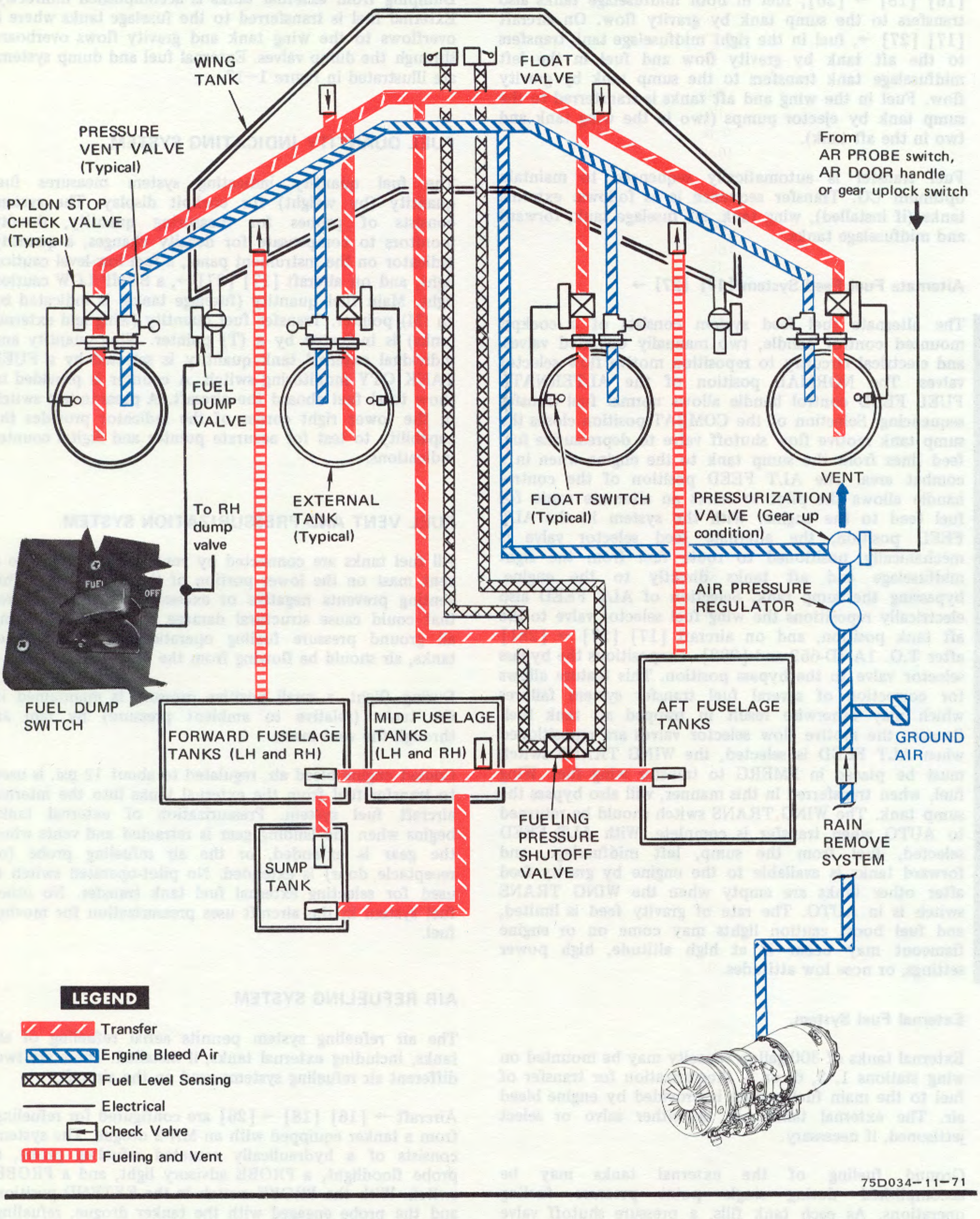


Figure 1–17

accomplished automatically, including automatic fuel shutoff when refueling is complete. With the probe extended and the probe switch in OFF, fuel is taken as before but goes into the internal fuel system only (external tanks are not fueled). The onloaded fuel is transferred into the tanks through the same valves and lines used in normal pressure fueling.

Aircraft [17] [27] → are configured for refueling from a tanker equipped with a flying boom. The system consists of a boom receptacle; manually actuated, hydraulically assisted slipway doors; slipway floodlights; three advisory lights; a refueling signal amplifier; an AR AMPL (Air Refueling Amplifier) switch; a disconnect switch; and an AR DOOR handle. Pulling the AR DOOR handle up opens the air refueling receptacle slipway door. Refueling is controlled by the boom operator with the receiver aircraft pilot monitoring cockpit lights and gages. The refueling indicator lights and receptacle boom nozzle locks are controlled by the refueling signal amplifier.

Boom disconnect can be achieved at any time during the refueling operation. The boom operator can actuate a boom disconnect switch or he can force disconnect from the receptacle boom locks. The receiver aircraft pilot can actuate a disconnect switch (nose gear steering switch) on the stick grip without regard to the position of the AR AMPL switch. Automatic disconnect is accomplished when the aircraft has a full fuel load.

If the refueling signal amplifier fails, placing the AR AMPL switch in OVERRIDE bypasses the amplifier and connects relay logic directly to the nozzle locks. In OVERRIDE, refueling may be accomplished without use of the indicator lights and boom operator disconnect capability. This type refueling requires the pilot to perform all disconnects.

OPERATION.

Thermistor Principle.

Thermistors are used to sense fuel level in various fuel tanks for fuel tank sequencing. A thermistor is a ceramic bead with an inverse resistance characteristic with temperature change. As temperature increases, resistance is reduced and as temperature decreases, resistance is increased. As long as the thermistor is covered by fuel, the resistance is high due to the low temperature. When the thermistor is uncovered, the temperature increases due to heating effects of the current flow. As the temperature increases, the resistance is reduced and the current flow increases. This trips a relay to signal uncovering of the thermistor.

Main and Wing Fuel Transfer.

Fuel Transfer (WING TRANS Switch in AUTO).

With full internal fuel, both fuel transfer control thermistors are covered and the selector valves are positioned to route motive flow to the wing tank ejector pumps. Fuel is transferred directly to the sump tank at a pressure sufficient to prevent gravity flow of fuel into the sump tank.

After the wing tank has been emptied, fuselage fuel transfers to the sump tank by gravity flow. On aircraft → [16] [18] → [26], the transfer is from both forward tanks and both mid tanks. On aircraft [17] [27] →, the transfer is from both forward tanks and the left mid tank. The gravity flow transfer continues until the No. 1 fuel transfer control thermistor located near the top of the right forward tank is uncovered. Uncovering of this thermistor completes circuitry to reposition the wing fuel selector valve to route motive flow to the aft tank ejector pumps. These pumps transfer more fuel to the sump tank than is required by the engine. The excess fuel overflows into the forward tanks through the vent lines. On aircraft [17] [27] → as aft tank fuel is used, fuel in the right midfuselage gravity flows into the aft tank.

As fuel level in the forward tanks rises, No. 1 fuel transfer control thermistor becomes covered again, causing the wing fuel selector valve to reposition open and send motive flow back to the wing fuel ejector pumps. This selector valve will cycle motive flow between the aft tank ejectors and the wing tank ejectors until the aft tank empties.

When the aft tank is empty, the No. 2 fuel transfer control thermistor in the bottom of the aft tank is uncovered, completing circuitry to position the bypass selector valve to direct motive flow directly to the sump tank. This causes pressure in the sump tank to drop to a predetermined level which allows gravity flow of fuselage fuel to the sump tank. At approximately 1,000 (±200) pounds of fuel remaining, the No. 3 thermistor in the left forward tank uncovers and turns on the FUEL LOW caution light. The FUEL LOW caution light thus indicates that 1,000 (±200) pounds are available to the engine. On aircraft → [16] [18] → [26] this fuel is distributed in both forward fuselage tanks, both midfuselage tanks, and the sump tank. On aircraft [17] [27] → this fuel is in both forward fuselage tanks, the left midfuselage tank, and the sump tank.

CAUTION

> If fueling/defueling procedures are not accomplished in accordance with T.O. 1A-7D-2-1, a correct indication of useable fuel remaining may not be obtained when the FUEL LOW caution light comes on.

On aircraft [17] [27] → in addition to the FUEL LOW caution light, a thermistor in the sump tank uncovers and turns on the SUMP LOW caution light when fuel in the sump tank has fallen below 360 (±40) pounds. The main and transfer fuel systems for aircraft → [16] [18] → [26] are illustrated in figure 1–18. The main and transfer fuel systems for aircraft [17] [27] → are illustrated in figure 1–19.

Fuel Transfer (WING TRANS Switch in EMERG).

If the main fuel quantity (M) pointer indicates a decrease while the transfer fuel quantity (T) pointer indicates wing fuel remaining or a constant quantity, loss of motive flow or failure of fuel transfer sequencing has occurred. Placing the WING TRANS switch in EMERG applies dc power to

MAIN AND TRANSFER FUEL SYSTEM → [16] [18] → [26]

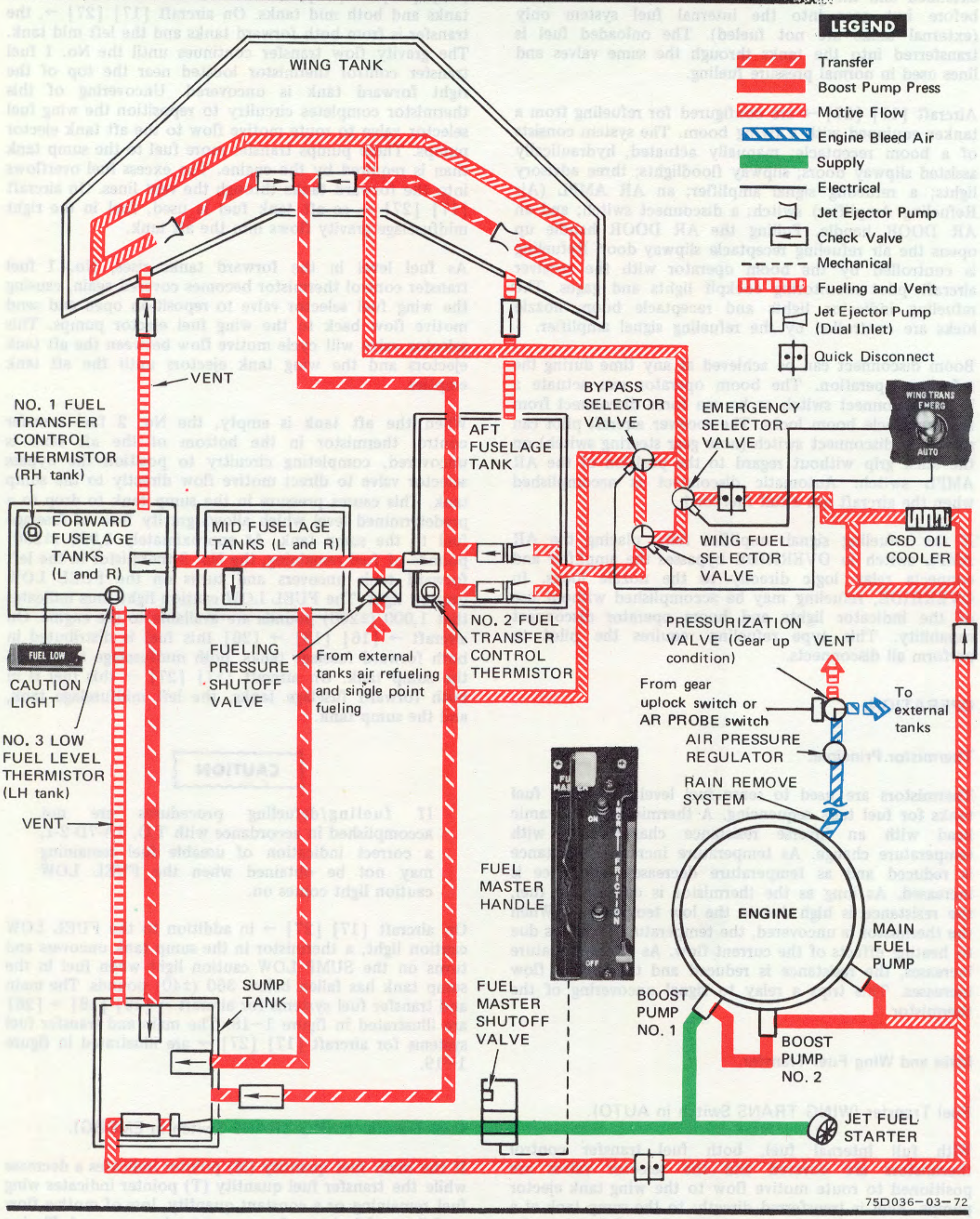
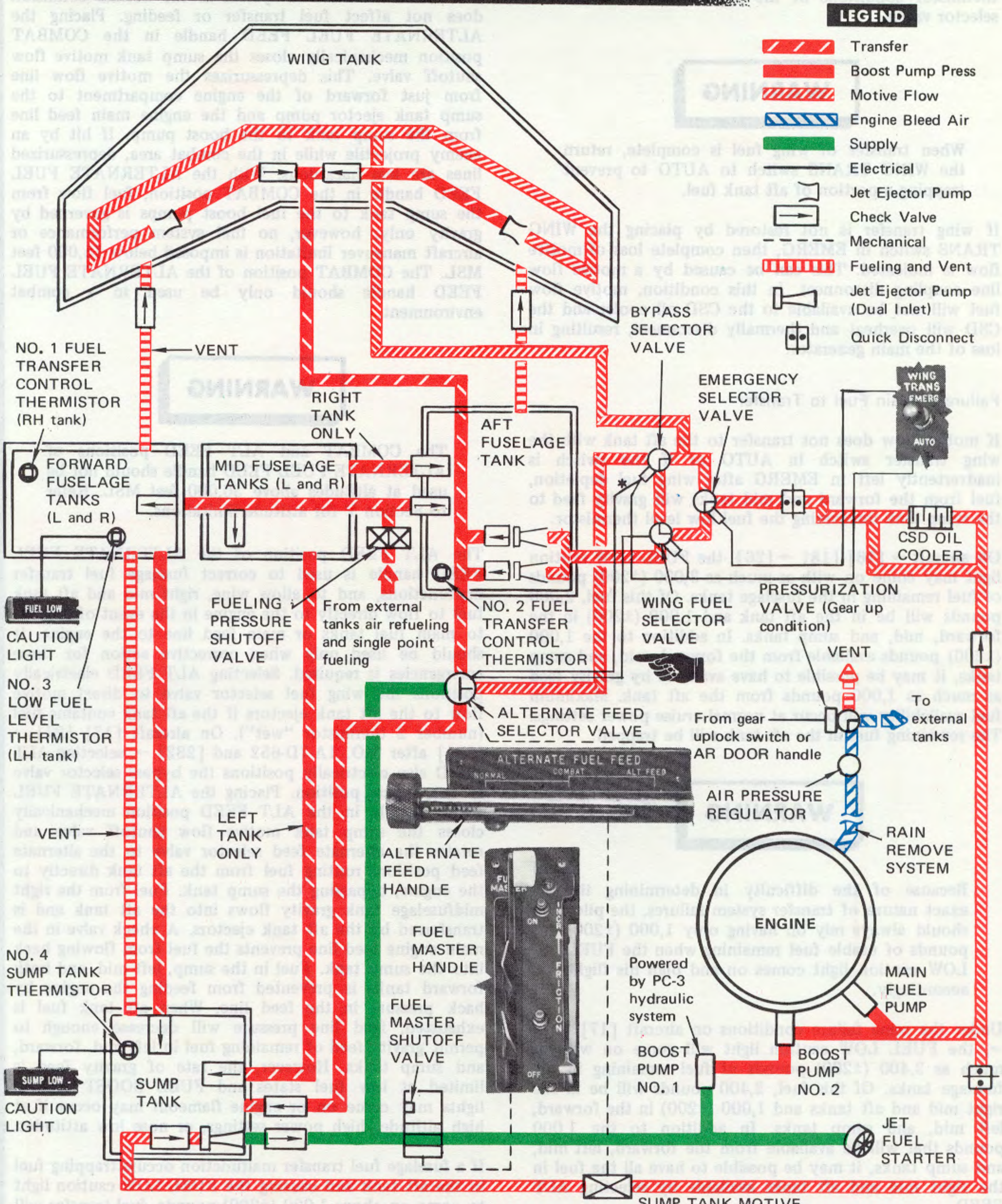


Figure 1–18

MAIN AND TRANSFER FUEL SYSTEM [17] [27] →



*On aircraft [17] [27] → [281] after T.O. 1A-7D-652 and [282] →

Figure 1–19

the emergency selector valve, actuating it to direct motive flow to the wing tank ejector pumps regardless of thermistor conditions or the position of the other two selector valves.

WARNING

When transfer of wing fuel is complete, return the WING TRANS switch to AUTO to prevent trapping a portion of aft tank fuel.

If wing transfer is not restored by placing the WING TRANS switch in EMERG, then complete loss of motive flow is indicated. This can be caused by a motive flow line coupling disconnect. In this condition, motive flow fuel will not be available to the CSD oil cooler and the CSD will overheat and thermally disconnect, resulting in loss of the main generator.

Failure of Main Fuel to Transfer

If motive flow does not transfer to the aft tank with the wing transfer switch in AUTO or if the switch is inadvertently left in EMERG after wing fuel depletion, fuel from the forward and mid tanks will gravity feed to the sump tank uncovering the fuel low level thermistor.

On aircraft → [16] [18] → [26], the FUEL LOW caution light may come on with as much as 3,000 (±200) pounds of fuel remaining in the fuselage tanks. Of this fuel, 2,000 pounds will be in the aft tank and 1,000 (±200) in the forward, mid, and sump tanks. In addition to the 1,000 (±200) pounds available from the forward, mid, and sump tanks, it may be possible to have available by gravity feed as much as 1,000 pounds from the aft tank. Maximum fuel availability will occur at normal cruise power settings. The remaining fuel in the aft tank will be trapped.

WARNING

Because of the difficulty in determining the exact nature of transfer system failures, the pilot should always rely on having only 1,000 (±200) pounds of usable fuel remaining when the FUEL LOW caution light comes on and plan his flight accordingly.

Under the same failure conditions on aircraft [17] [27] →, the FUEL LOW caution light will come on with as much as 3,400 (±200) pounds of fuel remaining in the fuselage tanks. Of this fuel, 2,400 pounds will be in the right mid and aft tanks and 1,000 (±200) in the forward, left mid, and sump tanks. In addition to the 1,000 pounds that will be available from the forward, left mid, and sump tanks, it may be possible to have all the fuel in the right mid and aft tanks available by selecting ALT FEED.

Alternate Fuel Feed System [17] [27] →

The alternate fuel feed system in the normal condition does not affect fuel transfer or feeding. Placing the ALTERNATE FUEL FEED handle in the COMBAT position mechanically closes the sump tank motive flow shutoff valve. This depressurizes the motive flow line from just forward of the engine compartment to the sump tank ejector pump and the engine main feed line from the sump tank to the boost pump. If hit by an enemy projectile while in the combat area, depressurized lines are less hazardous. With the ALTERNATE FUEL FEED handle in the COMBAT position, fuel flow from the sump tank to the fuel boost pumps is governed by gravity only; however, no fuel system performance or aircraft maneuver limitation is imposed below 15,000 feet MSL. The COMBAT position of the ALTERNATE FUEL FEED handle should only be used in a combat environment.

WARNING

The COMBAT and ALT FEED positions of ALTERNATE FUEL FEED handle should not be used at altitudes above 30,000 feet MSL. Refer to Section V for attitude limitations.

The ALT FEED position of the ALTERNATE FUEL FEED handle is used to correct fuselage fuel transfer malfunctions, and to allow wing, right mid and aft tank fuel to flow directly to the engine in the event of damage to main fuel tanks or main feed line to the engine. It should be used only when corrective action for these emergencies is required. Selecting ALT FEED electrically positions the wing fuel selector valve to direct motive flow to the aft tank ejectors if the aft tank contains fuel (number 2 thermistor "wet"). On aircraft [17] [27] → [281] after T.O. 1A-7D-652 and [282] →, selecting ALT FEED also electrically positions the bypass selector valve to the bypass position. Placing the ALTERNATE FUEL FEED handle in the ALT FEED position mechanically closes the sump tank motive flow shutoff valve and rotates the alternate feed selector valve to the alternate feed position, routing fuel from the aft tank directly to the engine, bypassing the sump tank. Fuel from the right midfuselage tank gravity flows into the aft tank and is transferred by the aft tank ejectors. A check valve in the main engine feed line prevents the fuel from flowing back into the sump tank. Fuel in the sump, left mid, and both forward tanks is prevented from feeding the engine by back pressure in the feed line. When aft tank fuel is exhausted, feed line pressure will decrease enough to permit gravity feed of remaining fuel in left mid, forward, and sump tanks. However, the rate of gravity feed is limited at low fuel states and FUEL BOOST caution lights may come on or engine flameout may occur if at high altitude, high power settings, or nose low attitudes.

If a fuselage fuel transfer malfunction occurs trapping fuel in the aft tank and causing the FUEL LOW caution light to come on above 1,000 (±200) pounds, fuel transfer will normally be restored by selecting ALT FEED. If selecting ALT FEED does not electrically reposition selector valves, motive flow will remain directed to an empty wing tank and a fuel/air mixture will be pumped through the transfer lines, causing the FUEL BOOST caution lights to flash on and off. Pressure in the transfer line running through the aft tank will reduce the capability of the aft tank to feed by gravity and as much as 1,000 pounds of fuel may remain trapped. Maximum fuel availability will occur at normal cruise power settings. If the wing fuel selector valve is positioned to the aft tank by selection of ALT FEED but remains in the aft tank when the aft tank empties (or cycles out of the aft tank and the bypass valve is in the wing position), a fuel/air mixture will again be pumped through the transfer lines, causing the FUEL BOOST caution lights to flash with approximately 1,000 (±200) pounds indicated on the M pointer. In both of these conditions FUEL BOOST caution lights will flash before the SUMP LOW caution light comes on.

WARNING

If ALT FEED is selected and FUEL BOOST caution lights flash on and off with the SUMP LOW caution light off, return the ALTERNATE FUEL FEED handle to NORMAL to avoid power loss and possible engine flameout.

Returning the ALTERNATE FUEL FEED handle to NORMAL will cause the fuel/air mixture being pumped through the transfer lines to be directed to the sump tank. Air collecting in the sump tank will vent overboard and will not reach the fuel boost pumps. On aircraft [17] [27] → [281] after T.O. 1A-7D-652 and [282] →, both selector valves are repositioned by selecting ALT FEED to ensure that motive flow is not directed to an empty wing tank. Even if the wing fuel selector valve should fail to reposition to the aft tank upon selecting ALT FEED, the bypass valve will be positioned in bypass and flashing FUEL BOOST caution lights will not occur. The transfer line running through the aft tank will be unpressurized, and at normal flight attitudes nearly all aft tank fuel will be available by gravity feed. With the transfer line unpressurized, gravity feed of mid, forward, and sump tanks will occur simultaneously with gravity feed of the aft tank. In this condition the SUMP LOW caution light may come on at an abnormally high fuel quantity. However, nearly all of the remaining fuel will be available. Once the SUMP LOW caution light comes on, FUEL BOOST caution lights are an indication of limited gravity feed capability, and not an indication of fuel/air mixture being pumped through the transfer lines to the engine.

WARNING

If FUEL BOOST caution lights come on after the SUMP LOW caution light comes on, remain in ALT FEED and reduce engine fuel demands by retarding the throttle until the FUEL BOOST lights go off.

If the sump tank or main engine fuel feed line is damaged, resulting in rapid loss of fuel, the SUMP LOW caution light may come on if the sump tank thermistor is uncovered by depletion of sump tank fuel. If the SUMP LOW caution light comes on with fuel remaining in other tanks, or any damage to main fuel tanks is suspected, the ALTERNATE FUEL FEED handle should be placed in ALT FEED to supply fuel directly to the engine from the aft fuselage tank. When aft tank fuel is exhausted, fuel remaining in the left mid, forward and sump tanks will gravity feed. If the wing tank contains fuel, the WING TRANS switch must be placed in EMERG to obtain wing fuel. Placing the WING TRANS switch in EMERG repositions the emergency selector valve to direct motive flow to the wing tank ejector pumps regardless of the position of the other two selector valves. When wing fuel is exhausted, return the WING TRANS switch to AUTO.

WARNING

The aircraft is restricted to positive pitch attitudes while in ALT FEED, EMERG transfer.

Note

In some external stores configurations, improper fuel transfer sequencing may cause aircraft cg to approach the aft cg limit, degrading longitudinal stability. If longitudinal stability is not improved by ensuring CONT AUG is engaged and reducing airspeed, it may be necessary to jettison external stores. Refer to Section VI for a description of the flying characteristics of an aircraft approaching the aft cg limit.

Refer to Section III for fuel system emergency procedures and Section V for fuel system operating limitations.

External Fuel Transfer.

When the landing gear is retracted, electrical power is removed from a pressurization valve which actuates and permits engine bleed air to pressurize the external tanks. This valve is fail-safe in that it is electrically held in the depressurized position and is spring-loaded to the pressurized position. As internal fuel is used, fuel flow begins from the external tanks to the fuselage tanks. The fuselage tanks overflow through vent lines into the wing tank. Thus, the fuselage and wing tanks are maintained full and the external tanks are emptied first.

Extending the landing gear, the air refueling probe (aircraft → [16] [18] → [26]) or pulling the AR DOOR handle (aircraft [17] [27] →) causes the external tanks to depressurize and fuel transfer to stop.

If the landing gear cannot be retracted and transfer of external tank fuel is desired, the tanks can be pressurized by removing electrical power from the secondary dc bus. This can be accomplished by extending the RAT, placing the EMER GEN switch in either CRUISE or T.O. LAND, and placing the MASTER GEN switch in OFF.

Air Refueling → [16] [18] → [26]

Placing the AR PROBE switch in EXTEND powers a selector valve to direct PC 2 pressure to extend the probe. Fuel taken on flows simultaneously into all fuselage tanks through a fueling pressure shutoff valve. If external tanks are installed, a portion of the fuel flows to these tanks until they are filled.

If external tanks are not to be refueled, placing the AR PROBE switch in OFF after the probe is fully extended will close the pylon pressure shutoff valves and turn the probe floodlight off.

When the fuselage tanks are full, fuel overflows from the forward and aft tanks into the wing tank. When the wing tank is full, a dual wing float valve actuates, causing the fueling pressure shutoff valve to close and stop flow into the aircraft.

The probe is retracted by placing the PROBE switch in RETRACT.

A PROBE advisory light comes on during probe transit and when the probe is not locked in EXTEND or RETRACT position. When the probe has fully extended and locked or retracted and locked the PROBE advisory light goes out. With the exterior lights switches in BRIGHT or DIM, the probe floodlight comes on when the PROBE switch is placed in EXTEND. The probe floodlight goes out when the PROBE switch is placed in OFF or RETRACT. The air refueling system for aircraft → [16] [18] → [26] is illustrated in figure 1–20. Refer to T.O. 1-1C-1-24 for Air Refueling procedure.

Air Refueling [17] [27] →

When the AR DOOR handle is pulled out, the signal amplifier circuit is energized to provide automatic sequencing during air refueling. The slipway door is unlocked and pulls back to form part of the slipway. A blue READY light in the cockpit illuminates when the door is in the full open position and ready to receive the tanker boom nozzle. Two slipway lights, located on either side of the receptacle slipway and provided to assist the boom operator, automatically illuminate when the door is open. Indicator and slipway light intensity is controlled by the pilot in the receiver aircraft.

When the boom nozzle enters the receptacle, the nozzle makes contact with a switch. Signals are sent to a solenoid operated hydraulic selector valve indicating that the nozzle is inside the receptacle and is ready to be locked in. The hydraulic selector valve automatically actuates the nozzle lock actuator on the receptacle and the boom nozzle is locked in place. When the nozzle is in and locked, the blue READY light goes off and a green LATCHED light comes on which indicates that the nozzle is in the full locked position and ready to receive fuel. Fuel taken on flows simultaneously into all fuselage tanks through a fueling pressure shutoff valve. If external tanks are installed, a portion of the fuel flows to these tanks until they are filled. There is no means to prevent external tanks from filling if installed. When the aircraft has received a full load of fuel, float valves in the wing tank actuate to close the fueling pressure shutoff valve. When pressure in the line from the pressure shutoff valve increases, a disconnect pressure switch signals the signal amplifier which automatically removes power from the solenoid operated hydraulic selector valve to hydraulically

AIR REFUELING SYSTEM (PROBE) → 16 18 → 26

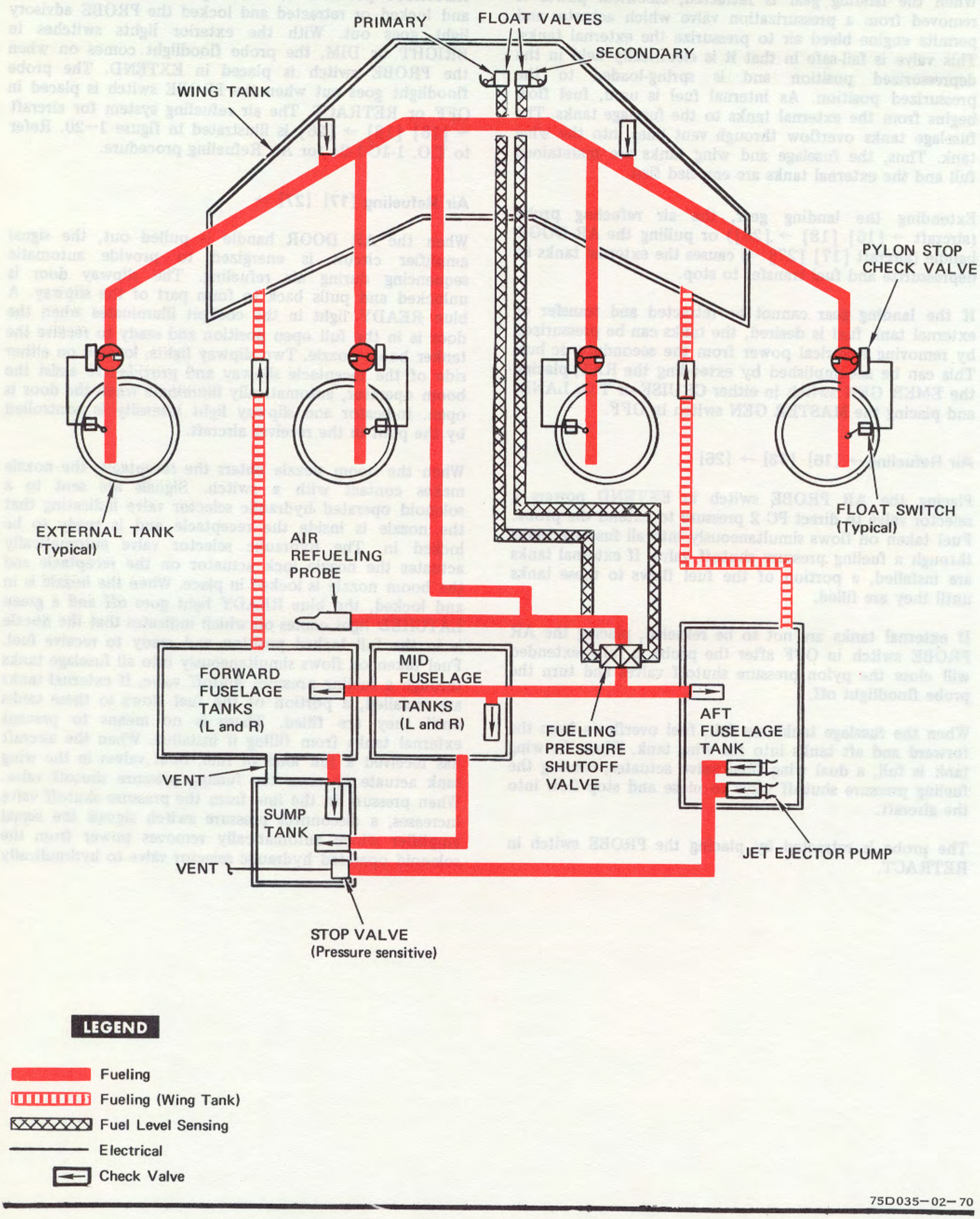


Figure 1–20

unlock the boom nozzle. A disconnect may be initiated at any fuel load, either by the pilot or the boom operator by use of a disconnect switch. The nose gear steering switch located on the pilot's stick grip serves as the disconnect switch in the receiver aircraft. When actuated, the disconnect switch signals the signal amplifier which automatically removes power from the solenoid operated hydraulic selector valve to unlock the boom nozzle. In an emergency, the boom operator can disconnect the boom by overpowering the hydraulically actuated receptacle lock rollers and withdrawing the boom. The amber DISCONNECT light illuminates when complete separation of the boom nozzle and air refueling receptacle has occurred.

If an additional hookup with the tanker is desired, the pilot must depress the AMPLIFIER RESET switch on the inboard end of the AR receptacle handle. This recycles the receptacle signal amplifier to a ready position and the refueling sequence starts over; the DISCONNECT light goes off and the READY light illuminates.

When refueling is completed, the pilot pushes the AR DOOR handle down to close and lock the slipway door in place, and return nose gear steering to normal operation. All receptacle indicator lights and slipway lights go out and the signal amplifier automatically recycles to the ready position.

Note

On aircraft [17] [27] → [114] before T.O. 1A-7D-597, if the AR DOOR handle is not all the way in, nose gear steering may not be available for landing rollout and taxi operation. On [17] [27] → [114] after T.O. 1A-7D-597 and [115] →, the AR DOOR handle position will not affect nose gear steering operation.

An AR amplifier override circuit is provided to back up the normal signal amplifier. Failure of the refueling signal amplifier is indicated when the READY light does not come on when the AR DOOR handle is pulled out. The function of the override circuit is the same as that of the refueling signal amplifier except that the pilot indicator lights are not included, and boom operator disconnect circuit through the amplifier is inoperative. With the AR AMPL switch in OVERRIDE, normal refueling operations including electrical disconnect may be conducted. However, there are no cockpit indicator lights to verify successful contact has been made or that fuel is being received.

If the PC 2 hydraulic supply is lost, the door may be unlocked manually by pulling the AR DOOR handle. Springs pull the door open. The hydraulically actuated nozzle locks on the boom receptacle are spring loaded to the open position, and the boom nozzle can be inserted and held in the receptacle during the refueling operation. The door will remain open for the remainder of the flight unless PC 2 pressure is regained.

The air refueling system (receptacle) for aircraft [17] [27] → is illustrated in figure 1–21. Refer to T.O. 1-1C-1-24 for Air Refueling procedure.

Tank Jettison.

External tanks can be salvo or select jettisoned from stations 1 and 8 if aircraft weight is off the gear. All tanks (stations 1, 3, 6, and 8) can be jettisoned if the landing gear is up and locked. Salvo jettisoning separates all tanks through momentary depression of a SALVO JETT switch on the cockpit left sidewall. Select jettisoning separates only the tank of a selected station. Selection is accomplished by placing the applicable station select switch on the instrument panel in the RDY position then holding the SEL JETT switch depressed until the tank jettisons.

Note

On aircraft → [16] [18] → [26], external stores cannot be jettisoned from wing stations with aircraft weight on the landing gear. On aircraft [17] [27] →, stations 1, 2, 7, and 8 can be jettisoned with aircraft weight on the landing gear. On all aircraft the main gear must be up and locked for stations 3 and 6 to be jettisoned.

Jettisoning is independent of the position of the MASTER ARM switch.

Fuel Dumping.

Wing tank fuel may be dumped by placing the FUEL DUMP switch in FUEL DUMP. This opens two dc motor operated dump valves (one on the trailing edge of each wing), allowing fuel to gravity flow overboard. External tank fuel transfers to the fuselage tanks, overflows into the wing tank, and is also dumped. An average dumping rate of approximately 540 pounds per minute is obtained in level flight or nose high attitudes. Dumping rate can be increased by application of positive g. A full wing can be dumped in approximately 7 1/2 minutes. The dump valves are powered by the primary dc bus.

Note

On aircraft [17] [27] →, fuel dumping requires approximately 12 minutes at 300 KIAS for wing fuel and 27 minutes at the same speed for wing fuel plus external fuel.

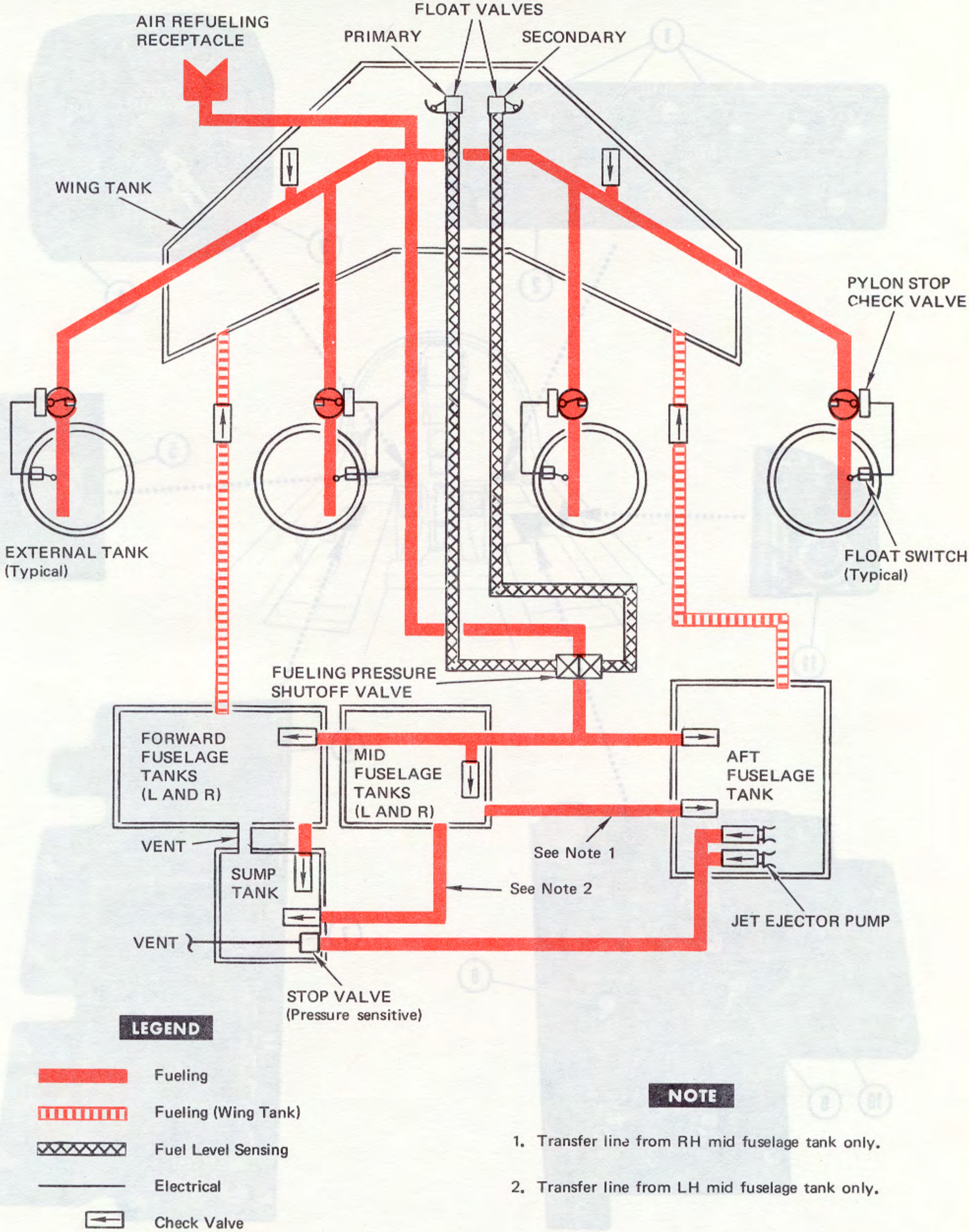
The FUEL DUMP switch should be returned to OFF when dumping is complete. This is to prevent spilling of fuel during refueling.

Fuselage fuel cannot be dumped.

FUEL SYSTEM CONTROLS.

Fuel system controls and indicators for aircraft → [16] [18] → [26] are shown and their functions described in figure 1–22. Fuel system controls and indicators for aircraft [17] [27] → are shown and their functions described in figure 1–23.

AIR REFUELING SYSTEM (RECEPTACLE) [17] [27] →



NOTE

1. Transfer line from RH mid fuselage tank only.
2. Transfer line from LH mid fuselage tank only.

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FUEL SYSTEM CONTROLS → [16] [18] → [26]

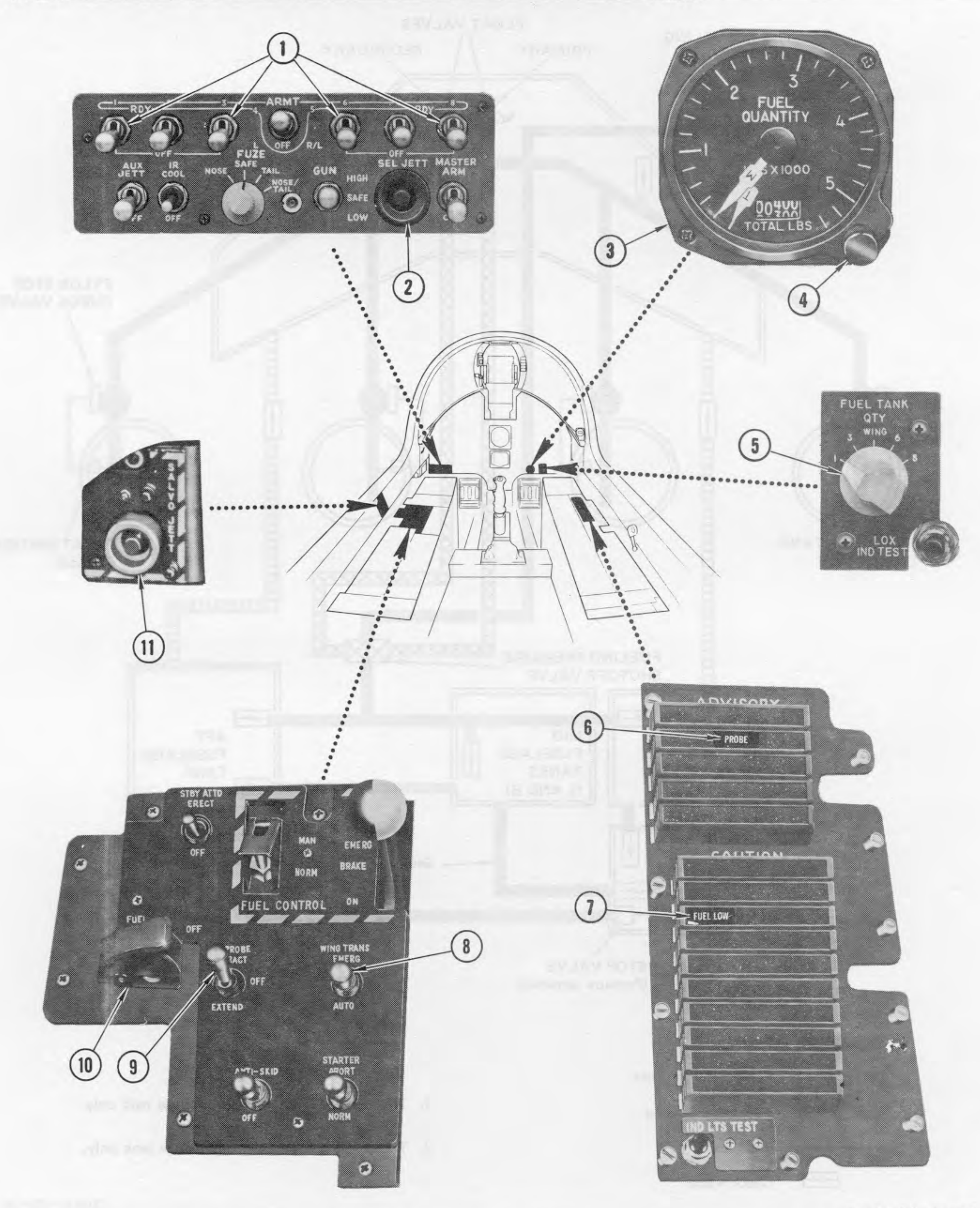

Figure 1–22 (Sheet 1)

FUEL SYSTEM CONTROLS — [16] [18] — [26]

Nomenclature	Function
1. Station select switches	RDY – selects station or stations for jettisoning.
2. SEL JETT switch	Depressed – jettisons stores from stations selected with station select switches. Stations 3 and 6 will not jettison unless the gear is up and locked.
3. FUEL QUANTITY indicator	M pointer – provides an indication of fuel quantity in main system (fuselage tanks). T pointer – provides an indication of fuel quantity in transfer system tank selected with fuel quantity monitoring switch (wing or selected external tank). Digital counter – displays total quantity, including external tank fuel.
4. Indicator press-to-test switch	Depressed – causes indicator pointers and counter to move to zero position. When released, pointers and counters return to position representing actual fuel quantities.
5. FUEL TANK QTY monitoring switch	1, 3, 6, or 8 – selects desired external fuel tank for fuel quantity indicator reading (wing stations 1, 3, 6, or 8). During switching from one external tank to another, total quantity reading may change due to variance in tank capacitance values. WING – selects integral wing tank for fuel quantity indicator reading.
6. Air refueling probe advisory light	On (PROBE) – indicates that AR probe is not locked in extended or retracted position.
7. Low fuel level caution light	On (FUEL LOW) – indicates that usable fuel remaining in the fuselage tank is 1,000 (±200) pounds when the light first comes on. The FUEL LOW light remains on as long as the fuel low condition exists. With quantity between 800 and 1,200 pounds, attitude changes may cause temporary covering of the light control thermistor and resultant on-off cycling of the caution and master lights.
8. WING TRANS switch	AUTO – actuates fuel transfer selector valves to provide jet ejector pump motive flow for normal transfer of fuselage and wing fuel. With switch in this position, sequence of internal fuel transfer is automatically accomplished. EMERG – actuates emergency fuel transfer selector valve to provide motive flow to the wing tank jet ejector pumps.
9. PROBE switch	EXTEND – actuates hydraulic valve to extend probe for refueling. Energizes the PROBE advisory light, the probe floodlight (if the exterior lights switch is on), and the fueling shutoff valves to open (if external tanks are installed) to permit refueling of external tanks. RETRACT – actuates hydraulic valve to retract probe. Energizes the PROBE advisory light, deenergizes the probe floodlight, and fueling shutoff valves (to close). OFF – Removes power from air refueling electrical circuit. Pylon fueling shutoff valves close (if external tanks are installed) and the probe floodlight goes out.

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Figure 1–22 (Sheet 2)

FUEL SYSTEM CONTROLS → [16] [18] → [26]

Nomenclature	Function
10. FUEL DUMP switch	FUEL DUMP – opens dump valves and dumps wing tank fuel through ports located on each side of the wing trailing edge between the flap and aileron. OFF – closes dump valves to stop fuel dumping.
11. SALVO JETT switch	Depressed – jettisons all stores and external tanks (those attached to the MAU-12B/A ejector racks) from wing pylons. Stations 3 and 6 will not jettison unless the landing gear is up and locked.

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Figure 1–22 (Sheet 3)

FUEL SYSTEM CONTROLS [17] [27] →

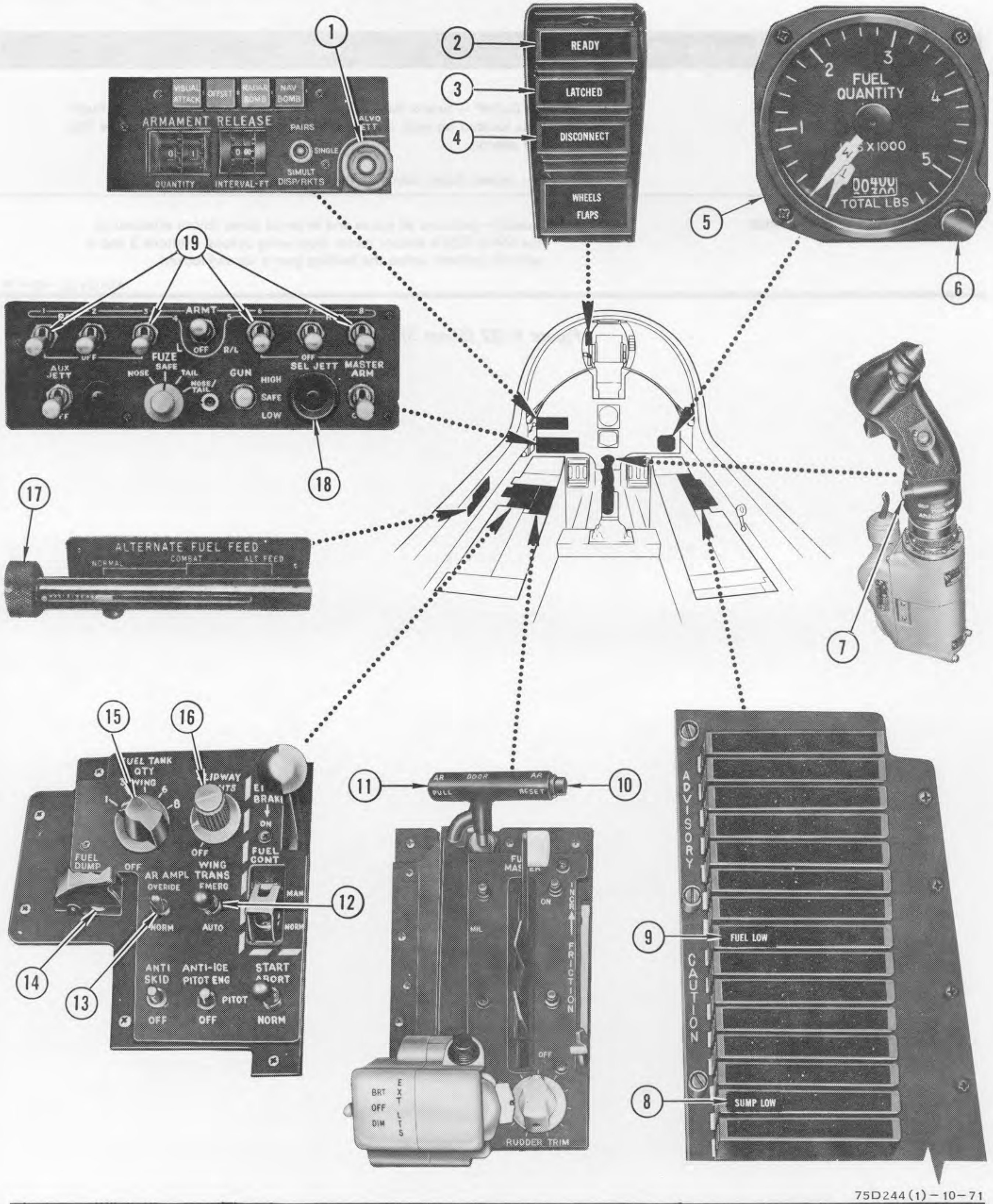

Figure 1–23 (Sheet 1)

FUEL SYSTEM CONTROLS [17] [27] →

Nomenclature	Function
1. SALVO JETT switch	DEPRESSED – jettisons all stores and external tanks (those attached to the MAU-12B/A ejector racks) from wing pylons with the aircraft on the ground or in the air. Stations 3 and 6 will not jettison unless the landing gear is up and locked.
2. READY advisory light (Blue)	On (READY) – indicates air refueling receptacle doors are open and receptacle is ready for use.
3. LATCHED advisory light (Green)	On (LATCHED) – indicates tanker boom is latched in place in air refueling receptacle.
4. DISCONNECT advisory light (Amber)	On (DISCONNECT) – indicates tanker boom has disconnected from air refueling receptacle.
5. FUEL QUANTITY indicator	M pointer – provides an indication of fuel quantity in main system (fuselage tanks). T pointer – provides an indication of fuel quantity in transfer system tank selected with fuel quantity monitoring switch (wing or selected external tank) Digital counter – displays total quantity, including external tank fuel.
6. Indicator press-to-test switch	DEPRESSED – causes indicator pointers and counter to move to zero position. When released, pointers and counters return to position representing actual fuel quantities.
7. Disconnect switch	On (actuated) – removes power from refueling receptacle lock solenoid to permit normal removal of the boom nozzle from the receptacle.
8. SUMP LOW caution light	On (SUMP LOW) – indicates fuel in sump tank has fallen below 360 (±40) pounds. Advises pilot to select alternate fuel feed system when fuel is remaining in other tanks.
9. FUEL LOW caution light	On (FUEL LOW) – indicates that usable fuel remaining in the fuselage tanks is 1,000 (±200) pounds when the light first comes on. Remains on as long as the fuel low condition exists. With quantity between 800 and 1,200 pounds, attitude changes may cause temporary covering of the light control thermistor and resultant on-off cycling of the caution and master lights. Indicates fuselage fuel transfer malfunction if more than 1,000 (±200) pounds of fuel are in fuselage tanks when light comes on.
10. AR RESET switch	When pressed and released, cycles the signal amplifier to the ready state without the necessity of recycling the AR slipway doors.
11. AR DOOR handle	Up – applies electric power to operate components of the air refueling system. Opens slipway doors mechanically or hydraulically. Down – removes power from air refueling system. Controls hydraulic power to close slipway doors. When hydraulic power is not available, slipway doors cannot be closed.

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Figure 1–23 (Sheet 2)

FUEL SYSTEM CONTROLS [17] [27] →

Nomenclature	Function
12. WING TRANS switch	AUTO – allows fuel transfer selector valves to provide jet ejector pump motive flow for normal transfer of fuselage and wing fuel. With switch in this position, sequence of internal fuel transfer is automatically accomplished. EMERG – actuates emergency fuel transfer selector valve to provide motive flow to the wing tank jet ejector pumps.
13. AR AMPL switch	NORM – connects power to air refueling system amplifier. Provides for normal connecting and disconnecting during refueling and powers the pilot indicator lights. OVERRIDE – Bypasses the normal refueling system amplifier. Permits operation of the relay circuit for connecting and disconnecting without use of pilot indicator lights. **NOTE** Air refueling indicator lights do not work when AR AMPL switch is in OVERRIDE position.
14. FUEL DUMP switch	FUEL DUMP – opens dump valves and dumps wing tank fuel through ports located on each side of the wing trailing edge between the flap and aileron. OFF – closes dump valves to stop fuel dumping.
15. FUEL TANK QTY monitoring switch	1, 3, 6, or 8 – selects desired external fuel tank for fuel quantity indicator reading on T pointer (wing stations 1, 3, 6, or 8). During switching from one external tank to another, total quantity reading may change due to variance in tank capacitance values. WING – selects integral wing tank for fuel quantity indicator reading.
16. SLIPWAY LIGHTS switch	Clockwise rotation – turns on and controls intensity of air refueling receptacle slipway lights.
17. ALTERNATE FUEL FEED handle	NORMAL – no effect on fuel system transfer or feeding. COMBAT – closes sump tank motive flow line shutoff valve. Fuel feed to engine is by gravity flow only. ALT FEED – closes sump tank motive flow line shutoff valve and rotates alternate fuel feed selector valve to route fuel from wing and aft tanks directly to engine. Electrically positions wing fuel selector valve to aft tank and, on aircraft [17] [27] → [281] after T.O. 1A-7D-652 and [282] →, positions bypass valve to bypass. Fuel in forward tanks, left midfuselage tank, and sump tank is available to the engine by gravity feed after other tanks are empty.
18. SEL JETT switch	DEPRESSED – jettisons stores from stations selected with station select switches with the aircraft on the ground or in the air. Stations 3 and 6 will not jettison unless the gear is up and locked.
19. Station select switches	RDY – selects station or stations for jettisoning.

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Figure 1–23 (Sheet 3)

ELECTRICAL SYSTEM.

The three basic sources of aircraft electrical power are a master ac generator, a battery, and an ac/dc generator in the ram air turbine (RAT). The master generator is a three-phase, 400-cps, 120/208-volt generator. The battery is a 19-cell, 22-amp/hr, 28-volt (nominal) nickel cadmium battery. The master generator, which is engine-driven through a constant speed drive unit, supplies aircraft ac buses directly, and supplies dc buses after conversion to dc power in a transformer-rectifier. The battery supplies power for the jet fuel starter motor and for lights and attitude instruments during transition from master generator power to RAT electrical power following a master generator failure. The RAT is extended into the airstream by pulling the EMER POWER handle in order to supply ac and dc power to aircraft buses following loss of the master generator. The RAT generator produces dc power independent of the aircraft transformer-rectifier.

Distribution of electrical power from the three aircraft power sources to the aircraft circuits is accomplished through a bus system. The bus system groups aircraft circuits in order of importance to flight operations. During starting or emergency conditions, fewer circuits are supplied to reduce electrical load consistent with battery or RAT output capabilities.

In addition to the three aircraft sources of electrical power, external power can be utilized through connection with an external dc or ac source. If the battery is depleted or a long period of UHF radio operation is required before engine start, external dc power from batteries only is permitted in an emergency to supplement the battery for starting. The external dc power receptacle is located on the right aft side of the fuselage. External ac power is used for ground test of electronic or electrical equipment. The external ac power receptacle is located on the left forward side of the aircraft. External power requirements and receptacle locations are detailed in the Strange Field Procedures in Section II.

ELECTRICAL SYSTEM MANAGEMENT.

Starting.

Starts are normally performed using internal battery power.

The BATT switch is placed in the BATT position for battery (or external dc) starts. With the switch in the BATT position, battery or external dc power is supplied to crank the jet fuel starter and to provide TOT indication, FIRE warning light, ENG HOT caution light, and MANUAL FUEL caution light. For additional circuits activated by the battery switch, refer to Electrical Supply and Distribution under Battery Bus, figure 1–24.

For information on acceptable sources of external dc power, refer to Section V, Engine and Starter Operating Limitations.

Normal Operation of Master Generator.

For battery or external dc starts, the MASTER GEN switch is placed in ON before engine start. When engine speed has built up sufficiently (approximately 45% rpm), a transition from battery or external power to master generator power occurs. Pilot indication of an operating master generator is a V indication in the master generator indicator. With the switch in ON, the engine up to speed, and the master generator functioning normally, all aircraft electrical circuits are supplied and no other electrical source is required. Battery bus circuits and battery charging is supplied by the secondary ac and dc buses with the master generator operating. The MASTER GEN switch is left ON until after engine shutdown, when it is moved to OFF RESET.

Master Generator Failure/RAT Extension.

If the master generator fails, a barberpole appears in the master generator indicator. Time permitting, the MASTER GEN switch should be cycled through the OFF RESET position in an attempt to reset the generator. If the generator will not reset or time is not available, the RAT must be extended to regain an electrical source. The RAT is extended by pulling out the EMER POWER handle on the left forward console. In the interim between master generator failure and RAT deployment, the battery powers an inverter to maintain continuity of flight instrument lights and attitude indicating instruments.

WARNING

IMS alignment and all attitude indications are lost 30 seconds after master generator failure if the RAT is not extended or generator operation is not regained. Under IFR conditions, do not attempt to reset the generator until after extending the RAT.

Attitude signals to the ADI originate in the IMS. In the event of master generator failure, an IMS internal battery supplies power to maintain the IMS platform in an erect condition for 30 seconds. The internal battery is automatically shut off after 30 seconds by thermal switches. The master generator must be reset or the RAT extended within 30 seconds after generator power failure or the IMS platform and the ADI become unreliable. Also, IMS alignment is lost if RAT extension is delayed.

The standby attitude indicator is powered by the primary ac bus. Loss of the master generator affects the reliability of the standby attitude indicator immediately. Accurate standby attitude indications are restored upon return of main generator power or by extending the RAT, provided the EMER GEN switch is in the CRUISE position.

With the RAT extended, a reduced number of aircraft circuits are supplied. With the RAT operating and the EMER GEN switch in CRUISE, the primary ac and dc and emergency ac and dc buses are supplied. Secondary ac and dc circuits are inoperative. If the landing gear is extended with the EMER GEN switch in CRUISE, the EMER GEN caution light comes on as a reminder to place the switch in T.O. LAND. With the EMER GEN switch in T.O. LAND, only the emergency ac and dc buses are supplied. This reduces the load on the RAT. The battery bus, normally supplied by the secondary dc bus except during starting, receives its power from the emergency dc bus with the RAT operating.

The decision of which EMER GEN switch position to use depends on airspeed and any hydraulic demands placed on the RAT. Figure 1–28 presents RAT minimum airspeed requirements for various conditions.

WARNING

If a flameout landing is to be attempted, the EMER GEN switch must be placed in OFF to permit the RAT to supply maximum flight control hydraulic pressure. Otherwise, loss of flight control could result during the final landing phase.

When using the RAT for electrical power only, the emergency generator may drop off the line in a narrow speed band (2 to 10 knots) while decelerating at speeds below 200 KIAS. Continuing deceleration, or accelerating 5 to 10 knots will normally restore electrical power.

CAUTION

With the RAT extended and the EMER GEN switch in T.O. LAND, the temperature limiter amplifier is inoperative. Throttle advancement must be made cautiously to avoid engine overtemp.

Note

Do not attempt to use the battery for emergency electrical power in lieu of RAT extension. The battery is designed only for starting and to provide circuit continuity while the RAT is being extended. The battery will discharge if used otherwise. A fully charged battery will provide power for normal operation of all equipment on the battery bus for approximately 1 hour.

The RAT is retracted by raising a trigger on the EMER POWER handle and allowing the handle to return to the stowed position. If the RAT is cycled with the flap handle in ISO UTILITY position, placing the flap handle out of ISO UTILITY for a minimum of 3 seconds recharges the RAT accumulator with PC 2 system pressure.

CIRCUIT BREAKERS.

The battery power, inverter power, and battery reference circuit breakers are located in the engine compartment; all other circuit breakers are located in the left and right avionic compartments.

ELECTRICAL DISTRIBUTION.

The electrical distribution diagram (figure 1–24) presents a comprehensive breakdown of the aircraft's electrical distribution system. Its use is best explained by the following examples:

1. Suppose the pilot desires to know what circuits are available following master generator failure, with the RAT extended and the EMER GEN switch in T.O. LAND. Sheet 1 of the diagram, which presents a separate block diagram for each set of power source circumstances, shows that six buses, and the instrument transformer, and the inverter transformer are powered under the stated conditions. Sheet 2 presents a list of circuits supplied by each of the six buses, the desired information.

2. Suppose the pilot is interested in learning the electrical circumstances necessary for the exterior lights to burn. He enters the alphabetical Circuit Explanation sheet under Exterior Lights. It can be seen that secondary bus power is required to operate land/taxi, formation and anticollision lights and that emergency power is required to operate the position lights and position light flasher. A review of sheet 1 block diagram reveals that secondary buses are available with the master generator operating normally (MASTER GEN switch ON) or with the external ac power connected (MASTER GEN switch TEST). Emergency bus power is seen to be available at all times except during the interval between generator failure and RAT extension, during battery start, or during a start on external dc power.

ELECTRICAL SYSTEM CONTROLS.

Electrical system controls are illustrated and described in figure 1–25.

ELECTRICAL SUPPLY AND DISTRIBUTION

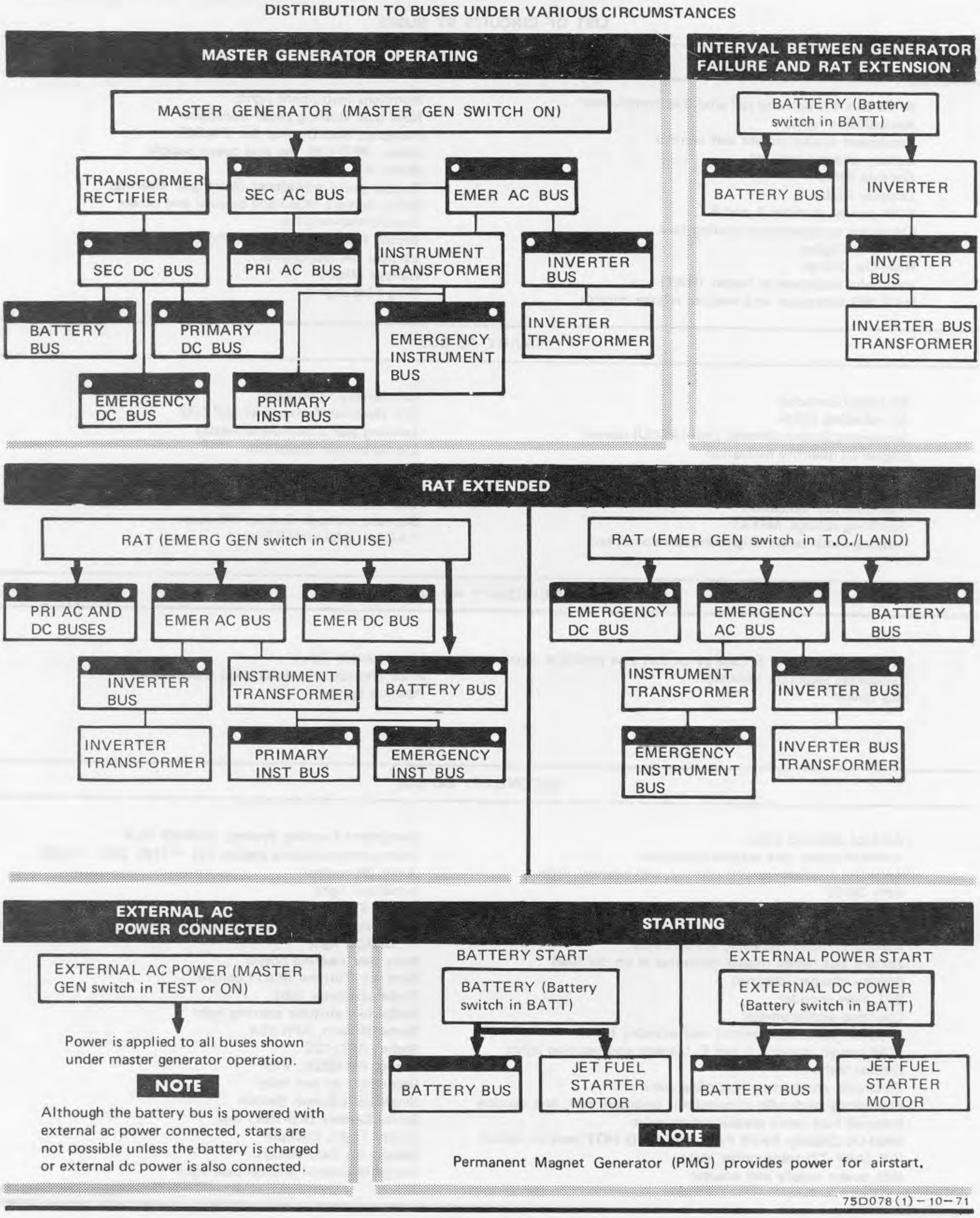

Figure 1–24 (Sheet 1)

ELECTRICAL SUPPLY AND DISTRIBUTION

LIST OF CIRCUITS BY BUSES

SECONDARY AC BUS

AFCS Bus 4 (pitch and roll amplifier computers)
Anticollision lights
Armament system power and control
Battery charger (power)
Console lights
Doppler Radar
ECM power, stations 1 and 8
Electronic compartment cooling fans
Formation lights
Head-Up Display
Hydraulic accumulator heater (RAT)
NAV WD Computer and weapon release control
Nonflight instrument lights
Nose gear steering pedal transducer
Projected Map Display Set (PMDS)
Radar, APQ-126, fan and power supply
Radar Altimeter, APN-141
Rudder pedal transducer (Nose gear steering)
Strike Camera (KB-18A) control and power
Transformer-rectifier
Vector Warning System, APR-36/37
Vertical tail floodlights
Walleye Missile
Wing Floodlights

PRIMARY AC BUS

Air Data Computer
Air refueling lights
Armament Station Control Unit (ASCU) power
Engine oil quantity indication
Flap Accumulator Heater
Fuel flowmeter
Fuel quantity indication
Gunfiring voltage, M61A1
Heading mode select (flight director computer)
Hi-intensity floodlights
IFF Receiver-Transmitter, APX-72
Landing gear accumulator heater
Liquid oxygen indication
Pitot heat
Radio Receiver, UHF-ADF, ARA-50 amplifier
Seat adjust
Standby attitude director indicator
TACAN, AN/ARN-52(V)

EMERGENCY AC BUS

AFCS Bus 1, 2, and 5 (rate gyros and yaw amplifier computer)
Horizontal Situation Indicator
IMS power
Master mode lights
Pitch and roll trim indication transmitters
Position lights

SECONDARY DC BUS

Anti-ice solenoid valve
Antiskid power and system operation
Armament system power, control, and advisory light
APR 36/37
Arresting gear control and caution light
Auxiliary jettison control
Auxiliary Radio Receiver, AN/ARR-69
Battery bus (when master generator is on the line)
Battery charger (control)
BFL slew encoder
Counting accelerometer
Doppler Radar (transmitter and advisory light)
ECM power, stations 1 and 8, blanker and warning lights
Ejector Valve
Electronic compartment cooling control
Emergency hydraulic accumulator isolation, test, and caution
External fuel tanks pressurization valve
Head-Up Display (HUD FAIL and HUD HOT caution lights)
IFF (APX-72) transponder tester
IMS power supply and adapter
Instrument Landing System, ARN-58 (ILS)
Intercommunications station [4] → [16] [18] → [26]
Juliet 28 control
Land/taxi light
Master Function Switches
NAV WD Computer control panel power, weapon release and caution light
Nose gear steering power
Ram Air Turbine (RAT) control
Radar altimeter light
Radar low altitude warning light
Radar Beacon, APN-154
Radar, APQ-126
Radio, FM-622A, VHF
Secondary dc bus relay
Single-Pairs-Simult Switch
Strike Camera (KB-18A) test
Utility Light, Cockpit
Weight On Gear Relays
Wingfold control and caution light

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Figure 1–24 (Sheet 2)

ELECTRICAL SUPPLY AND DISTRIBUTION

LIST OF CIRCUITS BY BUSES

PRIMARY DC BUS

Air data computer and advisory light
Air refueling probe control, exterior, and advisory light
Air refueling amplifier
Anti-Ice Failure indicator
Armament Station Control Unit (ASCU) power
Cabin temperature control
Canopy caution light
Chartboard lights
Emergency fuel transfer
Emergency generator caution light
Engine temperature limiter
External fuel tank capacitance panel
Flight Director Computer
Fuel dump valves
Fuel low caution light
Fuel selector valves (3)
Fueling and fuel transfer systems
Gun clearing and control, M61A1 gun
Head Up Display (HUD) standby reticle
Heading mode switch and select
IFF (APX-72) Receiver-Transmitter, control, and caution light
IMS power supply adapter
Landing gear safety
Low oxygen caution light
Low sump caution light
Master Arm switch and control
Radio Receiver, UHF-ADF, ARA-50
Rate gyro transmitter
Speed brake control and advisory light
Suit temperature control
TACAN, AN/ARN-52(V)
Trailing edge flap control
Trigger control

EMERGENCY DC BUS

AFCS Bus 3 (pitch, roll, and yaw amplifier computers, yaw actuator and advisory lights
Altimeter, AAU-19/A
Angle of attack
Anti-ice advisory light
Anti-skid caution light
Battery bus (RAT extended, EMER GEN switch in either position)
Caution panel lighting
Cockpit Dimming
Emergency flap control → [16] [18] → [26]
Engine fuel control selection and boost control
Engine oil caution lights
Exterior lights control relay
Exterior position lights flasher
Fuel boost caution lights
Ground align advisory light
Hook handle warning light
Hydraulic low pressure caution light
IMS caution light
IMS NOT ALIGNED light
IMS power adapter
Jettison power and control → [16] [18] → [26]
Landing gear indicator relay
Leading edge flap indication
Light test
Manual fuel control
Master caution light
Pitch AFCS advisory lights
Pitch trim brake
Rain remove hot caution light
Rain repel
Roll AFCS advisory light
Stall Warning
Wheels/Flaps warning light
YAW STAB advisory light

BATTERY BUS

Auxiliary floodlights (cockpit)
ECM destruct
Emergency Flap Control [17] [27] →
Emergency Hydraulic Accumulator Test
Engine crank control
Engine hot caution light
External tank refueling (ground operation)
Fire Detection and fire warning light
Intercommunications Set, AIC-26
Intercommunication station [17] [27] →
Igniter APR 36/37
Jettison power and control [17] [27] →
Manual fuel caution light
Turbine outlet temperature (TOT) indication and test
UHF Radio, ARC-51BX
Utility brake accumulator shutoff valve

PRIMARY INSTRUMENT BUS	EMERGENCY INSTRUMENT BUS
Horizontal Situation Indicator, AQU-6/A (HSI) NAV WD computer heading mode select Nose gear steering feedback transducer Projected map display set (PMDS) Radio Receiver, UHF-ADF, ARA-50 (antenna) TACAN, AN/ARN-52(V) True airspeed indicator (TAS) Turbine outlet pressure (TOP) indicator	Engine oil pressure indication Hydraulic pressure indication Pitch and roll trim indicatin Speed brake position indication Trailing edge flaps position indication
INVERTER BUS	
Attitude Director Indicator (ADI) Flight instrument lights IMS transformer and Power Adapter	

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Figure 1–24 (Sheet 3)

ELECTRICAL SUPPLY AND DISTRIBUTION

CIRCUIT EXPLANATION

CIRCUIT	POWER SOURCE(S) (AND PORTION OF CIRCUIT SUPPLIED BY EACH SOURCE)
Accelerometer, counting	Sec dc (indicator)
AFCS	Sec ac (AFCS Bus 4-pitch and roll amplifier computers) Emer ac (AFCS Bus 1, 2, 5 — rate gyros and yaw amplifier computer) Emer dc (AFCS Bus 3 — pitch and yaw amplifier computers; yaw actuator and advisory lights)
Air refueling probe	Pri dc (probe selector valve and probe exterior and advisory light)
Air refueling receptacle	Pri dc (refueling sequence amplifier) Pri ac (air refueling lights)
Altimeter, AAU-19/A	Emer dc
Altimeter, radar	Sec ac (operation) Sec dc (indicator)
Air data computer	Pri ac Pri dc (advisory light)
Angle of attack	Emer dc
Anti-collision lights	Sec ac
Anti-ice	Emer dc (ANTI-ICE advisory light) Pri dc (failure indicator) Sec dc (solenoid valve)
Anti-skid	Sec dc (system operation) Emer dc (ANTISKID caution light)
APR-36/37 (see vector warning system)	Sec dc
Armament system (ASCU)	Sec dc (mechanical fuzing, armament release switch, stations 1 through 8 master arm and firing power, auxiliary jettison control, Single-Pairs-Simult Switch and advisory lights) Pri dc (master arm control, ASCU power, M61A1 gun control and clearing) Emer dc (select and salvo jettison power and control → [16] [18] → [26] Battery bus (select and salvo jettison power and control [17] [27] → Sec ac, (stations 1 through 8 power) Pri ac (ASCU power, M61A1 gunfiring)
Arresting Gear Control	Sec dc
Bullpup controller	Sec ac (test) Sec dc (power)
Attitude Director Indicator (ADI)	Inverter bus
Auxiliary floodlights, cockpit (see console lighting)	Battery bus
Auxiliary Jettison	Sec dc
Auxiliary Radio Receiver, AN/ARR-69	Sec dc
Battery bus	Sec dc bus (main generator operating) or RAT (EMER GEN switch in either position)

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Figure 1—24 (Sheet 4)

ELECTRICAL SUPPLY AND DISTRIBUTION

CIRCUIT EXPLANATION

CIRCUIT	POWER SOURCE(S) (AND PORTION OF CIRCUIT SUPPLIED BY EACH SOURCE)
Battery charger	Sec ac (power) Sec dc (control)
Bullpup controller	Sec ac (test) Sec dc (power)
Cabin temperature control	Pri dc
Canopy caution light	Pri dc
Caution panel lights (see console lighting)	Emer dc
Chartboard lights (see console lighting)	Pri dc
Cockpit dimming	Emer dc
Console lighting	Sec ac (console panel edge lighting) Pri ac (hi-intensity floodlights) Sec dc (cockpit utility light) Pri dc (chartboard lights) Emer dc (caution panel lighting) Battery bus (auxiliary cockpit floodlights)
Counting accelerometer	Sec dc
Doppler radar	Sec ac (electronic unit) Sec dc (transmitter)
ECM (see vector warning system)	
ECM pods	Sec ac (station 1 and 8 ac power) Sec dc (station 1 and 8 dc power and warning lights) Battery bus (destruct)
Electronic compartment cooling	Sec ac (fan) Sec dc (control)
Emergency flap control	Emer dc → [16] [18] → [26] Battery bus [17] [27] →
Emergency generator caution light (see Ram Air Turbine)	Pri dc
Emergency hydraulic isolation test and caution light	Sec dc
Engine crank control	Battery bus
Engine fuel control selection and boost control (see fuel)	Emer dc
Engine oil	Pri ac (quantity indicator) Emer dc (ENG OIL caution light) Emer inst (pressure indication)
Engine temperature	Pri dc (temperature limiter) Battery bus (ENG HOT caution lights)

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Figure 1–24 (Sheet 5)

ELECTRICAL SUPPLY AND DISTRIBUTION

CIRCUIT EXPLANATION

CIRCUIT	POWER SOURCE(S) (AND PORTION OF CIRCUIT SUPPLIED BY EACH SOURCE)
Exterior lights	Sec ac (formation and anti-collision lights, wing floodlights, vertical tail floodlights) Emer ac (position lights) Sec dc (land/taxi light) Emer dc (position light flasher, exterior lights control relay)
External fuel tanks (see fuel)	Sec dc (pressurization valve) Pri dc (capacitance panel) Battery bus (external tank refueling)
Fire detection	Battery bus (detection circuits and FIRE warning light)
Flap accumulator heater	Pri ac
Flaps	Pri dc (trailing edge flap control) Pri ac (accumulator heater) Emer dc (leading edge flap position indicator) Emer inst (trailing edge flap position indicator) Emer dc (Emergency flap control → [16] [18] → [26]) Battery bus (Emergency flap control [17] [27] →)
Flight Instrument lights	Inverter bus
Flight Director Computer	Pri ac (heading mode select) Pri dc
Floodlights, cockpit (see console lighting)	Battery bus (auxiliary) Pri ac (Hi-intensity)
Formation lights (see exterior lights)	Sec ac
Fuel	Pri ac (fuel flowmeter indicator and fuel quantity indicator) Sec dc (external tank pressurization valve) Pri dc (FUEL LOW and SUMP LOW caution lights, fuel dump valves, fuel transfer selector valves, emergency transfer selector valve, fuel quantity capacitance panel, air and ground refueling systems) Emer dc (MAIN FUEL PUMP, FUEL BOOST 1, and FUEL BOOST 2 caution lights, manual fuel selector switch) Battery bus (MANUAL FUEL caution light)
Gun, M61A1 (see armament system)	Pri ac (gunfiring voltage) Pri dc (gun clearing and trigger control)
Heading mode select	Pri ac (flight director computer) Pri dc (heading mode switch, rate gyro transmitter, flight director computer) Pri inst (NAV/WD computer)
Head-up Display (HUD)	Sec ac (displays) Sec dc (displays, FAIL and HOT caution lights) Pri dc (standby reticle)
Hi-intensity floodlights (see console lighting)	Pri ac
Hook handle warning light	Emer dc
Horizontal Situation Indicator, AQU-6/A	Pri inst (distance (range) display) Emer ac (azimuth card, bearing pointers, heading error, course error, OFF flag)

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Figure 1–24 (Sheet 6)

ELECTRICAL SUPPLY AND DISTRIBUTION

CIRCUIT EXPLANATION

CIRCUIT	POWER SOURCE(S) (AND PORTION OF CIRCUIT SUPPLIED BY EACH SOURCE)
Hydraulic accumulator heaters	See ac (RAT accumulator) (See Ram Air Turbine) Pri ac (landing gear and flaps accumulators)
Hydraulic pressure	Emer dc (HYD PRESS caution light) Emer inst (pressure indicator)
IFF, APX-72	Sec dc (transponder test) Pri dc (receiver-transmitter, control, and caution light) Pri ac (receiver-transmitter)
Inertial Measurement Set (IMS)	Sec dc (adapter power supply) Emer dc (power adapter and indicator light) Emer ac ((IMS set power) Inverter bus (IMS transformer and power adapter) Pri dc (power supply adapter)
Instrument Landing System (ILS)	Sec dc
Instrumen lights	Sec dc (nonflight instruments) Inverter bus (flight instruments)
Intercommunications Set, AIC-26	Battery bus
Intercommunications station	Sec dc
Inverter bus	Emergency ac bus (main or emergency generator operating) Inverter (main and emergency generators not operating)
Jet fuel starter	Battery
Jettison, salvo and select	Emer dc → [16] [18] → [26] Battery bus [17] [27] → Sec dc (auxiliary jettison control)
Juliet 28	Sec dc
KB-18A strike camera	Sec ac (control and power) Sec dc (test)
Landing gear	Pri ac (accumulator heater) Pri dc (safety solenoid power) Emer dc (position indicators, handle warning light, down-and-locked indicators)
Land/taxi light	Sec dc
Leading edge flap indication	Emer dc
Liquid oxygen	Pri ac (quantity indicator) Pri dc (OXYGEN caution light)
Light test	Emer dc
Low altitude warning light	Sec dc
Manual fuel control	Emer dc (selector switch and valve) Battery bus (MANUAL FUEL caution light)
Master arm	Pri dc (control)

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Figure 1–24 (Sheet 7)

ELECTRICAL SUPPLY AND DISTRIBUTION

CIRCUIT EXPLANATION

CIRCUIT	POWER SOURCE(S) (AND PORTION OF CIRCUIT SUPPLIED BY EACH SOURCE)
Master caution light	Emer dc
Master function switches (attack mode)	Sec dc Emer ac (mode lights)
NAV/WD Computer and weapon release control (also see armament system)	Sec ac (computer power) Sec dc (control panel power) Pri inst bus (heading mode select)
Nonflight instrument lights	Sec ac
Nose gear steering	Sec ac (input transducer – rudder pedal) Sec dc (selector valve power) Pri inst (feedback transducer)
Pitch and roll trim	Emer ac (roll and pitch trim amplifiers and actuators) Emer inst (pitch and roll trim indicators) Emer dc (pitch trim brake)
Pitot heat	Pri ac
Projected Map Display Set (PMDS)	Sec ac Pri inst bus
Position lights (see exterior lights)	Emer ac (power) Emer dc (flasher)
Ram Air Turbine (RAT)	Sec ac (accumulator heater) Sec dc (selector valve) Pri dc (EMER GEN caution light)
Radar altimeter, APN-141	Sec ac Sec dc (indicator)
RADAR, APQ-126	Sec ac (fan and power supply) Sec dc (power supply)
Radar Beacon, APN-154	Sec dc
Radio Receiver, Auxiliary, ARR-69	Sec dc
Radio Receiver, UHF-ADF, ARA-50	Pri dc (receiver) Pri ac (amplifier) Pri inst (antenna)
Rain remove hot caution light	Emer dc
Rain repel	Emer dc
Rate gyros, AFCS (see AFCS)	Emer ac Pri dc (transmitter)
Seat adjust	Pri ac
Standby attitude director indicator	Pri ac
Speed brake	Pri dc (selector valve and SPEED BRAKE advisory light) Emer inst (position indicator)
Stall warning	Emer dc

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Figure 1–24 (Sheet 8)

ELECTRICAL SUPPLY AND DISTRIBUTION

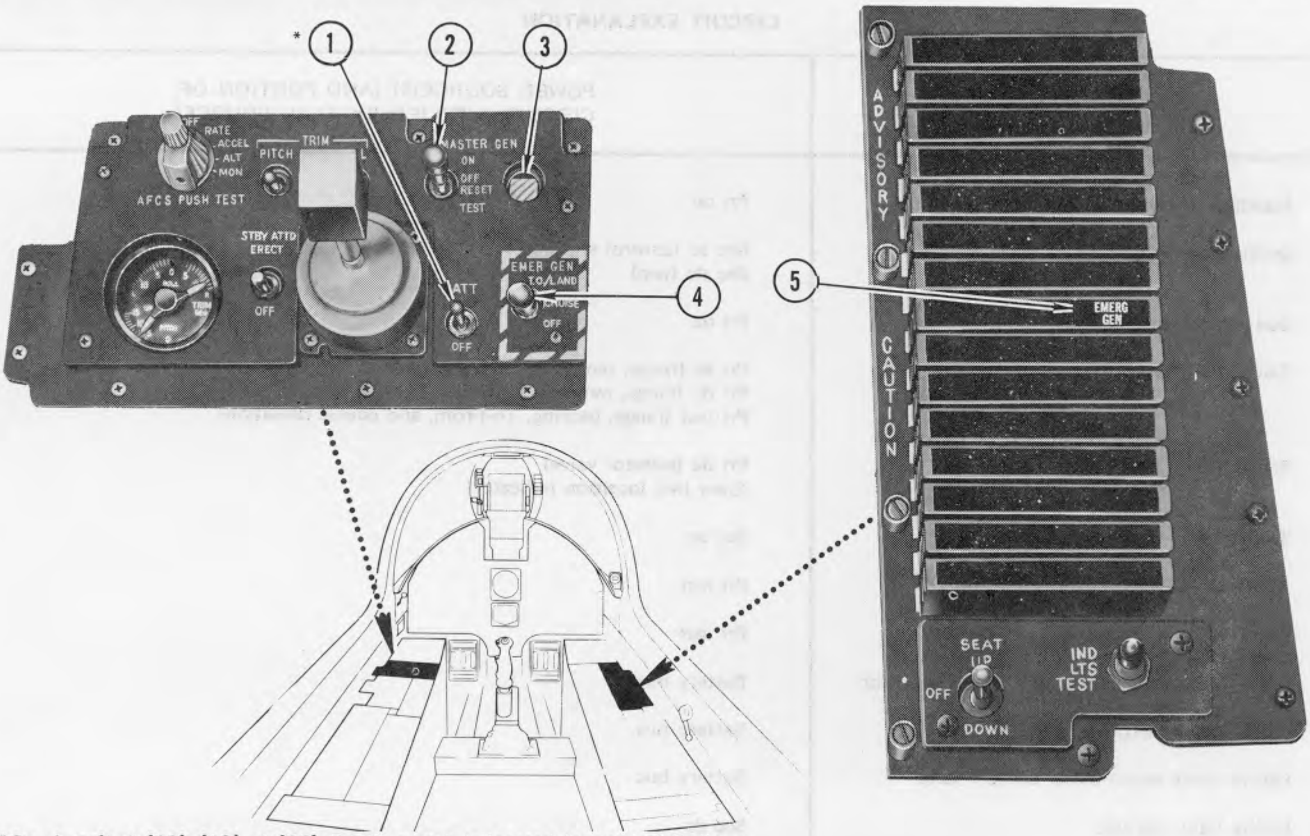
CIRCUIT EXPLANATION

CIRCUIT	POWER SOURCE(S) (AND PORTION OF CIRCUIT SUPPLIED BY EACH SOURCE)
Standby reticle (HUD)	Pri dc
Strike camera, KB-18A	Sec ac (control and power) Sec dc (test)
Suit temperature control	Pri dc
TACAN, ARN-52(V)	Pri ac (range, range flag, bearing, bearing flag) Pri dc (range, range flag, bearing, bearing flag) Pri inst (range, bearing, To-From, and course deviation)
Trailing edge flap	Pri dc (selector valve) Emer inst (position indicator)
Transformer rectifier	Sec ac
TRUE AIRSPEED (TAS) indicator	Pri inst
Turbine Outlet Pressure (TOP) indicator	Pri inst
Turbine Outlet Temperature (TOT) indicator	Battery bus
UHF Radio, ARC-51BX	Battery bus
Utility brake accumulator shutoff valve	Battery bus
Utility light, cockpit	Sec dc
Vector Warning System, APR-36/37	Sec ac (Power and control, ECM caution light, station 1 and 8 pod power) Sec dc (Station 1 and 8 pod power, blanker power) Battery bus (destruct system)
VHF Radio, FM-622A	Sec dc
Warning and advisory lights	Emer dc
Weapon release (see armament system and NAV/WD computer)	
Weight on gear relays	Sec dc
Wheels and flaps warning	Emer dc
Wingfold	Sec dc

75D078(9)-01-72

Figure 1–24 (Sheet 9)

ELECTRICAL SYSTEM CONTROLS



*On aircraft → [16] [18] → [26] BATT switch is located forward of Bullpup controller.

Nomenclature	Function
1. BATT switch	BATT – connects the battery (or external start power) to the battery bus if the master generator, external ac power and emergency generator are off the line. With the master generator off the line and with the aircraft airborne, the inverter is also activated to energize the inverter bus until the RAT is extended. RAT operation picks up circuits momentarily powered by the inverter, deactivates the inverter, and powers the battery bus. OFF – disconnects the battery (or external power) from the battery bus. If the RAT is supplying aircraft power, flow is not interrupted.
2. MASTER GEN switch	ON – connects master generator or external electrical power to the bus distribution system. Power will not connect unless it is within prescribed limits. OFF RESET – disconnects electrical power from the bus distribution system. Also resets the generator control panel if the master generator trips off during operation. TEST – connects external ac power to the bus distribution system.
3. Master generator indicator	V – indicates master generator is producing electrical power within prescribed limits. Barberpole – indicates master generator is not producing electrical power within prescribed limits.

75D079(1)–02–70

Figure 1–25 (Sheet 1)

ELECTRICAL SYSTEM CONTROLS

Nomenclature	Function
4. EMER GEN switch	T. O. LAND – connects emergency generator to emergency ac and dc buses if master generator power is lost (RAT extended). CRUISE – connects emergency generator to primary and emergency ac and dc buses if master generator power is lost (RAT extended). OFF – disconnects emergency generator from bus distribution system.
5. Emergency generator caution light	On (EMERG GEN) – indicates master generator is not operating and the emergency generator switch is in the CRUISE position, RAT extended, and the landing gear down.

75D079(2)-12-70

Figure 1–25 (Sheet 2)

HYDRAULIC POWER SUPPLY SYSTEMS → [16] [18] → [26]

Hydraulic power is supplied by two separate power control systems (PC 1 and PC 2), nine hydraulic accumulators, and a ram air turbine (RAT). A simplified block diagram of the hydraulic system is presented in figure 1–26. The following is a list of the aircraft hydraulic power supply systems:

- Power Control Systems
  - PC 1
  - PC 2
- Hydraulic Accumulators
  - Emergency Flap Accumulator
  - Emergency Brake Accumulator
  - Emergency Landing Gear Accumulator
  - RAT Accumulator
  - PC 1 Surge Damper
  - PC 1 (reservoir pressurization)
  - PC 2 Surge Damper
  - Arresting Hook Accumulator (normal extension)
  - Utility Wheel Brake Accumulator
- Ram Air Turbine (RAT)

Normally only the PC 1 and PC 2 systems supply hydraulic power. These systems are redundant with respect to operating flight controls. If either PC system fails, the other will supply adequate hydraulic power to continue flight. The PC 2 system also powers all hydraulically powered utilities (wheel brakes, landing gear, etc). The PC 2 flight control function and utility function are separated by means of a pilot-operated utilities isolation valve. With the utilities isolation valve closed, flight controls cannot be jeopardized through malfunction of an isolated utility system.

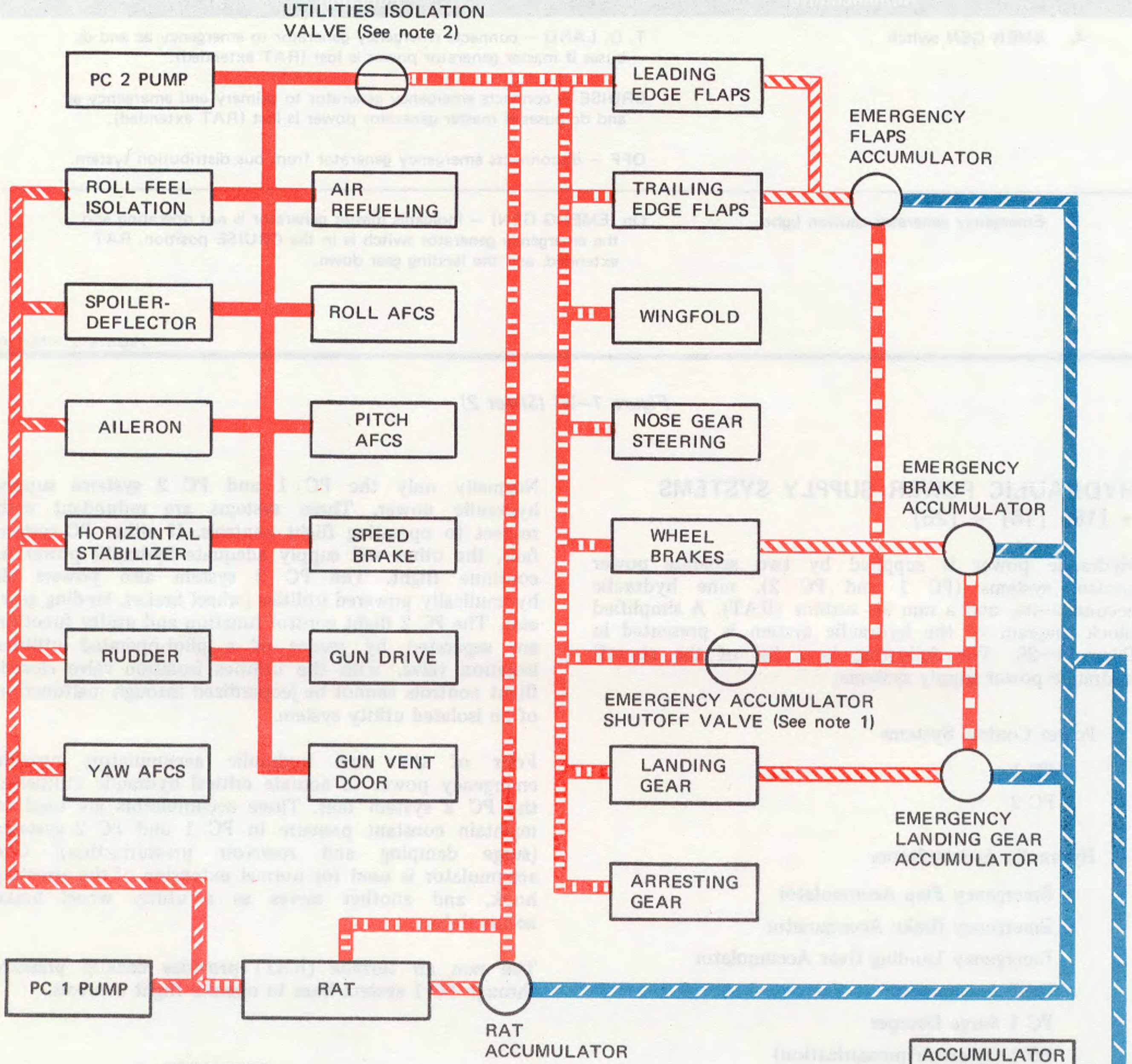
Four of the nine hydraulic accumulators provide emergency power to actuate critical hydraulic utilities if the PC 2 system fails. Three accumulators are used to maintain constant pressure in PC 1 and PC 2 systems (surge damping and reservoir pressurization). One accumulator is used for normal extension of the arresting hook, and another serves as a utility wheel brake accumulator.

The ram air turbine (RAT) provides backup pressure through PC 1 system lines to operate flight controls.

Note

Hydraulic schematics are cross-referenced so that hydraulic flow can be traced from power source to actuator, or vice versa. See individual system descriptions for utility hydraulic schematics.

POWER CONTROL HYDRAULIC SYSTEM → [16] [18] → [26]



LEGEND

- PC 1 Pressure
- PC 2 Pressure
- Isolated Utilities Circuit
- RAT Pressure
- Accumulator Charging Pressure
- Accumulator Precharge
- Emergency Accumulator Pressure

NOTES

1. Shutoff valve manually opened and closed with handle on valve.
2. Utilities isolation valve closed when flap handle is in ISO

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Figure 1–26

POWER CONTROL (PC) No. 1 HYDRAULIC SYSTEM.

The pilot has no control over the PC 1 system other than monitoring system pressure and extending the ram air turbine.

The PC 1 system supplies one-half the power for operating primary flight controls and roll feel isolation actuator, and total power for operating the automatic flight control system (AFCS) yaw actuator. The primary flight control and roll feel isolation actuators are internally divided so that PC 1 powers one-half of each actuator while PC 2 powers the other half. This design permits continued operation of an actuator at reduced control power if either power control system fails. The PC 1 system for aircraft → [16] [18] → [26] is presented schematically in figure 1–27.

Normal PC 1 operating pressure is supplied by a variable-delivery hydraulic pump which is driven through reduction gears in the engine high speed gearbox. Fluid discharged from the pump passes through a check valve and filter before reaching the power control circuits.

When a hydraulic component is actuated, fluid flows from the PC 1 pressure line to the actuating cylinder and from the return port of the cylinder to the PC 1 return line. Fluid in the return line is directed back to the hydraulic pump and the system reservoir. The reservoir, located in the left main wheel well, stores fluid under 90 psi to ensure an adequate flow of fluid to the hydraulic pump. The system contains two accumulators, one for surge damping and one for pressurizing the reservoir in the event the hydraulic pump fails.

System pressure is sensed by a pressure transmitter and is indicated by pointer No. 1 of the hydraulic pressure indicator on the instrument panel.

The system is protected from overpressure by a relief valve set to relieve at 3,850 psi. If pressure drops below approximately 1,500 psi, the MASTER CAUTION light on the instrument panel flashes and a HYD PRESS caution light on the right console comes on.

Note

If the HYD PRESS caution light has been illuminated previously by low pressure in the PC 2 system, low pressure in the PC 1 system will not cause the MASTER CAUTION light to flash.

If PC 1 fails, pressure to the system can be restored by extending the ram air turbine, provided system failure is not due to loss of fluid. Refer to Ram Air Turbine (RAT) for details of RAT operation.

System servicing points and approved hydraulic fluids are presented in the Servicing Diagram, figure 2–11.

RAM AIR TURBINE (RAT) HYDRAULIC SUPPLY.

The RAT is a backup source of hydraulic power for the PC 1 system. It also supplies emergency electrical power. The RAT is wind driven and is extended into the airstream at pilot discretion. Once extended, the RAT will supply PC 1 pressure provided PC 1 is inoperative. The pilot need only monitor pressures and ensure that minimum and maximum RAT speeds are maintained. It is essential to understand that the greater the electrical load on the RAT, the higher the airspeed required to satisfy hydraulic requirements. Airspeeds required are listed in figure 1–28. A RAT schematic is presented in figure 1–29.

Extension.

The RAT can be extended by normal PC 2 pressure or by RAT accumulator pressure. RAT accumulator pressure extends the RAT if the flap handle is in the ISO UTILITY position when the EMER POWER handle is pulled. If PC 2 pressure is available, the pressure from this system will extend the RAT if the flap handle is out of the ISO UTILITY position.

Note

It is not a requirement to leave the flap handle in ISO UTILITY following RAT extension. If the RAT is extended because of hydraulic failure, then only PC 1 pressure is being supplied. The utility isolation valve, which is controlled by the flap handle, is a part of the PC 2 system.

Extend pressure unlocks internal locking fingers before the package is extended. As the RAT compartment door opens, a door actuated switch is released. The switch opens a shutoff valve, permitting RAT retract fluid to enter the PC 2 return line through the shutoff valve and the RAT selector valve. A check valve in the shutoff valve bypass line permits extension of the RAT if the valve malfunctions in the closed position.

PC 1 HYDRAULIC SYSTEM → 16 18 → 26

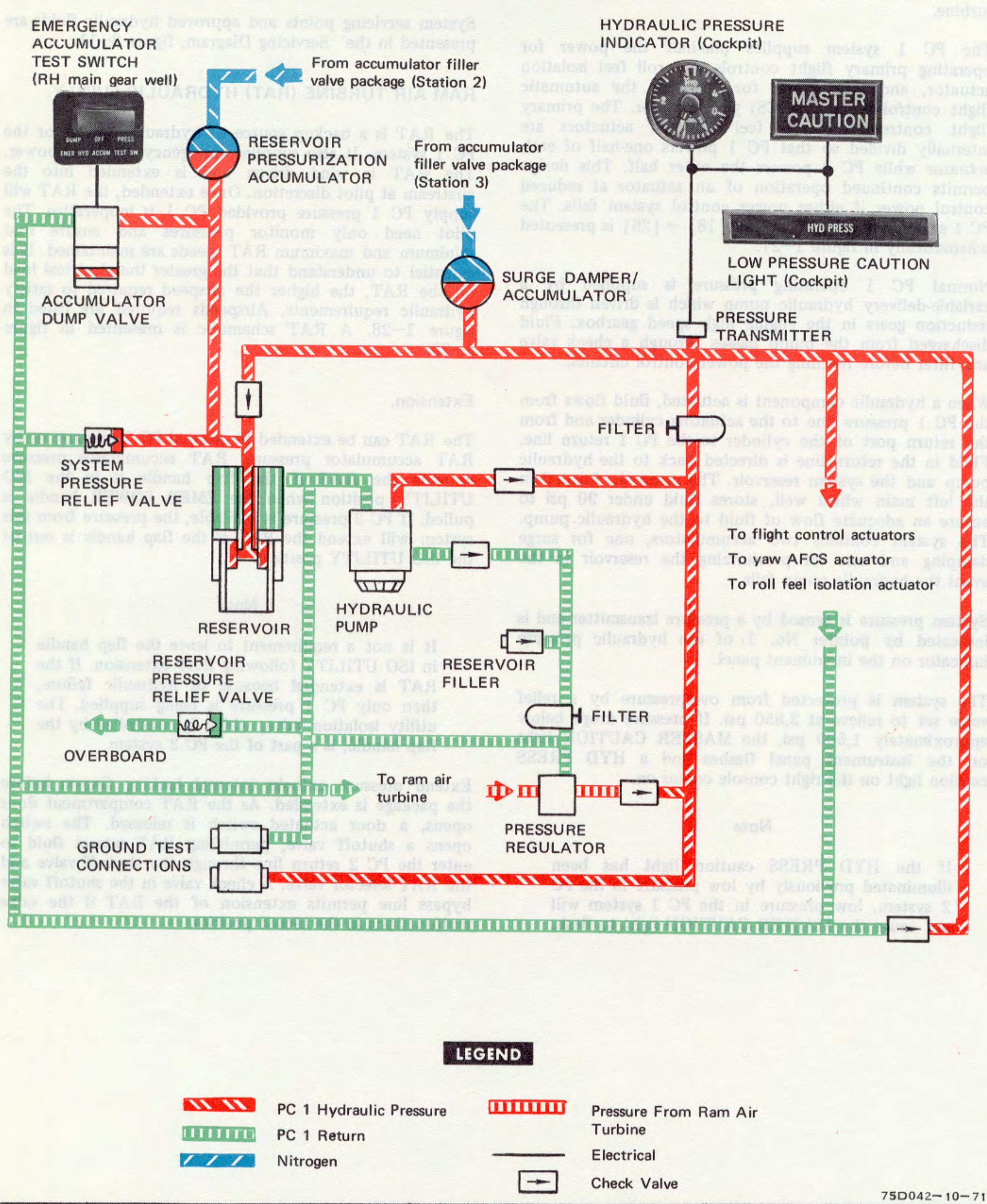

Figure 1–27

RAT EXTENSION MINIMUM AIRSPEEDS

EMERGENCY	REQUIREMENT	EMERGENCY GENERATOR SWITCH POSITION	MINIMUM AIRSPEED	
			→ [16] [18] → [26]	[17] [27] →
Generator failure	Electrical power	CRUISE	175 KIAS	175 KIAS
Generator failure	Electrical power	T.O. LAND	120 KIAS	120 KIAS
Engine failure	Electrical and hydraulic power	CRUISE	175 KIAS	175 KIAS
Engine failure	Electrical and hydraulic power	T.O. LAND	130 KIAS	140 KIAS
Engine failure	Hydraulic power for flight controls	OFF	125 KIAS	135 KIAS
Failure of all PC systems	Hydraulic power for flight controls	OFF	125 KIAS	135 KIAS

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Figure 1–28

RAT Output.

With the RAT extended, the airstream spins the RAT fan at approximately 12,000 rpm. Fan speed is maintained by a governor which varies fan pitch according to load conditions. Hydraulic fluid from the pump passes through a flow sensitive pressure regulator and into the PC 1 pressure line. The regulator determines the amount of fluid that passes into the pressure line and bypasses excessive fluid into the PC 1 return line. PC 1 return fluid flows into the RAT hydraulic pump inlet. Inlet pressure is furnished by the PC 1 surge damper/accumulator. Emergency hydraulic pressure is sensed by the PC 1 pressure transmitter and is indicated on pointer No. 1 of the hydraulic pressure indicator on the instrument panel.

The emergency generator supplies electrical power to the primary and emergency ac and dc buses with the EMER GEN switch in CRUISE. With the EMER GEN switch in T.O. LAND, power is supplied only to the emergency ac and dc buses. Figure 1–28 presents airspeeds for RAT electrical and hydraulic output requirements.

The normal range of hydraulic pressure available from the RAT is 600 psi at 125 KIAS, to 2,800 psi at 250 KIAS. These figures are with both normal PC systems inoperative and the EMER GEN switch OFF.

Retraction.

The RAT is retracted by raising a trigger on the EMER POWER handle and allowing the handle to return to the stowed position. This mechanically repositions the RAT selector valve, permitting remaining RAT accumulator pressure to be released through the open RAT shutoff valve to retract the package. Hydraulic pressure unlocks the internal locking fingers before the package is retracted.

After retracting the RAT, accumulator pressure is exhausted. The accumulator is recharged by PC 2 system pressure if the flap handle is moved out of ISO UTILITY for a minimum of 3 seconds. A charged accumulator is good for one extend-retract cycle before it must be recharged in this manner.

RAM AIR TURBINE

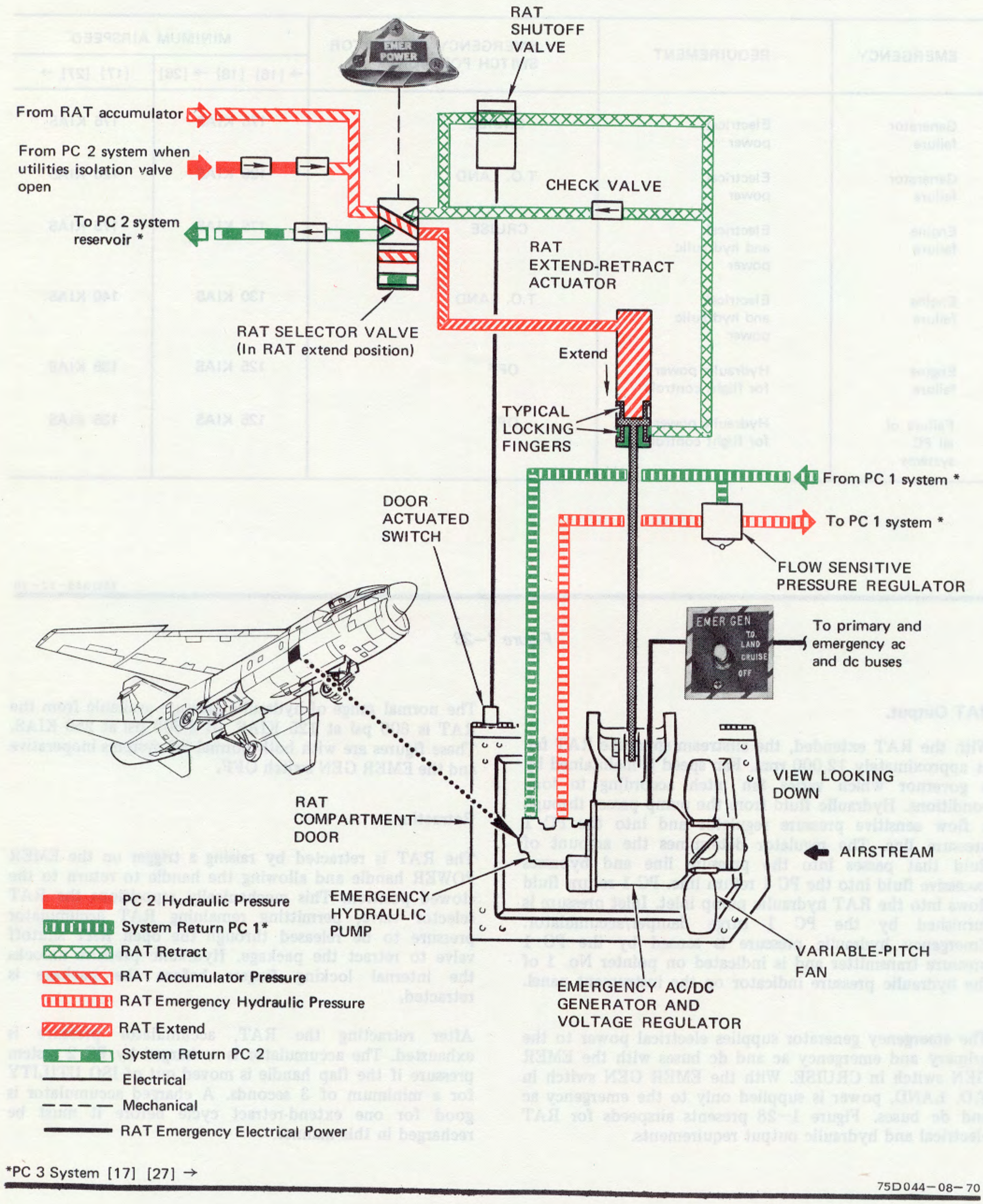


Figure 1–29

POWER CONTROL (PC) NO. 2 HYDRAULIC SYSTEM.

Basically, PC 2 is a duplicate of the PC 1 system. However, the PC 2 system supplies pressure to more actuators, including all utility hydraulic actuators. For this reason, the PC 2 system employs a larger capacity pump (40.3 gpm vs 24.1 gpm for PC 1) and larger fluid reservoir (917 inches vs 144 cubic inches). Also, the pilot exercises greater control over the PC 2 system through operation of the utilities isolation valve following takeoff and before landing. The PC 2 system for aircraft → [16] [18] → [26] is presented schematically in figure 1–30.

The PC 2 system supplies pressure to half of each flight control actuator and to half of the roll feel isolation actuator. PC 1 pressure supplies the other half of these tandem actuators. Also supplied are the automatic flight controls system roll and pitch actuators and the utility hydraulic systems. The utility hydraulic systems are as follows:

Nosewheel steering*

Wheel brakes*

Secondary flight controls (leading and trailing edge flaps*, speed brake)

Wingfold*

Landing gear*

Gun drive and vent door

Air refueling probe

Arresting hook*

Ram air turbine (RAT) extension

Fluid charge, emergency accumulators

Moving the flap handle to ISO UTILITY position closes the utilities isolation valve. The closed valve prevents a leak in the isolated utilities from causing a PC 2 pressure loss. With the flap handle out of ISO UTILITY, the isolation valve is open.

WARNING

On aircraft → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685, if the PC 2 system fails, turn off the antiskid system before using wheel brakes. If the ANTI-SKID switch is left on and brakes are applied, all utility brake accumulator pressure will bypass through the antiskid control valve in less than 20 seconds. Leakage occurs even if brakes are applied moderately enough to prevent antiskid system cycling. Even with the antiskid system off, the utility brake accumulator cannot be relied on 45 minutes after the flap handle is placed in ISO UTILITY. Power brake cylinder leakage may deplete the accumulator in this time span.

On aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →, if the PC 2 system fails, the ANTI-SKID switch must be placed in the BRAKE ACCUM position to obtain hydraulic pressure for brake application. Bleed off of the stored PC 2 pressure in the leak resistant utility brake accumulator system will not occur, provided the ANTI-SKID switch remains in the OFF or ANTI-SKID position. Antiskid protection is not available when the ANTI-SKID switch is placed in the BRAKE ACCUM or OFF position.

Note

All isolated utilities are lost if fluid loss occurs within the isolated utility system.

System pressure is sensed by a pressure transmitter and is displayed on the hydraulic pressure indicator by pointer No. 2. System pressures are as described for the PC 1 system. Low system pressure (1,500 psi or less) causes the HYD PRESS caution light to illuminate and the MASTER CAUTION light to flash.

Note

If the HYD PRESS caution light has been illuminated previously by low pressure in the PC 1 system, low pressure in the PC 2 system will not cause the MASTER CAUTION light to flash.

Emergency accumulators provide a source of stored energy to operate landing gear, wheel brakes, flaps, and the RAT if the PC 2 system should fail. These accumulators are fluid charged by the PC 2 system as described in the HYDRAULIC ACCUMULATORS writeup which follows.

A hydraulic handpump is installed in the left wheel well for ground operation of utilities. The handpump provides sufficient pressure to cycle one utility system at a time when the utilities isolation valve is open and the manual wingfold selector valve (adjacent to the hand pump) is in the forward position. With the wingfold valve in the aft position, hand pump pressure will fold the outer wing panels.

HYDRAULIC ACCUMULATORS.

Aircraft systems use nine hydraulic accumulators which are precharged with nitrogen and, except for the arresting hook accumulator, are fluid charged by the PC 2 hydraulic system during normal aircraft operation. Five accumulators provide for normal operation of the following systems:

Wheel brakes

PC 1 hydraulic system surge damping

PC 2 hydraulic system surge damping

PC 1 hydraulic system reservoir pressurization

Arresting hook (extension)

Four accumulators provide for emergency operation of the following systems:

Landing gear (extension only)

Wheel brakes (approximately five applications)

Leading and trailing edge flaps (extension only)

Ram air turbine (extension and retraction)

*Isolated utilities

PC 2 HYDRAULIC SYSTEM → [16] [18] → [26]

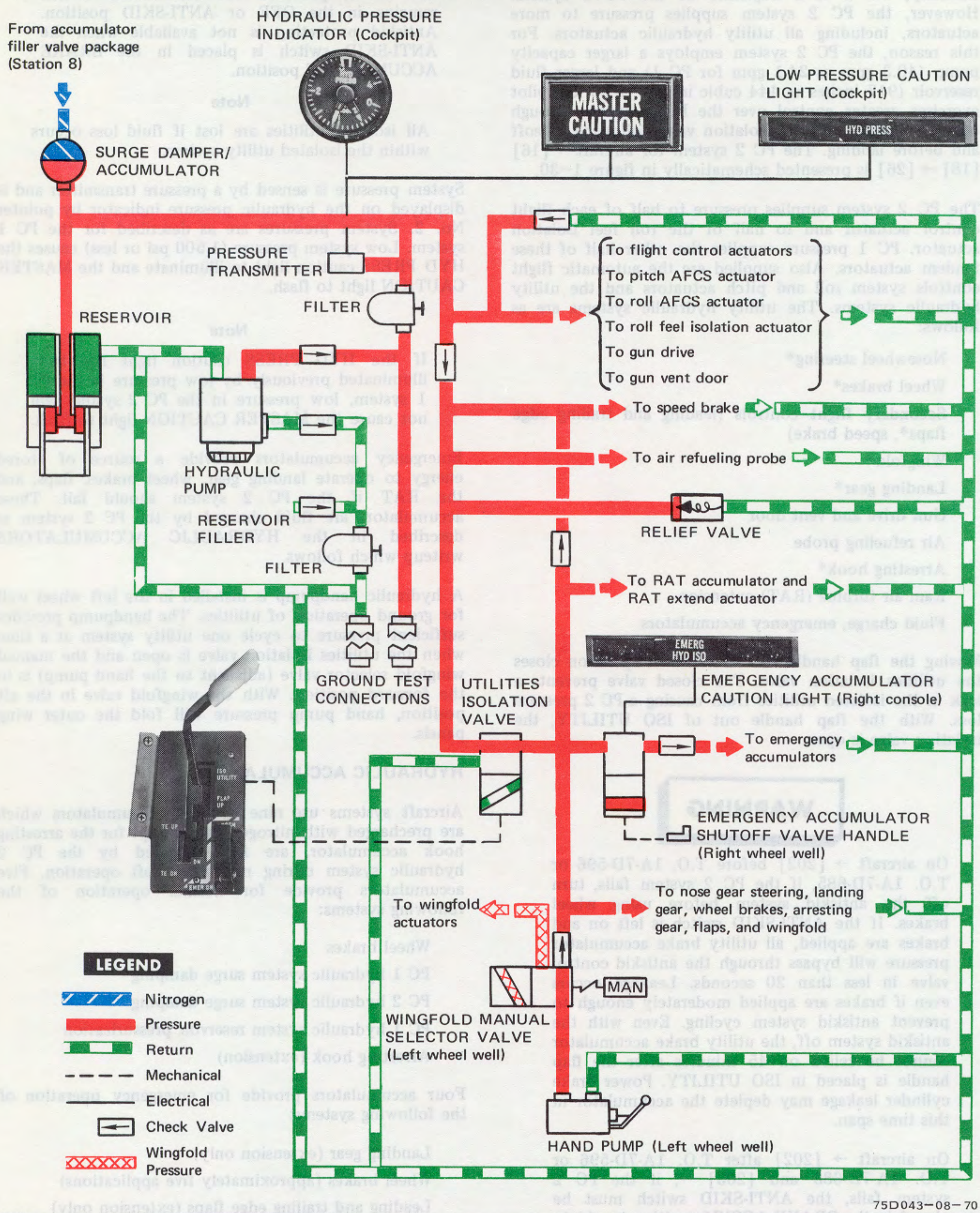


Figure 1–30

The landing gear, flaps, and ram air turbine accumulators are equipped with heater blankets to assure maximum pressure at altitude. The RAT blanket is powered by the secondary ac bus; the landing gear and flap accumulator blankets by the primary ac bus.

Accumulator Filler Valve Package.

The accumulators are serviced with nitrogen through a filler valve package located in the right main gear wheel well. The package has a charge valve and a pressure gage for each of the accumulators.

Emergency Accumulator Test Switch.

The emergency accumulator test switch is used during nitrogen servicing of the four emergency accumulators and the PC 1 system reservoir pressurization accumulator. The test switch, located adjacent to the filler valve package has three positions: OFF, DUMP, and PRESS. In the DUMP position, dump valves are powered open and hydraulic pressure is simultaneously released from the five accumulators into system return lines. This permits an accurate reading of nitrogen pressure in these accumulators. In the PRESS position, precharge shutoff valves located between the filler valve package and the emergency accumulators are powered open and the emergency accumulators can be precharged with nitrogen. The switch must be in PRESS position to connect the gage with the accumulators. The switch need not be placed in PRESS to charge any of the nonemergency accumulators with nitrogen. Hydraulic pressure in these accumulators is released by aileron movement (PC 1 and PC 2 system accumulators), brake applications (utility brake accumulator), and retraction of the arresting hook (hook accumulator). In the OFF position, the precharge shutoff valves and accumulator dump valves are positioned to isolate the emergency accumulators from the filler valve package and from the PC 2 return line.

Emergency Accumulator Shutoff Valve.

The emergency accumulator shutoff valve is located in the right main gear wheel well. When in the OPEN position, the valve connects the gear, flaps, and brakes emergency accumulators to PC 2 pressure and illuminates an emergency hydraulic accumulator isolation caution light (EMERG HYD ISO). When the valve is in the CLOSED position, these accumulators are isolated from PC 2 pressure, the caution light is off, and the PC 2 system is protected from any leaks that may develop downstream of the accumulator shutoff valve. The RAT emergency accumulator is upstream of the shutoff valve and is hydraulically charged without regard to position of the shutoff valve.

The shutoff valve is opened by the crew chief after each flight and is checked open by the pilot during exterior inspection prior to the next flight. After engine start, the crew chief closes the valve if the accumulators have the proper hydraulic charge. Valve closed condition is indicated to the pilot by the EMERG HYD ISO caution light going out.

Accumulator servicing is covered in SERVICING DIAGRAM, figure 2–11. The emergency accumulator and precharge system is shown in figure 1–31.

HYDRAULIC POWER SYSTEM CONTROLS.

Hydraulic power system controls are illustrated and described in figure 1–32.

HYDRAULIC POWER SUPPLY SYSTEMS [17] [27] →

Hydraulic power is supplied by three redundant power control systems (PC 1, PC 2, and PC 3), 10 hydraulic accumulators, and a ram air turbine (RAT). The horizontal stabilizer, rudder, ailerons, and spoiler deflectors are controlled by tandem actuators. Each tandem actuator is powered by two of the three power control systems. If one PC system fails, the other two systems continue to supply hydraulic power to the flight controls. Should two PC systems fail, the remaining system provides hydraulic power to a sufficient number of flight controls to maintain flight. A simplified block diagram of the entire aircraft hydraulic system is presented in figure 1–33. Flight control backup capabilities are summarized in figure 1–34. The following is a complete list of the aircraft hydraulic power supply systems:

- Power Control Systems
  - PC 1
  - PC 2
  - PC 3
- Hydraulic Accumulators
  - Emergency Flap Accumulator
  - Emergency Brake Accumulator
  - Emergency Landing Gear Accumulator
  - RAT Accumulator
  - PC 1 Surge Damper
  - PC 3 (reservoir pressurization)
  - PC 2 Surge Damper
  - PC 3 Surge Damper
  - Arresting Hook Accumulator (normal extension)
  - Utility Wheel Brake Accumulator

POWER CONTROL (PC) NO. 1 HYDRAULIC SYSTEM.

The pilot has no control over the PC 1 system other than monitoring system pressure.

The following systems are powered by the PC 1 system:

- Roll AFCS actuator
  - Left and right aileron actuators
  - Left and right spoiler-deflector actuators
  - Left and right horizontal stabilizer actuators

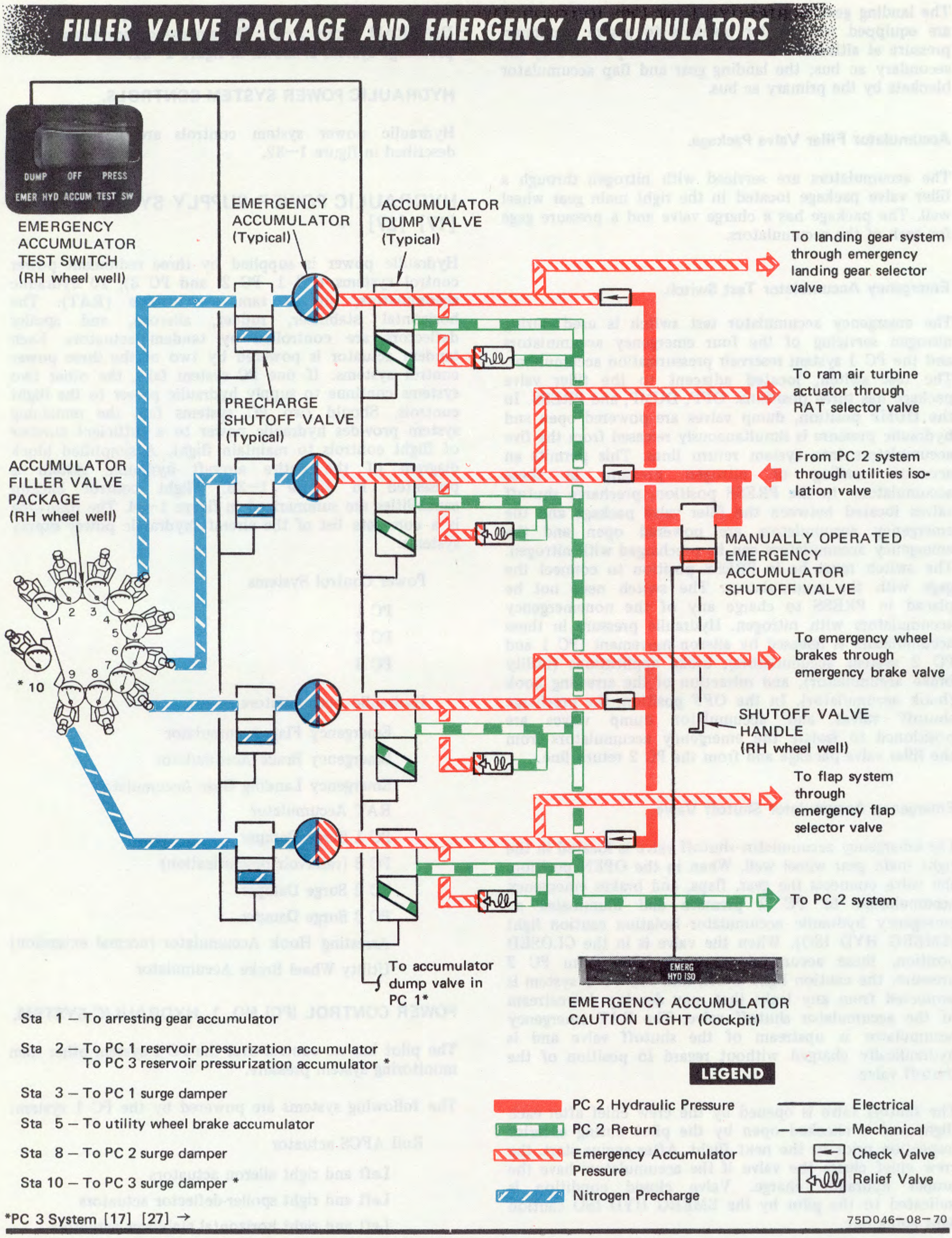
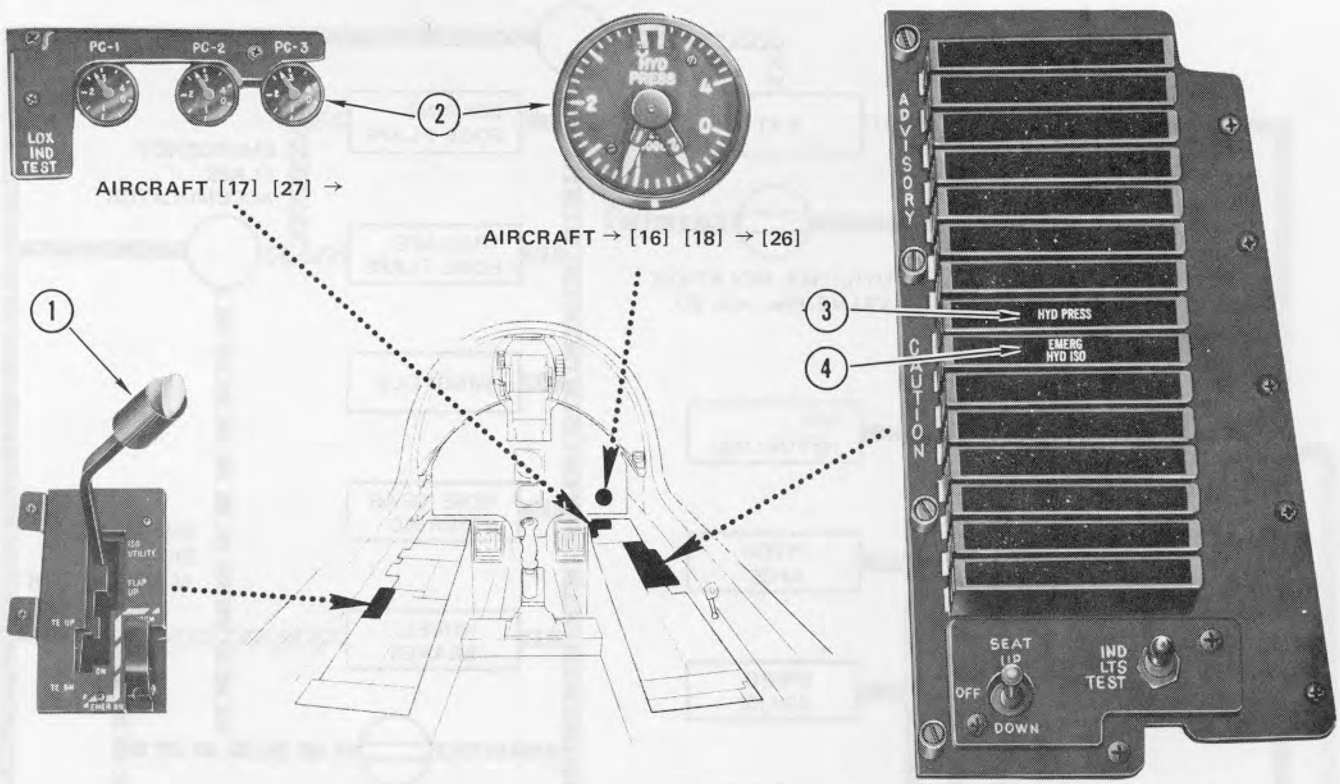

FILLER VALVE PACKAGE AND EMERGENCY ACCUMULATORS
DUMP OFF PRESS
EMER HYD ACCUM TEST SW
EMERGENCY ACCUMULATOR TEST SWITCH (RH wheel well)
EMERGENCY ACCUMULATOR (Typical)
ACCUMULATOR DUMP VALVE (Typical)
To landing gear system through emergency landing gear selector valve
PRECHARGE SHUTOFF VALVE (Typical)
To ram air turbine actuator through RAT selector valve
ACCUMULATOR FILLER VALVE PACKAGE (RH wheel well)
From PC 2 system through utilities isolation valve
MANUALLY OPERATED EMERGENCY ACCUMULATOR SHUTOFF VALVE
To emergency wheel brakes through emergency brake valve
* 10
SHUTOFF VALVE HANDLE (RH wheel well)
To flap system through emergency flap selector valve
To PC 2 system
To accumulator dump valve in PC 1*
EMERG HYD ISO
EMERGENCY ACCUMULATOR CAUTION LIGHT (Cockpit)
Sta 1 – To arresting gear accumulator
Sta 2 To PC 1 reservoir pressurization accumulator
To PC 3 reservoir pressurization accumulator *
Sta 3 – To PC 1 surge damper
Sta 5 – To utility wheel brake accumulator
Sta 8 – To PC 2 surge damper
Sta 10 – To PC 3 surge damper *
*PC 3 System [17] [27] →
LEGEND
PC 2 Hydraulic Pressure
PC 2 Return
Emergency Accumulator Pressure
Nitrogen Precharge
Electrical
Mechanical
Check Valve
Relief Valve
75D046–08–70

Figure 1–31

HYDRAULIC POWER SYSTEM CONTROLS

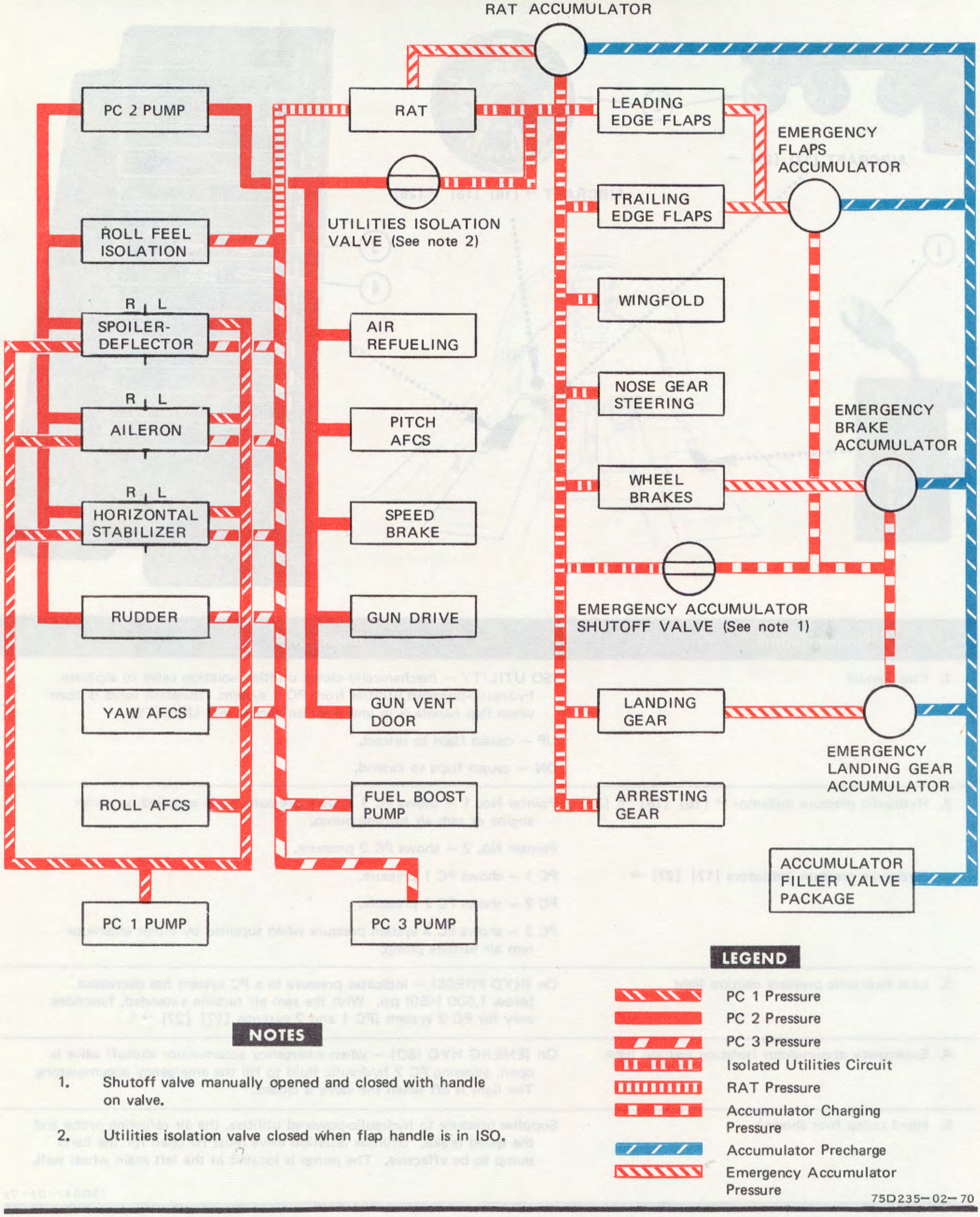


Nomenclature	Function
1. Flap handle	ISO UTILITY – mechanically closes utilities isolation valve to separate hydraulic-powered utilities from PC 2 system. Isolation valve is open when flap handle is in any position except ISO UTILITY. UP – causes flaps to retract. DN – causes flaps to extend.
2. Hydraulic pressure indicator → [16] [18] → [26]	Pointer No. 1 – shows PC 1 system pressure when supplied by either engine or ram air turbine pump. Pointer No. 2 – shows PC 2 pressure.
Hydraulic pressure indicators [17] [27] →	PC 1 – shows PC 1 pressure. PC 2 – shows PC 2 pressure. PC 3 – shows PC 3 system pressure when supplied by either engine or ram air turbine pump.
3. Low hydraulic pressure caution light	On (HYD PRESS) – indicates pressure in a PC system has decreased below 1,500 (+50) psi. With the ram air turbine extended, functions only for PC 2 system (PC 1 and 2 systems [17] [27] →).
4. Emergency accumulator isolation caution light	On (EMERG HYD ISO) – when emergency accumulator shutoff valve is open, allowing PC 2 hydraulic fluid to fill the emergency accumulators. The light is off when the valve is closed.
5. Hand pump (not shown)	Supplies pressure to hydraulic-powered utilities, the air refueling probe and the speed brake. Utilities isolation valve must be open for the hand pump to be effective. The pump is located in the left main wheel well.

75D047-03-71

Figure 1–32

POWER CONTROL HYDRAULIC SYSTEM [17] [27] →

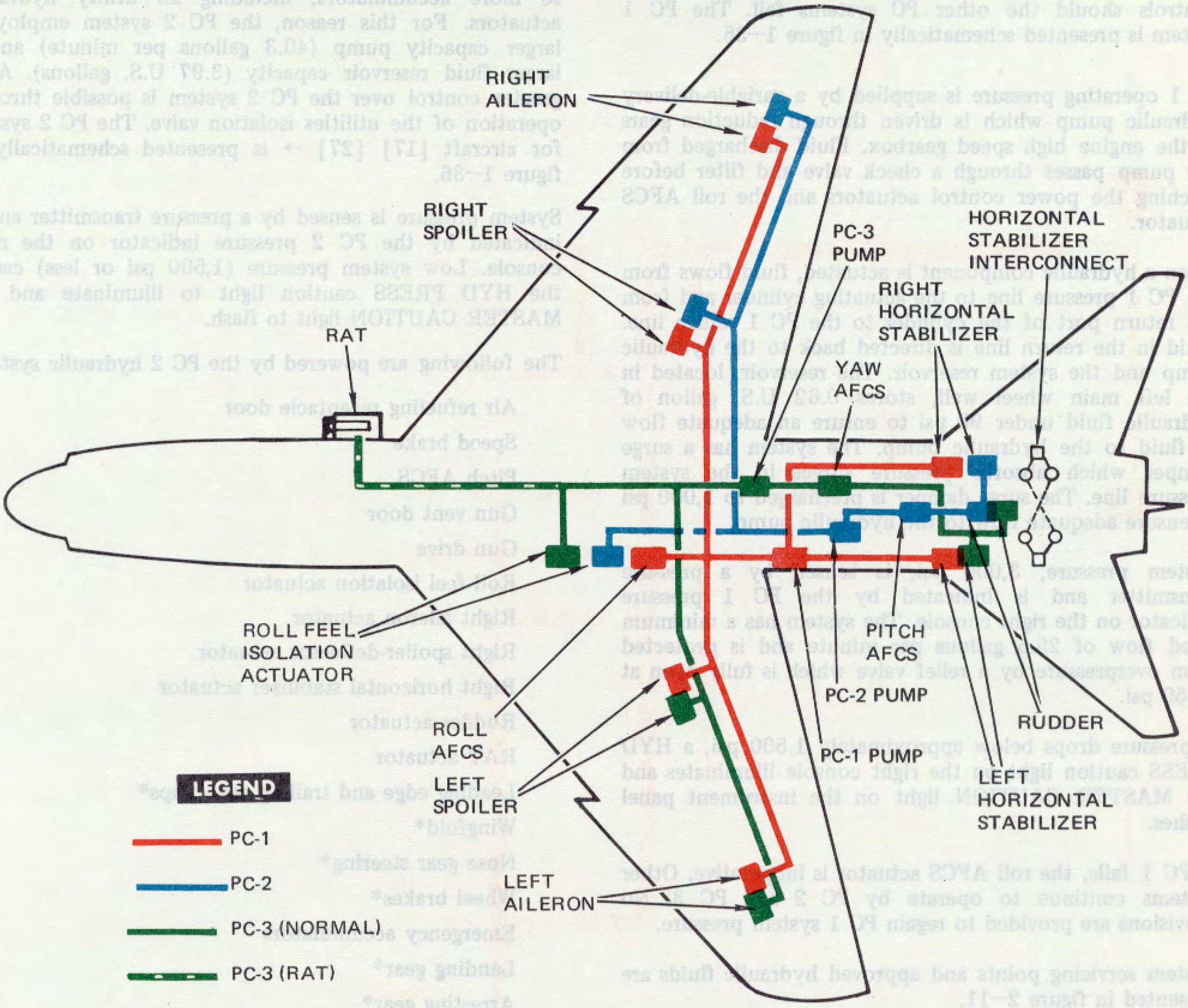


NOTES

1. Shutoff valve manually opened and closed with handle on valve.
2. Utilities isolation valve closed when flap handle is in ISO.

Figure 1-33

FLIGHT CONTROL BACKUP CAPABILITIES [17] [27] →



PC SYSTEM(S) OPERATING:	AILERONS AND SPOILER/ DEFLECTORS	HORIZONTAL STABILIZER	RUDDER	ROLL AFCS	PITCH AFCS	YAW AFCS
PC 1 and 2 ONLY	YES	YES	YES	YES	YES	NO
PC 1 and 3 ONLY	YES	YES	YES	YES	NO	YES
PC 2 and 3 ONLY	YES	YES	YES	NO	YES	YES
PC 1 ONLY	YES *	YES	NO	YES	NO	NO
PC 2 ONLY	RIGHT ONLY	YES	YES	NO	YES	NO
PC 3 ONLY	LEFT ONLY	YES	YES	NO	NO	YES

*AFCS must be operating in CONT AUG, ATTD hold for ailerons to operate strictly on PC 1 pressure. Aileron operation on PC 1 pressure only is achieved through stick force sensor operation of the roll AFCS actuator.

75D245—11—71

Figure 1—34

The aileron, spoiler and horizontal stablizer actuators are internally divided so that PC 1 powers one-half of each tandem actuator while PC 2 or PC 3 powers the other half. The design permits continued operation of the flight controls should the other PC systems fail. The PC 1 system is presented schematically in figure 1—35.

PC 1 operating pressure is supplied by a variable-delivery hydraulic pump which is driven through reduction gears in the engine high speed gearbox. Fluid discharged from the pump passes through a check valve and filter before reaching the power control actuators and the roll AFCS actuator.

When a hydraulic component is actuated, fluid flows from the PC 1 pressure line to the actuating cylinder and from the return port of the cylinder to the PC 1 return line. Fluid in the return line is directed back to the hydraulic pump and the system reservoir. The reservoir, located in the left main wheel well, stores 0.62 U.S. gallon of hydraulic fluid under 90 psi to ensure an adequate flow of fluid to the hydraulic pump. The system has a surge damper which absorbs pressure surges in the system pressure line. The surge damper is precharged to 1,000 psi to ensure adequate flow to the hydraulic pump.

System pressure, 3,000 psi, is sensed by a pressure transmitter and is indicated by the PC 1 pressure indicator on the right console. The system has a minimum rated flow of 25.5 gallons per minute and is protected from overpressure by a relief valve which is fully open at 3,850 psi.

If pressure drops below approximately 1,500 psi, a HYD PRESS caution light on the right console illuminates and the MASTER CAUTION light on the instrument panel flashes.

If PC 1 fails, the roll AFCS actuator is inoperative. Other systems continue to operate by PC 2 and PC 3. No provisions are provided to regain PC 1 system pressure.

System servicing points and approved hydraulic fluids are presented in figure 2—11.

POWER CONTROL (PC) NO. 2 HYDRAULIC SYSTEM.

Basically, the PC 2 system is similar to and operates the same as PC 1. However, the PC 2 system supplies pressure to more accumulators, including all utility hydraulic actuators. For this reason, the PC 2 system employs a larger capacity pump (40.3 gallons per minute) and a larger fluid reservoir capacity (3.97 U.S. gallons). Also, greater control over the PC 2 system is possible through operation of the utilities isolation valve. The PC 2 system for aircraft [17] [27] → is presented schematically in figure 1—36.

System pressure is sensed by a pressure transmitter and is indicated by the PC 2 pressure indicator on the right console. Low system pressure (1,500 psi or less) causes the HYD PRESS caution light to illuminate and the MASTER CAUTION light to flash.

The following are powered by the PC 2 hydraulic system:

- Air refueling receptacle door
- Speed brake
- Pitch AFCS
- Gun vent door
- Gun drive
- Roll feel isolation actuator
- Right aileron actuator
- Right spoiler-deflector actuator
- Right horizontal stabilizer actuator
- Rudder actuator
- RAT actuator
- Leading edge and trailing edge flaps*
- Wingfold*
- Nose gear steering*
- Wheel brakes*
- Emergency accumulators
- Landing gear*
- Arresting gear*

*Isolated utilities

The isolated utilities are separated from the PC 2 system by a utilities isolation valve located in the pressure line to the utility actuators. Moving the flap handle to ISO UTILITY position closes the utilities isolation valve. Hydraulic-powered isolated utilities cannot be operated when this valve is closed. The closed valve prevents a leak in the isolated utilities from causing a PC 2 pressure loss. With the flap handle out of ISO UTILITY, the isolation valve is open and hydraulic-powered isolated utilities can be operated. The speed brake, air refueling receptacle door, gun vent door, and gun drive can be operated with the isolation valve open or closed.

Note

Operation of isolated utilities by means of the PC 2 system is lost if fluid loss occurs within the isolated utility system.

PC 2 pressure is used to fluid charge all aircraft accumulators except PC 1 surge damper, PC 3 surge damper, and PC 3 reservoir pressurization accumulator.

Emergency accumulators provide a source of stored energy to operate landing gear, emergency wheel brakes, and leading and trailing edge flaps. These accumulators and the arresting hook accumulator must be hydraulically charged before flight and cannot be recharged in flight. The other accumulators supplied by PC 2 (RAT and utility wheel brakes) are kept hydraulically charged in flight.

On aircraft [17] [27] → [202] after T.O. 1A-7D-596 and [203] →, the utility brake accumulator is separated from the braking system by a solenoid actuated shutoff valve, located in the pressure line between the accumulator and the brakes. The shutoff valve is held open by battery power and is spring loaded to the closed position. In the closed position the shutoff valve prevents bleed off of accumulator pressure during PC 2 failure. With the valve open, brake accumulator pressure is available for normal braking of up to four applications. The accumulator is continually charged with PC 2 pressure. The type of braking desired can be selected by the ANTI-SKID switch in the cockpit. The switch has three positions: ANTI-SKID, OFF, and BRAKE ACCUM. Antiskid operation is available only in ANTI-SKID position and brake accumulator pressure is available only in BRAKE ACCUM position. In the OFF position, normal braking only is available but without antiskid or utility brake accumulator capability.

WARNING

On aircraft [17] [27] → [202] after T.O. 1A-7D-596 and [203] →, if the PC 2 system fails, the ANTI-SKID switch must be placed in the BRAKE ACCUM position to obtain hydraulic pressure for brake application. Bleed off of the stored PC 2 pressure in the leak resistant utility brake accumulator system will not occur, provided the ANTI-SKID switch remains in the OFF or ANTI-SKID position. Antiskid protection is not available when the ANTI-SKID switch is placed in the BRAKE ACCUM or OFF position.

A hydraulic hand pump is located in the left wheel well for ground operation of utilities. The hand pump provides sufficient pressure to cycle one utility system at a time

PC 1 HYDRAULIC SYSTEM [17] [27] →

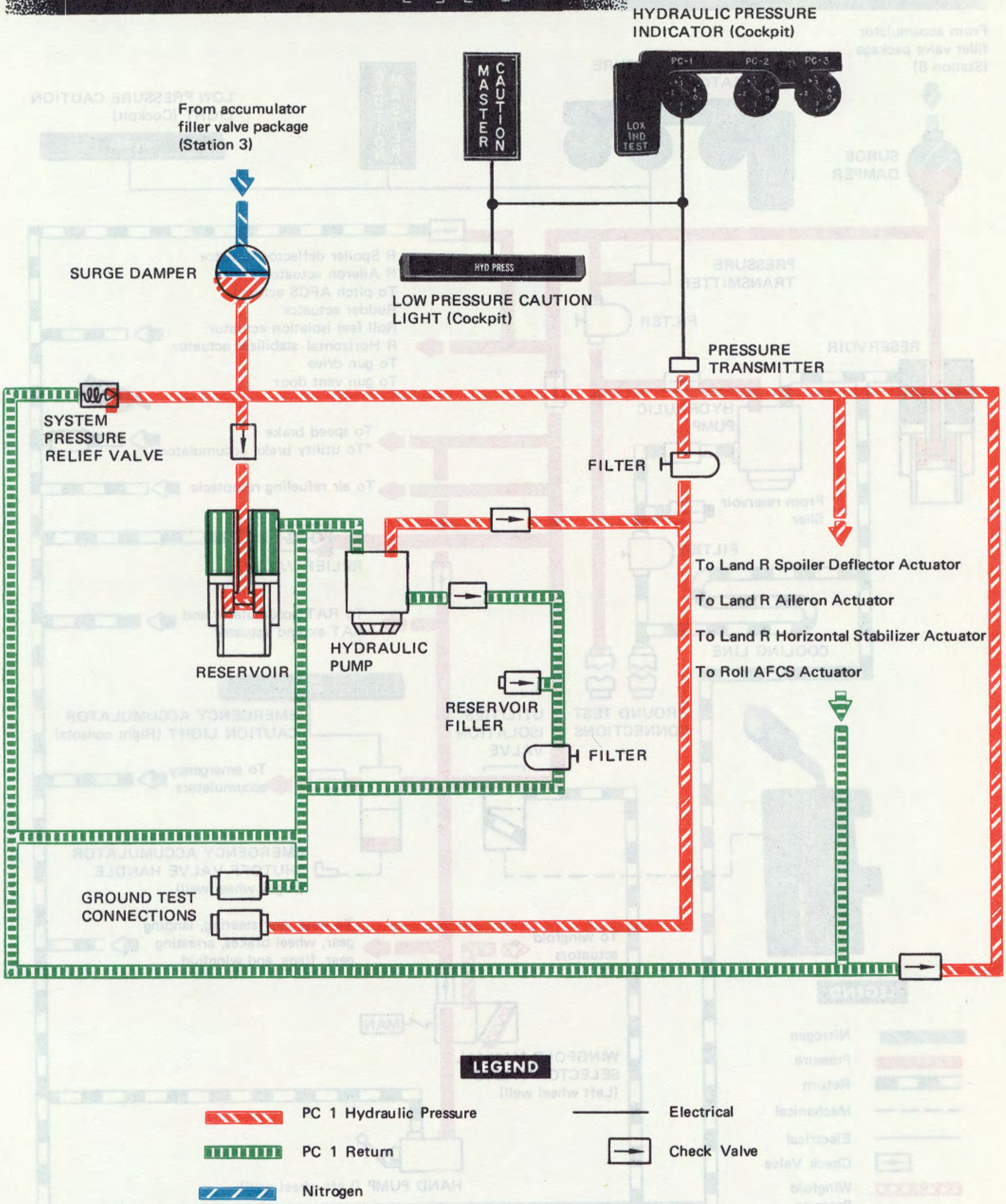
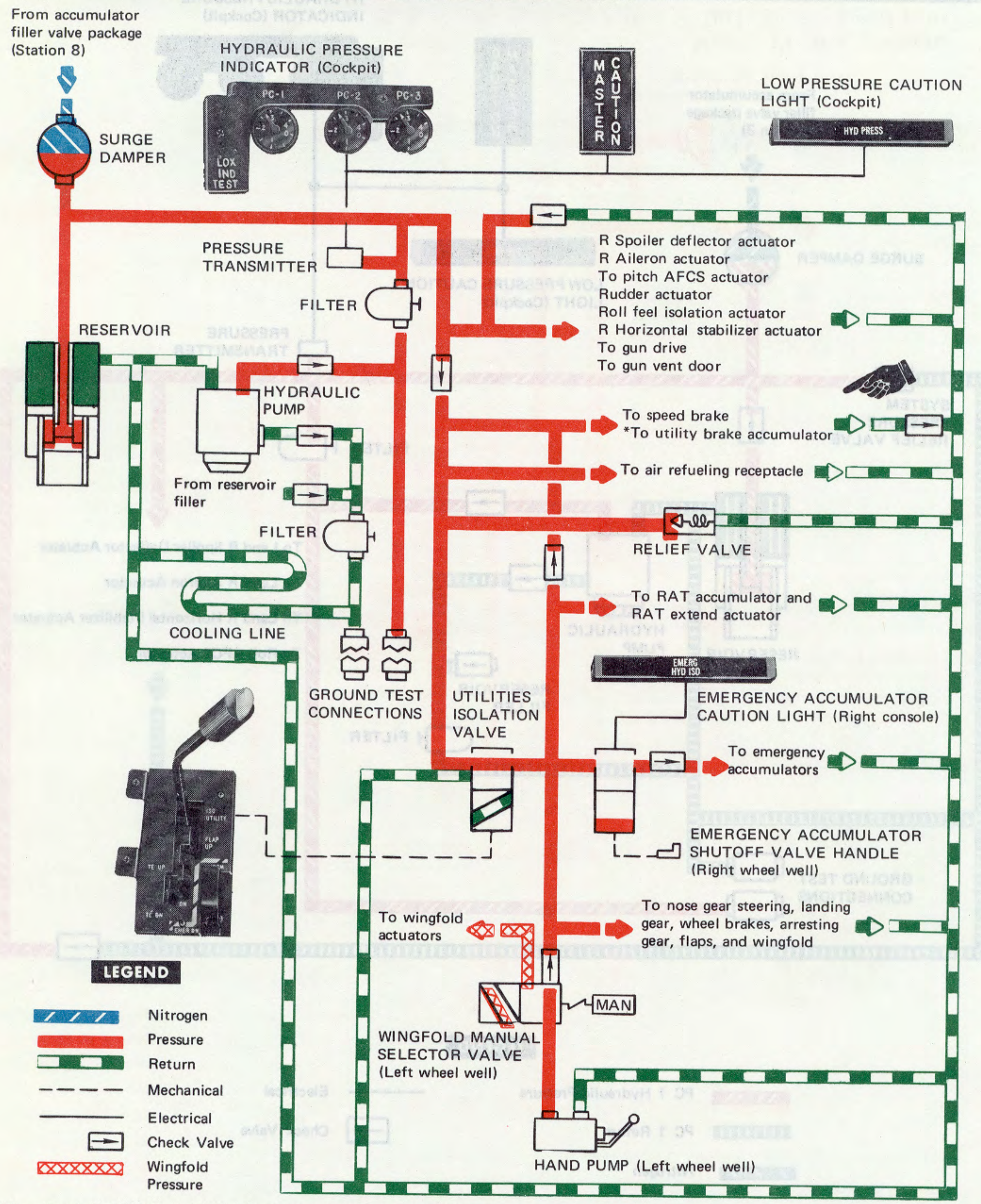


Figure 1–35

PC 2 HYDRAULIC SYSTEM [17] [27] →



*On aircraft [17] [27] → [202] after T.O. 1A-7D-596 and [203] →

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Figure 1–36

when the utilities isolation valve is open and the manual wingfold selector valve (adjacent to the hand pump) is in the forward position. With the wingfold valve in the aft position, hand pump pressure folds the outer wing panels.

POWER CONTROL (PC) NO. 3 HYDRAULIC SYSTEM.

The PC 3 system is similar to and operates the same as PC 1 and PC 2. The engine driven hydraulic pump has a rated flow of 15.6 gallons per minute and a reservoir capacity of 0.62 U.S. gallon. The PC 3 system is presented schematically in figure 1–37.

System pressure is sensed by a pressure transmitter and is indicated by the PC 3 pressure indicator on the right console.

The following are powered by the PC 3 hydraulic system:

- Roll feel isolation actuator
- Left aileron actuator
- Left spoiler-deflector actuator
- Left horizontal stabilizer actuator
- Rudder actuator
- Yaw AFCS
- Fuel boost pump

The RAT hydraulic pump supplies emergency hydraulic power to the PC 3 system.

The system incorporates a surge damper to absorb pressure surges in the system pressure line. A reservoir pressurization accumulator maintains pressure on the system return line in the event of PC 3 system pressure loss, assuring supply flow to the RAT hydraulic pump. The surge damper is precharged to 1,000 psi, the reservoir pressurization accumulator to 1,500 psi. Both are hydraulically charged from the PC 3 system pressure line.

If PC 3 system pressure is lost, a check valve retains approximately 3,000 psi in the reservoir accumulator. This pressure applied to the reservoir results in a system return pressure of approximately 90 psi. This pressure is present in the return line as long as the accumulator is charged. An accumulator dump valve, actuated by the emergency accumulator test switch in the right wheel well, is used to dump system pressure from the accumulator into the system return line.

RAM AIR TURBINE (RAT) HYDRAULIC SUPPLY.

The RAT is a backup source of hydraulic power for the PC 3 system. It also supplies emergency electrical power. The RAT is wind driven and is extended into the airstream at pilot discretion. Once extended, the RAT supplies PC 3 pressure as required. The pilot need only monitor PC 3 pressure and ensure that minimum RAT speeds are maintained. It is essential to understand that the greater the electrical load on the RAT, the higher the airspeed required to satisfy hydraulic requirements. Airspeeds required are listed in figure 1–28. A RAT schematic is presented in figure 1–29.

Extension.

The RAT can be extended by normal PC 2 pressure or by RAT accumulator pressure. RAT accumulator pressure extends the RAT if the flap handle is in the ISO UTILITY position when the EMER POWER handle is pulled. If PC 2 pressure is available, the pressure from this system extends the RAT if the flap handle is out of the ISO UTILITY position.

Note

> It is not a requirement to leave the flap handle in ISO UTILITY following RAT extension. If the RAT is extended because of hydraulic failure, then only PC 3 pressure is being supplied. The utility isolation valve, which is controlled by the flap handle, is a part of the PC 2 system.

Extend pressure unlocks internal locking fingers before the package is extended. As the RAT compartment door opens, a door actuated switch is released. The switch opens a shutoff valve, permitting RAT retract fluid to enter the PC 2 return line through the shutoff valve and the RAT selector valve. A check valve in the shutoff valve bypass line permits extension of the RAT if the valve malfunctions in the closed position.

RAT Output.

With the RAT extended, the airstream spins the RAT fan at approximately 12,000 rpm. Fan speed is maintained by a governor which varies fan pitch according to load conditions. Hydraulic fluid from the pump passes through a flow sensitive pressure regulator and into the PC 3 pressure line. The regulator determines the amount of fluid that passes into the pressure line and bypasses excessive fluid into the PC 3 return line. PC 3 return fluid flows into the RAT hydraulic pump inlet. Inlet pressure is furnished by the PC 3 surge damper. Emergency hydraulic pressure is sensed by the PC 3 pressure transmitter and is indicated on the PC 3 hydraulic pressure indicator on the right console.

The emergency generator supplies electrical power to the primary and emergency ac and dc buses with the EMER GEN switch in CRUISE. With the EMER GEN switch in T.O. LAND, power is supplied only to the emergency ac and dc buses. Figure 1–28 presents airspeeds for RAT electrical and hydraulic output requirements.

Retraction.

The RAT is retracted by raising a trigger on the EMER POWER handle and allowing the handle to return to the stowed position. This mechanically repositions the RAT selector valve, permitting remaining RAT accumulator pressure to be released through the open RAT shutoff valve to retract the package. Hydraulic pressure unlocks the internal locking fingers before the package is retracted.

PC 3 HYDRAULIC SYSTEM [17] [27] →

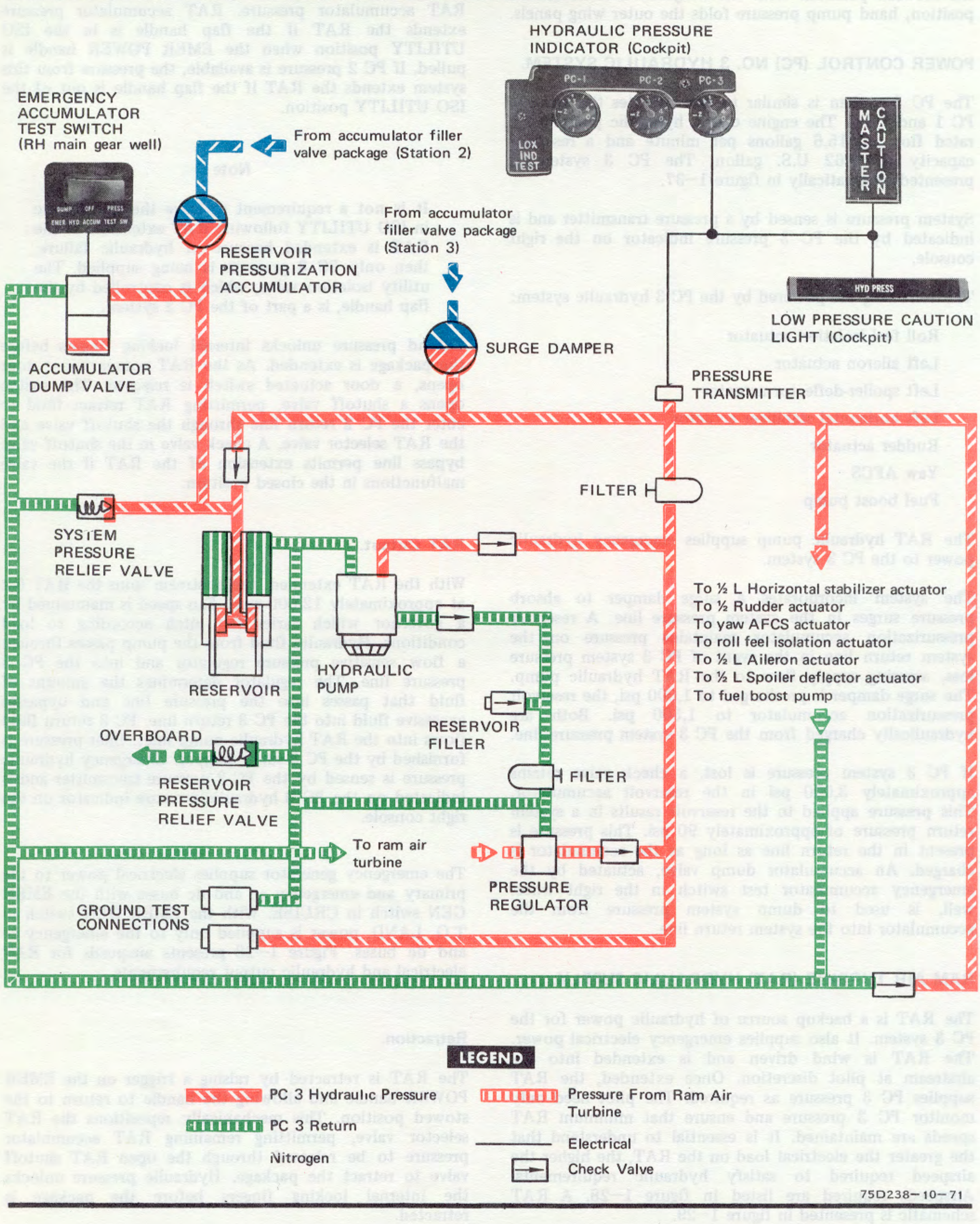


Figure 1—37

After retracting the RAT, accumulator pressure is exhausted. The accumulator is recharged by PC 2 system pressure if the flap handle is moved out of ISO UTILITY for a minimum of 3 seconds. A charged accumulator is good for one extend-retract cycle before it must be recharged in this manner.

LANDING GEAR SYSTEM.

The tricycle landing gear consists of an aft-retracting nose gear and forward-retracting main gear. Dual nose gear wheels are independently mounted on a common axle which is attached to a conventional air-oil shock strut. The nose gear is mechanically centered during retraction. Each main gear is a tripod arrangement consisting of an air-oil shock strut, a drag strut, and a tension strut. Gear doors completely enclose the retracted gear and are mechanically locked. Hydraulic power for normal operation of the landing gear is supplied by the PC 2 hydraulic system through the utilities isolation valve which is manually operated by movement of the flap handle. In an emergency, the gear can be extended once by accumulator pressure. The accumulator is precharged with nitrogen and charged to normal system operating pressure by the PC 2 hydraulic system. On aircraft → [16] [18] → [26] after T.O. 1A-7D-524, and aircraft [17] [27] →, full nose gear steering is available for ground operation when the right upper main landing gear door is open.

Cockpit indication of landing gear position is provided by three green lights on the instrument panel and a warning light in the landing gear handle. In addition, a WHEELS FLAPS warning light on the windshield frame flashes under the following conditions:

Landing gear not up and locked with the leading edge flaps up and locked.

Landing gear not down and locked with the leading edge flaps down.

The exact meaning of the WHEELS FLAPS warning light indication is determined by reference to the gear and flap position indicators.

EXTENSION – RETRACTION.

The landing gear is extended by first moving the flap handle out of ISO UTILITY and then placing the landing gear handle in WHLS DOWN. The WHEELS FLAPS warning light flashes and the gear handle light is on until the gear is down and locked. Leading edge flaps must also be down for the WHEELS FLAPS light to stop flashing. As each gear strut locks in the down position, its corresponding position indicating green light comes on.

With weight off the main gear, the landing gear is retracted by placing the landing gear handle in WHLS UP with the flap handle out of ISO UTILITY position. The green gear position lights go out as the gear leaves the down-and-locked position. The landing gear handle warning light comes on and stays on until the gear is up and locked. The WHEELS FLAPS warning light begins flashing and continues to flash until both the landing gear and leading edge flaps are retracted.

CAUTION

The pilot should wait at least 8 seconds after the landing gear indicates UP (gear handle warning light out) before placing the flap handle in ISO UTILITY. This is to allow time for the gear doors to close and lock. If ISO UTILITY is selected before 8 seconds have elapsed, the main landing gear may reextend. Extension may not always occur immediately, but can occur later in the flight as airspeed and/or normal accelerations increase.

Note

During landing gear retraction, the position indicator lights normally come on momentarily after the landing gear is up and locked when the flap handle is placed in ISO UTILITY.

Emergency gear extension is obtained with the gear handle in the WHLS DOWN position by pushing in on the landing gear handle, turning it clockwise approximately 90 degrees, and pulling it out. The handle pulls out about 2 inches, and is spring loaded to the prepulled position. Warning and indicator lights operate as for normal extension.

CAUTION

To ensure proper operation of the emergency gear lowering system, the landing gear handle should be placed in the WHLS DOWN position, pushed in, turned clockwise approximately 90 degrees and then pulled positively all the way out (approximately 2 inches). The handle shall be held out until a safe indication is obtained.

Note

Maximum airspeed for emergency extension of the landing gear is 180 KIAS. The gear cannot be retracted with the emergency or PC 2 system after emergency extension.

Emergency retraction of the landing gear with the aircraft on the ground is obtained by first pressing the emergency downlock release switch on the left side of the landing gear handle, and then moving the landing gear handle to the WHLS UP position. The downlock release switch bypasses a safety circuit which normally prevents moving the landing gear handle to WHLS UP with weight on the right main gear.

NORMAL SYSTEM OPERATION.

A schematic of the landing gear system is shown in figure 1–38.

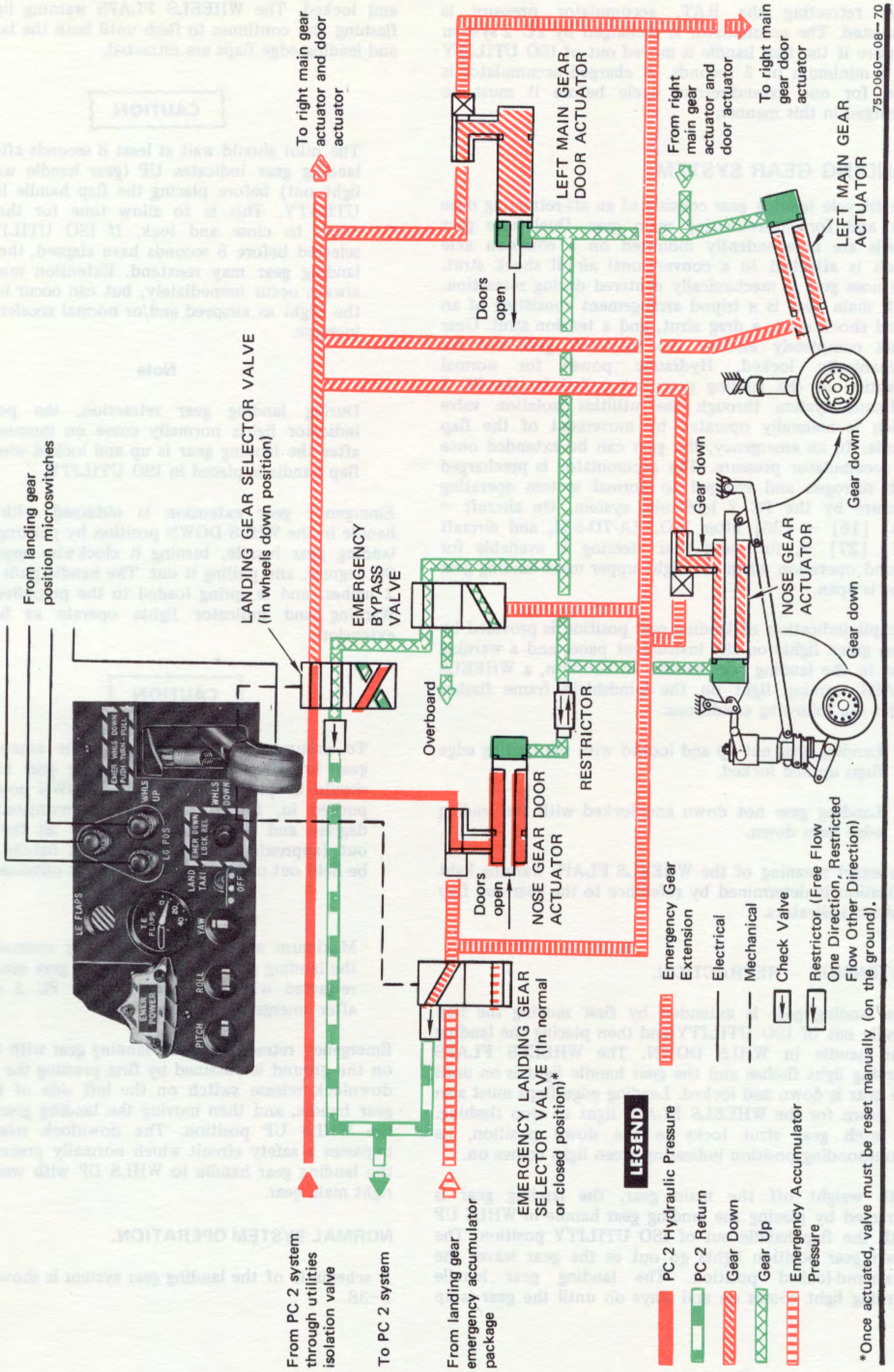

From landing gear position microswitches
LANDING GEAR SELECTOR VALVE (In wheels down position)
EMERGENCY BYPASS VALVE
To right main gear actuator and door actuator
From PC 2 system through utilities isolation valve
To PC 2 system
From landing gear emergency accumulator package
EMERGENCY LANDING GEAR SELECTOR VALVE (In normal or closed position)*
Overboard
Doors open
NOSE GEAR DOOR ACTUATOR
RESTRICTOR
Doors open
LEFT MAIN GEAR DOOR ACTUATOR
From right main gear actuator and door actuator
To right main gear door actuator
LEFT MAIN GEAR ACTUATOR
Gear down
NOSE GEAR ACTUATOR
Gear down
Gear down
LEGEND
PC 2 Hydraulic Pressure
PC 2 Return
Gear Down
Gear Up
Emergency Accumulator Pressure
Emergency Gear Extension
Electrical
Mechanical
Check Valve
Restrictor Free Flow One Direction, Restricted Flow Other Direction)
*Once actuated, valve must be reset manually (on the ground).
75D060-08-70

Figure 1–38

The gear is extended by first placing the flap handle out of ISO UTILITY, and then placing the gear handle in WHLS DOWN. Placing the flap handle out of ISO UTILITY permits PC 2 pressure to be applied to both sides of the piston in the nose gear door actuator. The doors remain closed since the piston area on the doors closed side is larger than that on the doors open side.

Placing the gear handle in WHLS DOWN permits fluid to flow from the doors closed side of the piston through a restrictor, which regulates door opening rate, into PC 2 return; and the doors open. Placing the gear handle in WHLS DOWN also applies PC 2 pressure to the nose gear actuator and to the main gear door and gear actuators. The gear doors open first, while the landing gear is restrained by mechanical uplocks. When gear doors are sufficiently open, the uplocks release the landing gear and the gear extends. Return fluid enters the PC 2 return line through an emergency bypass valve and the gear selector valve. The main gear is locked in the down position by locking fingers in the main gear actuators. The nose gear is locked down by a spring loaded mechanical downlock.

Placing the gear handle in WHLS DOWN illuminates the red warning light in the gear handle, which remains on while the gear is extending. The WHEELS FLAPS warning light on the windshield frame flashes during gear-down transit but goes out when the gear locks down, provided the leading edge flaps are down. As each gear fully extends and locks, the corresponding gear position indicator light (green) illuminates. It is normal for one landing gear position indicator light (green) to come on after the other lights are on. When all three gears are locked down, the gear handle warning light goes out.

The retract sequence is the reverse of the extend sequence. With weight off the gear and the flap handle out of ISO UTILITY, the gear is retracted by placing the gear handle in WHLS UP. PC 2 pressure is routed through the open utilities isolation valve and retract position of the gear selector valve. The landing gear retracts fully before the gear door actuators are allowed to stroke. While the gear is retracting, the WHEELS FLAPS and gear handle warning lights are displayed as during extension. As the main gear reaches the up-and-locked position, uplock switches are actuated to extinguish the gear handle warning light. If the flaps are up, the WHEELS FLAPS warning light ceases flashing when the nose gear locks in the up position. The rate at which the nose gear doors close is regulated by PC 2 pressure on the door open side of the actuator. The gear doors are not fully closed and locked until approximately 8 seconds after the gear handle warning light goes out.

EMERGENCY SYSTEM OPERATION.

Emergency gear extension is selected by pushing in on the gear handle, turning it clockwise approximately 90 degrees, and then pulling it out approximately 2 inches and holding it out until a safe indication is obtained. The handle is spring loaded to return to the prepulled position. This action mechanically places both the emergency and normal landing gear selector valves in the wheels down position. Stored hydraulic pressure from the landing gear emergency accumulator package is released through the open emergency landing gear selector valve into the emergency extend line. Emergency pressure opens shuttle valves to the nose gear actuator and to the nose and main gear door actuators. Emergency pressure also actuates a bypass valve to relieve return fluid overboard. The gear door actuators stroke together. When the nose gear doors are sufficiently open, the nose gear uplock is released and the nose gear is extended. Nose gear extension utilizes spring tension and hydraulic power. The tension spring arrangement on the nose gear drag strut aids in nose gear extension against airload if the emergency accumulator pressure is low. When the main gear doors are sufficiently open, uplocks release the gear. The main gear extends by a combination of gravity and airloads. Gear warning lights and indicators operate as described for normal system flow.

ELECTRICAL POWER.

The three landing gear position indicator lights, the gear handle warning light, and the WHEELS FLAPS warning light are powered by the emergency dc bus. The landing gear safety circuit is powered by the primary dc bus. Cycling of the landing gear itself requires no electrical power, as selector valves are mechanically positioned.

LANDING GEAR CONTROLS.

Landing gear controls and indicators are illustrated and their functions described in figure 1–39.

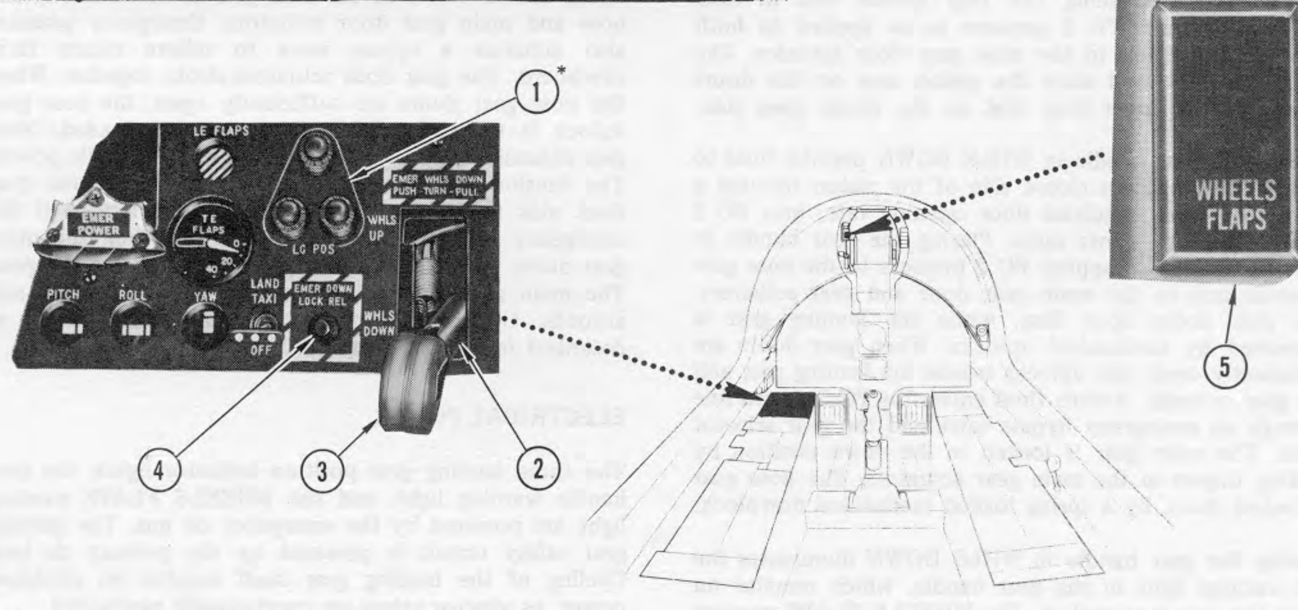
NOSE GEAR STEERING.

The nose gear steering system is electrically controlled and hydraulically actuated. Steering power is supplied by a hydraulic cylinder which is mounted on the nose gear shock strut. When the system is not energized, the steering cylinder provides automatic nose gear shimmy damping. During gear retraction, mechanical centering is provided.

ENGAGEMENT – DISENGAGEMENT.

Before engaging nose gear steering, the rudder pedals should be neutralized. On aircraft → [16] [18] → [26] before T.O. 1A-7D-524, nose gear steering is restricted to 6 degrees with the trailing edge flaps up. Trailing edge flaps must be extended 20 degrees or more to get full nose gear steering. On aircraft → [16] [18] → [26] after T.O. 1A-7D-524, and aircraft [17] [27] →, the clean condition stops cable is removed from the left trailing edge flap and connected to the right upper main landing gear door. Full nose gear steering is available at all times for ground operation. The nose gear steering button is also used for air refueling quick-disconnect. Pulling out the AR DOOR handle to receive the refueling boom engages the air refueling quick-disconnect circuit. This enables the pilot to quick-disconnect the air refueling boom by momentarily depressing the steering button. Pushing the AR DOOR handle full in disengages the air refueling quick-disconnect circuit. The steering system is engaged by momentarily pressing the steering button on the stick grip. The steering system is disengaged by

LANDING GEAR SYSTEM CONTROLS



*On aircraft → [16] [18] → [26] the landing gear lights are located on instrument panel.

Nomenclature		Function
1.	Landing gear position indicators (3 green lights)	ON – Indicates corresponding gear is down and locked. OFF – Indicates corresponding gear is not down and locked.
2.	Landing gear handle	WHLS UP or WHLS DOWN – mechanically actuates the normal landing gear selector valve to allow PC 2 hydraulic system pressure to extend or retract, and lock, the landing gear (flap handle not in ISO utility). Emergency extension – pushing the gear handle in, turning it clockwise, then pulling it out, mechanically positions the emergency landing gear selector valve, allowing hydraulic pressure from the landing gear emergency accumulator package to extend the nose gear and open the main gear doors. Main gear is extended by airloads and gravity.
3.	Landing gear handle warning light	ON – indicates position of one or more landing gear differs from the selected position, or gear in transit. OFF – indicates all gear locked in position selected by handle.
4.	EMER DOWN LOCK REL switch	Depressed – completes a ground circuit to energize a downlock solenoid which unlocks the landing gear handle. The gear handle can then be moved to retract the gear with the airplane on the ground.
5.	Wheels flaps warning light	Flashing (WHEELS FLAPS) – warns of one or more of the following discrepant conditions: Leading-edge flap down – landing gear not down and locked. Landing gear down and locked – leading-edge flap not down. Nose gear up and locked – one or more leading-edge flaps not up and locked. Leading-edge flaps up and locked – nose gear not up and locked.

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Figure 1–39

momentarily pressing the steering button a second time. If desired, the steering button can be pressed and held for steering. However, the button must be released, then momentarily pressed and released, to subsequently disengage steering. The rudder pedals are used for steering. Differential braking should be avoided when in the steering mode.

CAUTION

> On aircraft [17] [27] → [114] before T.O. 1A-7D-597, do not taxi the aircraft with the AR DOOR handle pulled out. With the handle pulled as little as 1/8 inch from full in, nose gear steering system remains in the position selected when the handle is pulled, i.e., if nose gear steering is engaged, depressing the steering button will not disengage nose gear steering. Likewise, if nose gear steering is disengaged, depressing the steering button will not engage nose gear steering. Refueling indicator lights going off is not a positive indication that the AR DOOR handle is full in. On [17] [27] → [114] after T.O. 1A-7D-597 and [115] →, nose gear steering is not affected by AR DOOR handle position.

Steering is manually disengaged by momentarily pressing the steering button. Automatic disengagement occurs any time the 60-degree steering limit is exceeded or the aircraft becomes airborne.

SYSTEM OPERATION.

Hydraulic pressure from the PC 2 system is directed to the nose gear steering system when the utilities isolation valve is out of ISO UTILITY position.

Other conditions necessary for system operation are nose gear within 60 degrees of center, aircraft weight on the main gear, and the steering button momentarily pressed. With ac power on the aircraft, electrical power is supplied through a holding circuit to open the steering selector valve which permits pressure to be applied to a steering servo control valve. Hydraulic pressure is also applied to a damper shutoff valve, positioning it for steering mode operation. With the nose gear steering system operating, the nosewheel follows rudder pedal position.

Figure 1—40 shows the servocontrol valve in full right turn position. Pressure is being directed from the servocontrol valve through the damper shutoff valve to the steering cylinder. As the steering cylinder piston moves, return fluid from the cylinder is routed through the damper shutoff and servocontrol valves to the PC 2 return line. If gear left is commanded by the rudder pedals, the servocontrol valve is displaced in the opposite direction and pressure flow is directed to the opposite side of the piston. Return flow is again directed through the damper shutoff and servocontrol valves to the return line.

When the steering switch is pressed a second time, the holding relay is deenergized and the steering selector valve closes. Pressure flow to the system is blocked, the servocontrol valve shifts to neutral, and the damper shutoff valve spring loads to the damping mode position. Both sides of the steering cylinder are hydraulically interconnected through a damping orifice that dampens gear shimmy.

If the nose gear is steered past 60 degrees, a cutout switch is actuated to revert the system to damping mode. Free nosewheel swivel is available in the damping mode. It is necessary to use differential braking and engine power to return the nose gear to an angle of less than 60 degrees. Also, the steering button must be pressed to reengage the steering system.

ELECTRICAL POWER.

Electrical power for the system is supplied by the secondary ac and dc buses and the primary ac instrument bus.

WHEEL BRAKE SYSTEM.

Each main landing gear wheel is equipped with a hydraulically actuated, self-adjusting disk type brake assembly. Each brake contains a self-adjusting mechanism that gradually moves the pressure plate outboard as wear occurs, thereby maintaining a constant brake clearance. The inner half of each main wheel contains blowout plugs that prevent tire blowout following excessive braking. These plugs melt at 392°F, releasing air from the tire. Normally, heat and pressure buildup from heavy braking reaches a peak 20 to 30 minutes after excessive braking. An antiskid system is incorporated in the normal brake system for improved braking efficiency and to prevent wheel skid. Brake pressure is normally supplied by the PC 2 hydraulic system and is metered by depression of the rudder pedal tip. Normal braking is obtained by pressing the rudder pedal tips. Braking action begins at 23 pounds of pedal tip pressure and brakes are fully applied at 80 pounds. Emergency brakes use pressure from an emergency brake accumulator and are controlled by an emergency brake handle on the left console.

The wheel braking system is schematically represented in figure 1—41.

Note

> The aircraft is not equipped with a parking brake.

NORMAL BRAKE OPERATION.

Normal braking is available with the flap handle out of the ISO UTILITY position. For the antiskid system to be operative, the flap handle must be out of the ISO UTILITY position, the ANTI-SKID switch must be in ANTI-SKID, and aircraft weight must be on main gear. The antiskid system is designed to permit touchdown with the brakes applied. Maximum performance antiskid braking is obtained by fully depressing and holding the brake pedals.

NOSE GEAR STEERING SYSTEM

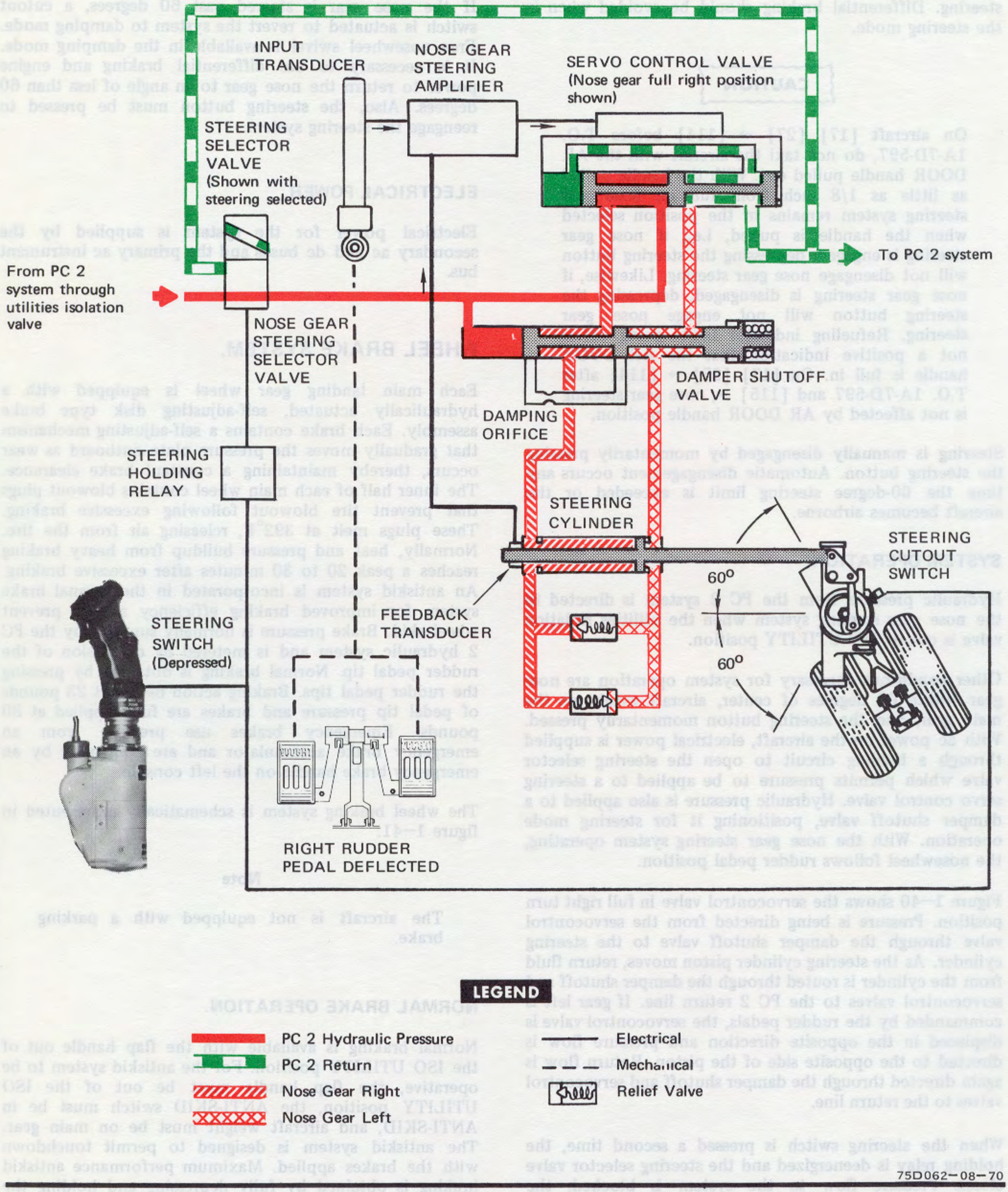


Figure 1–40

WHEEL BRAKE SYSTEM

AIRCRAFT → [202] BEFORE T.O. 1A-7D-596
OR T.O. 1A-7D-685

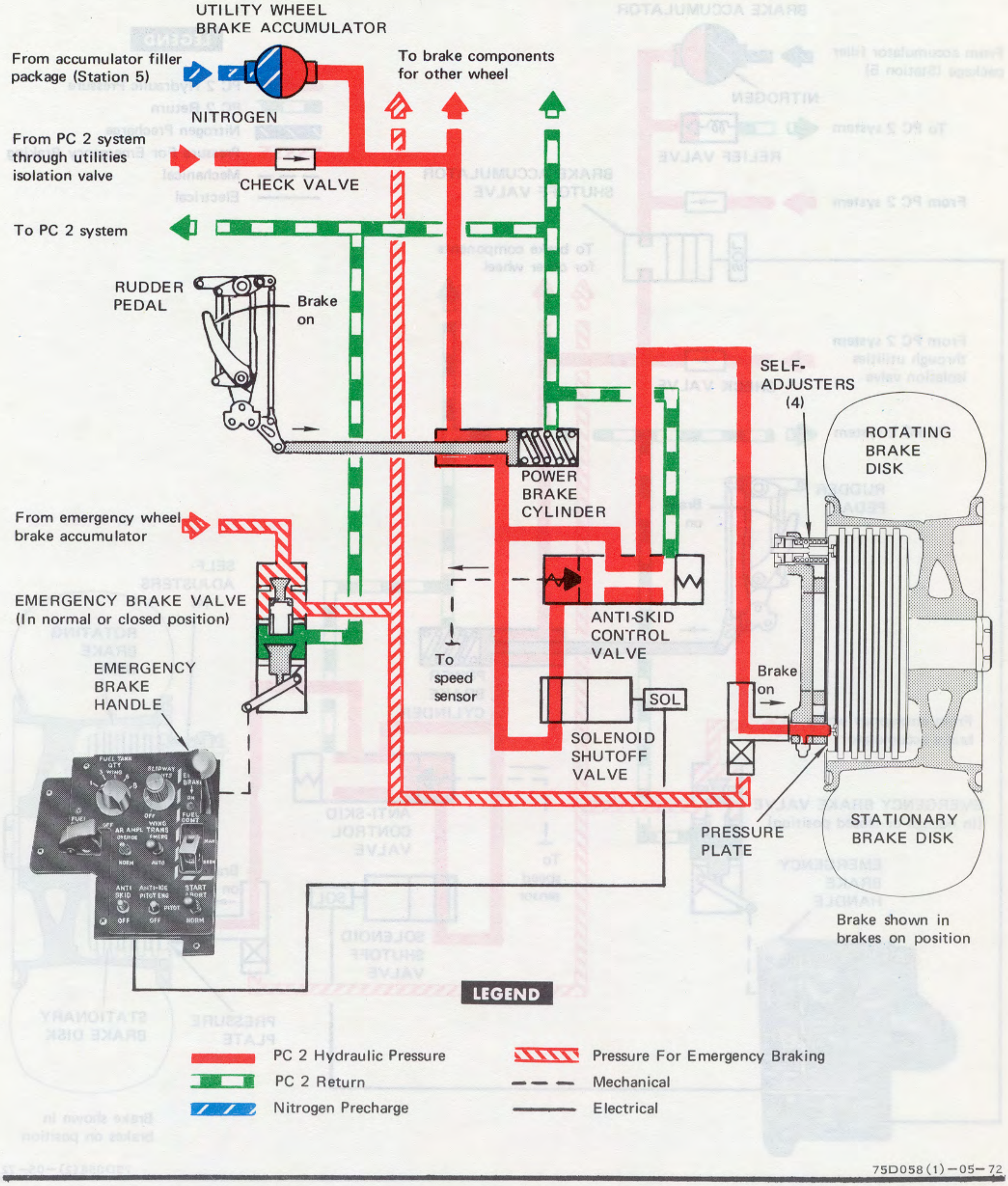


Figure 1–41 (Sheet 1)

WHEEL BRAKE SYSTEM

AIRCRAFT → [202] AFTER T.O. 1A-7D-596 OR T.O. 1A-7D-685 AND [203] →

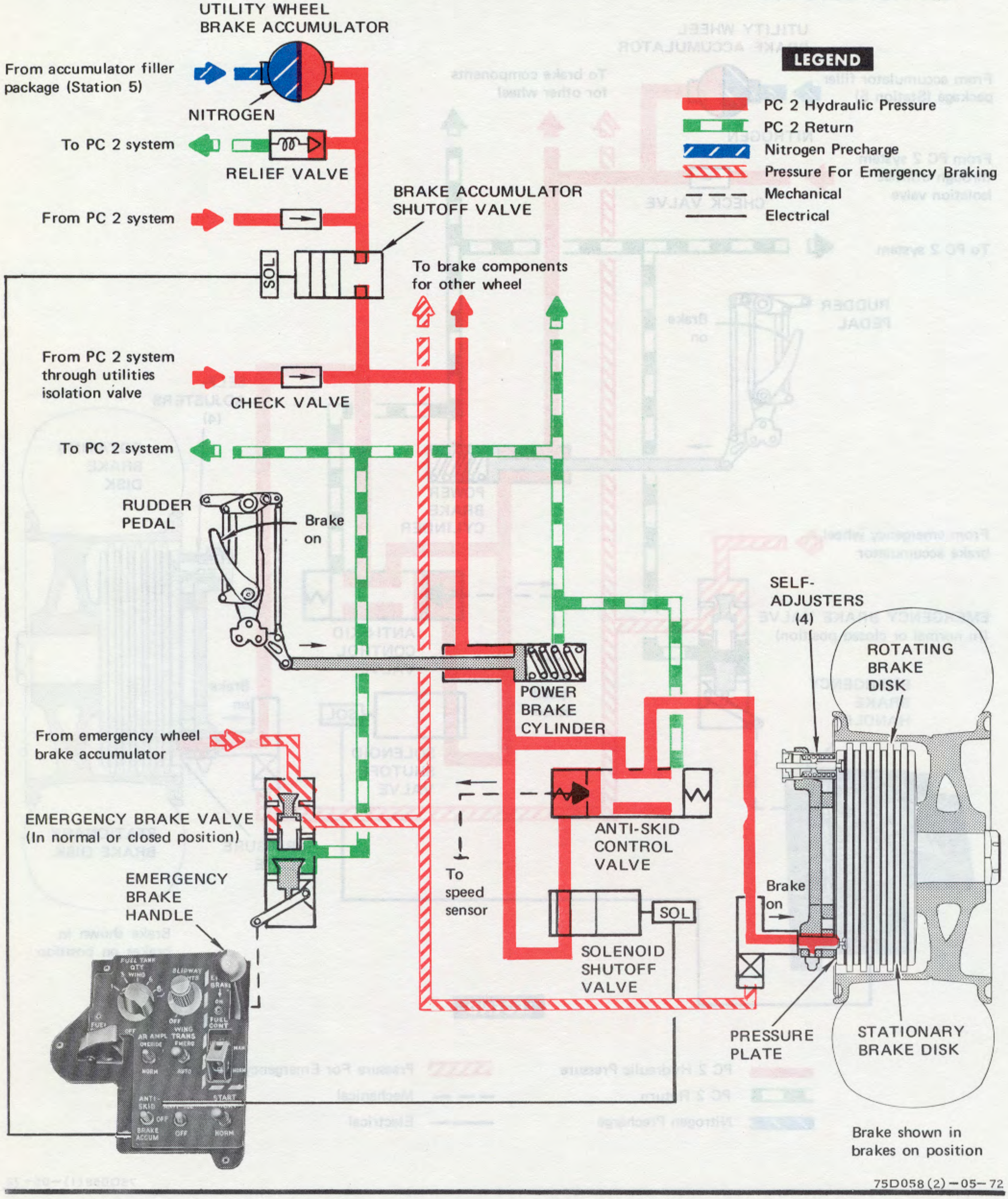


Figure 1–41 (Sheet 2)

Antiskid System Operation.

The antiskid system is normally placed in operation before takeoff and left on until after landing. The antiskid system protects against skids resulting from normal braking at speeds greater than 20 knots on increasing speed or 8 knots on decreasing speed. The brake system will operate in a normal manner proportional to pedal pressure up to the point where an impending skid is detected by a wheel speed sensor. If excessive wheel deceleration occurs, the speed sensor for that wheel sends a signal to the antiskid control box which sends a signal to the control valve and pressure is reduced to both brakes in proportion to the magnitude of the skid signal. When the skid signal no longer exists, normal braking is resumed. If either wheel speed sensor generates a locked wheel signal, pressure is momentarily released from both brakes to allow wheels to spin up and braking is again applied. Blowout of a main gear tire degrades antiskid operation. If mechanical malfunction causes wheel seizure, all braking pressure is lost until the ANTI-SKID switch is placed OFF (OFF or BRAKE ACCUM on aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →), reverting braking to normal operation without antiskid protection.

Very little braking is available above 90 knots because weight on gear is reduced by aerodynamic lift. Lack of rapid deceleration with brake application above that speed is normal and does not indicate malfunction of the antiskid system.

CAUTION

If braking action is not apparent below 90 knots during antiskid operation, the ANTI-SKID switch should be placed in OFF immediately. Release the brakes before turning the ANTI-SKID switch off to prevent skidding and possible blown tires.

Note

On a wet or icy runway, or when heavy differential braking is used, intermittent brake release by the antiskid system should be expected and indicates normal operation. During maximum performance braking, the aircraft may tend to fishtail due to wheel skids, especially on wet or icy runways; however, nose gear steering is very effective in reducing and controlling fishtailing and should be used whenever necessary to maintain aircraft directional control.

An ANTI-SKID caution light on the right console illuminates in the event of an electrical failure within the system or if the landing gear is down with the ANTI-SKID switch OFF (OFF or BRAKE ACCUM on aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →).

Control circuitry is routed through the weight-on-gear switch to prevent tire skid on touchdown due to pilot application of brakes before touchdown. Brake pedal application before wheel spinup bypasses brake pressure to return.

The antiskid system is represented schematically in figure 1–41. If electrical failure occurs in the antiskid system, antiskid must be turned off to regain normal braking. An exception is power failure to the control valve; in this case, braking automatically reverts to normal braking without antiskid.

MANUAL BRAKE OPERATION.

Braking without antiskid is obtained by pressing the tip of the desired rudder pedal or pedals. When a rudder pedal tip is pressed, it repositions a brake valve in proportion to tip deflection. PC 2 pressure is applied through the open valve and into wheel brake cylinders. The pressure moves a piston and puck in each cylinder against a pressure plate. This causes the brake linings of stationary brake disks to be forced against the surfaces of disks which are rotating with the wheel. The resulting friction supplies the braking force. Without antiskid, braking is proporational to brake pedal force applied, up to and including tire skid. When the rudder pedal is released, the brake valve is forced back by a spring to relieve pressure from the brake cylinders, allowing the pressure to be ported into the PC 2 return line.

ACCUMULATOR BRAKE OPERATION.

Backup braking in the event of PC 2 failure is provided by two accumulators, a utility and an emergency accumulator. The utility accumulator provides differential braking and up to four brake applications. (One brake application is defined as a full application and release of the brakes.) On aircraft → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685, utility brake accumulator pressure is available provided the ANTI-SKID switch is in the OFF position and brake applications are made soon after PC 2 failure. On aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 [203] →, utility brake accumulator pressure is available provided the ANTI-SKID switch is in the BRAKE ACCUM position. There is no time limit for accumulator bleed off as long as the ANTI-SKID switch remains in ANTI-SKID or OFF position. The utility accumulator is operated by the rudder pedal tips. Once the utility accumulator is depleted, the emergency accumulator can be selected by pulling aft on the EMERG BRAKE handle on the left console.

WARNING

On aircraft → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685, if the PC 2 system fails, turn off the antiskid system before using wheel brakes. If the ANTI-SKID switch is left on and brakes are applied, all utility brake accumulator pressure will bypass through the antiskid control valve in less than 20 seconds. Leakage occurs even if brakes are applied moderately enough to prevent antiskid system cycling. Even with the antiskid system off, the utility brake accumulator cannot be relied on 45 minutes after the flap handle is placed in ISO UTILITY. Power brake cylinder leakage may deplete the accumulator in this time span.

On aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →, if the PC 2 system fails, hydraulic pressure trapped in the utility brake accumulator system is available for backup braking only with the ANTI-SKID switch in the BRAKE ACCUM position. Antiskid protection is bypassed and will not be available. This system prevents bleed off leakage and bypass pressure loss, provided the ANTI-SKID switch remains in the OFF or ANTI-SKID position.

Note

Brakes should be used sparingly following PC 2 failure. Although two accumulators back up the normal wheel braking system, only one of these accumulators, the utility wheel brake accumulator, provides differential braking. Differential braking is not available when depletion of the utility accumulator requires reversion to the emergency braking system.

EMERGENCY BRAKE OPERATION.

Emergency braking is initiated by aft movement of the EMERG BRAKE handle to mechanically actuate the emergency brake valve. This applies emergency brake accumulator pressure to a shuttle valve on each brake, shuttling the valves to the emergency position and permitting pressure to be applied to the brakes. Release of the EMERG BRAKE handle allows the emergency brake valve to return to the off position, routing braking pressure to return and releasing the brakes. Braking is proportional to brake handle movement. However, application is extremely sensitive in the effective braking range. Differential braking is not provided by the emergency braking system.

CAUTION

Emergency brake application is extremely sensitive to handle movement in the effective braking range. Use of handle during landing roll may immediately lock the wheels.

The brakes can be applied approximately five times with pressure stored in a fully charged emergency brake accumulator. Since the antiskid system is not operative during emergency brake operation, ANTI-SKID switch position does not affect the number of applications possible. One brake application is defined as a full application and release of the brakes. During an application, a given quantity of fluid is exhausted from the accumulator to return.

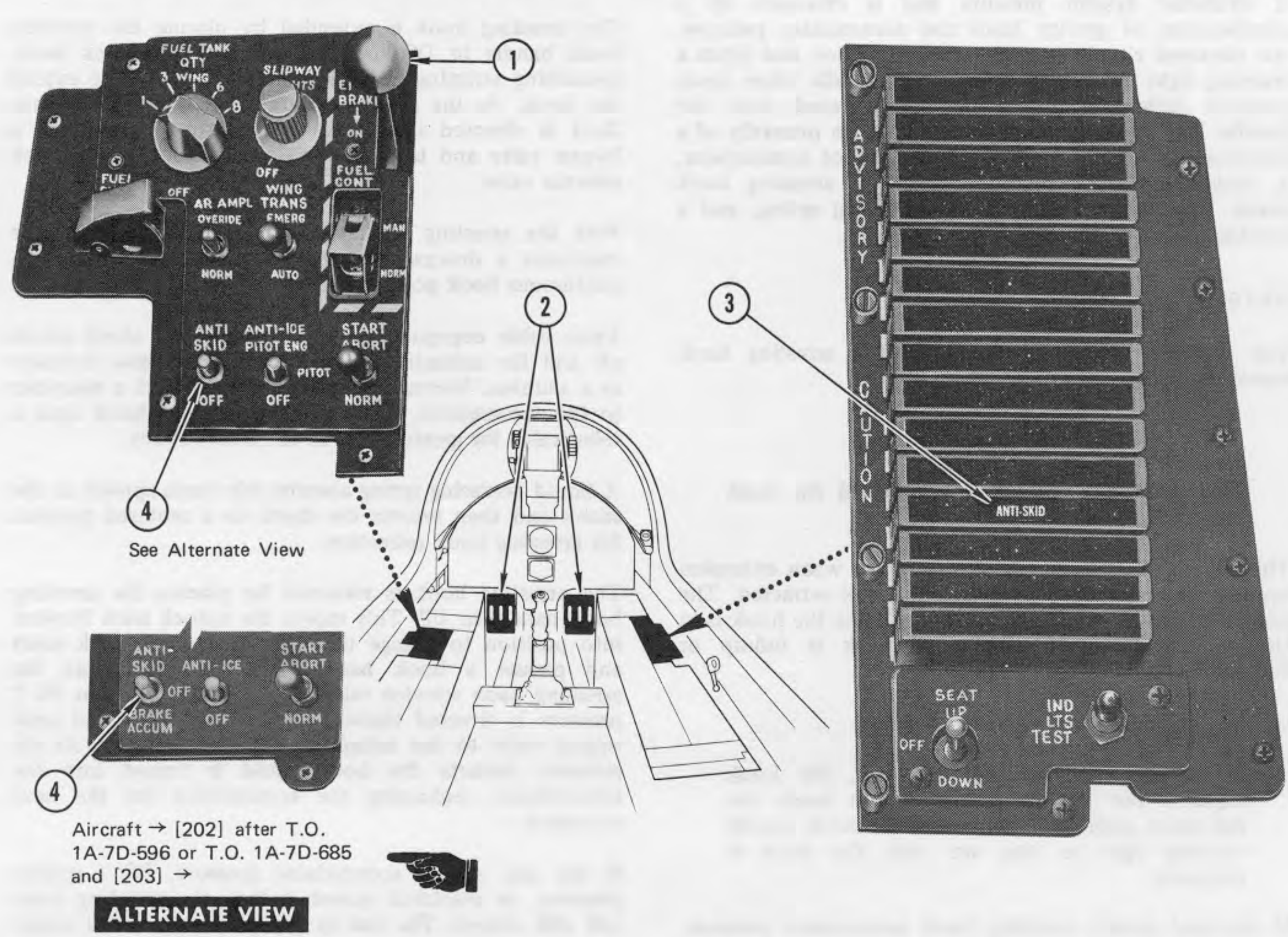
ELECTRICAL POWER.

The antiskid system is supplied by the secondary dc bus. The ANTI-SKID caution light is supplied by the emergency dc bus.

WHEEL BRAKE SYSTEM CONTROLS.

Wheel brake controls are illustrated and described in figure 1–42.

WHEEL BRAKE CONTROLS



Nomenclature	Function
1. EMERG BRAKE handle	Moving handle aft opens an emergency brake valve, applying equal pressure from the emergency brake accumulator to the two wheel brakes. Stopping power is proportional to the amount the handle is moved aft.
2. Rudder pedals	Depressing tips directs PC 2 or utility wheel brake accumulator hydraulic pressure to wheel brake cylinders to obtain stopping power in proportion to amount of force applied.
3. Antiskid caution light	On – (ANTI-SKID) – indicates electrical malfunction in the antiskid system, or the ANTI-SKID switch is in OFF (OFF or BRAKE ACCUM aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →) (landing gear down).
4. ANTI-SKID switch	ANTI-SKID – activates antiskid system by routing braking pressure to the antiskid control valve. OFF – reverts braking to manual by removing braking pressure from the antiskid control valve. BRAKE ACCUM (aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →) – opens utility brake accumulator valve to provide back-up accumulator braking.

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Figure 1–42

ARRESTING HOOK SYSTEM.

The arresting hook is retracted hydraulically, utilizing PC 2 hydraulic system pressure and is extended by a combination of gravity loads and accumulator pressure. An electrical circuit controls hook retraction and lights a warning light in the arresting hook handle when hook position differs from the position selected with the handle. The arresting hook system consists primarily of a combination actuating cylinder and dashpot accumulator, a cockpit-controlled selector valve, an arresting hook shank and hook point, a liquid centering spring, and a mechanical uplock and bumper mechanism.

EXTENSION – RETRACTION.

The arresting hook extends when the arresting hook handle is placed in DOWN.

Note

> Three to four seconds are required for hook extension.

The HOOK DN caution light comes on when extension begins and remains on until the hook is retracted. The hook handle warning light comes on while the hook is in transit and goes off when the hook is full-up or full-down.

Note

> During the preflight hook check, the hook contacts the runway before it can reach the full-down position. This causes the hook handle warning light to stay on until the hook is retracted.

If electrical power, arresting hook accumulator pressure, or PC 2 system pressure is not available, the hook will free-fall when the handle is placed DOWN.

With the flap handle out of ISO UTILITY, the arresting hook is retracted by placing the arresting hook handle in UP. Approximately 2 seconds are required for retraction. When the hook locks up, the HOOK DN caution light and the arresting hook handle warning lights go out. The hook cannot be retracted if PC 2 system pressure or electrical power is lost.

SYSTEM OPERATION.

The arresting hook system is illustrated in figure 1–43.

The arresting hook is extended by placing the arresting hook handle in DOWN. This releases an uplock latch, permitting arresting hook accumulator pressure to extend the hook. As the arresting hook actuator strokes, return fluid is directed into the PC 2 return line through a bypass valve and through the deenergized arresting hook selector valve.

With the arresting hook extended, accumulator pressure maintains a downward force on the hook to maintain continuous hook point contact.

Upon cable engagement, the arresting hook shank pivots aft and the actuating cylinder and accumulator function as a snubber. Normal damping flow is through a restrictor to the accumulator. Abrupt loadings to the hook open a relief valve for greater flow to the accumulator.

A liquid centering spring absorbs side loads applied to the shank and then returns the shank to a centered position for arresting hook retraction.

The arresting hook is retracted by placing the arresting hook handle in UP. This moves the uplock latch forward into position to engage the arresting hook uplock roller and presses a hook handle switch to reposition the arresting hook selector valve to the retract position. PC 2 pressure is directed through the selector valve and open bypass valve to the retract side of the actuator. As the actuator retracts the hook, fluid is forced into the accumulator, recharging the accumulator for the next extension.

If for any reason accumulator pressure, PC 2 system pressure, or electrical power is lost, the arresting hook will still extend. The loss in accumulator pressure causes the pressure-sensing bypass valve to reposition when the arresting hook handle is placed in DOWN. Fluid from the retract side of the actuator passes through the bypass valve and overboard.

A circuit is completed through the arresting hook up-and-locked switch, down switch, and hook handle switch, which causes the arresting hook warning light in the handle to come on any time arresting hook position differs from the selected position.

ARRESTING HOOK SYSTEM

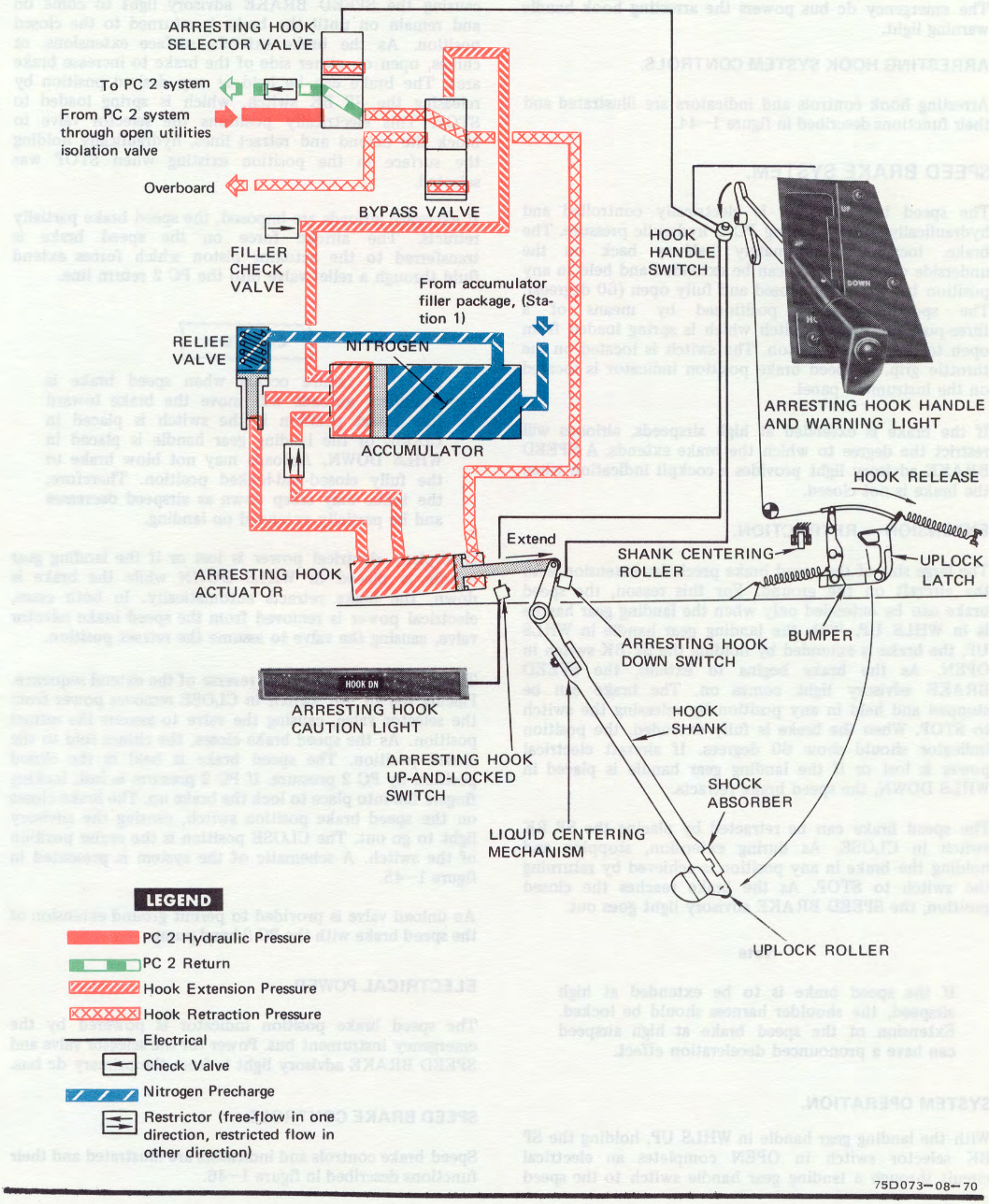


Figure 1-43

ELECTRICAL POWER.

Power for the arresting hook selector valve and the hook down caution light is supplied by the secondary dc bus. The emergency dc bus powers the arresting hook handle warning light.

ARRESTING HOOK SYSTEM CONTROLS.

Arresting hook controls and indicators are illustrated and their functions described in figure 1–44.

SPEED BRAKE SYSTEM.

The speed brake system is electrically controlled and hydraulically actuated using PC 2 hydraulic pressure. The brake, located approximately halfway back on the underside of the aircraft, can be extended and held in any position between fully closed and fully open (60 degrees). The speed brake is positioned by means of a three-position SP BK switch which is spring loaded from open to the STOP position. The switch is located on the throttle grip. A speed brake position indicator is located on the instrument panel.

If the brake is extended at high airspeeds, airloads will restrict the degree to which the brake extends. A SPEED BRAKE advisory light provides a cockpit indication when the brake is not closed.

EXTENSION – RETRACTION.

The large size of the speed brake precludes extension with the aircraft on the ground. For this reason, the speed brake can be extended only when the landing gear handle is in WHLS UP. With the landing gear handle in WHLS UP, the brake is extended by holding the SP BK switch in OPEN. As the brake begins to extend, the SPEED BRAKE advisory light comes on. The brake can be stopped and held in any position by releasing the switch to STOP. When the brake is fully extended, the position indicator should show 60 degrees. If aircraft electrical power is lost or if the landing gear handle is placed in WHLS DOWN, the speed brake retracts.

The speed brake can be retracted by placing the SP BK switch in CLOSE. As during extension, stopping and holding the brake in any position is achieved by returning the switch to STOP. As the brake reaches the closed position, the SPEED BRAKE advisory light goes out.

Note

If the speed brake is to be extended at high airspeed, the shoulder harness should be locked. Extension of the speed brake at high airspeed can have a pronounced deceleration effect.

SYSTEM OPERATION.

With the landing gear handle in WHLS UP, holding the SP BK selector switch in OPEN completes an electrical circuit through a landing gear handle switch to the speed brake selector valve. The selector valve moves to the speed brake open position routing PC 2 pressure to the speed brake actuator to extend the speed brake. As the brake extends, it breaks contact with a position switch, causing the SPEED BRAKE advisory light to come on and remain on until the brake is returned to the closed position. As the brake extends, surface extensions, or chines, open on either side of the brake to increase brake area. The brake can be held at any desired position by releasing the SP BK switch, which is spring loaded to STOP. This electrically positions the selector valve to block the extend and retract lines, hydraulically holding the surface in the position existing when STOP was selected.

If excessive airloads are imposed, the speed brake partially retracts. The airload force on the speed brake is transferred to the actuator piston which forces extend fluid through a relief valve into the PC 2 return line.

CAUTION

If PC 2 failure occurs when speed brake is extended, airloads will move the brake toward the retract position if the switch is placed in CLOSE or the landing gear handle is placed in WHLS DOWN. Airloads may not blow brake to the fully closed-and-locked position. Therefore, the brake may creep down as airspeed decreases and be partially extended on landing.

If airplane electrical power is lost or if the landing gear handle is placed in WHLS DOWN while the brake is down, the brake retracts automatically. In both cases, electrical power is removed from the speed brake selector valve, causing the valve to assume the retract position.

The retract sequence is the reverse of the extend sequence. Placing the SP BK switch in CLOSE removes power from the selector valve, causing the valve to assume the retract position. As the speed brake closes, the chines fold to the closed position. The speed brake is held in the closed position by PC 2 pressure. If PC 2 pressure is lost, locking fingers fall into place to lock the brake up. The brake closes on the speed brake position switch, causing the advisory light to go out. The CLOSE position is the cruise position of the switch. A schematic of the system is presented in figure 1–45.

An unload valve is provided to permit ground extension of the speed brake with the PC 2 hand pump.

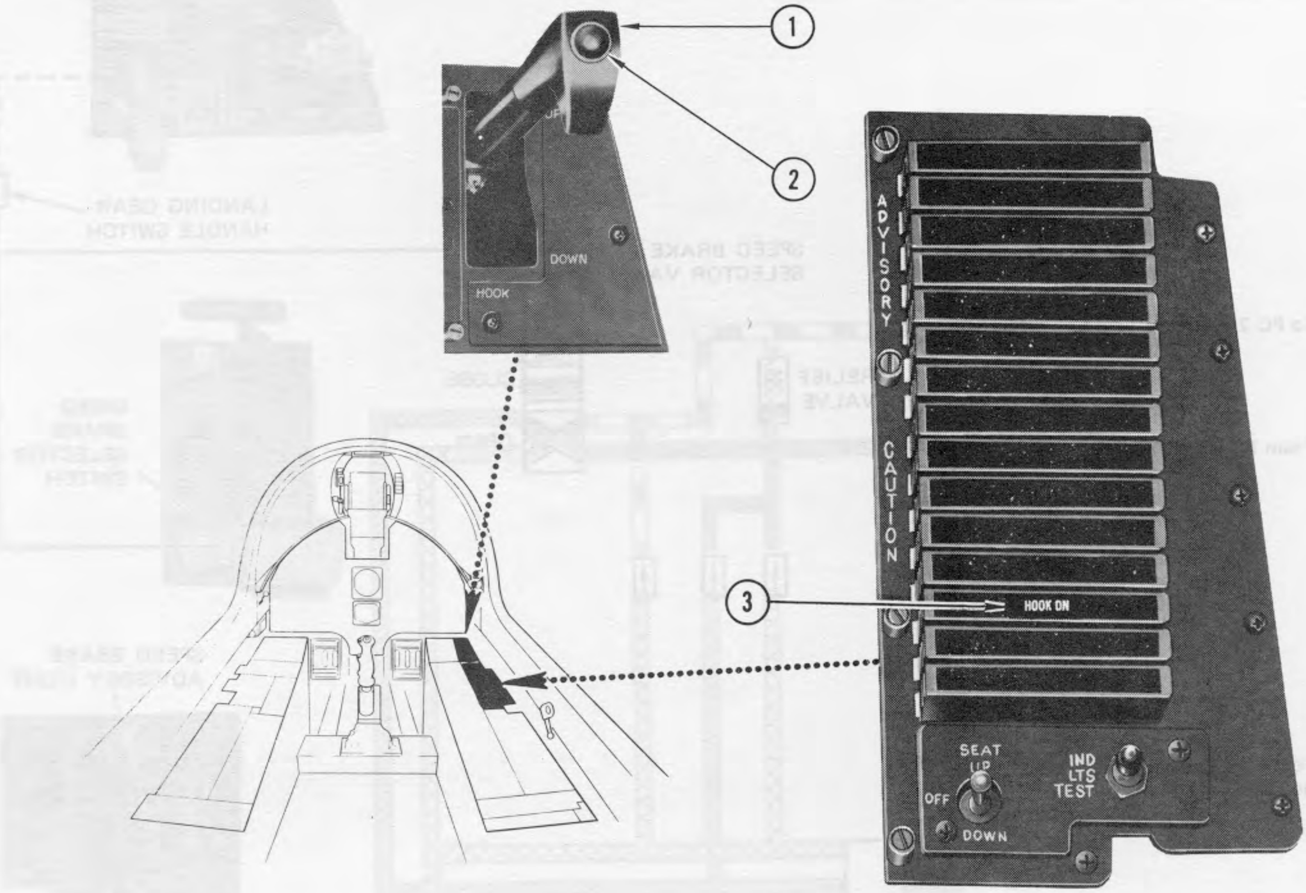
ELECTRICAL POWER.

The speed brake position indicator is powered by the emergency instrument bus. Power for the selector valve and SPEED BRAKE advisory light is from the primary dc bus.

SPEED BRAKE CONTROLS.

Speed brake controls and indicators are illustrated and their functions described in figure 1–46.

ARRESTING HOOK SYSTEM CONTROLS



Nomenclature	Function
1. Arresting hook handle	UP – electrically positions arresting hook selector valve to allow PC 2 hydraulic system pressure to retract the arresting hook and recharge the arresting hook accumulator with fluid. Hook mechanically locked in up position upon completion of retraction cycle. DOWN – mechanically releases uplock latch and deenergizes the arresting hook selector valve so that accumulator pressure extends the arresting hook. If accumulator pressure is lost, arresting hook will gravity-drop into position.
2. Arresting hook handle warning light (in arresting gear handle)	On – indicates arresting hook position differs from selected position.
3. Arresting hook caution light	ON – (HOOK DN) indicates arresting hook is extended.

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Figure 1–44

SPEED BRAKE SYSTEM

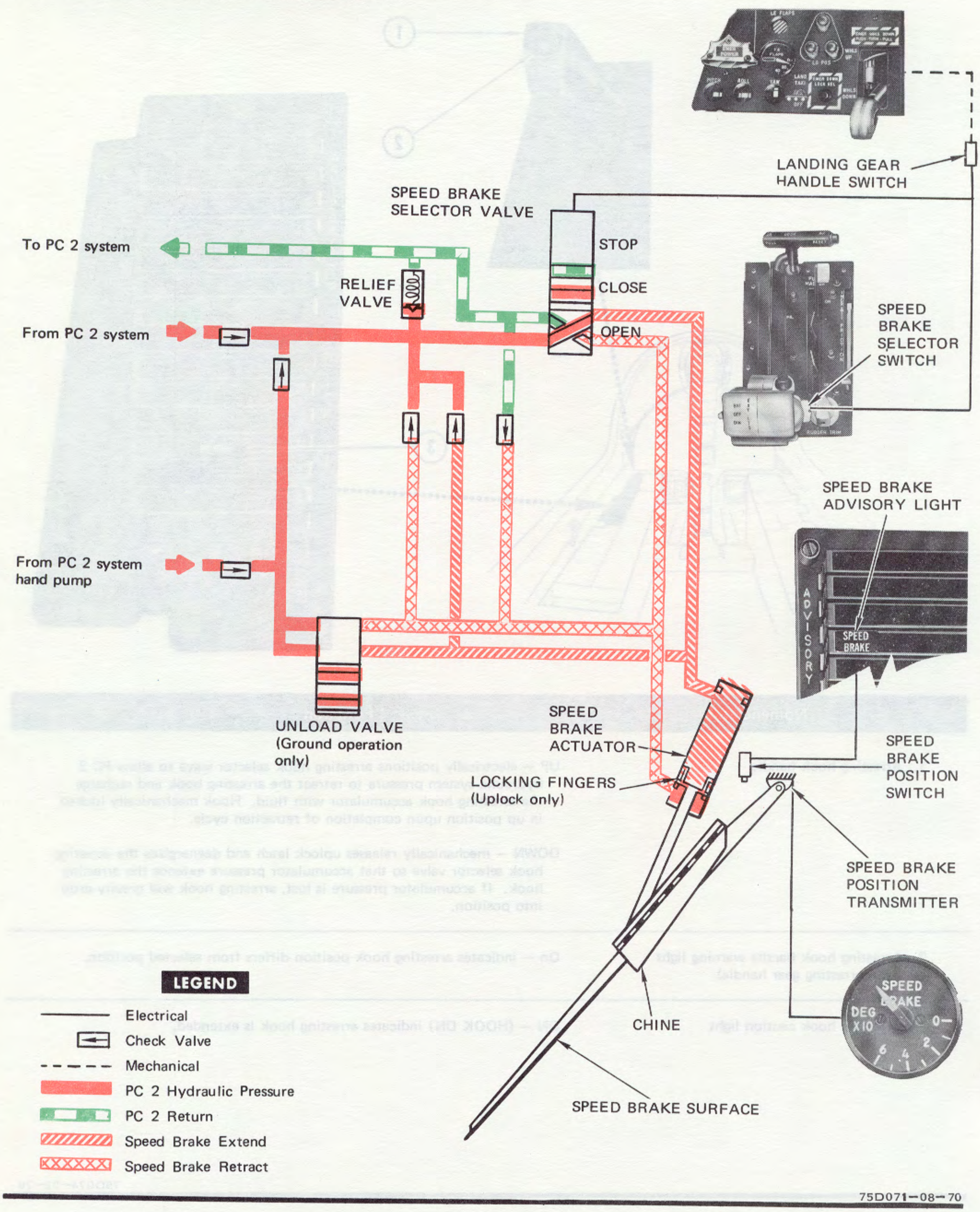
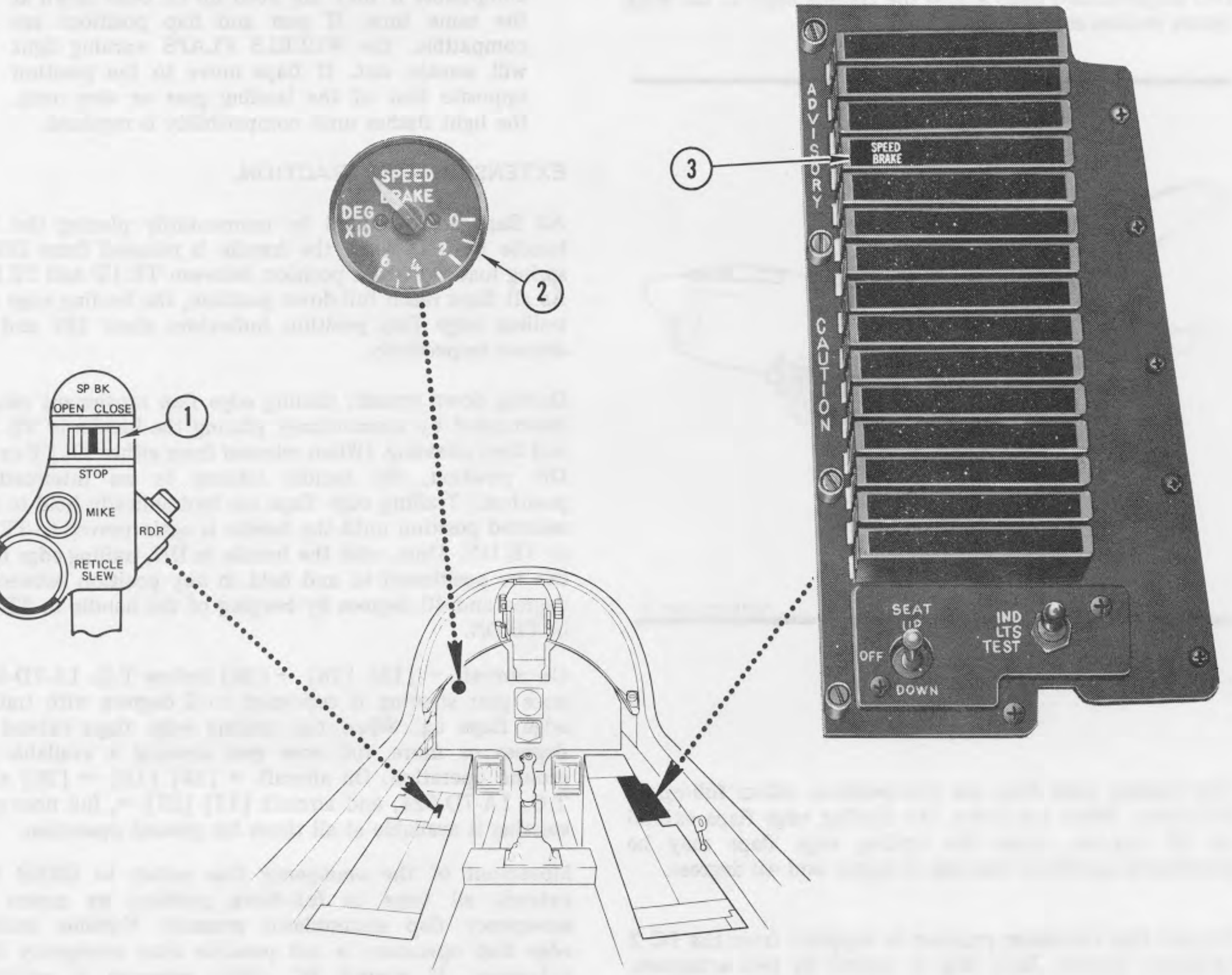


Figure 1–45

SPEED BRAKE CONTROLS



Nomenclature	Function
1. SP BK switch	OPEN – holding switch in this position, with the landing gear handle in WHLS UP, electrically positions the speed brake selector valve to direct PC 2 hydraulic pressure to unlock the speed brake and move the brake toward the open position. Released, switch returns to STOP position. STOP – in this position, with the landing gear handle in WHLS UP, electrically positions the speed brake selector valve to hydraulically hold the brake in the position existing when STOP was selected. CLOSE – placing switch in this position, with the landing gear handle in WHLS UP, electrically positions the speed brake selector valve to direct PC 2 hydraulic pressure to close the speed brake.
2. Speed brake position indicator	Speed brake position in degrees from closed (0^{o}) to fully open (60^{o}).
3. SPEED BRAKE advisory light	On (SPEED BRAKE) – indicates speed brake is not closed.

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Figure 1–46

FLAP SYSTEM.

Four flaps are installed across the wing leading edge and two single-slotted flaps across the trailing edge of the wing center section as shown in figure 1–47.

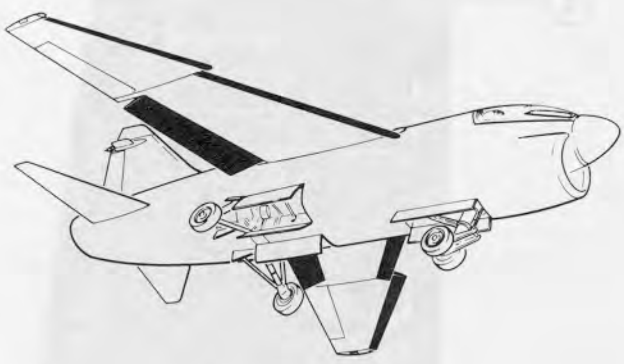


Figure 1–47

The leading edge flaps are two-position, either full-up or full-down. When full-down, the leading edge flaps extend to 35 degrees, while the trailing edge flaps may be positioned anywhere between 0 degree and 40 degrees.

Normal flap operating pressure is supplied from the PC 2 hydraulic system. Each flap is moved by two actuators. The actuators contain internal locks which lock when the flaps are full-up or full-down. Operation is controlled with the flap handle on the left console.

The flaps can also be extended with pressure from an emergency accumulator. Emergency extension is controlled by an emergency flap switch on the left console.

Cockpit indication of flap position is provided by two indicators on the main instrument panel, one showing position of the leading edge flaps and one showing position of the trailing edge flaps. A WHEELS FLAPS warning light on the left windshield frame flashes when flap position and gear position are not compatible.

Note

Landing gear position and flap position are compatible if they are both up or both down at the same time. If gear and flap positions are compatible, the WHEELS FLAPS warning light will remain out. If flaps move to the position opposite that of the landing gear or vice versa, the light flashes until compatibility is regained.

EXTENSION – RETRACTION.

All flaps are extended by momentarily placing the flap handle in DN. When the handle is released from DN, it spring loads left to a position between TE UP and TE DN. As all flaps reach full-down position, the leading edge and trailing edge flap position indicators show DN and 40 degrees respectively.

During down transit, trailing edge flap movement can be interrupted by momentarily placing the handle in TE UP, and then releasing. (When released from either TE UP or TE DN position, the handle returns to an intermediate position.) Trailing edge flaps are hydraulically held in any selected position until the handle is again moved to TE UP or TE DN. Thus, with the handle in DN, trailing edge flaps can be positioned to and held in any position between 0 degree and 40 degrees by beeping of the handle to TE UP or TE DN.

On aircraft → [16] [18] → [26] before T.O. 1A-7D-524, nose gear steering is restricted to 6 degrees with trailing edge flaps up. When the trailing edge flaps extend 20 degrees or more, full nose gear steering is available for ground operation. On aircraft → [16] [18] → [26] after T.O. 1A-7D-524, and aircraft [17] [27] →, full nose gear steering is available at all times for ground operation.

Movement of the emergency flap switch to EMER DN extends all flaps to full-down position by means of emergency flap accumulator pressure. Variable trailing edge flap operation is not possible after emergency flap extension. If normal PC utility pressure is available following emergency flap extension, normal flap retraction can be accomplished by returning the emergency flap switch to NORM. To prevent shuttle valve chatter when returning to normal PC 2 pressure, the flap handle should be moved from ISO UTILITY to DN for 10 seconds and then moved to FLAP UP.

Note

The emergency flap accumulator contains sufficient pressure for only one extension of the flaps.

Emergency flap extension can be initiated at any speed up to the emergency flap extension maximum airspeed. However, full extension of the flaps probably will not be achieved until aircraft speed decreases to about 160 KIAS.

Placing the handle in UP causes all flaps to retract regardless of trailing edge flap position at the time. As all flaps reach the full up-and-locked position, the leading edge and trailing edge flap indicators should show UP and 0 degree, respectively. Variable trailing edge flap operation is not possible with the flap handle in UP.

The WHEELS FLAPS warning light flashes during flap transit but goes out on completion of transit, provided the landing gear is in the correct position with respect to the flaps. Since the light senses only leading edge flap position, retraction of trailing edge flaps when the landing gear is down will not cause the light to flash.

The leading edge flap position indicator will show barberpole during flap transit, when a leading edge flap position switch fails or when electrical power is off the aircraft.

CAUTION

When moving the flap handle in either direction between FLAP UP and ISO UTILITY positions, extreme care should be used to ensure that the handle is not inadvertently moved into the slot between FLAP UP and DN. Inadvertent aft movement into the intermediate slot may cause the leading and/or trailing edge flaps to extend. If the flaps are extended inadvertently, slow the aircraft immediately to flap retraction airspeed before attempting to retract the flaps. Flap retraction above the retraction airspeed will cause damage to the wing leading edge. If feasible, do not retract leading edge flaps except in those circumstances that would preclude a safe landing.

NORMAL SYSTEM OPERATION.

The flap system is illustrated in figure 1–48.

Placing the flap handle in DOWN opens the ISO UTILITY valve, mechanically positions the leading edge flap selector valve to the down position, and energizes the down solenoid of the trailing edge flap selector valve. PC 2 pressure is directed to the 12 flap actuators. (There are two actuators per flap surface.) Return fluid enters the PC 2 return line through an emergency bypass valve and the flap selector valve. As the flaps reach the full-down position, mechanical locking fingers inside the actuators lock the flaps down. As the flaps become extended, flap position switches are actuated. When the leading edge flap position switch is actuated, the leading edge flap position indicator on the instrument panel indicates DN. The leading edge flap indicator indicates a barberpole when the leading edge flaps are in transit, when the leading edge flap position switch fails, or when electrical power is off the aircraft. The trailing edge flap position indicator indicates 40 degrees when trailing edge flaps are full-down.

Note

When operating on RAT electrical power, the EMER GEN switch must be in the CRUISE position for normal extension of the trailing edge flaps.

If an intermediate trailing edge flap position is desired, the flap handle is momentarily moved to the (TE UP) position. This stops trailing edge flap extension. The flap handle is spring loaded to the neutral position in the flaps down detent. Holding the flap handle forward (TE UP) energizes the up solenoid of the trailing edge flap selector valve and the trailing edge flaps move toward the up position. Holding the handle aft (TE DN) energizes the down solenoid of the selector valve, and the trailing edge flaps move toward the down position.

Lock valves trap pressure in flap lines to hold the trailing edge flaps in the selected position. If electrical failure occurs, flaps are held in the position existing at the time of electrical power loss.

The retract sequence is the reverse of the extend sequence. With the flaps retracted, locking fingers snap into place, depressing uplock switches which change the leading edge flap position indicators from barberpole to UP when the actuators are locked. Trailing edge flaps up position is indicated by a reading of 0 degree on the trailing edge flap indicator.

The flap position switch gives an indication that the leading edge flaps are down but does not give a positive indication that the flaps are locked, since the switch does not sense the position of mechanical locking fingers. Flap uplock switches are actuated by the locking fingers and provide both up and locked indications.

EMERGENCY SYSTEM OPERATION.

Placing the emergency flap switch in EMER DN opens the emergency flap selector valve permitting pressure from the emergency flap accumulator package to extend the flaps. Emergency pressure is directed to the actuators through shuttle valves. Pressure releases the locking fingers and strokes the actuators to the flaps down-and-locked position. Emergency pressure also actuates emergency bypass valves to permit return fluid to be routed into the PC 2 return line around the flap selector valve. This permits unrestricted return flow in the event the flap selector valve is jammed. Emergency pressure is available for one extension of the flaps. Variable flap operation is not possible after flaps have been extended with the emergency system. On aircraft → [16] [18] → [26], the emergency flap selector valve is powered by the emergency dc bus. On [17] [27] → the valve is powered by the battery bus.

ELECTRICAL POWER.

The leading edge flap indicator and WHEELS FLAPS warning light are powered by the emergency dc bus. The trailing edge indicator is powered by the emergency instrument bus and the trailing edge flap selector by the primary dc bus. The leading edge flap selector requires no electrical power.

FLAP SYSTEM CONTROLS.

All flap system controls and indicators are illustrated and described in figure 1–49.

FLAP SYSTEM

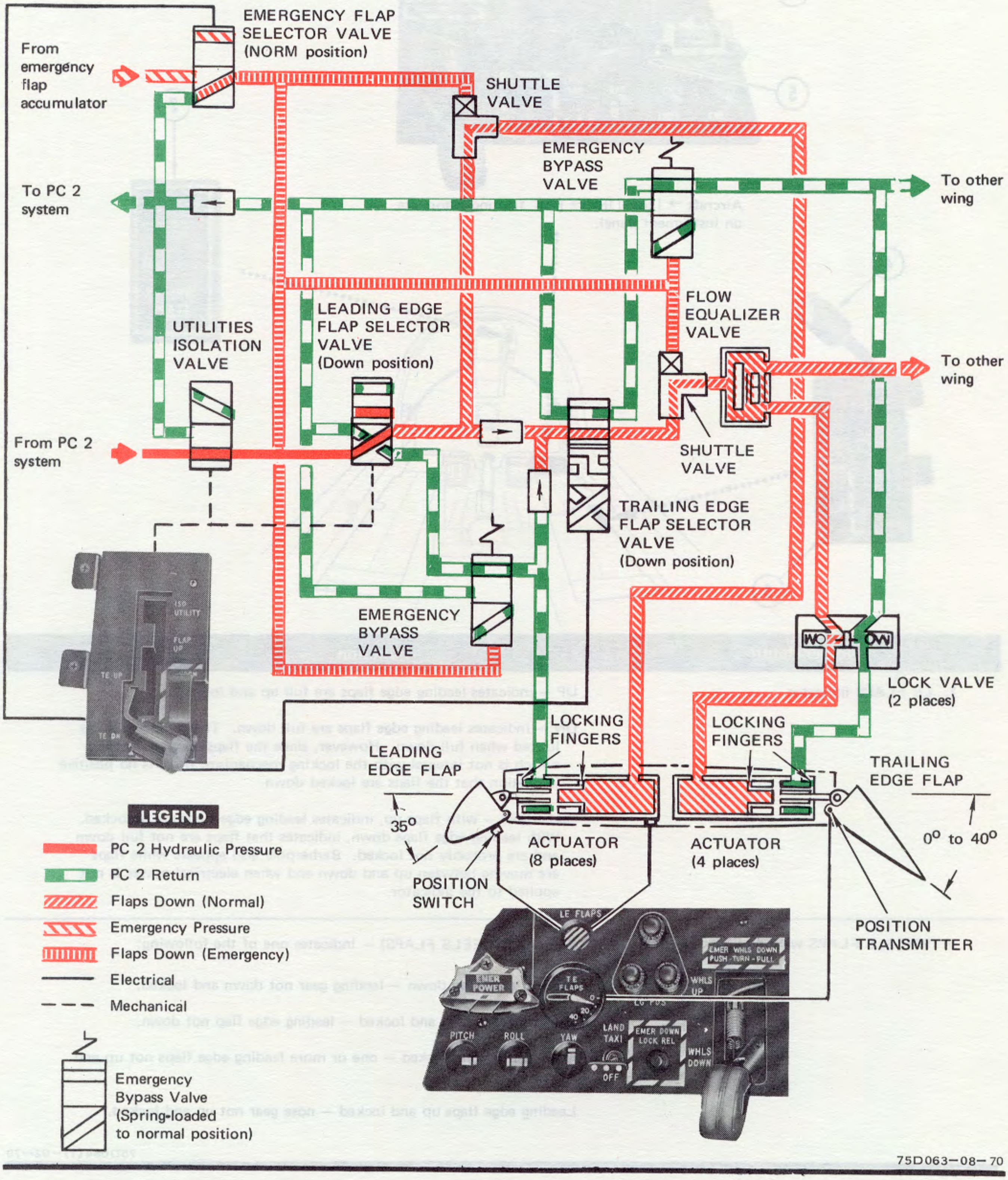
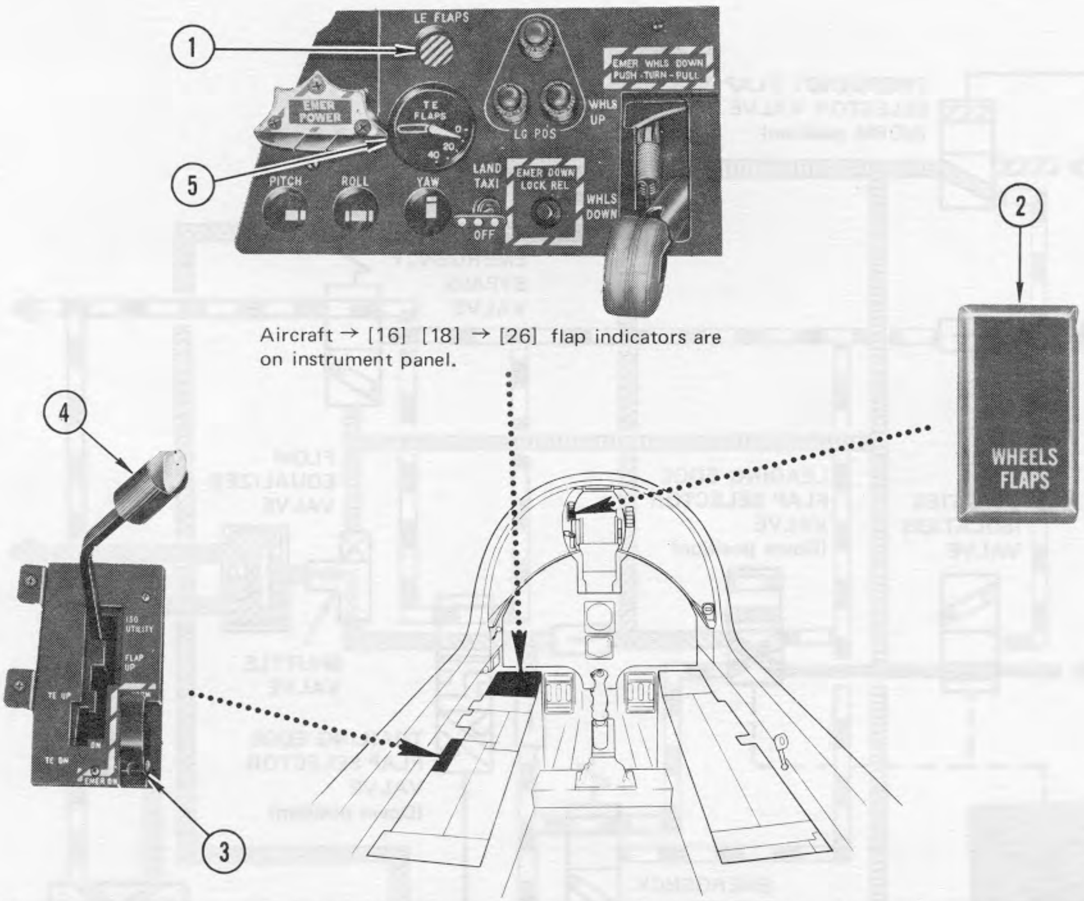


Figure 1–48

FLAP SYSTEM CONTROLS



Nomenclature	Function
1. LE FLAPS indicator	UP – indicates leading edge flaps are full up and locked. DN – indicates leading edge flaps are full down. The flaps should be locked when full down. However, since the flaps-down indicating switch is not integral with the locking mechanism, there is no positive indication that the flaps are locked down. Barberpole – with flaps up, indicates leading edge flaps are unlocked. With leading edge flaps down, indicates that flaps are not full down and are probably not locked. Barberpole also appears while flaps are moving between up and down and when electrical power is not applied to the indicator.
2. WHEELS FLAPS warning light	Flashing (WHEELS FLAPS) – indicates one of the following: Leading edge flap down – landing gear not down and locked. Landing gear down and locked – leading edge flap not down. Nose gear up and locked – one or more leading edge flaps not up and locked. Leading edge flaps up and locked – nose gear not up and locked.

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Figure 1–49 (Sheet 1)

FLAP SYSTEM CONTROLS

Nomenclature	Function
3. Emergency flap switch	NORM — emergency flap selector valve is closed, preventing flap emergency accumulator package pressure from entering flap system lines. EMERG DN — opens emergency flap selector valve by means of emergency dc bus power → [16] [18] → [26] and battery bus power [17] [27] →. This permits emergency flap accumulator package pressure to be released into the flap-down lines to extend the flaps.
4. Flap handle	ISO UTILITY — mechanically places the utilities isolation valve in the closed position to isolate hydraulic powered utilities from PC 2 system. Maintains the leading edge flap selector valve in the flaps-up position. Deenergizes the trailing edge flap selector valve. FLAP UP — mechanically opens the utilities isolation valve, repositions the leading edge flap selector valve, and energizes the up solenoid of the leading edge flap selector valve, permitting PC 2 pressure to raise the flaps. DN — mechanically repositions the leading edge flap selector valve and electrically repositions the trailing edge flap selector valve, permitting PC 2 pressure to extend all flaps. TE UP — energizes the up solenoid of the trailing edge flap selector valve, permitting PC 2 pressure to raise the trailing edge flaps. TE DN — energizes the down solenoid of the trailing edge flap selector valve, permitting PC 2 pressure to extend the trailing edge flaps. (When released from the TE DN or the TE UP position, the handle spring loads to a neutral position, deenergizing both solenoids of the trailing edge selector valve. Flaps are hydraulically locked in the desired position.)
5. Trailing edge flap indicator	Indicates position of the trailing edge flaps in degrees of extension.

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Figure 1–49 (Sheet 2)

WINGFOLD SYSTEM.

Wing outer panels are folded or spread and locked using PC 2 system hydraulic pressure. Folding and spreading is accomplished by a single hydraulic actuator for each panel. This actuator exerts sufficient force to overcome airloads imposed by winds up to 40 knots at 90 degrees to the fuselage centerline during fold operation or 36 knots during spread operation. The panels are locked in the spread position by hydraulic hinge pin actuators (two actuators for each panel) which insert hinge pins through joints formed by hinge lugs when the panels are spread. Mechanical locks safety the hinge pins in place and warning flags visually indicate lock position.

Wingfold system operation is controlled by a wingfold switch and a wing hinge pin lock lever on the right console. Access to the wingfold switch is gained by raising the lock lever. The lever latch is released by pressing upward on the latch tab beneath the outboard end of the lever. Raising the lever to the near vertical position releases the wing hinge pin lock latches and exposes the wingfold switch. The hinge pin lock lever must be in the full upright position for the wingfold switch to be operative. The wingfold system is illustrated in figure 1–50.

SPREAD – FOLD.

The wing outer panels are spread by placing the wingfold switch in SPREAD with the flap handle out of ISO UTILITY. When the panels reach the spread position, lowering the wing hinge pin lock lever extinguishes the WINGFOLD caution light and retracts the warning flags, indicating a locked condition.

The wing panels are folded by placing the wingfold switch in FOLD with the flap handle out of ISO UTILITY. The WINGFOLD light will remain on and the warning flags extended after the panels fold.

Electrical and hydraulic power must be applied to the aircraft during normal spread – fold operations.

WINGFOLD SYSTEM

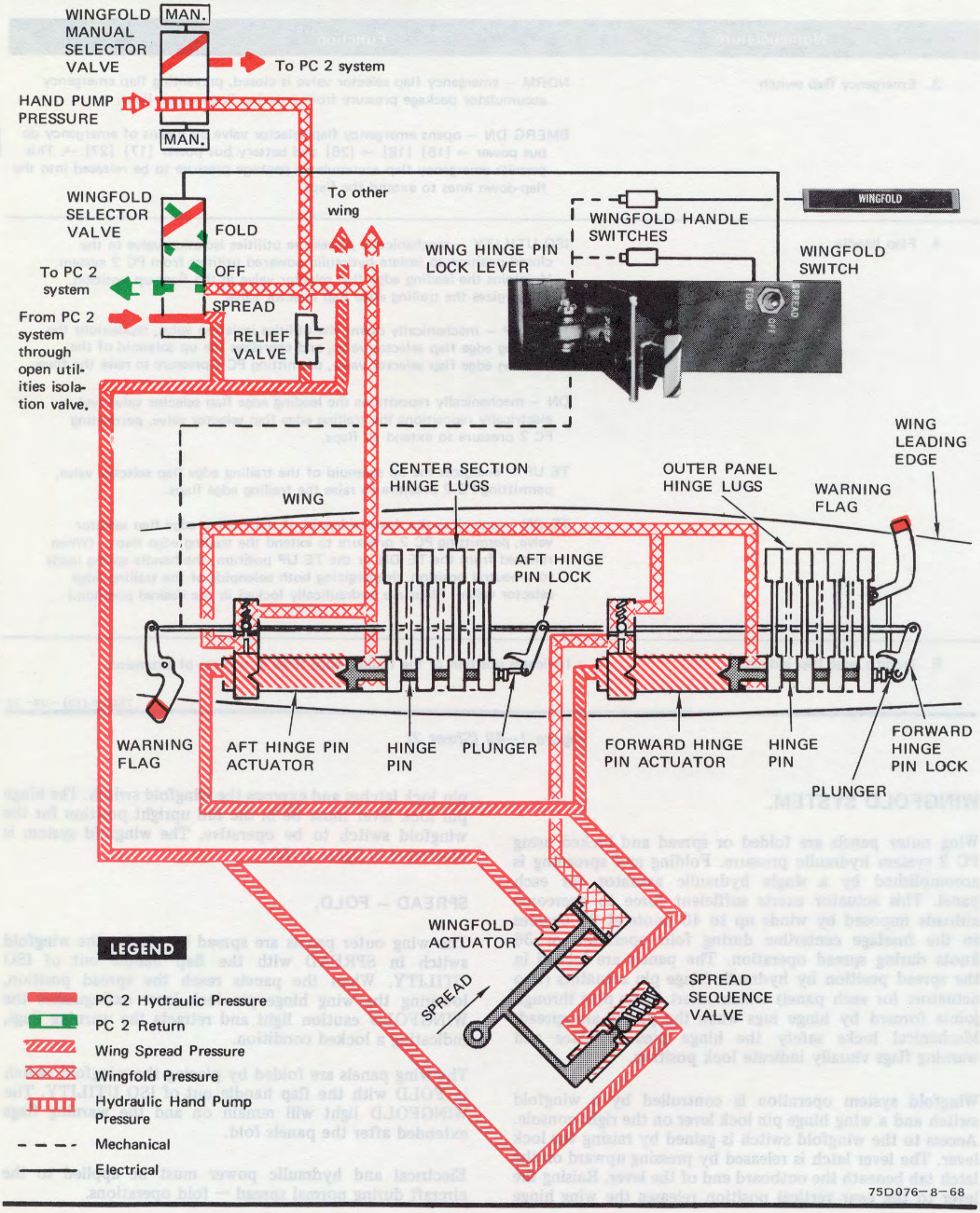


Figure 1–50

WARNING

Any of the following conditions indicate the outer panels are improperly locked by the hinge pins or the locks are failing to engage the hinge pins properly:

1. The wing hinge pin lock lever does not close.
2. An excessive force is required to move the lock lever to the lock position.
3. Warning flags are not fully retracted.
4. WINGFOLD caution light remains illuminated.

NORMAL SYSTEM OPERATION.

The wing outer panels are spread by placing the wingfold switch in SPREAD. The hinge pin lock lever must be in the full upright and latched position for the wingfold switch to function. PC 2 pressure is directed to the spread side of each wingfold actuator through the wingfold selector valve. With the wing outer panels fully spread, PC 2 pressure extends hinge pins to secure the panels. Lowering the wing hinge pin lock lever places latches over the ends of the hinge pins, locking the pins in place. Warning flags are mechanically retracted by the latches as a visual indication of the hinge pin locked condition. The wingfold switch remains in SPREAD position until the switch is placed in OFF or the lock lever is moved out of the fully upright and latched position.

Folding the outer panels is accomplished by raising the lock lever to the full upright and latched position and placing the wingfold switch in FOLD. PC 2 pressure retracts the hinge pins, then folds the wing panels. The wingfold switch remains in the FOLD position until the switch is placed in OFF or the lock lever is fully closed. With the wings folded and the flaps extended, the flaps protrude approximately 18 inches outboard of the wingfold hinge line.

ELECTRICAL POWER.

The secondary dc bus supplies power for the wingfold system.

WINGFOLD SYSTEM CONTROLS.

Wingfold system controls are illustrated and described in figure 1–51.

FLIGHT CONTROL SYSTEMS.

PRIMARY FLIGHT CONTROLS AND TRIM.

Primary flight control of the aircraft is supplied by the aileron/spoilers, horizontal stabilizer, and rudder. Conventional stick and rudder pedals operate the flight control surfaces, which are fully hydraulic powered. On aircraft → [16] [18] → [26], hydraulic power is furnished by PC 1 and PC 2 systems. On aircraft [17] [27] →, hydraulic power is furnished by PC 1, PC 2 and PC 3 systems.

The control stick and rudder pedals operate mechanical linkage to position servo valves of hydraulic power control actuators for the horizontal stabilizer and rudder. The control stick also mechanically positions the servo valve on the roll feel isolation actuator. The roll feel isolation actuator operates mechanical linkage to position servo valves of the hydraulic power control actuators for the ailerons and spoilers. The hydraulic power control actuators, mechanically linked to the primary control surfaces, cause movement of the desired surface.

Since there is no airload feedback to the control stick or rudder pedals, artifical feel is introduced into the system mechanically. The longitudinal feel system consists of a dual-gradient feel spring, two bobweights, two viscous dampers, and balance and preload springs. The dual-gradient feel spring provides a high gradient about trim and a much lower gradient for larger stick deflections. For cruise configuration maneuvering flight at high load factors, most of the stick force gradient is provided by the bobweights. Therefore, changes in aircraft gross weight and flight conditions have comparatively little effect on the cruise configuration stick force gradients. The mechanical springs return the control stick to its trimmed position or rudder to neutral after the stick or pedal has been actuated and released.

Movement of the control surfaces is controlled also by trim and, when engaged, by the automatic flight control system.

Trim controls for the ailerons and horizontal tail are on the control stick. The trim control for the rudder is on the throttle quadrant. The rudder pedals can be adjusted fore and aft with a crank located between the pedals.

An illustration depicting the flight and trim systems controls is shown in figure 1–52.

Control deflections attainable with and without trim, and with and without automatic flight control (AFCS) inputs, are presented in figure 1–53.

Using The Flight Controls.

The flight control surfaces can be moved as soon as engine rotation produces hydraulic pressure. The only actions required of the pilot in managing hydraulic power to the control surfaces are monitoring all PC systems pressure, isolating the PC 2 system with the flap handle following takeoff, and extending the RAT if control pressure is lost.

WARNING

All items of personal equipment should be stowed prior to engaging in flight maneuvers which may demand full stick reversals. Inadvertent positioning of the pilot's kneeboard along the inside of the thigh may restrict the short throw stick to limits below full available excursions.

Stick.

Pitch Control.

Horizontal tail surface response per unit of stick displacement increases as the stick is displaced from neutral position. This design, obtained through employment of a variable gain linkage, helps to eliminate pilot-induced oscillations or other unwanted aircraft reactions resulting from sensitivity near stick neutral position (horizontal tail 3 degrees trailing edge up).

A fore or aft force of approximately 1 pound is required to overcome breakout force and initiate horizontal tail movement.

Roll Control.

Roll control is obtained through lateral movement of the control stick. To increase roll control, spoiler-deflectors are tied in with aileron control linkage so that, when either aileron exceeds 2 degrees 30 minutes deflection above the trim position, the spoiler and deflector on that wing deflect a proportional amount. Roll trim will not actuate the spoiler-deflectors.

Lateral stick breakout and aileron movement begin when approximately 1 pound of stick force is applied.

Yaw Control.

Yaw control is provided by a conventional rudder control system. Pedal breakout and rudder movement begin at an applied force of approximately 10 pounds.

On aircraft → [16] [18] → [26] before T.O. 1A-7D-524, rudder pedal throw is restricted and rudder surface travel is limited to 6 degrees when trailing edge flaps are retracted past 20 degrees. Nose gear steering is also limited to 6 degrees, and full pedal deflection requires approximately 106 pounds of force. When trailing edge flaps are extended past 20 degrees, full rudder surface deflection of 24 degrees is restored, at which time full rudder pedal deflection requires approximately 73 pounds of force. On aircraft → [16] [18] → [26] after T.O. 1A-7D-524, and aircraft [17] [27] →, full nose gear steering is available at all times during ground operations. During flight, rudder pedal throw and rudder surface travel is limited to 6 degrees when the landing gear is retracted.

A stall warning device provides an indication that the aircraft is approaching a stall condition. The warning consists of a vibration of the right rudder pedal when the angle of attack reaches 20.5 units. The system functions for all configurations. The purpose of the rudder pedal shaker is to give the pilot adequate warning of an impending stall while in the landing configuration. In cruise configuration, the rudder pedal shaker effect is masked by the aircraft buffet during approaches to accelerated stalls.

Emergency Flight Control Power.

On aircraft → [16] [18] → [26] with only one of the PC systems providing hydraulic pressure, there will be a slight reduction in control effectiveness at higher airspeeds. When the RAT pump is the only source of flight control hydraulic pressure, rapid control inputs should be avoided.

On aircraft [17] [27] →, flying qualities with one PC system out are unchanged except for some reduction in aileron effectiveness at high speeds at low altitudes because of reduced hinge moments. With only one PC system providing hydraulic pressure, control effectiveness is degraded. Refer to figure 1—34 for flight control backup capabilities, and Section VI, Flight Characteristics With Failed PC Systems.

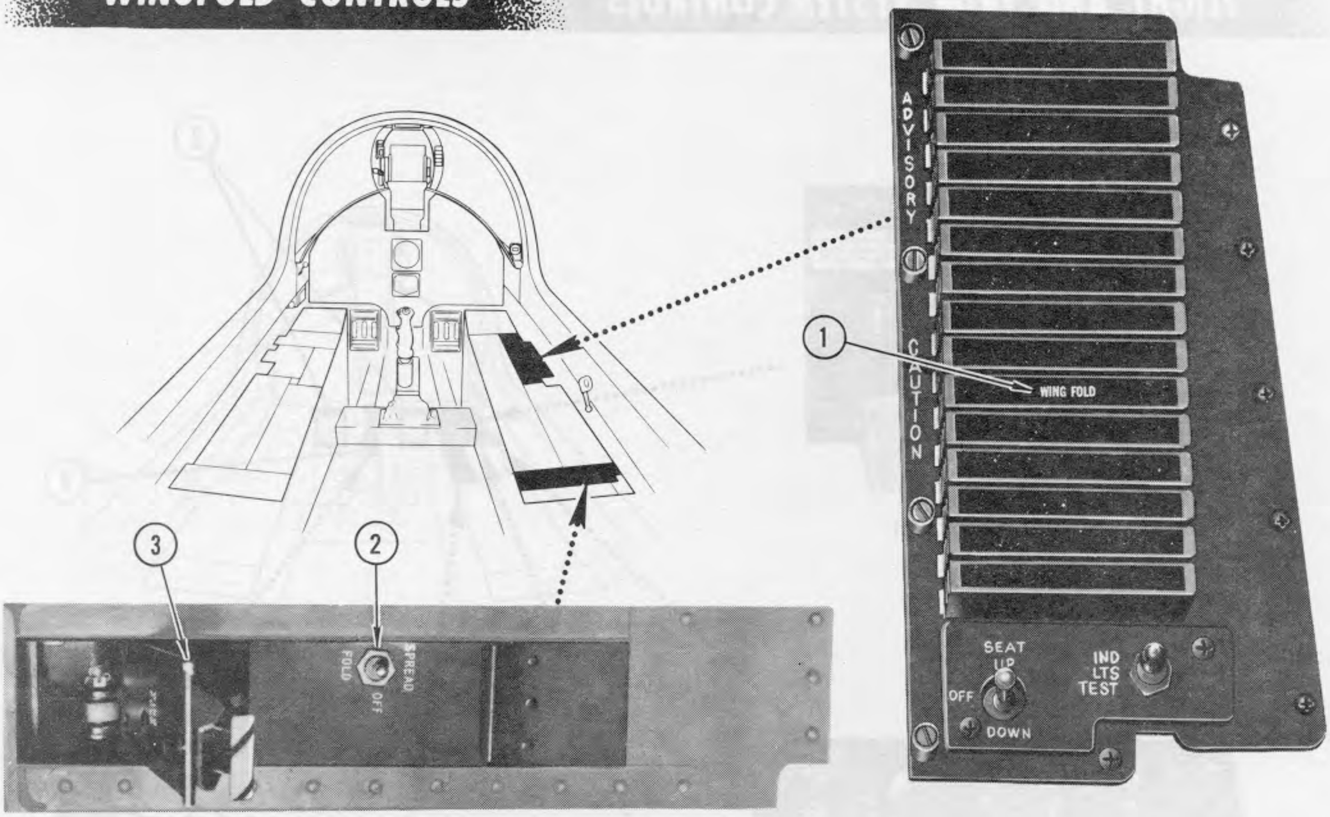
WARNING

Observe RAT minimum flight control airspeeds as presented in figure 1—28. Failure to observe speed minimums, particularly while utilizing emergency electrical power, could result in loss of flight control during the final phase of landing.

Trim.

Trim controls and their functions are presented in figure 1—52. The roll and pitch trim systems each have a single-channel, electromechanical actuator which positions the ailerons or horizontal stabilizer to provide lateral and longitudinal trim. The actuators are positioned by electric motors which are controlled with a five-position, beep type switch spring-loaded to the neutral position. The switch is located on the pilot's control stick. Each actuator contains an electrically operated brake which holds the actuator in the last position commanded by the trim switch. Trim position is indicated by a combination roll and pitch trim indicator located on the left console. ROLL and PITCH TRIM disconnect switches, located on the left console, can be placed in OFF to disengage the

WINGFOLD CONTROLS



Nomenclature	Function
1. WINGFOLD caution light	On (WINGFOLD) – indicates wing hinge pin lock lever is not in full lowered position.
2. Wingfold switch	FOLD – with utilities isolation handle out of ISO UTILITY position and wing hinge pin lock lever fully raised, electrically positions the wingfold selector valve to direct PC 2 hydraulic pressure to fold the wings. SPREAD – with utilities isolation handle out of ISO UTILITY and wing hinge pin lock lever fully raised, electrically positions the wingfold selector valve to direct PC 2 hydraulic pressure to spread the wings. OFF – deenergizes the wingfold selector valve. In deenergized position, valve blocks PC 2 pressure from wingfold system and relieves spread pressure into the PC 2 return line. The wingfold selector valve is reenergized to the spread position after the wing hinge pin lock lever is lowered.
3. Wing hinge pin lock lever	Raised to full upright position – disengages hinge pin locks from hinge pins, extends warning flags, connects electrical power to the wingfold switch and lights the WINGFOLD caution light. Lowered – engages hinge pin locks in hinge pin locking detents, retracts warning flags, and removes electrical power from the wingfold switch. Causes the selector valve to move to the spread position with electrical power on the airplane.
4. Wing hinge pin warning flags (4) (Upper and lower wing surfaces in wingfold area)	Extended – flags indicate locks are not engaged in hinge pin locking detents. Wing panels unsafe. Retracted – flags indicate locks are engaged in the hinge pin locking detents. Wing panels safe.

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Figure 1–51

FLIGHT AND TRIM SYSTEM CONTROLS

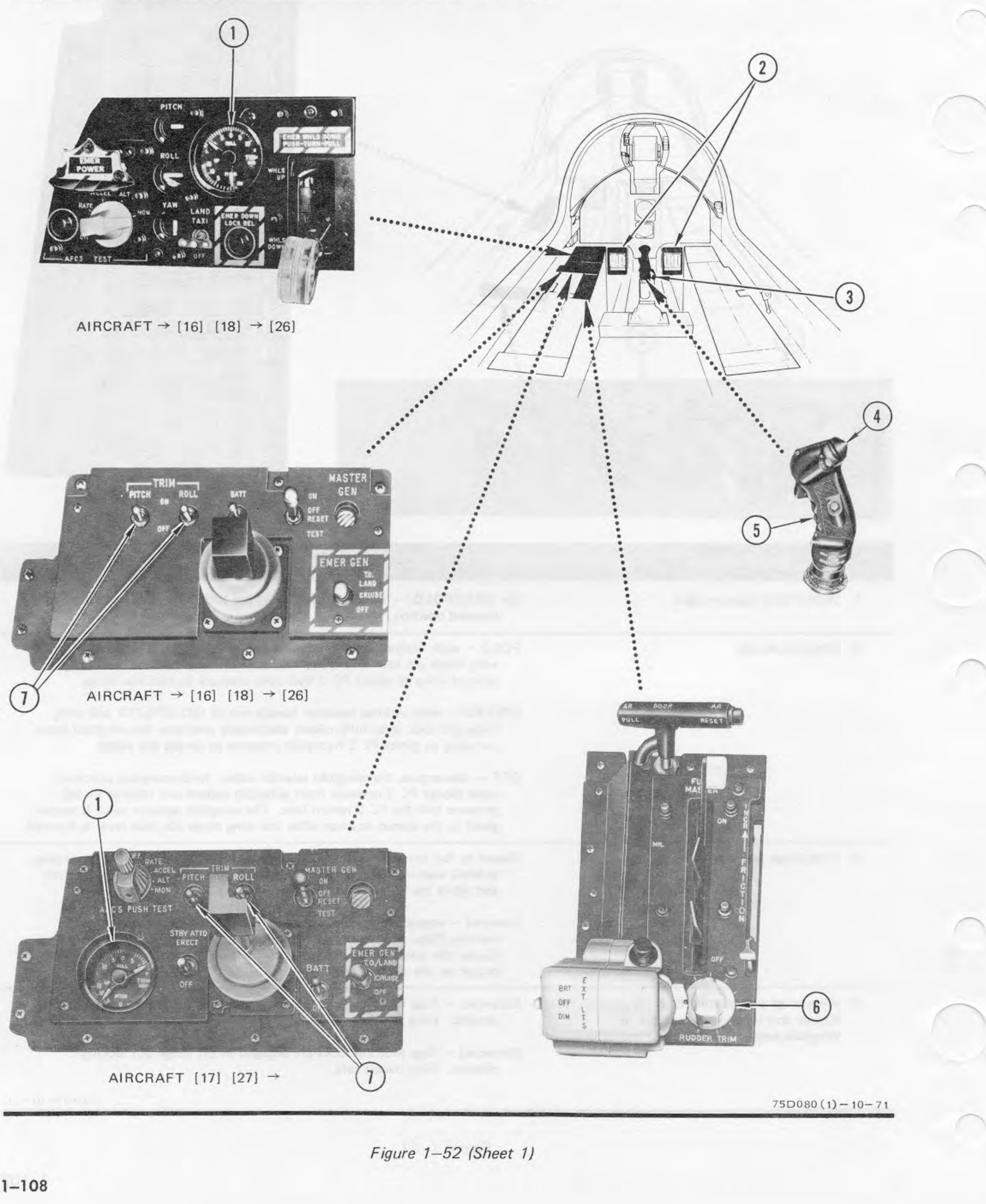

Figure 1–52 (Sheet 1)

FLIGHT AND TRIM SYSTEM CONTROLS

Nomenclature	Function
1. Roll and pitch trim indicator	Indicates position of roll and pitch trim in degrees.
2. Rudder pedals	In cruise condition, control rudder surface to a maximum deflection of 6° to either side of neutral. On aircraft → [16] [18] → [26] before T.O. 1A-7D-524, with trailing edge flaps beyond 20°, control rudder surface to a maximum deflection of 24° to either side of neutral. On aircraft → [16] [18] → [26] after T.O. 1A-7D-524 and [17] [27] → with the landing gear extended, control rudder surface to a maximum deflection of 24° to either side of neutral.
3. Rudder pedal adjustment crank	Rotated right or left adjusts rudder pedal assembly fore or aft.
4. Roll and pitch trim switch	Positioned left or right, adds corresponding aileron trim. Positioned forward, adds nosedown pitch trim. Positioned aft, adds nose-up pitch trim.
5. Control stick	Controls aileron deflection through a total range of 16°. When either aileron exceeds 2° 30' above trim position, the spoiler and deflector on that wing will deflect in direct proportion to stick lateral deflection. The spoiler will deflect approximately 2° for each degree of aileron deflection. Controls horizontal stabilizer deflection through a range of 26° 30' trailing edge up to 6° 45' trailing edge down.
6. RUDDER TRIM knob	Rotated left or right with stabilization engage switch in STAB adds corresponding yaw trim.
7. ROLL and PITCH TRIM disengage switches	OFF – connects the actuator motor and actuator brake coil to ground, disabling the respective trim system. ON – connects power to actuator motor and actuator brake coil, allowing normal operation of respective trim system.

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Figure 1–52 (Sheet 2)

CONTROL DEFLECTIONS

CONTROL SURFACE	CONTROL DEFLECTIONS				DEFLECTION LIMITS (4)
	STICK	RUDDER	TRIM (1)	AFCS	
Aileron UP	16°		14°	10°	25°
DN	16°		13°	10°	25°
Spoiler UP	36°			(5) 24°	60°
Horizontal Stabilizer UP	26.5°		14.5°	(2) 4°	26.5°
DN	6.75°		2°	(2) 4°	6.75°
Rudder (L or R) Clean Condition		6°	5°	(3) 12.5°	18.5°
Landing Condition		24°	5°	12.5°	24°

NOTES

(1) Creates new neutral position for control surface.

(2) In CONT AUG, the control deflection is around the control surface position established by the control stick. In ATTD, the AFCS will trim the control surface to the selected condition (to trim limits), then have a 4° deflection around that position.

(3) AFCS uses rudder trim system. This limits the trim/AFCS combination to a maximum of 12.5°.

(4) Deflection limits are the limits to which the control surface actuator will move the surface in the configurations shown. These limits are reached by using combinations of stick, rudder, trim and AFCS.

(5) AFCS deflection of spoilers is limited to 19.5° if movement begins from stick neutral position.

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Figure 1–53

respective trim system and the five-position trim switch on the control stick. The yaw trim system uses the AFCS yaw actuator to position the rudder. Therefore, yaw trim is only available when the yaw STAB engage switch is in STAB. Yaw trim is regulated with a trim knob located on the left console.

Pitch Trim.

When the AFCS is not in attitude or altitude hold mode, the trim switch is moved forward for nosedown trim and aft for noseup trim. The control stick moves in the direction of trim. When operating the AFCS attitude or altitude hold modes, automatic pitch trim is provided. However, in attitude hold, the pilot's pitch trim switch can be used to make small pitch attitude corrections. In altitude hold, the pilot's pitch trim system is disabled.

Note

In event of pitch trim actuator runaway, it can be stopped by moving the pitch trim disconnect switch to OFF. The actuator remains in the position existing at time of disengagement.

Roll Trim.

Positioning the five-position trim switch on the control stick to the right or left applies emergency dc bus power to position the roll trim actuator in the direction commanded by the trim switch. Roll trim deflection is approximately plus or minus 13 degrees of aileron. Spoiler deflectors are not actuated when ailerons are positioned with the trim switch. The roll trim actuator operates on mechanical linkage between the roll feel isolation actuator and aileron actuator; therefore, control stick neutral is not affected by roll trim.

Yaw Trim.

Yaw trim requires the yaw STAB engage switch to be in STAB with the yaw stabilization system operating. Refer to AUTOMATIC FLIGHT CONTROL SYSTEM, this section, for more information. Rudder trim is zero when the rudder trim knob points midway between positions L and R.

SECONDARY FLIGHT CONTROLS.

Refer to flap and speed brake writeups, this section.

AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS), AN/ASW-30(V).

The Automatic Flight Control System (AFCS) is a three-axis, dual channel autopilot. With control augmentation mode engaged, force applied to the control stick displaces force transducers that electrically transmit steering signals to the autopilot. This is known as control stick steering.

Other system features include automatic pitch and yaw trim, failure monitoring, automatic disconnect, and system self-test. There are six operational modes provided:

1. Yaw stabilization
2. Control augmentation
3. Attitude hold
4. Heading hold
5. Heading select
6. Altitude hold

AFCS controls are illustrated and described in figure 1–54.

Electrical and hydraulic power are required for AFCS operation. Both PC systems furnish hydraulic power for the system. If the main generator fails, only the yaw stabilization mode remains when the ram air turbine (RAT) is supplying electrical power.

As related to AFCS operation, the aileron-rudder interconnect system automatically provides either lead or opposing rudder deflections to maintain coordinated flight.

The AFCS is subject to operating limitations in all modes except yaw stabilization and control augmentation. The yaw stabilization and control augmentation modes can be engaged and remain engaged in any aircraft attitude. All other modes are subject to limitations of plus or minus 60 degrees in pitch and 70 degrees in bank. The application of a pitch stick force greater than 2.5 or roll stick force greater than 2.5 pounds will disengage the altitude hold and heading select when switches are engaged. One additional exception to the stick force limitation is described under Heading Select Mode. AFCS switches and indicators are located on the left console. The AFCS disconnect switch is on the forward side of the control stick, below the stick grip. Advisory lights are on the right console.

Control surface deflections are shown in figure 1–53. Directional, longitudinal, and lateral AFCS operation is presented in figures 1–55, 1–56, and 1–57.

AFCS actuator position indicators reflect direction of aircraft rotation in the event AFCS is suddenly disengaged. They should be visually checked prior to AFCS disengagement.

AFCS CONTROLS

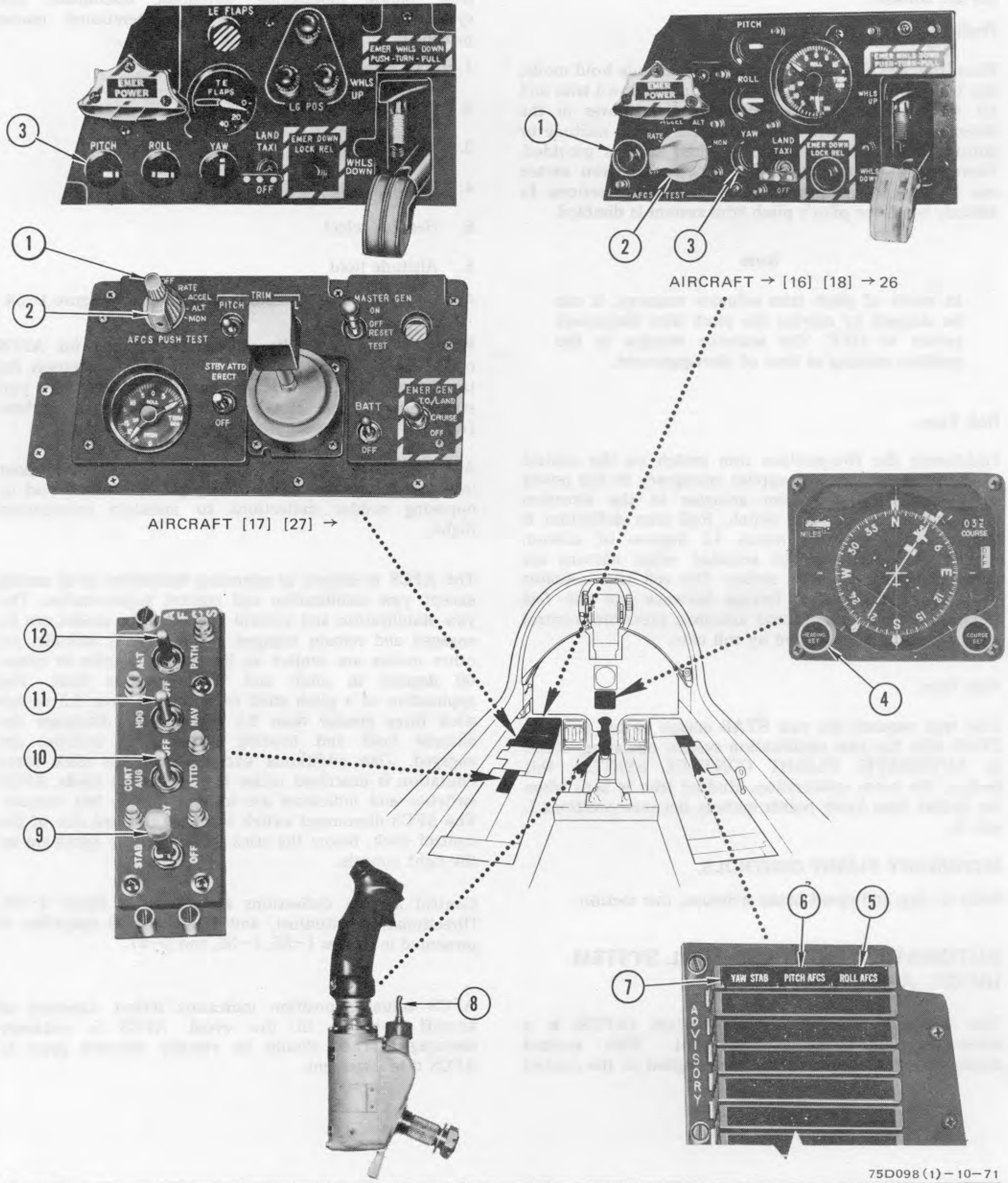

Figure 1–54 (Sheet 1)

AFCS CONTROLS

Nomenclature	Function
1. AFCS test pushbutton	Depressed – activates AFCS self-test circuits.
2. AFCS test selector switch	OFF – disengages AFCS self-test functions. RATE – connects rate gyros to self-test circuits for testing. ACCEL – connects accelerometers to self-test circuits for testing. ALT – connects altitude hold circuits to self-test circuits for testing. MON – connects monitor circuits to self-test circuits for testing.
3. PITCH, ROLL, YAW indicators	Indicate movement of AFCS actuators, thus potential aircraft movement if AFCS disconnects.
4. HEADING SET knob	Used to select desired heading while in the heading select mode.
5. Roll AFCS advisory light	On (ROLL AFCS) – indicates AFCS roll axis has become disengaged.
6. Pitch AFCS advisory light	On (PITCH AFCS) – indicates AFCS pitch axis has become disengaged due to malfunction.
7. Yaw stabilization advisory light	On (YAW STAB) – indicates yaw stabilization switch is not in STAB or that yaw stabilization has become disengaged.
8. AFCS disconnect switch	Actuated – disengages control augmentation, attitude hold, heading hold, heading select and altitude hold modes if they are engaged. Unlatches and returns respective mode switches to OFF reverting AFCS operation to the yaw stabilization mode.
9. Yaw STAB engage switch	OFF – deenergizes all AFCS functions. STBY – power supplied to rate gyros, system computers, and all transducers. STAB – yaw stabilization mode energized and power supplied to allow engagement of the AFCS engage switch. Cycling from STAB to STBY or OFF will disengage all other AFCS modes.
10. AFCS engage switch	CONT AUG – engages pitch and roll control augmentation provided the yaw stab engage switch is in STAB. Also allows engagement of the lateral mode and longitudinal mode engage switches. OFF – deenergized position. ATTD – engages pitch and roll attitude hold, provided the yaw stab engage switch is in STAB. Also allows engagement of the lateral mode and the longitudinal mode engage switches.
11. Lateral mode engage switch	HDG – engages heading hold mode if yaw stabilization and attitude hold (switch in CONT AUG or ATTD) are operating normally. OFF – deenergized position. NAV – engages heading select mode if yaw stabilization and attitude hold mode are operating normally.
12. Longitudinal mode engage switch	ALT – engages the altitude hold mode if the yaw STAB switch is in STAB and the attitude hold mode (switch in CONT AUG or ATTD) is operating normally. OFF – deenergized position. PATH – not operational.

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Figure 1–54 (Sheet 2)

DIRECTIONAL CONTROL AND YAW STABILIZATION

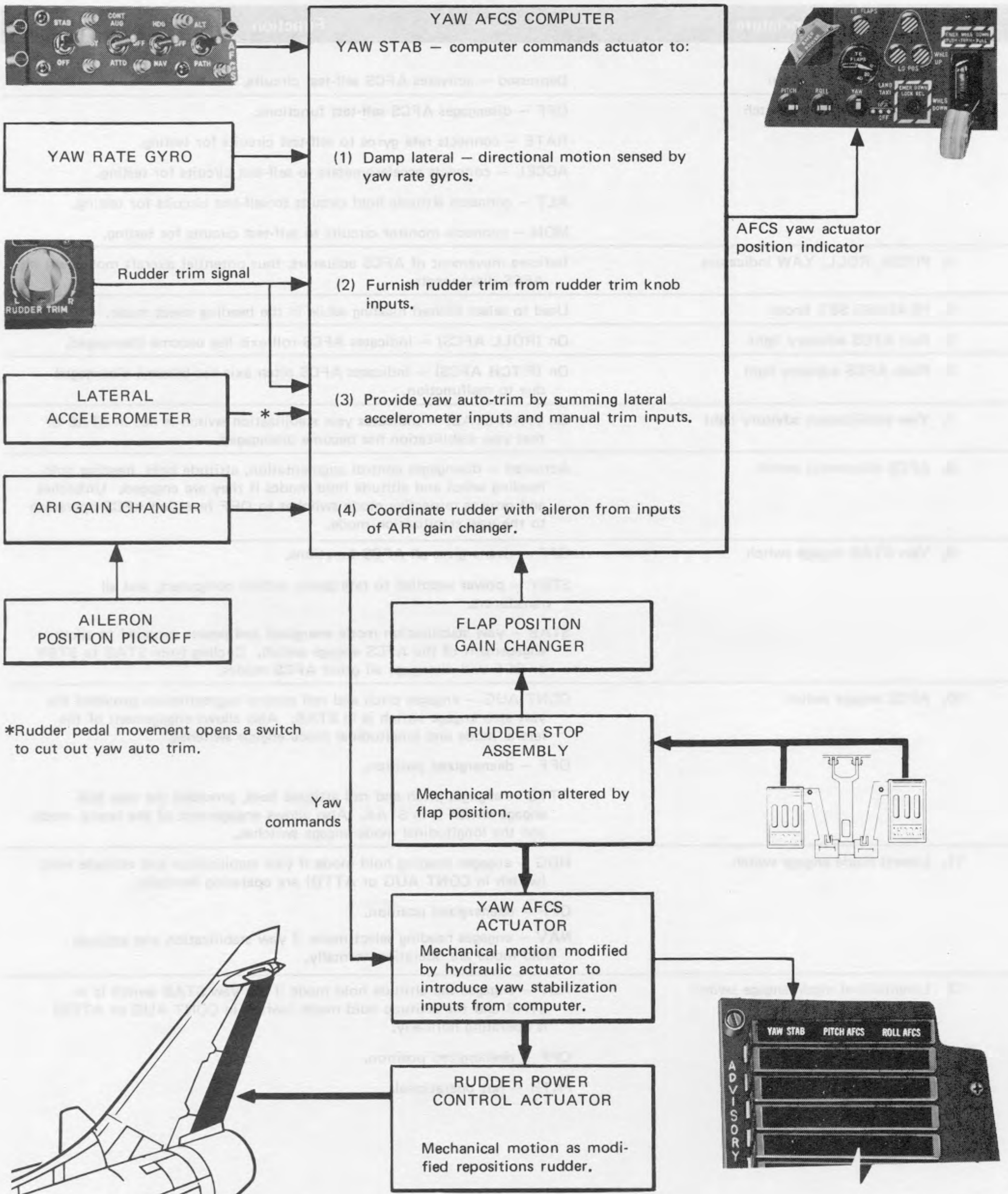

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Figure 1–55

LONGITUDINAL FLIGHT CONTROL AND PITCH AFCS

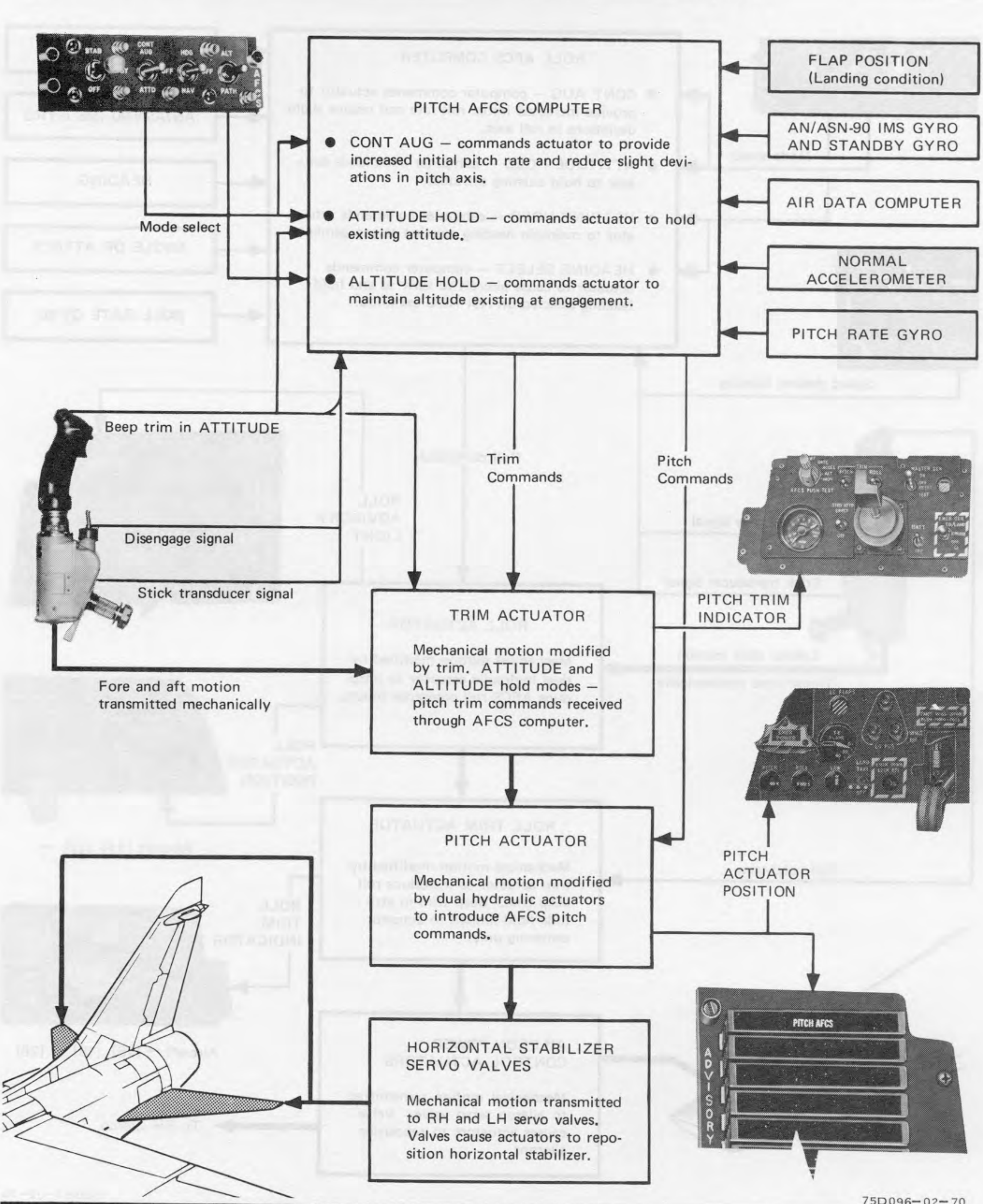


Figure 1–56

LATERAL FLIGHT CONTROL AND ROLL AFCS

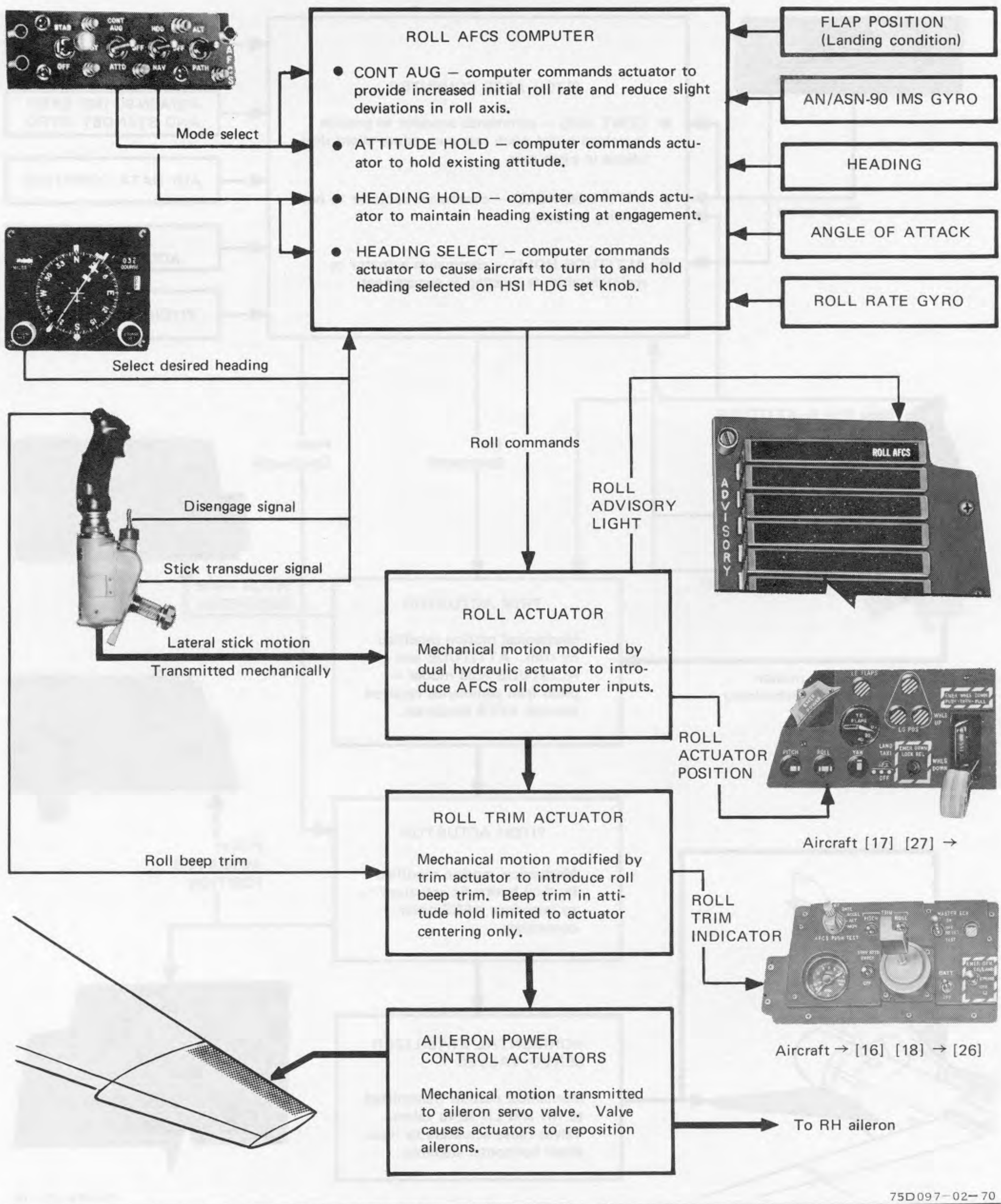


Figure 1–57

USING THE AFCS.

Yaw stabilization (STAB) mode of AFCS operation should be engaged at all times, including takeoff and landing.

Note

Engagement of control augmentation or attitude hold modes requires only that the yaw STAB engage switch be in the STAB position. Yaw stabilization and control augmentation or attitude hold must be engaged and operating prior to engaging heading hold, NAV (heading select), or altitude hold modes.

Control augmentation (CONT AUG) may be engaged before takeoff to improve lateral and longitudinal stability, and reduce pilot effort required for aircraft control. However, some lateral overcontrolling may be encountered in CONT AUG with flaps down. After takeoff, any desired mode may be engaged. If desired, after climb attitude has been established, climb angle can be maintained by engaging attitude hold (ATTD) mode. After a desired altitude has been reached, it can be held by engagement of altitude hold (ALT) mode. Engagement of heading hold (HDG) mode maintains the heading being flown at the time of engagement. If heading select (NAV) mode is selected, the aircraft turns to and maintains the heading selected with the HDG SET knob on the HSI. In heading select mode the aircraft senses the shortest route to the desired heading.

Yaw Stabilization.

Yaw stabilization is engaged by placing the yaw STAB engage switch in STAB. The YAW STAB advisory light should go out within 30 seconds after system warmup.

If yaw stab becomes disengaged, it may be reset by cycling the yaw STAB switch to STBY, and then back to STAB. If yaw stab cannot be reset (YAW STAB advisory light remains on), yaw stab functions and rudder trim are lost. However, by leaving the switch in STAB, all AFCS modes except heading hold and heading select can be obtained.

To voluntarily disengage yaw stabilization, the yaw STAB switch must be placed in STBY or OFF (YAW STAB advisory light comes on). System malfunction also causes the YAW STAB light to come on.

Note

The AFCS disconnect switch does not disengage yaw stab.

Control Augmentation.

Control augmentation mode is engaged by placing the AFCS engage switch in CONT AUG.

If either the pitch or roll axis becomes disengaged, it is reset by cycling the AFCS engage switch to OFF, and then back to CONT AUG. If the axis cannot be reset (its advisory light remains on), the switch may be left on and the good axis used, or the switch may be placed in OFF and both axes disconnected. If yaw stab disengages, roll and pitch control augmentation are not affected.

Control augmentation is disengaged by actuating the AFCS disconnect switch, or by placing the AFCS engage switch in the OFF position. There are no pitch attitude restrictions in the control augmentation mode; therefore, it can be used during the entire mission. Roll augmentation automatically disengages at 22 units angle of attack. Manual trim is available in all axes. Stick forces do not cause disengagement.

Pitch AFCS and roll AFCS advisory lights are provided to indicate that the corresponding axis is disengaged.

Note

Engagement or disengagement of CONT AUG while in maneuvering flight may cause abrupt pitching moments. The CONT AUG mode should not be intentionally disengaged during accelerated flight.

Attitude Hold.

With the aircraft within attitude limits (plus or minus 60 degrees pitch, 70 degrees roll) and the ADI OFF flag out of sight indicating proper IMS operation, attitude hold mode is engaged by ensuring the PITCH TRIM disengage switch is ON and placing the AFCS engage switch in ATTD. If the pitch or roll axis becomes disengaged, it is reset by cycling the AFCS engage switch to OFF, and then back to ATTD. If the axis cannot be reset (respective advisory light remains on), the switch is left in ATTD and the good axis used, or the switch is placed to the OFF position and both axes disconnected. If the YAW STAB advisory light comes on, attitude hold is still available if the yaw STAB engage switch is left in STAB.

Attitude hold is disengaged by actuating the AFCS disconnect switch or by placing the AFCS engage switch in the OFF position.

Note

Attitude hold should not be engaged for takeoff or landing.

Heading Hold.

Provided the aircraft is within attitude limits, the ADI OFF flag is not visible, and the IMS gyro has erected (IMS caution light out), heading hold mode is engaged by placing the AFCS engage switch in either CONT AUG or ATTD, and the lateral mode engage switch in HDG.

Heading hold is disengaged by actuating the AFCS disconnect switch, leaving only the yaw stab mode in operation. Roll AFCS malfunction turns on the ROLL AFCS advisory light and returns the heading mode switch to OFF. Heading hold may also be disengaged by moving the lateral mode engage switch from HDG to OFF.

Heading Select.

Engagement procedures for heading select are the same as heading hold mode, except that for heading select the lateral mode switch is placed in NAV and the desired heading is set with the HSI HDG SET knob. With the AFCS engage switch in CONT AUG, control augmentation automatically transfers to attitude hold upon engaging heading select and reverts to control augmentation when heading select is disengaged. The switch remains latched in CONT AUG.

Heading select is disengaged by actuating the AFCS disconnect switch or by panel switch. AFCS reverts to yaw stab mode.

Altitude Hold.

With the aircraft within attitude limits, altitude hold mode is engaged by placing the AFCS engage switch in CONT AUG or ATTD, and the longitudinal mode engage switch in ALT.

If the longitudinal mode switch is returned to OFF, the autopilot assumes the mode previously selected with the AFCS engage switch (CONT AUG or ATTD).

Actuating the AFCS disconnect switch reverts the system to yaw stab mode.

DETAILS OF SYSTEM OPERATION.

Except for automatic pitch trim, no AFCS input will cause movement of the control stick or rudder pedals. Pitch and yaw AFCS actuators are downstream of the feel springs. The roll AFCS actuator is downstream of the feel isolation actuator. Automatic pitch trim in attitude hold or altitude hold uses the normal pitch trim actuator which repositions the control stick neutral.

Yaw Stabilization Mode.

In addition to providing automatic and manual rudder trim, yaw stabilization also dampens adverse yaw tendencies inherent in short-coupled (short moment arm) aircraft; therefore, it should be engaged at all times, including takeoff and landing. No other mode can be engaged until the yaw STAB engage switch is in STAB position. Heading select and heading hold modes require that yaw stab be operational prior to their engagement. With yaw stab engaged, rudder trim of 5 degrees in either direction becomes available. (Manual pitch and roll trim do not require AFCS engagement to become operative.) Yaw AFCS actuator position is indicated on the AFCS yaw actuator position indicator on the left console.

Control Augmentation Mode.

Lateral and longitudinal stability of the aircraft is improved by use of control augmentation. In this mode, manual stick inputs are converted to electrical signals by stick force transducers. These signals are applied to the autopilot for aircraft control. Deviations from normal flightpath are small, resulting in less pilot fatigue.

With control augmentation selected, manually induced pitch or roll inputs result in large initial control surface deflection. This permits more rapid entry into pitch or roll maneuvers. As the maneuver progresses, deflections decrease to the amount normally obtained with manual stick movement.

Note

> Roll augmentation will automatically disengage when the aircraft reaches an angle of attack of approximately 22 units. To reengage the roll axis, move the AFCS engage switch to OFF, and then back to CONT AUG.

Attitude Hold Mode.

In attitude hold mode, aircraft attitude existing at the time of engagement is maintained in pitch and roll. Pitch trim is automatic in this mode. Manual yaw trim is available through use of the rudder trim knob. Roll beep trim is used to zero the AFCS actuator to neutralize disengage transient.

There is no apparent response to roll beep trim, since this trim is offset by AFCS actuator movement. There is enough trim available to deflect the ailerons beyond the 10-degree movement available with the AFCS. Attitude hold disengages in the affected axes when attitude and stick force limitations are exceeded. The disengaged axes revert to the control augmentation mode as long as the condition exists and the AFCS engage remains in the ATTD position. If AN/ASN-90 IMS gyro failure occurs, both axes disengage.

When normal operating conditions are reestablished, the respective axes engage attitude hold at the existing attitude.

A 6.5-degree difference between the AN/ASN-90 IMS gyro and standby attitude indicator gyro while operating in attitude hold causes the pitch to disengage. The pitch AFCS actuator locks to center and the pitch AFCS advisory light comes on. Roll attitude hold is not affected. Exerting a stick force greater than 1.5 pounds in roll and pitch directions disengages attitude hold in both axes and reverts the system to control augmentation mode but does not unlatch the AFCS engage switch. When stick force is relaxed, attitude hold comes back on the line automatically.

Heading Hold Mode.

With heading hold mode engaged, the aircraft heading existing at the time of engagement is maintained and heading cannot be changed until mode is disengaged. Although the AFCS engage switch is in CONT AUG or ATTD when heading hold is engaged, internal circuitry engages attitude hold mode in addition to heading hold. If the roll AFCS position indicator deflects about an offcenter position, manual roll trim is used to recenter it. Placing the lateral mode engage switch in OFF or exerting a lateral stick force greater than 2.5 pounds unlatches the lateral switch. AFCS operation reverts to the control augmentation or attitude hold mode, whichever was selected. Fast slewing of the IMS compass disengages the heading hold mode.

Heading Select Mode.

The aircraft automatically turns to and maintains the heading selected with HSI HDG SET knob with the AFCS in the NAV select position.

The aircraft assumes a fixed maximum roll attitude of 30 degrees when turning to the selected heading. If a faster turn rate is desired, stick force can be used to increase bank angle as desired up to a maximum of 70 degrees. The bank angle is maintained until within 5 degrees of the selected heading, at which time the bank angle decreases proportionately until the wings level condition is obtained at the selected heading.

Heading select is disengaged by actuating the AFCS disconnect, causing both the lateral engage switch and the AFCS engage switch to disengage and return to OFF. AFCS reverts to the yaw stab mode. Placing the lateral mode engage switch in OFF or exerting a lateral stick force greater than 2.0 pounds, when within 5 degrees of the selected heading, unlatches the lateral mode switch. AFCS operation reverts to the control augmentation or attitude hold mode, whichever was selected.

Altitude Hold.

With altitude hold mode engaged, the aircraft maintains altitude existing at the time of engagement. If the aircraft is climbing or diving at the time of engagement, it returns to the altitude of engagement. Attitude hold is automatically engaged in this mode. Pitch trim is automatic, with no manual vernier pitch trim available. Yaw trim is manual. If the roll AFCS position indicator deflects about an offcenter position, manual roll trim is used to recenter it. Manual roll trim does not affect aircraft roll attitude.

Placing the longitudinal path engage switch in OFF or exerting a stick force greater than 1.5 pounds in pitch also unlatches the longitudinal path engage switch and returns it to OFF. AFCS operation reverts to the control augmentation or attitude hold mode, whichever was selected.

Inadvertent disengagement of the altitude hold mode lights the AFCS advisory light(s) to indicate that an AFCS axis(es) has tripped off the line. Refer to Attitude Hold Mode for possible causes and remedies.

AFCS Actuator Position Indicators.

The position indicators are centered when the respective axis is disengaged. During normal AFCS operation, indicator motion shows AFCS inputs required to perform the function of the selected mode of operation.

Note

> AFCS actuator position indicators should be visually checked before disengaging AFCS. Direction of deflection indicates the direction the aircraft would rotate if the AFCS would suddenly disengage.

The yaw indicator deflects about the center position when the yaw trim knob is centered. If yaw trim is applied, the indicator deflects about an offcenter position.

The pitch indicator deflects about the center position while operating in the control augmentation or attitude hold modes. If the aircraft becomes momentarily out of trim when operating in attitude or altitude hold, the pitch indicator deflects about an offcenter position until the automatic trim system restores proper trim.

The roll indicator operates the same as the pitch trim indicator except there is no automatic roll trim. If the indicator deflects about an offcenter position while operating in attitude hold, altitude hold, or heading hold modes, the pilot's roll trim switch is used to trim the aircraft so that the indicator deflects about its center position.

AFCS TEST CIRCUITRY.

The AFCS has a self-test capability for ground testing of the system. The test circuitry is disabled when weight is off the landing gear, preventing inadvertent input while airborne. Two switches, AFCS test pushbutton and AFCS test selector, are related to self-test. The test procedure is included in Section II.

ELECTRICAL POWER.

AC power for the AFCS system is supplied by the secondary and emergency ac buses; dc power, by the emergency dc buses.

PITOT-STATIC SYSTEM.

A single pitot tube, mounted just aft of the radome on the left side of the aircraft, supplies impact pressure to the Mach and airspeed indicator and to the Air Data Computer.

Static pressure is supplied by four static ports located on the left side of the fuselage just below the canopy rail. One of the two forward ports supplies static pressure to the cockpit pressure safety valve and the other supplies the cockpit air pressure regulator. The next port aft supplies static pressure to the vertical velocity indicator, Mach and airspeed indicator, and the servoed altimeter. The most aft port supplies static pressure to the Air Data Computer.

Ice formation in the pitot tube impact opening is prevented by heat from an electrical element. The element is energized by placing the ANTI-ICE switch in either PITOT or PITOT ENG. Since the heating element receives its power from the primary ac bus, pitot heat is available if the RAT is extended for electrical power and the EMER GEN switch is in CRUISE.

Note

Pitot heat is not available with the RAT extended for electrical power if the EMER GEN switch is in T.O. LAND.

FLIGHT INSTRUMENTS.

NORMAL ACCELEROMETER.

On aircraft → [16] [18] → [26], the ABU-4/A Normal Accelerometer is mounted on the instrument panel. On [17] [27] →, the accelerometer is mounted on the instrument cowl. The scale of the instrument is from minus 5g to plus 10g. A reset knob is located on the lower left front of the instrument case. When the knob is depressed, the secondary pointers are reset to the plus 1g position. Electrical power for instrument lighting is controlled by rotation of the FLIGHT INST control on the right console.

MAGNETIC COMPASS (STANDBY).

On aircraft → [16] [18] → [26], an AQU-5/A Magnetic Compass is mounted on the right instrument cowl to display the magnetic heading of the aircraft as a supplement to the normal navigation instruments and systems. On aircraft [17] [27] →, the magnetic compass is mounted on the left instrument cowl. Electrical power for instrument lighting is controlled by rotation of the FLIGHT INST control on the right console.

AAU-19/A ALTIMETER.

The AAU-19/A servo-pneumatic altimeter is a combined pneumatic altimeter and servo repeater indicator. The servo repeater indication is controlled by the Air Data Computer and is corrected for position error. The position error correction applied internally in the Air Data Computer is not optimum for all flight conditions and thus additional corrections must be applied. The pneumatic function operates in a normal barometric manner and is uncorrected for position error. The normal mode of operation is the servoed mode which is obtained by placing the RESET-STBY lever on the lower right corner of the instrument case in RESET when normal aircraft power is available. If power failure, ADC failure, or servo system malfunctions occur, the altimeter automatically reverts to the pneumatic (STBY) mode of operation. During STBY operation, a STBY flag appears on the instrument face to indicate pneumatic operation. The servo and pneumatic position error correction information is contained in Appendix I and in T.O. 1A-7D-1CL-1.

WARNING

If the altimeter's internal vibrator is inoperative due to either internal failure or dc power failure while in the STBY mode only, the 100-foot pointer may momentarily hang up when passing through "0" (12 o'clock position). If the vibrator has failed, the 100-foot pointer hangup can be minimized by tapping the case of the altimeter. Be especially watchful for this failure when minimum approach altitude lies within the 800 – 1,000-foot part of the scale (1,800 – 2,000 feet, 2,800 – 3,000 feet, etc), and use any appropriate altitude backup information available for altitude cross-check.

The altimeter has a counter-drum-pointer display. The 10,000- and 1,000-foot counters and the 100-foot drum provide a direct digital readout of altitude in increments of 100 feet, from -1,000 to 80,000 feet. The pointer repeats the 100-foot indications of the drum, and serves both as a vernier for the drum and as a quick indication of the rate and sense of altitude changes. Two methods may be used to read indicated altitude on the counter-drum-pointer altimeter: (1) read the counter-drum window, without reference to the pointer, as a direct digital readout in thousands and hundreds of feet, or (2) read the thousands of feet on the two counter indicators, without referring to the drum, and then add the 100-foot pointer indication.

During standby operation, an internal vibrator operates to minimize friction to allow a smoother display during altitude changes. A dithering pointer and counter-drum may be noticeable due to vibrations set up by the vibrator. This behavior is an indication that the vibrator is operating and shall be considered normal provided excursions of the pointer do not exceed approximately the width of a large graduation marker on the dial face and the counters are not excited to the extent that the counters appear blurred. Should vibrator failure occur, the altimeter continues to function pneumatically, but the dithering will not be present and a less-smooth movement of the instrument display is evident with changes in altitude.

If the altimeter automatically reverts to STBY, an attempt should be made to reset to the servoed mode. If the fault condition was temporary, the altimeter will reset and the STBY flag will disappear.

The altimeter setting is entered in the normal manner and can be set over a range from 28.10 to 31.00. A field elevation check should be made in both the pneumatic and servoed modes of operation, using the normal ±75 feet as the maximum allowable error in either case. In addition, indications in the two modes should correspond to within 75 feet.

CAUTION

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

Note

If altimeter setting knob can be moved in or out and the pointer moves without a corresponding change of the barometric setting when the knob is rotated, accurate altimeter settings cannot be made.

In the event of loss of the barometric altimeter and the radar altimeter, the cabin altimeter can be used for rough estimation of altitude below 8,000 feet. Most accurate altitude readings are made while maintaining a constant altitude. Because of instrument lag, changing altitude results in erroneous indication.

At high airspeeds, the differences between servoed and pneumatic indications can be as much as 1,000 feet.

AIRSPEED – MACH INDICATOR.

An AVU-8/A Airspeed – Mach indicator is installed on the instrument panel. A pointer indicates airspeed below 0.5 Mach and both airspeed and Mach number at 0.5 Mach and above. The range of the instrument is from 80 to 850 knots of airspeed and from 0.5 to 2.2 Mach. The calibrated operating altitude is from minus 1,000 feet to plus 80,000 feet. A maximum allowable speed pointer indicates, in terms of indicated airspeed, the specific airspeed value which has been preset into the indicator. An airspeed setting index is incorporated on the dial face which can be manually set by a control knob (SET INDEX) located on the lower right corner of the case. The airspeed index is set by rotating the knob left or right over the range of 100 to 700 knots indicated airspeed. Electrical power for instrument lighting is controlled by rotation of the FLIGHT INST control on the right console.

TRUE AIRSPEED INDICATOR.

The true airspeed indicator receives inputs from the Air Data Computer to provide a continuous display of true airspeed. A flag covers the true airspeed indication when the Air Data Computer system is inoperative. On aircraft → [16] [18] → [26], the true airspeed indicator is located on the instrument panel. On [17] [27] →, the indicator is located on the right console.

RADAR ALTIMETER.

An AN/APN-141(V) Radar Altimeter provides a continuous, highly accurate indication of absolute altitude from 0 (±5 feet) to 5,000 feet above terrain or water. The equipment is accurate within plus or minus 5 feet or plus or minus 5 percent of absolute altitude, whichever is greater. The radar altimeter supplies altitude information to the Forward Looking Radar and to the Head-Up Display.

The altitude indicator is located on the instrument panel. The indicator has a dial graduated from 0 to 5,000 feet, a pointer, an OFF flap, a low altitude limit indexer, and a mask. The dial is graduated in 10-foot increments between 0 and 200 feet, 50-foot increments between 200 and 600 feet, 100-foot increments between 600 and 2,000 feet, and 500-foot increments between 2,000 and 5,000 feet. The OFF flag is visible when the set is off, when pointer indication is unreliable, or when airplane altitude is above 5,000 feet.

Operating limits vary with altitude. At 5,000 feet absolute, the radar altimeter should operate normally with a 30-degree bank angle or with a 50-degree climb or dive angle.

Operation.

The system should be ready for operation after a 3-minute warmup period.

A control knob, located on the height indicator, is rotated clockwise to turn the set on and is used to set a low altitude limit index marker. The knob is also used to perform a self-test function. Pressing the control knob causes the range integrator and transmitter section to operate in the low altitude mode and causes ramp triggering operation in the high altitude mode. If the set is working properly, a resulting indication of 0 (+10, -5) feet is displayed, regardless of actual aircraft altitude. When the aircraft descends below the altitude selected by the index marker, a warning light on the instrument panel illuminates. In flight, with the set operating, pressing the

ANGLE-OF-ATTACK INDICATIONS

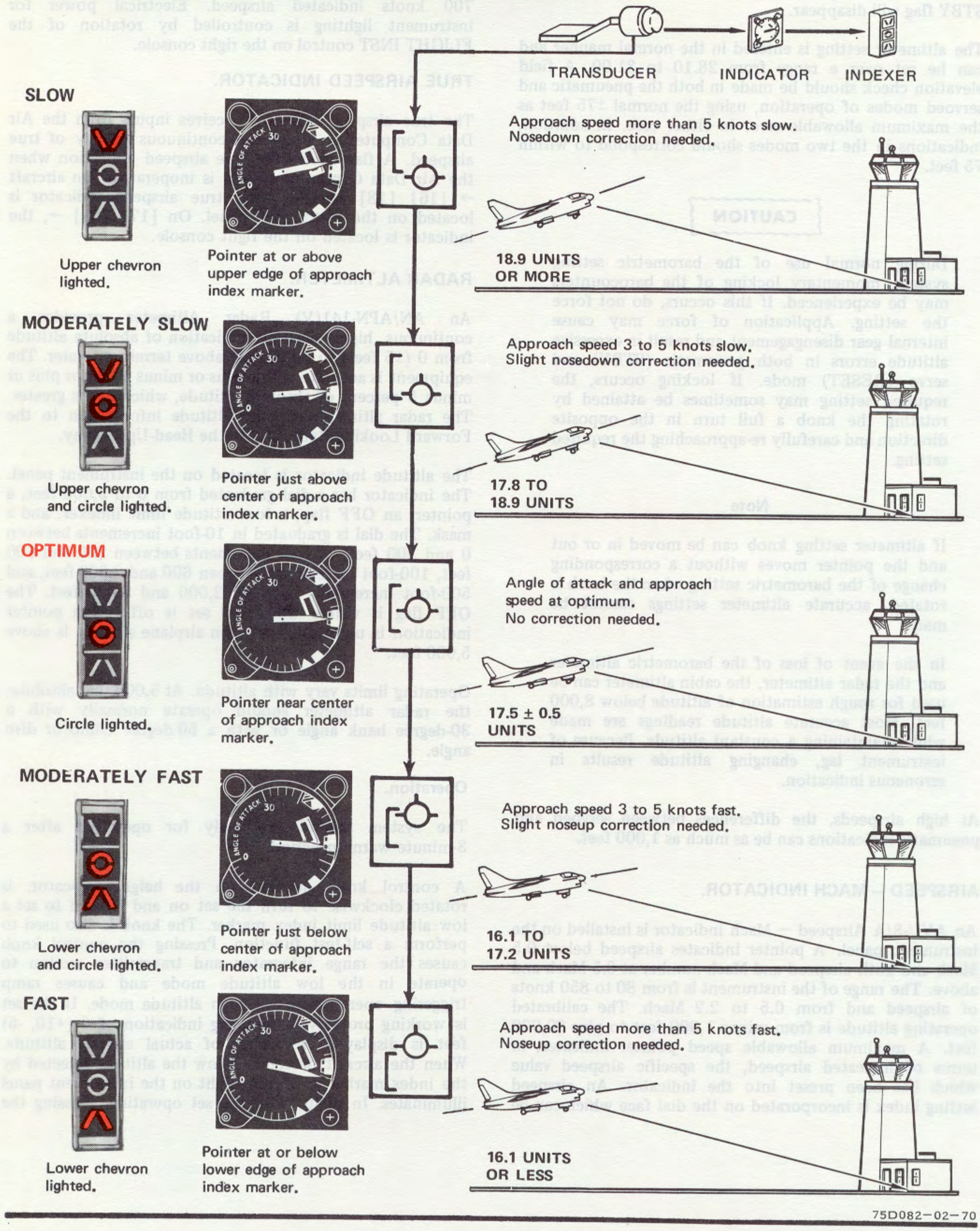


Figure 1–58

control knob actuates the self-test function. The set is automatically in the self-test mode whenever weight is on the gear.

VERTICAL VELOCITY INDICATOR.

An AAU-18A vertical velocity indicator, located on the instrument panel, senses atmospheric pressure changes to give a visual indication of rates of ascent and descent from zero to 6,000 feet per minute. A zero adjustment screw is accessible at the lower left front of the case. Electrical power for instrument lighting is controlled by rotation of the FLIGHT INST control on the right console.

ATTITUDE INDICATOR (STANDBY).

A remote standby attitude indicator is located on the instrument panel and is for emergency use in the event of failure of the primary attitude indicating system. The remote system displays airplane pitch and roll with respect to gravity vertical. The system functions through 360 degrees of roll attitude, but is limited to plus or minus 82 degrees from horizontal in pitch attitude. System components consist of a vertical displacement gyro, standby attitude indicator, and a rate switching gyro.

Displacement signals to drive the indicator are supplied by the vertical displacement gyro which senses aircraft pitch and roll attitude. The vertical gyro also supplies pitch displacement signals to the automatic flight control system (AFCS) pitch computer. The rate switching gyro disconnects the roll erection function in the displacement gyro to prevent false erection of the displacement gyro when the aircraft rate of turn exceeds 15 degrees per minute.

A STBY ATTD ERECT switch on the left console provides manual control of fast erection voltage of the displacement gyro. Actuation of the switch allows the pilot to speed up the normal erection rate until approximately level indications are obtained on the standby attitude indicator.

CAUTION

The fast erect circuit remains energized until the STBY ATTD ERECT switch is released. The switch should not be held in ERECT position for periods exceeding 30 seconds during any 2 1/2-minute period, as damage to the gyros may occur.

The system is powered by the primary ac bus. A power failure during operation will cause an OFF flag to appear on the indicator.

ANGLE-OF-ATTACK INDICATING SYSTEM.

The Angle-of-Attack Indicating System senses aircraft angle of attack and displays this information to the pilot.

Angle of attack is read from a dial-type indicator on the instrument panel and by approach indexer lights on the windshield frame. Indexer lights operate only when the landing gear handle is down. The angle-of-attack indicator operates during all flight phases. The indicator has preset (not adjustable by pilot) index markers to indicate the desired angle of attack for basic 1g flight conditions. Angle-of-attack indications are illustrated in figure 1–58. Angle-of-attack markers are illustrated in figure 1–59.

ANGLE-OF-ATTACK MARKERS

CONDITION	UNITS	MARKER
Maximum range	10.7	
Maximum endurance	13.4	
Landing approach	17.5	
Stall	23.0	

75D250–02–70

Figure 1–59

USE OF SYSTEM AS AN EMERGENCY AIRSPEED INDICATOR.

If the airspeed indicator fails or is suspected to be erroneous, the angle-of-attack indicator can be used to establish desired flight conditions. Units angle of attack used to establish various flight conditions are presented in the Pitot-Static System Failures discussion in the Inflight Emergencies, Section III.

Note

If the airspeed indicator is lost or suspected to be erroneous, the TAS indicator may be similarly affected.

THE MECHANICS OF SYSTEM OPERATION.

The angle-of-attack indicator receives signals from a transducer located on the left side of the fuselage. The indicator reflects indicated angle of attack (true angle is less than indicated). In the region of the optimum approach angle of attack, each unit on the indicator dial is equal to 1.5 degrees of indicated angle of attack or approximately 5 knots indicated airspeed.

The transducer also supplies signals which actuate the stall warning system and cause automatic cutoff of AFCS roll augmentation. If angle of attack reaches 20.5 units, a switch in the angle-of-attack indicator closes to complete a circuit which causes the right rudder pedal to shake. If angle of attack reaches approximately 22 units, a circuit is completed which automatically cuts off AFCS roll augmentation to prevent pro-spin aileron from being applied by the AFCS.

The angle-of-attack indicator controls operation of the approach indexer to provide indications of high, optimum, and low angles of attack in the landing condition. The indexer is operated relative to pointer movement about the reference index marker at the 3 o'clock position on the indicator.

Due to an allowable indicator tolerance of plus or minus 0.5 units, the pointer position on an indicator may be as high as 18.0 or as low as 17.0 units when the angle-of-attack vane is in optimum position (17.5 units). Each indicator should be adjusted to bring pointer and scale to the center of the index marker at the 3 o'clock position, provided the allowable tolerance is not exceeded.

On aircraft → [16] [18] → [26], the approach indexer lights function when the landing gear handle is in WHLS DOWN and the APPROACH INDEXER dimming knob is rotated out of the OFF position. On aircraft [17] [27] →, functions of the APPROACH INDEXER dimming knob are controlled by the WINDSHIELD BOW lights dimming knob. Light intensity is controlled by positioning either dimming knob as desired out of the OFF position.

A pilot preflight check is performed during the exterior inspection to ensure that the angle-of-attack vane or arm is not bent.

ELECTRICAL POWER.

Power for the Angle-of-Attack Indicating System and Stall Warning System is supplied by the emergency dc bus.

CANOPY.

The canopy consists of an aluminum frame with the optical portion formed of stretched acrylic plastic. Normally, the pilot or ground crewman opens and closes the canopy manually. Manual operation is made possible by a pneumatic counterbalance cylinder. In the event the canopy jams or cannot be opened manually, it can be jettisoned by means of a pyrotechnic impulse cartridge. Jettisoning is accomplished by use of exterior or cockpit-mounted emergency jettison handles or through seat ejection.

The canopy is locked in the closed position by four rotating hooks. The hooks rotate up into the canopy and engage four rollers in the canopy frame. A CANOPY not locked light on the caution panel (right console) illuminates when the canopy is unlocked. The instrument panel-mounted MASTER CAUTION light also flashes.

Safety pins that must be removed prior to flight include the interior canopy jettison initiator (forward side, left longeron), the ejection seat initiator (upper left side of seat), and canopy actuated initiator (aft near canopy actuator).

NORMAL OPERATION.

The canopy is locked and unlocked by a release handle on the right side of the cockpit. Pulling the handle aft unlocks the canopy. Pushing the handle forward locks the canopy. When not in use, the handle may be telescoped to the stowed position to give better access to the right console-mounted controls. With the canopy unlocked, it automatically raises to the full open position. A slight downward pull closes the canopy. A closing handle located at the top of the canopy bow aids in opening and closing. The canopy should be held during all opening and closing to avoid undue stress on the shearpins that could lead to inflight canopy loss.

CAUTION

The throttle will be placed in IDLE before opening or closing the canopy with the engine running. Open the canopy slowly in cold weather. Hydraulic dampening fluid in the canopy actuator flows less freely at lower temperatures. Therefore, rapid movement of the canopy could shear the canopy actuator shearpin.

Note

During ground operations and with the canopy open, a tailwind of approximately 15 knots causes the canopy to slowly lower to the closed position.

An exterior canopy release handle located on the left side of the aircraft and below the canopy rail is provided to permit locking and unlocking from the outside. The handle is flush-mounted with the surface and springs out when the handle latch is released. Turning the handle counterclockwise unlocks the canopy, and turning the handle clockwise to the horizontal position locks the canopy. When the handle is in the stowed position, it is disengaged from the canopy locking mechanism.

Note

To prevent damage to the exterior release handle, it should be returned to the stowed position before entering the cockpit and operating the interior release handle.

A dampening device in the canopy actuator prevents rapid canopy movement that may otherwise shear the pivot bolts by overtravel beyond the full-up position.

CAUTION

The canopy should be manually restrained when opening during periods of strong, gusty wind conditions to prevent actuator rod shearpin failure.

JETTISONING THE CANOPY.

The canopy can be jettisoned for inflight, landing, or ground emergencies and is automatically jettisoned during the seat ejection sequence. Pulling the canopy emergency jettison handle on the left side of the cockpit or pulling either exterior jettison handle fires their respective M99 initiator which detonates an MK-14 impulse cartridge that jettisons the canopy. There are two exterior jettison handles, one on each side of the aircraft.

WARNING

Do not attempt to jettison a partially opened or raised canopy. Do not eject with the canopy in the partially or fully open position.

To jettison the canopy from the cockpit, the interior canopy jettison handle is moved forward, down, and then full aft.

CANOPY CONTROLS.

Canopy controls are illustrated and described in figure 1–60.

EJECTION SEAT AND PILOT'S EQUIPMENT.

The aircraft is equipped with a rocket catapult powered ESCAPAC IC-2 Ejection Seat Escape System. From the time the pilot pulls the ejection control until the parachute opens and the survival kit deploys (AUTO selected), all ejection functions occur automatically. The ESCAPAC IC-2 Ejection Seat System provides safe escape during level flight conditions from ground level to 50,000 feet and from zero airspeed through 650 KIAS. The ejection seat is illustrated in figure 1–61. Altitude required for safe ejection increases greatly as sink rate and bank angle is increased. Therefore, ejection should not be delayed (see figures 3–1, 3–2, 3–3, 3–5, and 3–6).

ESCAPE SYSTEM DESCRIPTION.

The Escape System consists of the following subsystems: ejection seat, ejection seat sequencing/canopy jettison controls, rocket catapult, stabilization, separation, parachute, survival kit container, and restraint and seat adjustment.

The ejection seat is the core of the escape system from which the other subsystems operate. The seat is a high-strength, lightweight, upright seat of monocoque construction. It employs canopy breakers which flip up into position for possible canopy penetration during ejection. The ejection seat control system is illustrated in figure 1–62. A primary ejection handle is located on the front beam of the ejection seat between the pilot's legs, and an alternate face curtain control is located above the headrest. Either handle may be pulled to initiate ejection. Located between the two headrest pads is an ejection control safety handle which prevents inadvertent seat ejection when placed in the down-and-locked position.

WARNING

Do not unbuckle leg straps before entering or exiting cockpit. Unbuckled straps may become entangled with the primary ejection handle and fire the seat.

Once either ejection handle is pulled, the seat sequencing/canopy jettison system provides automatic jettisoning of the canopy and seat ejection as soon as the canopy has had time to clear the ejection path of the seat. If the canopy fails to jettison during a normal ejection sequence, the seat ejects through the canopy with no interruption of the sequence and no additional pilot action required.

A MK-7 MOD 2 rocket catapult provides thrust to eject a maximum mass of 400 pounds at zero altitude and zero airspeed to a height necessary to give a full parachute at 90 feet. The rocket catapult has an initial catapult boost stroke which is initiated by hot gases from the canopy jettison/seat sequencing system. The sustaining rocket thrust is ignited by the catapult boost charge.

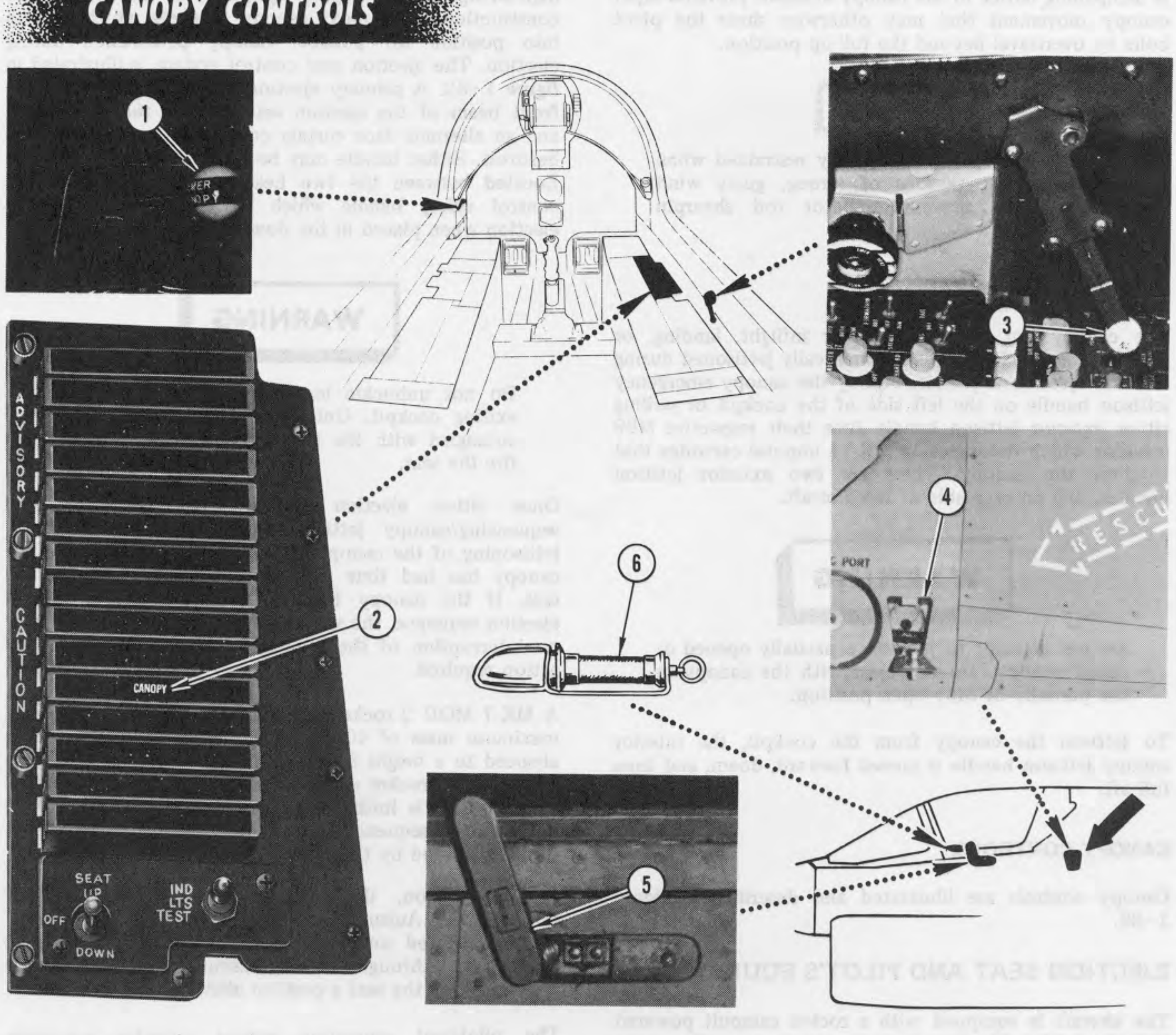
During ejection, the seat is stabilized by a DART (Directional Automatic Realignment of Trajectory) lanyard located under the seat. The DART lanyard is played out through braking devices under a specific tension giving the seat a positive attitude.

The pilot/seat separation system provides automatic release of the pilot's shoulder harness, lap belt, and both ejection control handles, and positive separation of the pilot from the seat by nitrogen inflated bladders after the pilot's restraint has been released. These bladders are located in the seat pan and backrest.

WARNING

Inadvertent firing of the harness release actuator delay cartridge (MK 86 Mod 0) will result in rotation of the harness release bellcrank and preclude ejection from the aircraft. In addition to inflation of seat and back bladders, both primary and secondary ejection control handles, shoulder harness and lap belt will be disconnected by rotation of the harness release bellcrank. Approach end or barrier engagements should be avoided because of the lack of pilot restraint.

CANOPY CONTROLS



Nomenclature	Function
1. Canopy emergency jettison handle	Moved forward, down and aft — fires initiator cartridge which fires actuator cartridge to jettison canopy.
2. Canopy caution light	On — (CANOPY) indicates canopy hooks not fully engaged.
3. Interior release handle	Aft position — rotates canopy hooks to unlock canopy. Forward position — rotates canopy hooks to lock canopy. Stowed position — knob pushed in to limit of travel.
4. Exterior jettison handles (one on each side of aircraft)	Pulled — fires initiator cartridge which fires actuator cartridge to jettison canopy.
5. Exterior release handle	Rotated counterclockwise — rotates canopy hooks to unlock canopy. Rotated clockwise — rotates canopy hooks to lock canopy.
6. Canopy breaker tool (left canopy rail)	Use to break away the canopy for emergency egress should all other methods of opening the canopy fail.

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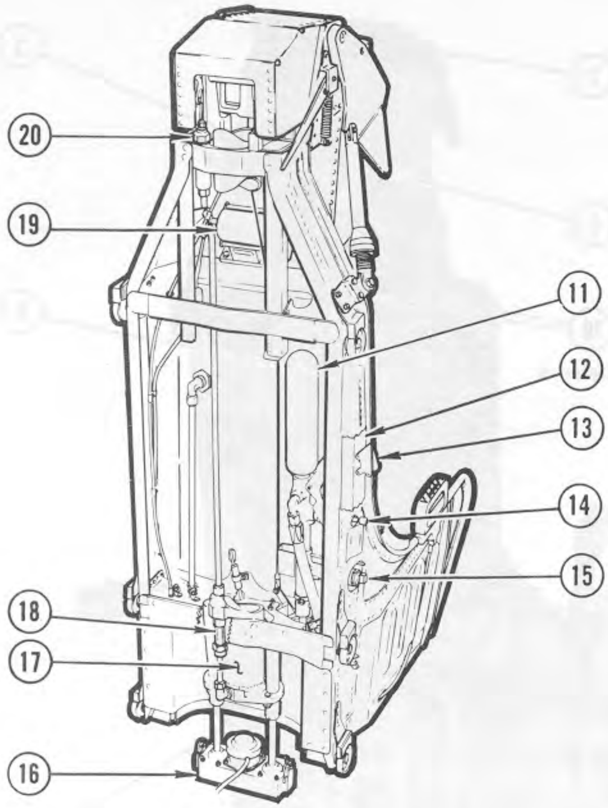
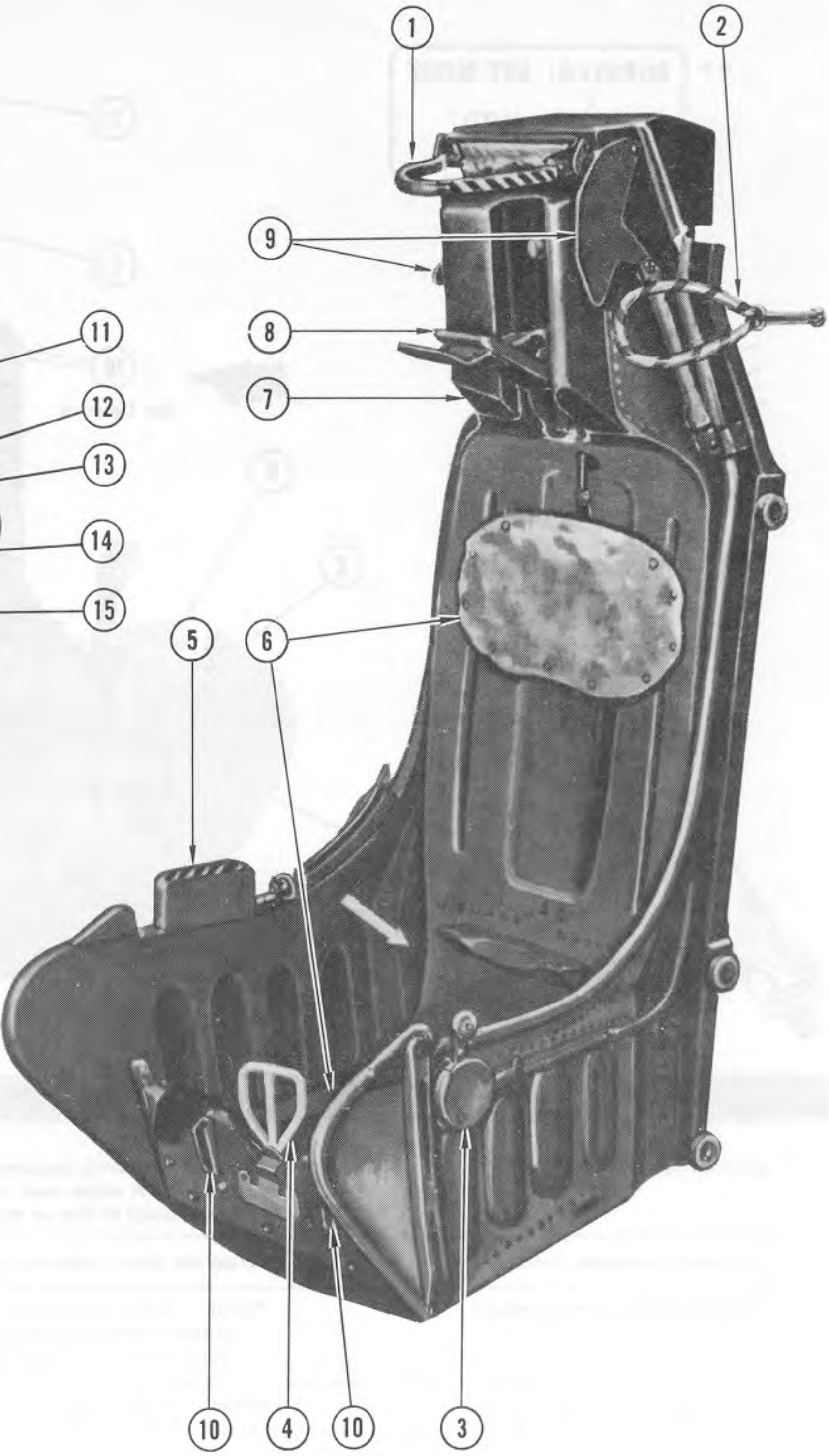
Figure 1–60

EJECTION SEAT





1. Face curtain ejection handle
2. Canopy jettison override handle *
3. Inertia reel control lever
4. Primary ejection handle
5. Emergency harness release handle
6. Separation bladders
7. Headrest
8. Ejection controls safety handle
9. Flip-up canopy breakers
10. Seat pivot rods for survival kit hooks
11. Nitrogen storage bottle
12. Seat rail
13. Harness release striker plate
14. Harness release actuator detent pin
15. Harness release actuator firing pin sear
16. Seat adjust actuator
17. Catapult (cutaway)
18. 0.4-second delay initiator
19. Shoulder harness inertia reel
20. M99 seat initiator

* On aircraft → [10]

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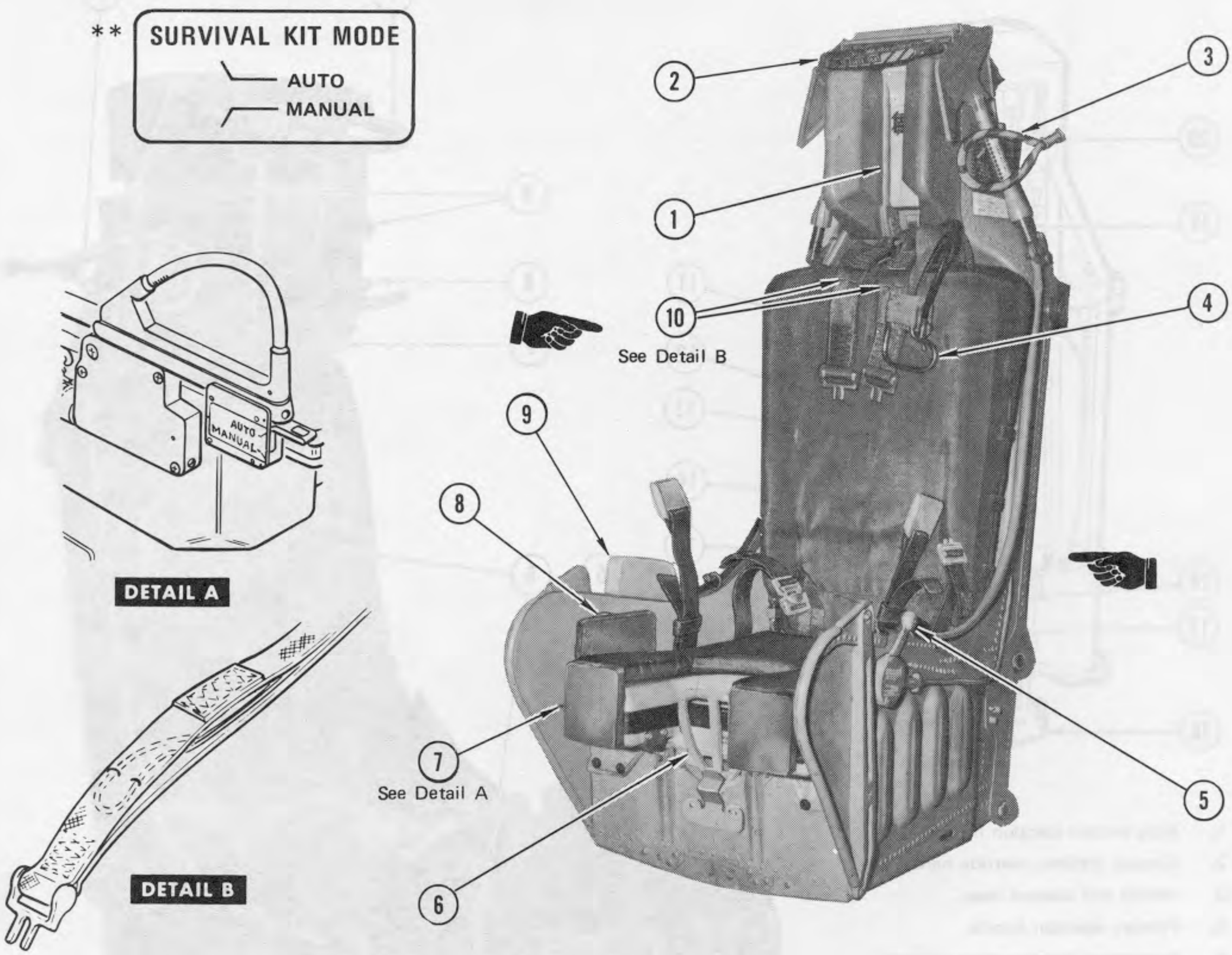
Figure 1–61

EJECTION SEAT CONTROLS



Nomenclature	Function
1. Ejection controls safety handle	Lowered – prevents inadvertent seat ejection by pulling either of the ejection handles. A safety lever must be manually depressed before the handle can be returned to the up or armed position.
2. Face curtain ejection handle	Pulled out fully – jettisons canopy and ejects seat.
3.* Canopy jettison override handle	Pulled – interrupts automatic canopy jettison portion of seat ejection sequence so that when the primary ejection handle or the face curtain is pulled, the seat ejects through the canopy.
4. Parachute manual D-ring	Pulled – deploys parachute.

*On aircraft → [10]

**On aircraft 203 → and → 202 after TCTO 1A-7D-625, a placard is installed on the right canopy rail for easy reference of survival kit mode switch position.

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Figure 1–62 (Sheet 1)

EJECTION SEAT CONTROLS

Nomenclature	Function
5. Inertia reel control lever	In aft (unlocked) position – unlocks shoulder harness inertia reel. Inertia reel will automatically lock if subjected to an inertia load of more than 2.0 g. If inertia reel has automatically locked, cycle control to release. In forward (locked) position – locks inertia reel at any increment of strap extension. Prevents forward motion of pilot in excess of 1/2 inch.
6. Primary ejection handle	Pulled upward fully – jettisons canopy and ejects seat.
7. Survival kit mode select switch	AUTO (up) – survival kit automatically deployed after parachute opens. MANUAL (down) – survival kit deployed by pulling the survival kit release handle all the way out.
8. Emergency kit release handle	Emergency egress (survival kit in seat): Handle pulled – frees pilot from survival kit. Ejection (after parachute deployment): Handle pulled – deploys kit.
9. Emergency harness release handle	Trigger squeezed and handle pulled up – releases parachute shoulder harness and lap belt from the seat. Disconnects parachute arming cable so pilot can leave the seat with parachute and survival kit.
Seat adjustment switch (located on the right console)	UP or DOWN (spring loaded to OFF) – raises or lowers seat to desired height. Also, as seat lowers, face curtain handle is raised and vice-versa.
10. Four-line jettisoning lanyard	Pulled (2) – releases the correct four suspension lines for improved directional control during descent after parachute opening.

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Figure 1–62 (Sheet 2)

Note

If automatic release from the seat fails to occur, the pilot must manually release himself, parachute and survival kit by squeezing and then pulling the emergency harness release handle, and rolling forward and away from the seat. Pulling the emergency harness release handle releases the pilot's restraint shoulder straps and lap belt.

The seat is equipped with an NB-10A back style parachute. The semirigid contoured pack contains a 28-foot four color parachute canopy, an automatic opener and a survival kit deployment sensing cable. The automatic opener is powered by a MK-5, 2-second delay cartridge. An aneroid prevents opener operation unless at or below a preset altitude of 14,000 (±500) feet above sea level. The parachute opener is armed at first seat movement by a delay lanyard attached to the aircraft structure.

The seat also accommodates a USAF rigid seat survival container. For pilot comfort the fiber glass container is fitted with a 1-inch thick cushion.

WARNING

No additional material for cushions shall be used as injury could result on ejection.

With the mode select switch the pilot can elect to manually deploy the survival kit or let it automatically deploy 4 seconds after parachute line stretch. On kit deployment the kit opens and the liferaft and survival kit bottom containing the ruck sack and the survival items fall away from the pilot but remain attached to his harness by a 25-foot lanyard. The inflation bottle for the raft is actuated when the connecting lanyard becomes taut. For interface between the pilot's PCU-3/P torso harness and the kit, Air Lock 720 type connectors are used. As an aid to the pilot on emergency ground egress, a mode sensor gives him the ability to egress from the cockpit leaving his survival kit without disconnecting the two Air Lock 720 type connectors. This is accomplished by first pulling the emergency kit release handle all the way out, then pulling the harness release handle, and then standing up. The Emergency Egress procedure is presented in Section III.

The PCU-3/P torso harness, when used with the inertia reels and independent lap belt, positively restrains the pilot in the seat during the application of flight loads and negative g loads; the torso harness provides positive torso restraint during the parachute opening. Connectors are provided on the harness to interface with the parachute riser connectors and the survival kit retention strap connectors. Also mounted on the harness is the CRU-60/P oxygen connector mounting plate.

The lap belt, which is fully independent of the torso harness, connects into the lap belt attach fittings on the lower rear inside seat side, providing lower body restraint for the pilot.

The inertia reel with the torso harness functions as a self-compensating restraint against involuntary forward movement. An inertia reel control lever on the left arm of the seat can be manually locked or unlocked to prevent or allow extension of the shoulder harness straps. In the locked position, each time the pilot leans back in the seat, the spring-loaded inertia reel automatically rewinds any slack in the straps. Each time the inertia reel senses induced forward loads of 2g to 3g, it automatically locks regardless of the preselected position. Once automatically locked, the lock can be released by cycling the control lever to lock and back to unlock.

The seat adjustment switch located on the right console permits vertical height adjustment of the seat. AC power is required to raise or lower the seat.

EJECTION SEQUENCE DESCRIPTION.

Canopy Jettison/Seat Ejection → [10]

Canopy jettison/seat ejection are initiated by pulling either the primary ejection control handle or the face curtain handle. Pulling either handle raises the canopy breakers, initiates the canopy actuator, and jettisons the canopy. After 0.4-second delay, the initiator fires and ejects the seat. In the event the canopy fails to jettison, the seat ejects through the canopy after the 0.4-second delay has expired.

Canopy Jettison/Seat Ejection [11] →

Canopy jettison/seat ejection are initiated by pulling either the primary ejection handle or the face curtain handle. Pulling either handle raises the canopy breakers, initiates the canopy actuator, and jettisons the canopy. As soon as the canopy is clear of the ejection path, an initiator mechanically linked to the canopy fires and ejects the seat. In the event the canopy fails to jettison or the canopy operated initiator fails to fire during an ejection sequence, the seat ejects through the canopy after a 0.4-second time delay.

As the seat moves up the guide rails, the harness release time delay cartridge is actuated, pilot's services are disconnected at their respective disconnects and the parachute arming lanyard is pulled actuating the delay portion of the parachute opening cartridge. The sustainer portion of the rocket catapult is ignited as the two barrels separate. As tension is applied to the DART lanyard, the ECM destruct/emergency IFF switch is thrown to destroy the ECM, erase mode 4 from the Mk XII computer, and turn on the emergency IFF signal.

One second later, when the delay portion of the harness release cartridge has expired and the seat is at the maximum height of its trajectory, the cartridge fires, actuating simultaneous release of the parachute shoulder straps and lap belt connections to the seat and inflating the separation bladders which force the pilot from the seat. Two seconds from its initiation or approximately 1 second after the pilot has separated from the seat, the parachute opener fires, deploying the parachute.

Note

> If automatic release from the seat fails to occur, the pilot must manually release himself, parachute, and survival kit by pulling the emergency harness release handle located on the seat.

The 1-second delay between seat/man separation and parachute opening provides safe separation between the seat and the pilot, and if at high airspeeds, permits body deceleration to approximately 250 knots prior to parachute opening.

Note

> If the automatic parachute opener fails to deploy the parachute, the parachute must be deployed by pulling the parachute D-ring.

Automatic survival kit deployment occurs 4 seconds after parachute line stretch, if the automatic mode has been selected. Liferaft inflation occurs when the kit deploys.

See Sequence of Events illustration under Ejection, Section III.

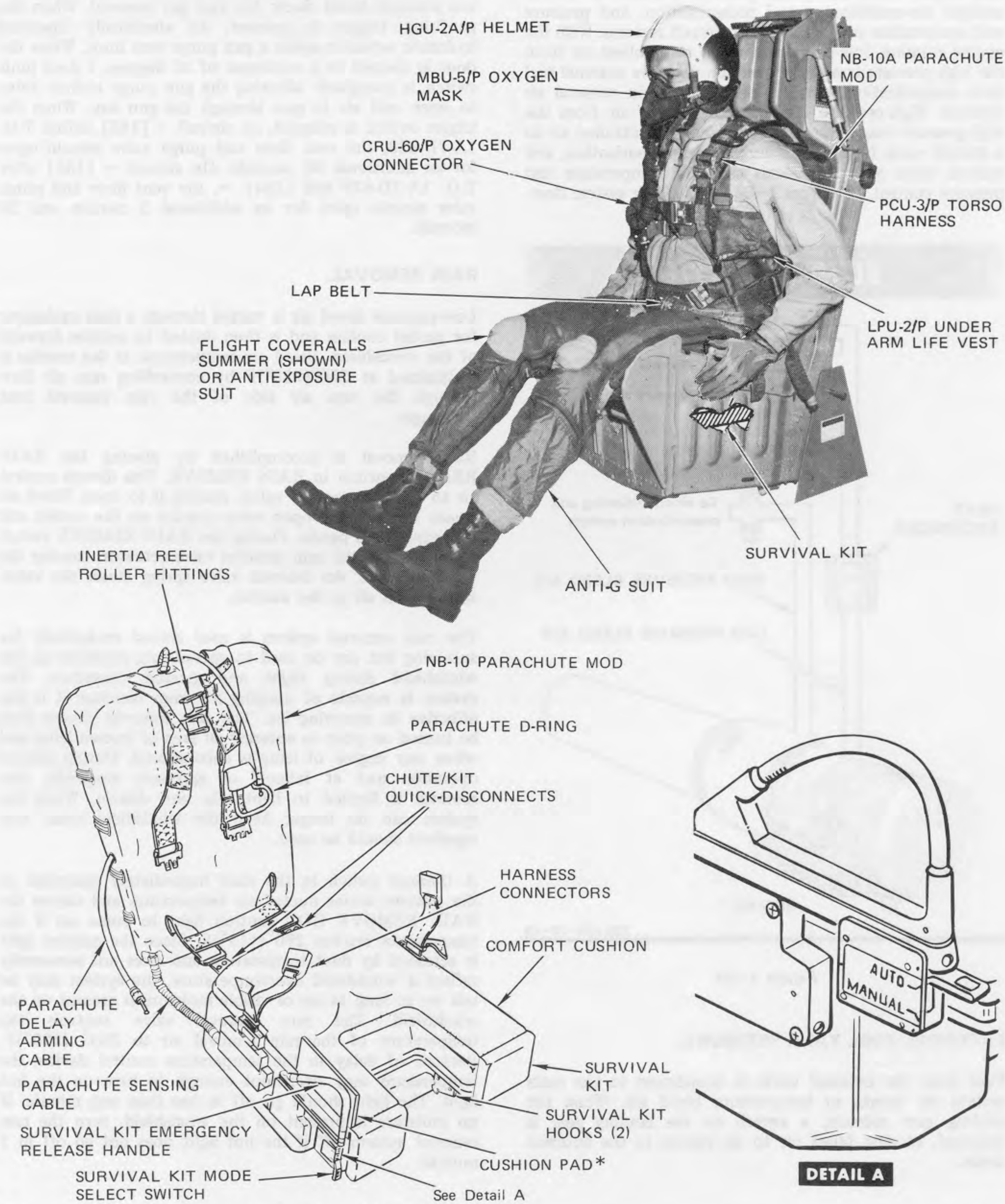
PILOT'S EQUIPMENT.

Pilot's equipment is illustrated in figure 1–63.

INFLIGHT SUSTENANCE SYSTEM [11] →

The inflight sustenance system consists of two liquid containers (insulated vacuum bottles) for use during extended flight. Each container is bracket mounted, one on each side of the cockpit near the ejection seat. When a nozzle valve at the lower end of either container is turned on, liquid flows through a flexible feeding tube attached to the valve. By releasing a spring-loaded button on the feeding tube probe, contained liquid is released. To discontinue feeding, depress the button on the feeding tube probe and close the valve at the container. A pouch located below each container is provided for feeding tube stowage when not in use.

PILOT'S EQUIPMENT



*On aircraft → [202] after T.O. 1A-7D-355-1 and [203] →

Figure 1–63

BLEED AIR SYSTEM.

The engine bleed air system provides a source of air for cockpit air-conditioning and pressurization, and pressure and temperature control of other aircraft systems. With the engine running, low-pressure seventh stage bleed air from the high-pressure compressor section provides external fuel tank pressurization, gun gas purge, and rain removal air systems. High-pressure eleventh stage bleed air from the high-pressure compressor section provides controlled air to a shutoff valve for air-conditioning and pressurization, and various other aircraft systems requiring temperature and pressure control. See figure 1–64 for bleed air system flow.

BLEED AIR SYSTEM

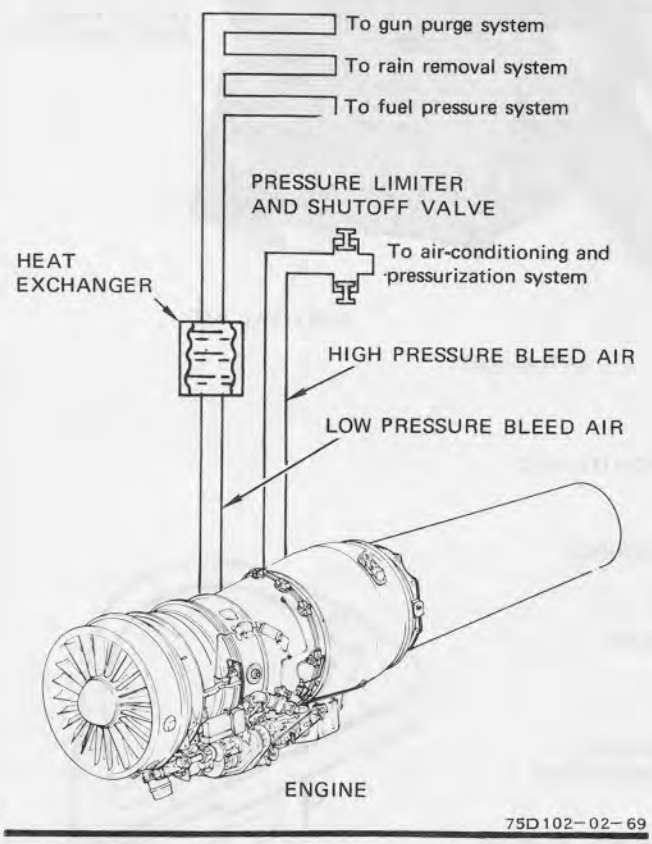


Figure 1–64

EXTERNAL FUEL TANK PRESSURE.

Fuel from the external tanks is transferred to the main system by means of low-pressure bleed air. When the landing gear retracts, a switch on the landing gear is actuated, causing bleed air to be routed to the external tanks.

GUN GAS PURGE.

The gun bay venting system utilizes air from the low pressure bleed ducts for gun gas removal. When the gunfiring trigger is pressed, an electrically operated hydraulic actuator opens a gun purge vent door. When the door is opened to a minimum of 20 degrees, a door limit switch is energized allowing the gun purge airflow valve to open and air to pass through the gun bay. When the trigger switch is released, on aircraft → [183] before T.O. 1A-7D-628, the vent door and purge valve remain open for an additional 30 seconds. On aircraft → [183] after T.O. 1A-7D-628 and [184] →, the vent door and purge valve remain open for an additional 1 minute and 20 seconds.

RAIN REMOVAL.

Low-pressure bleed air is routed through a heat exchanger for partial cooling and is then ducted to nozzles forward of the windshield. Bleed air temperature at the nozzles is maintained at 250°(±20°)F by controlling ram air flow through the ram air side of the rain removal heat exchanger.

Rain removal is accomplished by placing the RAIN REMOVE switch in RAIN REMOVE. This directs control air to the rain remove valve, causing it to open. Bleed air passes through the open valve nozzles on the center and left windshield panels. Placing the RAIN REMOVE switch in OFF vents the rain removal valve actuator, causing the valve to close. An internal valve spring closes the valve, shutting off air to the nozzles.

The rain removal system is used almost exclusively for anti-icing but can be used to spread rain repellent on the windshield during flight and ground operation. The system is capable of keeping ice from forming; it is less effective in removing ice. The rain removal system shall be turned on prior to entering an area of known icing and when any degree of icing is encountered. During ground operation and at takeoff or approach airspeeds, rain removal is limited to light rain and drizzle. When the system can no longer keep the windshield clear, rain repellent should be used.

A thermal switch in the duct immediately upstream of the nozzles senses ducted air temperature and causes the RAIN REMOVE HOT caution light to come on if the temperature reaches 290°(±10°)F. Since the caution light is actuated by duct temperature and does not necessarily reflect a windshield overtemperature, the system may be left on as long as ice or visible moisture is present on the windshield. The rain removal valve controls the temperature of the rain removal air to 250° (±20°)F. Because of delay in the temperature control device, the temperature may overshoot enough to turn on the hot light. The light should go off in less than one minute. If no moisture is present on the windshield, turn the rain removal system off if the hot light does not go off in 1 minute.

RAIN REPEL.

The rain repel system may be operated separately or in conjunction with the rain removal system. When the RAIN REPEL button is pressed, the rain repellent chemical is applied for 0.17 second. The chemical is applied to the center and left windshield from exit nozzles located near the rain removal duct nozzles. The RAIN REPEL button is located on the air-conditioning control panel.

Rain repellent coverage of the lower portion of the center and left windshield is quite good during takeoff, approach, and refueling, without rain removal air. With rain removal air, two rabbit-ear shaped areas at the edges of the center windshield remain free of rain repellent, but coverage on the remainder of the windshield is much improved. To get complete coverage, squirt repellent on the lower part of the windshield with rain remove OFF. Place RAIN REMOVE switch in RAIN REMOVE; squirt repellent until coverage of the windshield is complete. This procedure gives windshield coverage for low speeds at taxi. A high power setting is used when rain removal air is used.

The repellent container is charged with approximately 500 cc of rain repellent chemical and 75 psi of dry nitrogen, which is sufficient for approximately 50 applications. The container is mounted on the cockpit aft bulkhead inboard of the canopy hinge. A sight gage, located beneath the container, provides for checking the container supply.

The number of squirts of repellent for windshield coverage is dependent on bottle pressure. For normal operation, squirt repellent until good coverage is attained or until clouding occurs. Low bottle pressure causes clouding before good coverage is attained. Rain removal air is required to carry the repellent up the windshield.

The length of time an application remains effective varies with rain intensity. Use as necessary during taxi, takeoff, approach, and landing. During heavy rain, one to three applications should be adequate for improved visibility up to 1/2 hour. To extend time between applications, rain removal air may be left on; however, air blast is not required in rain conditions.

CAUTION

Do not apply to a dry windshield or during light rain, as residue may form on the windshield and cause a restriction to visibility.

AIR-CONDITIONING AND PRESSURIZATION.

The air-conditioning system consists of heat exchangers, a compressor and turbine, a bleed air pressure limiter and shutoff valve, associated control valves, and cockpit controls. The system provides cockpit air temperature and pressure control, antiexposure suit ventilation and temperature control, windshield defogging, electronic systems cooling, camera compartment temperature control, radar cooling and wave guide pressurization, and anti-g suit pressure.

The bleed air pressure limiter and shutoff valve regulates airflow to the air-conditioning system. Pneumatic control of the various air-conditioning control valves is furnished by high-pressure control air bled off the high-pressure supply line upstream of the pressure limiter and shutoff valve. Control air also supplies the anti-g suit and radar pressurization. Because control air is bled off upstream of the pressure limiter and shutoff valve, anti-g suit and radar pressurization are unaffected by the position of the cockpit pressure switch.

Ground cooling of the cockpit, antiexposure suit, selected avionic equipment, and camera compartment is obtained by connecting a ground cooling supply to a connector socket on the right side of the fuselage.

Cockpit pressurization is provided by temperature controlled air from the air-conditioning system. Pressurized air enters the cockpit through canopy windshield vents, canopy rail vents, and two floor vents when selected. Proper cockpit pressure is maintained by a pressure regulator that meters cockpit air to the radar compartment where it is exhausted overboard. In the event the cockpit pressure regulator fails, a cockpit air safety valve prevents excessive cockpit pressure.

OPERATION.

The air-conditioning system is turned on by placing the cockpit temperature manual override switch in AUTO and the cockpit pressure switch in CABIN PRESS. This causes control pressure air to open the bleed air pressure limiter and shutoff valve and close the cockpit air safety valve. The opened shutoff valve permits high-pressure bleed air to flow into the heat exchangers and turbine-compressor while the closed cockpit air safety valve permits the cockpit to be pressurized.

To reduce the high temperature of the bleed air from the engine, the air passes through the primary heat exchanger, a compressor, the secondary heat exchanger, and finally through an expansion turbine of the air-conditioner for final cooling. The heat exchangers reduce the temperature of the bleed air by passing ram air around the heat exchanger coils. Some high temperature air is bled off before it reaches the first stage of the heat exchanger. This high temperature air is mixed with refrigerated air in varying amounts to control the temperature of air entering the cockpit and antiexposure suit. High temperature air is mixed with cockpit temperature controlled air for defogging the windshield.

During ground operation with the engine running, in flight with the landing gear down, or in flight with the rain remove system operating, a high-pressure bleed ejector, located in the ram air exhaust of the heat exchanger, creates airflow around the heat exchanger coils for ground air-cooling.

WARNING

There is an air-conditioning exhaust duct on the lower right side of the fuselage forward of the speed brake. Hot air is exhausted down, aft, and outboard. With the engine running or soon after shutdown, direct contact with the metal around the exhaust area could result in burns.

CAUTION

To prevent overheating of air conditioning system, verify that ram air flow starts immediately from ram air exhaust duct after engine start. If no airflow occurs, place switch in CABIN DUMP and shut down engine.

Air-conditioning and pressurization controls are presented in figure 1–65. An air-conditioning and pressurization schematic is presented in figure 1–66.

Cockpit Air Temperature Control.

Cockpit air temperature is controlled by means of an electro-pneumatic control system that regulates the amount of high temperature air to be mixed with refrigerated air. Cockpit temperature may be controlled automatically or manually. With the cockpit temperature manual override switch in AUTO, cockpit temperature is automatically maintained at whatever temperature is set with the cockpit temperature control knob. With the override switch in MAN, cockpit temperature may be manually controlled with the temperature control knob. Foot warmer vents are provided to allow temperature controlled cockpit air to circulate through the cockpit floor area. The vents are manually opened and closed by a PULL FOR AIR knob, located on the right console.

Note

For takeoff, the normal setting of the temperature control knob should be the 12 o'clock position.

Cockpit overtemperature protection is provided in the MAN position by a thermal safety switch in the windshield air supply duct. The switch limits temperature of air coming from the duct to 200°(+10°, -5°)F. If overtemperature occurs, the safety switch actuates and closes the cockpit temperature control valve. When the temperature decreases below 200°(+10°, -5°)F, the switch permits the valve to open. Cycling of the valve causes pressure fluctuation in the cockpit.

Cockpit overtemperature protection in AUTO is provided by an independent temperature control circuit. Maximum cockpit temperature is limited to 185°F to 195°F.

Note

With the manual temperature override switch in MAN and the cockpit temperature knob set further clockwise than the 12 o'clock position, cockpit air may become full hot and pressure variations may occur. This condition can be prevented by rotating the temperature knob counterclockwise from the 12 o'clock position.

Windshield And Canopy Defog.

Internal windshield and canopy fog may be removed by selecting DEFOG on the air-conditioning control panel. Selecting the DEFOG position opens a valve that mixes hot air with cockpit temperature controlled air already being exhausted on the inside of the windshield and windshield side panels. The added heat achieves the necessary defog capability to remove visible moisture from the windshield. A temperature sensing transmitter closes the defog valve any time defog duct temperature exceeds 180°(±10°)F. Additional overtemperature protection is provided by a thermal safety switch, described under Cockpit Air Temperature Control.

Antiexposure Suit Ventilation.

The temperature of antiexposure suit ventilating air is controlled separately from cockpit air. Temperature control between 50°F and 100°F is achieved by means of an electro-pneumatic temperature control system that regulates the amount of high temperature air to be mixed with refrigerated air. Airflow and temperature control is regulated through control knobs located on the cockpit left subpanel. There is no manual mode option to control suit temperature but flow is manually controlled.

Electronic Equipment Cooling.

Some temperature sensitive electronic equipment in the avionic compartments is cooled by unregulated refrigerated air. Other electronic equipment in both the left and right compartments is cooled by ram air introduced by two flush scoops in the engine air inlet duct. Air is exhausted through gills in the left and right sides of the fuselage. With a near zero pressure differential between the engine air inlet duct and the avionic compartments, a fan installed in each exhaust duct is automatically activated to draw air through the inlet duct air scoops. Under conditions of negative inlet duct pressure, reverse flow cooling occurs.

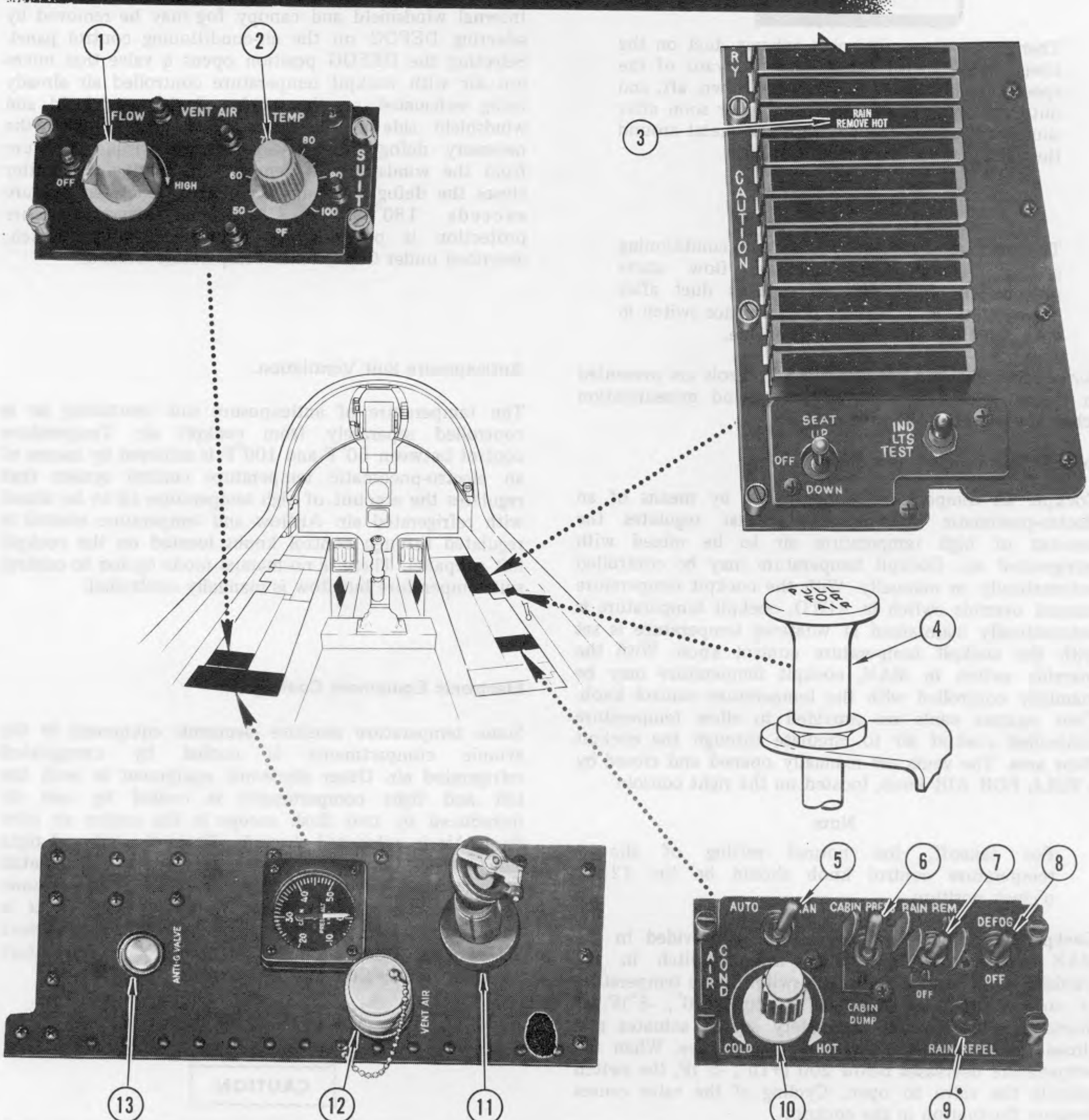
CAUTION

During ground operation, the cabin pressure switch must be in CABIN PRESS for avionic and camera compartment cooling.

Radome Cooling And Ventilation.

With the canopy closed, the radar compartment is cooled and the radome ventilated by cockpit air which is exhausted into the radome through the cockpit air pressure regulator. The radome air is exhausted overboard through exit gills.

AIR-CONDITIONING AND PRESSURIZATION CONTROLS



Nomenclature	Function
1. Flow control knob	OFF to HIGH – with cockpit pressure switch in CABIN PRESS, selects desired volume of ventilating air entering the antiexposure coverall.
2. TEMP control knob	50° to 100°F – selects desired temperature of ventilating air flowing into the antiexposure coverall. Selected temperature automatically maintained by electronic control of suit temperature control valve.

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Figure 1–65 (Sheet 1)

AIR-CONDITIONING AND PRESSURIZATION CONTROLS

Nomenclature	Function
3. Rain remove hot caution light	On (RAIN REMOVE HOT) – indicates rain removal duct temperature is exceeding 290° (±10°)F. This is an indication that the rain and ice removal switch should be turned off unless ice or visible moisture is still present on the windshield or left side panel.
4. PULL FOR AIR knob	Pull (open) – opens foot vents to allow temperature controlled air to circulate through cockpit floor area. Push (close) – shuts off airflow through cockpit floor vents.
5. Cockpit temperature manual override switch	AUTO – normal position, cockpit temperature maintained at temperature selected by the cockpit temperature control knob. Cockpit temperature control valve regulated electronically. MAN – shuts off automatic cockpit temperature control. Temperature is still controlled with temperature control knob. However, temperature setting must be manually changed to compensate for cockpit temperature changes.
6. Cockpit pressure switch	CABIN PRESS – opens the bleed air pressure limiter and shutoff valve to initiate cockpit pressurization and cooling of selected avionics in the right and left avionics bays. Permits selection of windshield defogging and anti-exposure suit ventilation by means of separate controls. CABIN DUMP – closes bleed air pressure limiter and shutoff valve to stop all air-conditioning functions. Vents cockpit air safety valve to dump cockpit pressure.
7. Rain and ice removal switch	RAIN REMOVE – opens rain removal shutoff valve, admitting warm high-velocity air to rain removal nozzles forward of windshield and left-hand side panel. OFF – closes rain removal shutoff valve, stopping airflow to rain removal nozzles.
8. Defog switch	DEFOG – with cockpit pressure switch in CABIN PRESS, opens defog valve to exhaust warm air onto the inside surface of the windshield and windshield side panels. Defog air mixes with air-conditioned air already being exhausted on these surfaces. OFF – closes defog valve and shuts off warm air to windshield and side panel.
9. RAIN REPEL switch	DEPRESSED – provides 10 cc of rain repellent chemical distributed through nozzles to the center and left windshield. Use as necessary during approach or landing in rain conditions to provide improved visibility.
10. Cockpit temperature control knob	COLD to HOT – electrically regulates temperature of air entering the cockpit through canopy rail vents, floor vents, and windshield defog vents. Cockpit temperature range is 40° to 90°F. Temperature is automatically maintained at the selected setting when cockpit temperature manual override switch is in AUTO.
11. Anti-g suit connection	Quick-disconnect receptacle for anti-g suit hose.
12. VENT AIR connection	Quick-disconnect receptacle for antiexposure ventilating air hose.
13. ANTI-G VALVE test button	Depressed – directs flow of air into anti-g suit for purpose of checking anti-g system operation or for providing pilot body massage.

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Figure 1–65 (Sheet 2)

AIR-CONDITIONING AND PRESSURIZATION

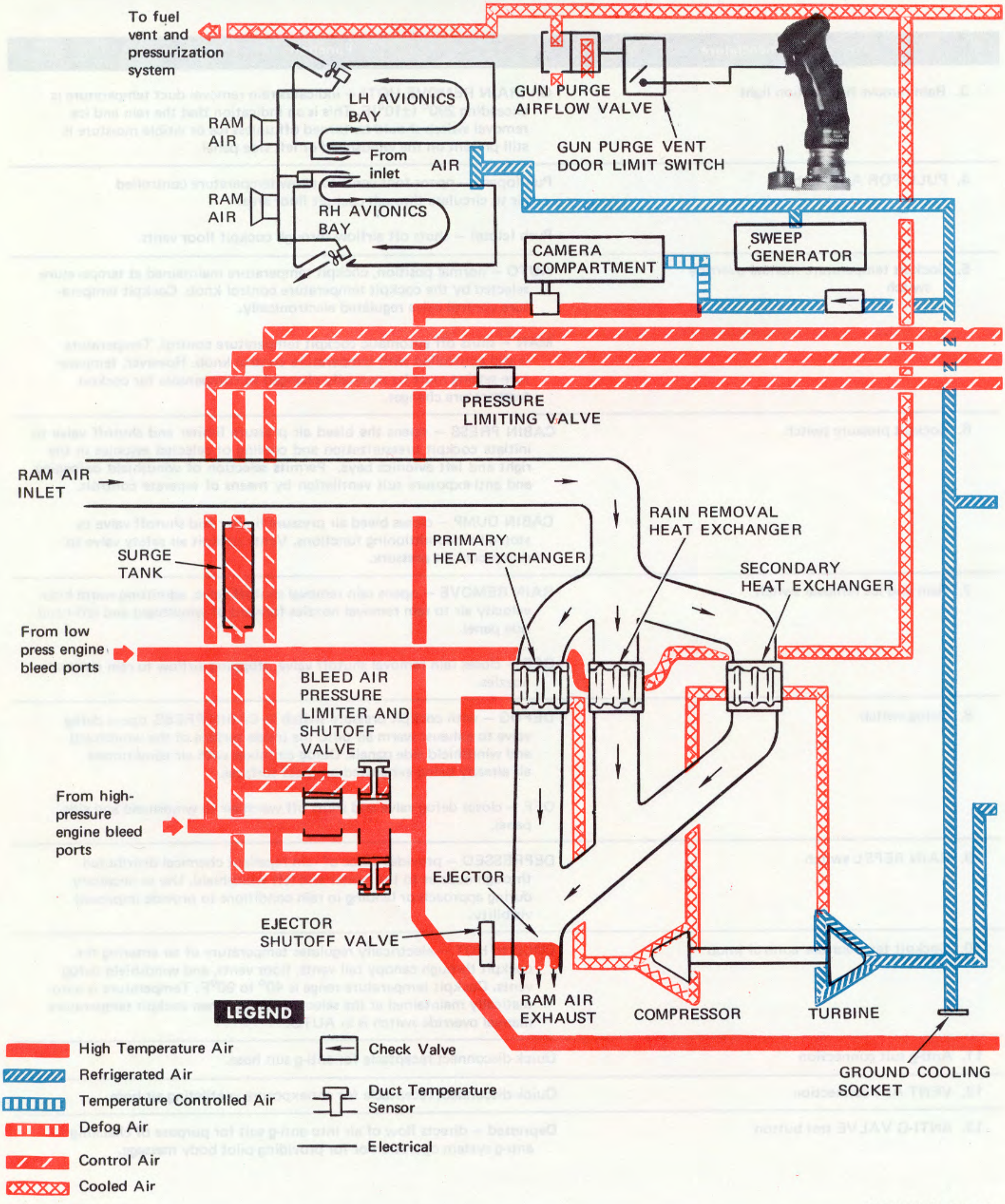


Figure 1–66 (Sheet 1)

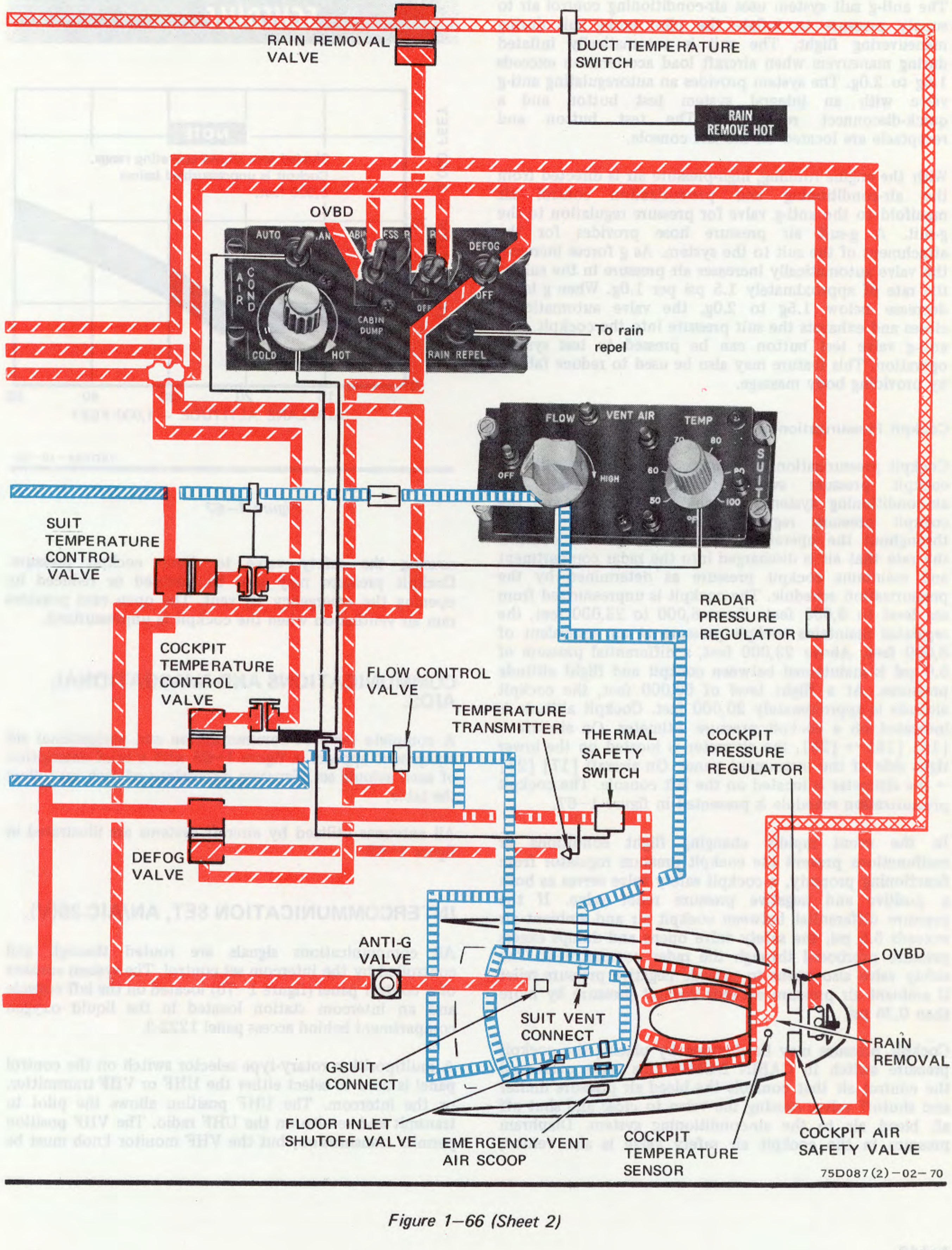


Figure 1–66 (Sheet 2)

Anti-G Suit Pressure.

The anti-g suit system uses air-conditioning control air to supply pressure to inflate the pilot anti-g suit during maneuvering flight. The suit is automatically inflated during maneuvers when aircraft load acceleration exceeds 1.5g to 2.0g. The system provides an autoregulating anti-g valve with an integral system test button and a quick-disconnect receptacle. The test button and receptacle are located on the left console.

With the engine running, high-pressure air is directed from the air-conditioning and pressurization control air manifold to the anti-g valve for pressure regulation to the g-suit. A g-suit air pressure hose provides for the attachment of the suit to the system. As g forces increase, the valve automatically increases air pressure in the suit at the rate of approximately 1.5 psi per 1.0g. When g loads decrease below 1.5g to 2.0g, the valve automatically closes and exhausts the suit pressure into the cockpit. The anti-g valve test button can be pressed to test system operation. This feature may also be used to reduce fatigue by providing body massage.

Cockpit Pressurization.

Cockpit pressurization takes place automatically with the cockpit pressure switch in CABIN PRESS. The air-conditioning system provides the pressure, and the cockpit pressure regulator provides pressure control throughout the operating range. The regulator controls the rate that air is discharged into the radar compartment and maintains cockpit pressure as determined by the pressurization schedule. The cockpit is unpressurized from sea level to 8,000 feet. From 8,000 to 23,000 feet, the regulator maintains cockpit pressure at an equivalent of 8,000 feet. Above 23,000 feet, a differential pressure of 5.0 psi is maintained between cockpit and flight altitude pressures. At a flight level of 50,000 feet, the cockpit altitude is approximately 20,000 feet. Cockpit altitude is indicated on a cockpit pressure altimeter. On aircraft → [16] [18] → [26], the altimeter is located on the lower right side of the instrument panel. On aircraft [17] [27] → the altimeter is located on the left console. The cockpit pressurization schedule is presented in figure 1—67.

In the event rapidly changing flight conditions or malfunctions prevent the cockpit pressure regulator from functioning properly, a cockpit safety valve serves as both a positive and negative pressure relief valve. If the pressure differential between cockpit air and ambient air exceeds 5.5 psi, the safety valve opens and dumps excess pressure overboard through the radar compartment. The safety valve also opens to provide negative pressure relief if ambient air pressure exceeds cockpit pressure by more than 0.25 psi.

Cockpit pressure may be dumped by placing the cockpit pressure switch in CABIN DUMP. This vents overboard the control air that controls the bleed air pressure limiter and shutoff valve, causing the valve to close and shut off all bleed air to the air-conditioning system. Diaphram pressure in the cockpit air safety valve is also vented, causing the safety valve to dump cockpit pressure. Cockpit pressure may also be dumped or reduced by opening the emergency air vent. The open vent provides ram air ventilation when the cockpit is unpressurized.

COCKPIT PRESSURIZATION SCHEDULE

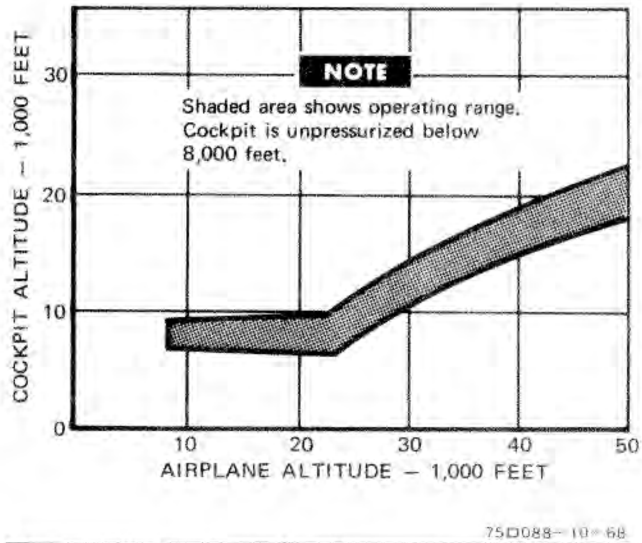


Figure 1—67

COMMUNICATIONS AND NAVIGATIONAL AIDS.

A complete table of communication and navigational aid equipment appears in figure 1—68 with a brief description of each avionic set. Separate discussions of each set follow the table.

All antennas utilized by aircraft systems are illustrated in figure 1—69.

INTERCOMMUNICATION SET, AN/AIC-26(V).

All communications signals are routed through and controlled by the intercom set control. The system consists of a control panel (figure 1—70) located on the left console and an intercom station located in the liquid oxygen compartment behind access panel 1222-3.

A multiposition rotary-type selector switch on the control panel is used to select either the UHF or VHF transmitter, or the intercom. The UHF position allows the pilot to transmit and receive on the UHF radio. The VHF position permits transmission, but the VHF monitor knob must be

COMMUNICATIONS AND NAVIGATIONAL AIDS

TYPE	DESIGNATION	FUNCTION	RANGE	CONTROL LOCATION
Intercommunication Set	AN/AIC-26(V)	A multi-channel audio monitoring and transmitter selection facility. All audio signals heard in pilot's headset are routed through, or controlled by, the AIC-26(V). During ground operation, set functions as interphone between pilot and ground personnel.	Dependent upon function selected.	Left Console
UHF Command Radio	AN/ARC-51BX	Serves as main communications receiver-transmitter and as auxiliary automatic direction finder (ADF) receiver.	Line of sight	Left Console
ADF/Auxiliary UHF Receiver	AN/ARA-50	A navigational aid used to indicate relative bearing of transmitting UHF station and presents the information on HSI.	Line of sight	Left Console
VHF Radio Set	FM-622A	Provides two-way communication between air-to-air and air-to-ground stations operating within the tactical frequency modulation band of 30.00 to 75.95 mc.	Line of sight	Right Console
TACAN System	AN/ARN-52(V)	An airborne tactical navigation system to operate in conjunction with a surface navigation beacon or with another airplane equipped with similar TACAN system.	Line of sight	Right Console
Radar Beacon	AN/APN-154(V)	Extend the tracking range of a ground based navigational system to aid in determining the range and azimuth of an airplane.	Line of sight	Right Console
Airborne Transponder (IFF)	AN/APX-72	Provides automatic radar identification of the airplane to all suitably equipped challenging aircraft, surface ships, and ground facilities within operational range of the system.	Line of sight	Left Console
Instrument Landing System (ILS)	AN/ARN-58A	Used in conjunction with ground transmitting equipment and the ADI, HSI, HUD and Flight Director Computer to form an instrument landing system.	Localizer – approximately 25 miles. Glide slope – approximately 20 miles.	Right Console

75D110-02-69

Figure 1-68

ANTENNA LOCATIONS

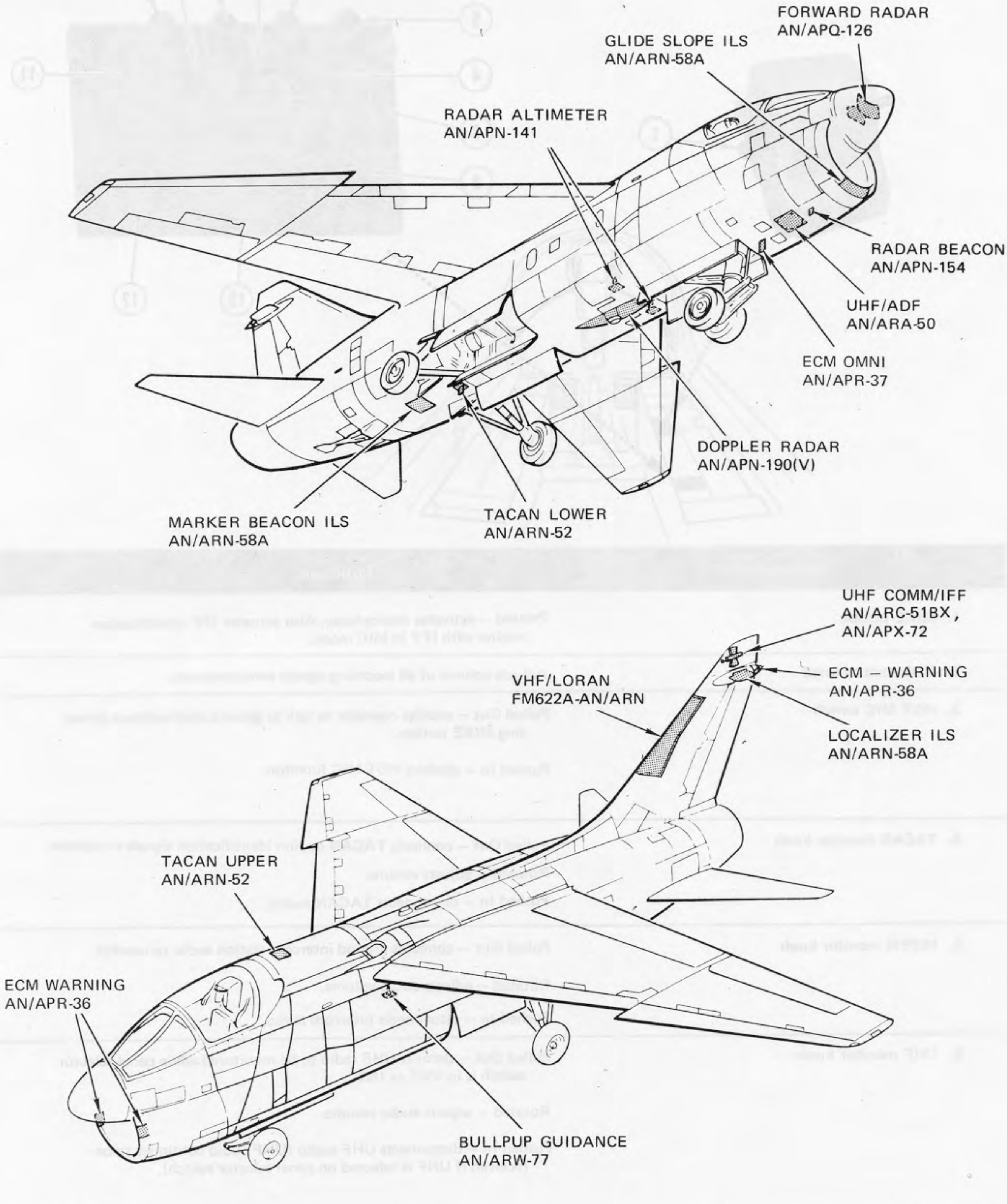
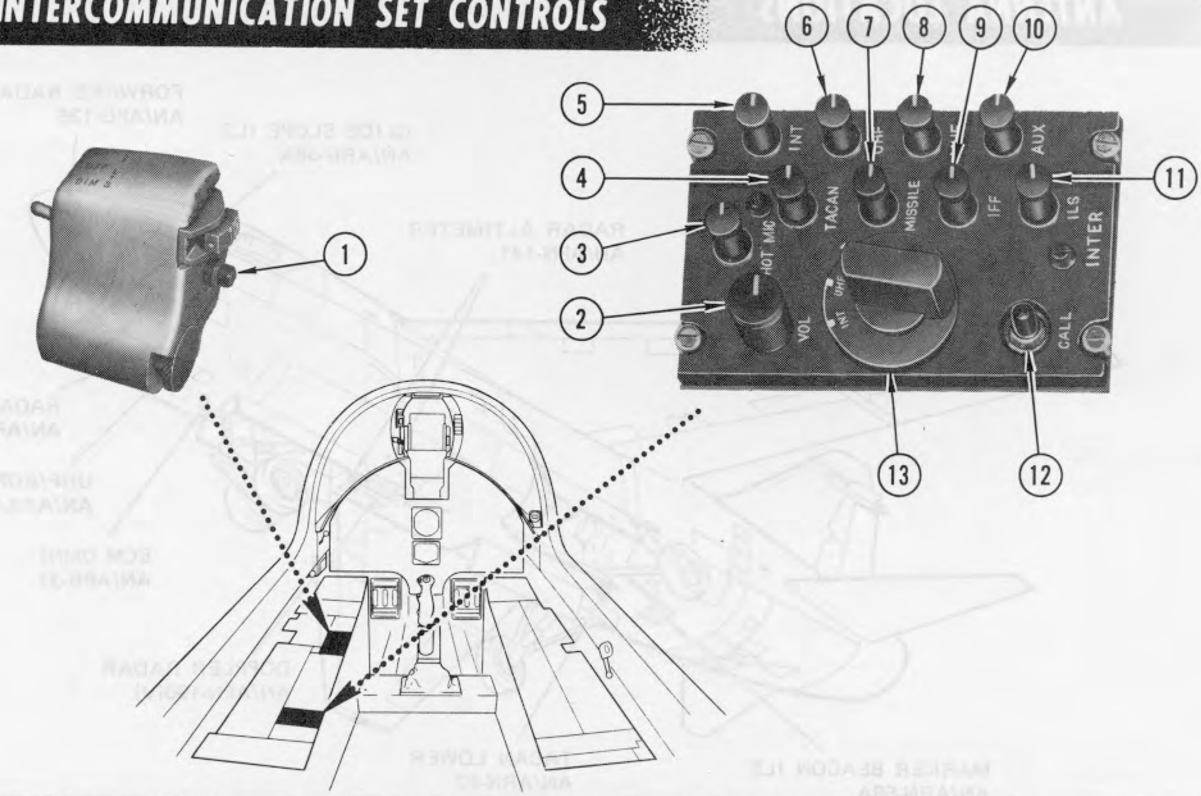


Figure 1–69

INTERCOMMUNICATION SET CONTROLS



Nomenclature	Function
1. MIKE button	Pressed – activates microphone. Also actuates IFF identification replies with IFF in MIC mode.
2. VOL control knob	Adjusts volume of all incoming signals simultaneously.
3. HOT MIC switch	Pulled Out – enables operator to talk to ground crew without depressing MIKE button. Pushed In – disables HOT MIC function.
4. TACAN monitor knob	Pulled Out – connects TACAN station identification signals to headset. Rotated – adjusts volume. Pushed In – disconnects TACAN audio.
5. INTER monitor knob	Pulled Out – connects ground intercom station audio to headset. Rotated – adjusts audio volume. Pushed In – disconnects intercom audio.
6. UHF monitor knob	Pulled Out – permits UHF radio to be monitored while panel selector switch is in VHF or INT. Rotated – adjusts audio volume. Pushed In – disconnects UHF audio (UHF audio continues to be received if UHF is selected on panel selector switch).

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Figure 1–70 (Sheet 1)

INTERCOMMUNICATION SET CONTROLS

Nomenclature	Function
7. MISSILE monitor knob	PULLED OUT – connects missile tone to headset. ROTATED – adjusts volume. PUSHED IN – disconnects missile tone.
8. VHF monitor knob	PULLED OUT – connects audio output of VHF radio. ROTATED – adjusts VHF volume. PUSHED IN – disconnects VHF audio.
9. IFF monitor knob	PULLED OUT – connects IFF Mode 4 interrogations and replies to headset. ROTATED – adjusts volume. PUSHED IN – disconnects IFF Mode 4 audio.
10. AUX radio monitor knob	PULLED OUT – connects audio output of AUX receiver to headset. ROTATED – adjusts volume. PUSHED IN – disconnects AUX audio.
11. ILS monitor knob	PULLED OUT – connects audio output of ILS localizer to headset. ROTATED – adjusts audio volume. PUSHED IN – disconnects ILS audio.
12. CALL button	DEPRESSED – connects amplified microphone output to ground intercom station.
13. Selector switch	INT – selects ground intercom system. UHF – selects UHF transmitter and connects audio input of UHF receiver to headset. VHF – selects VHF transmitter. VHF monitor knob must be pulled out to receive audio.

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Figure 1–70 (Sheet 2)

pulled out to connect receiver audio to the headset. The INT (intercom) position permits communication between the pilot and ground personnel using the intercom station.

Eight monitor knobs on the control panel permit individual monitoring and volume adjustment of Intercom, UHF, VHF, Auxiliary Radio, ILS, Missile, IFF and TACAN audio. A master VOL control adjusts volume of all signals simultaneously.

Note

IFF audio is used with Mode 4 operation.

The HOT-MIC switch on the control panel enables the pilot to talk to ground crew personnel using the intercom station without pressing the MIKE button. A CALL button on the control panel permits operation of the interphone system without turning the selector switch to INT. The call signal is heard at least 6 decibels louder than any other signal present.

Note

On aircraft [4] → [158] before T.O. 1A-7D-647, to receive side tone during hot mike operation, the throttle quadrant mike button must be depressed. On aircraft [4] → [158] after T.O. 1A-7D-647 and [159] →, side tone is present at all times during hot mike operation.

The intercom station in the liquid oxygen compartment is for ground use. The call switch on the intercom station operates in the same manner as the CALL button on the cockpit control panel. The volume control adjusts the listening level of incoming signals. The receptacle at the intercom station permits connection of a microphone headset assembly. The set is powered by the secondary dc

bus during normal electrical system operation, and by the external ac power bus when the master generator is not on the line.

Note

The intercom station, located in the liquid oxygen compartment, operates on external or internal ac power. On aircraft [17] [27] →, the intercom system is powered by the battery bus.

UHF RADIO SET, AN/ARC-51BX.

The AN/ARC-51BX radio set is the command radio and can also be used as an automatic direction finder receiver (ADF). Bearing of the ADF station is displayed on the number 2 pointer of the Horizontal Situation Indicator (HSI) when the HDG MODE switch is in TACAN or MAN.

The set transmits and receives on any one of 3,500 frequencies, spaced at 50-kilocycle intervals, in the 225.00 to 399.95-megacycle band. The set operates on electrical power from the battery bus.

Note

It is possible to set frequencies below 225.00 megacycles, but reception or transmission is not possible. Normal side tone may give the impression that the set operates on frequencies below 225.00 megacycles.

Radio set controls permit presetting and selection of 20 channels within the specified frequency range, or manual selection of any of the 3,500 available frequencies. Guard channel may be monitored simultaneously.

When at extreme reception ranges, placing the squelch disable switch in the ON position permits readability of weak signals at the expense of constant noise of the headset.

Controls for the AN/ARC-51BX radio are illustrated and described in figure 1–71.

The set may be used in conjunction with the Juliet-28 speech security system. When Juliet-28 is not installed, a jumper cable is required to complete audio circuits to the intercommunications system.

CHANNEL RESET PROCEDURE.

Twenty frequencies can be selected with the preset channel knob. Presetting the 20 frequencies is accomplished by opening the hinged cover on the upper front panel of command radio control panel and adjusting the selector pins using the preset tool provided.

ADF/AUXILIARY UHF SET, AN/ARA-50.

The AN/ARA-50 is an ADF/auxiliary UHF receiver and an automatic direction finder (ADF) set consisting of an AN/ARR-69 auxiliary radio receiver, an antenna, and an ARR-40 control panel. The set is a navigational aid used to determine the direction of a selected transmitting UHF radio station, or the set may be used as an auxiliary UHF command radio receiver. The relative bearing of the selected transmitting station is displayed on bearing pointer number 2 of the Horizontal Situation Indicator (HSI). The auxiliary receiver can be tuned to any one of 20 preset channels between 265.0 and 284.9 megacycles, plus guard channel at 243.0 megacycles.

On aircraft before T.O. 1A-7D-547 preset frequencies are as follows:

1	265.2 mc	11	275.6 mc
2	266.6 mc	12	276.2 mc
3	267.6 mc	13	277.2 mc
4	268.6 mc	14	278.0 mc
5	269.8 mc	15	279.0 mc
6	270.8 mc	16	280.4 mc
7	271.6 mc	17	281.0 mc
8	272.2 mc	18	282.0 mc
9	273.2 mc	19	283.0 mc
10	274.8 mc	20	284.2 mc

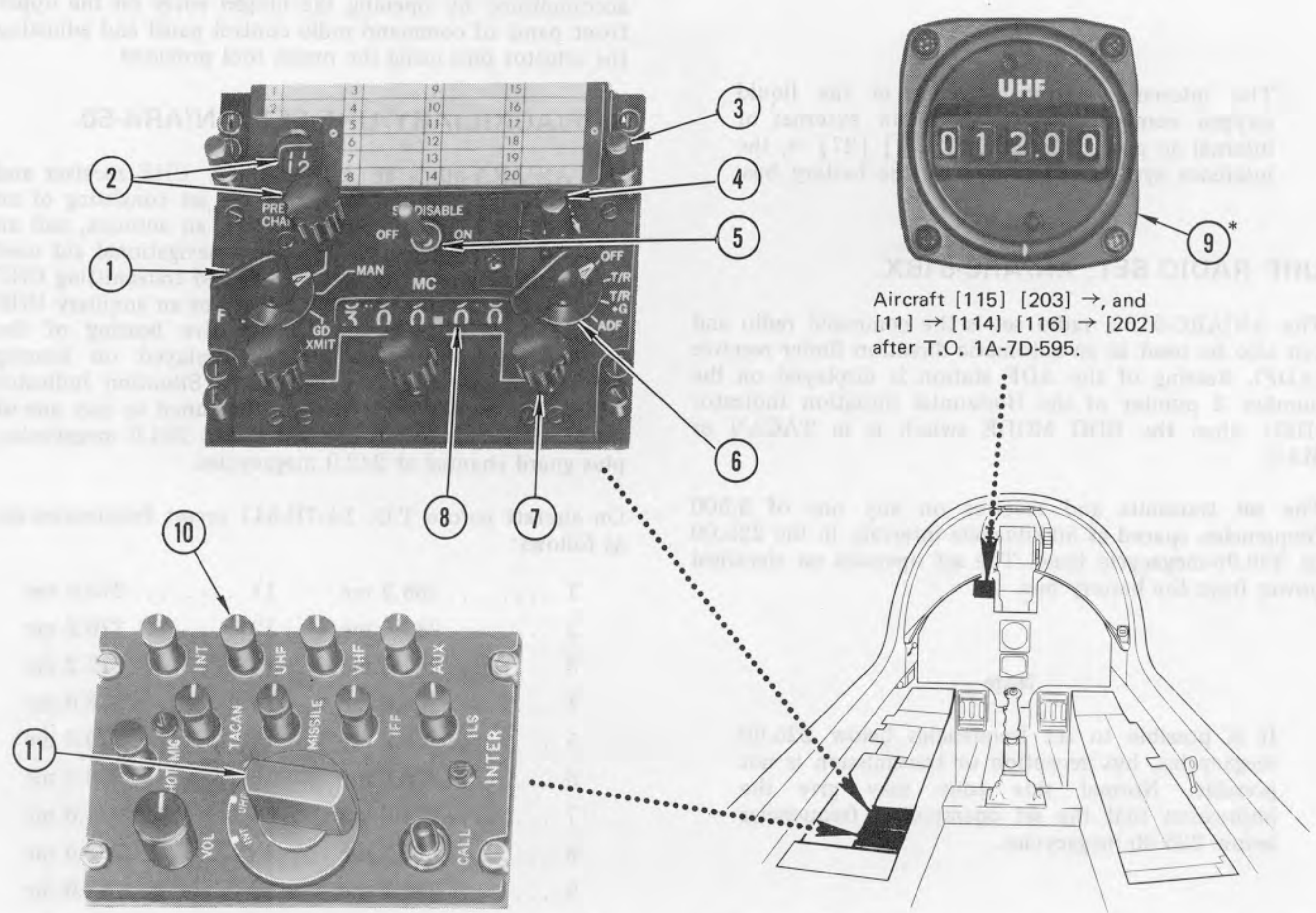
Note

On aircraft after T.O. 1A-7D-547, standard Air Force preset frequencies apply.

By selection of a CR-55/U crystal of the proper frequency, reception of one guard channel shall be obtained with the range 238.0 to 248.0 mc. Unless otherwise specified, guard channel operation shall be adjusted for 243.0 mc.

The ADF is controlled by the auxiliary UHF control panel (ARR-40) on the left console (figure 1–72). The function switch on the panel has dual functional markings. The

COMMAND RADIO CONTROLS



*On aircraft [11] → [16] [18] → [26] frequency/channel remote indicator is located to the right of the HUD.

Nomenclature	Function
1. Mode selector	PRESET CHAN – permits automatic selection of one of 20 preset channels with the preset channel knob. MAN – permits manual selection of any one of 3,500 frequencies by use of the manual frequency selectors. GD XMIT – Selects preset guard frequency of 243.0 mc for the guard transmitter and receiver. With the command radio function switch set at T/R or T/R+G, the guard transmitter and receiver are turned on.
2. PRESET CHAN knob and indicator	The indicator displays which of 20 channels has been selected by the knob. Selected channel becomes operable when the mode selector switch is placed in PRESET CHAN.
3. Preset memory drum hinged cover	Cover raised – provides access to preset memory drum. Cover closed – provides placard for recording 20 preset frequencies.
4. VOL knob	Adjusts level of audio signals delivered to headset.
5. SQ DISABLE switch	In the ON position, the receiver squelch circuit is disabled.

75D094(1)–07–71

Figure 1–71 (Sheet 1)

COMMAND RADIO CONTROLS

Nomenclature	Function
6. Function switch	OFF – all power removed from set. T/R – set is energized to receive or transmit on a selected channel or frequency. Turns the guard transmitter and receiver on. T/R + G – same as for T/R position, except that the set's guard receiver is energized to receive transmissions on the guard frequency. ADF – with the ADF set turned off, places the command radio in the ADF mode of operation. If the ADF set is operating, this position is ineffective. Station may be selected with the preset channel knob or the manual frequency selectors. The HDG MODE switch must be in TACAN or MAN for ADF station indication on the HSI bearing pointer number 2.
7. Manual frequency selector knobs	Rotated to manually select any one of 3,500 preset channels. Frequency selected becomes operable when the mode switch is placed in MAN.
8. Frequency counters	Indicate manually selected frequency.
9. Frequency/channel remote indicator	Displays which number of 20 preset channels is selected for operation when the mode selector switch is in PRESET CHAN position. Displays digits of the manually selected frequency when the mode selector switch is in MAN position. Displays G when the mode selector switch is in GD XMIT position.
10. UHF monitor knob	Pulled – permits monitor of UHF audio with the intercom panel selector switch in INT or VHF position.
11. Intercommunications panel selector switch	UHF – permits pilot to receive and transmit on selected UHF channel.

75D094(2)-06-71

Figure 1-71 (Sheet 2)

markings below the AUX REC decal relate to the auxiliary receiver. The function switch markings above the MAIN T/R decal relate to the command radio.

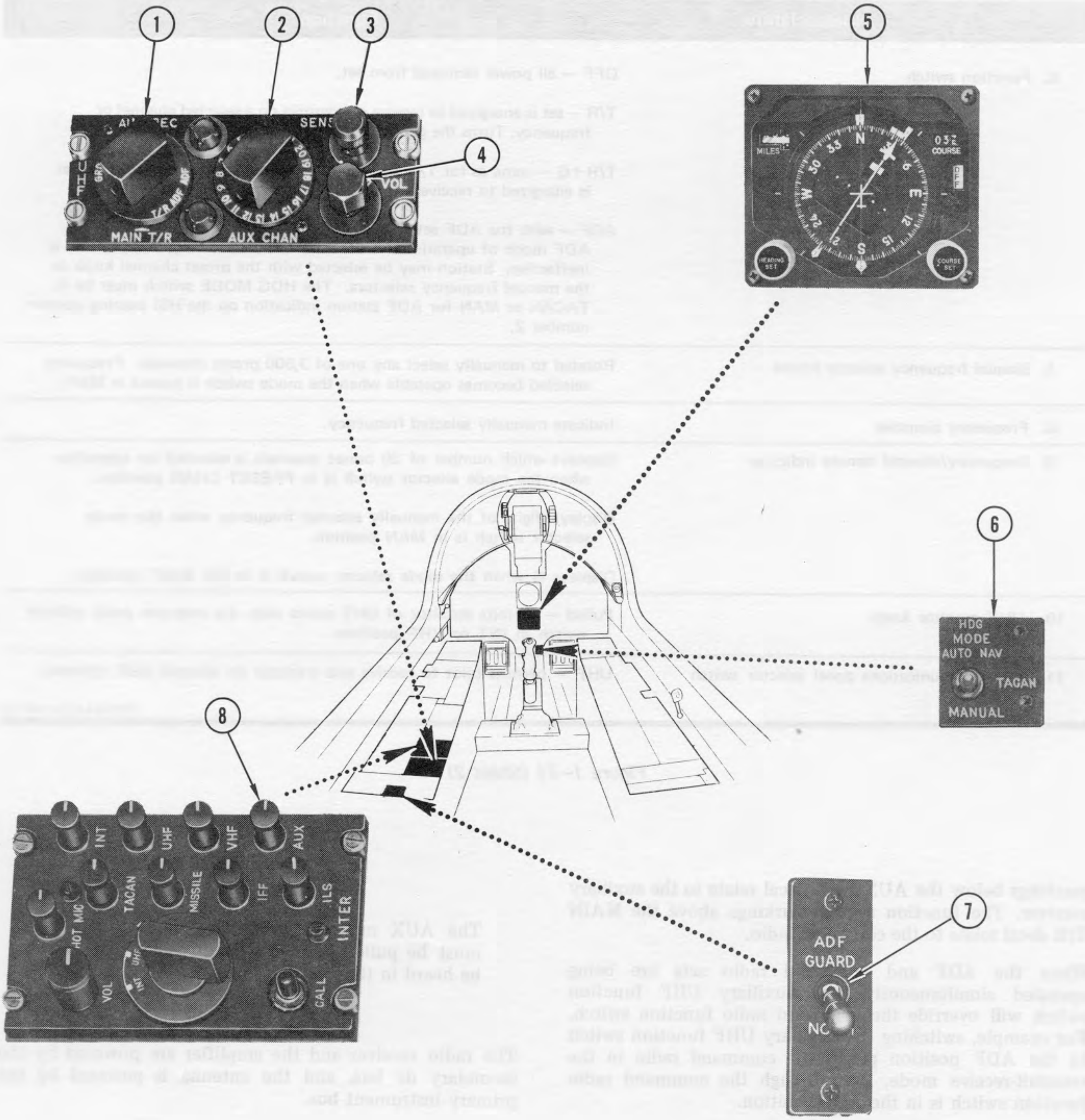
When the ADF and command radio sets are being operated simultaneously, the auxiliary UHF function switch will override the command radio function switch. For example, switching the auxiliary UHF function switch to the ADF position places the command radio in the transmit-receive mode, even though the command radio function switch is in the ADF position.

Note

The AUX monitor switch on the intercom set must be pulled to permit audio transmissions to be heard in the headset.

The radio receiver and the amplifier are powered by the secondary dc bus, and the antenna is powered by the primary instrument bus.

ADF/AUXILIARY UHF RECEIVER CONTROLS



Aircraft [17] [27] →, and → [16] [18] → [26] after T.O. 1A-7D-505

75D119(1)–05–70

Figure 1–72 (Sheet 1)

ADF/AUXILIARY UHF RECEIVER CONTROLS

Nomenclature	Function
1. Auxiliary UHF function switch	OFF – all power removed from ADF receiver. ADF – (MAIN T/R on T/R) – energizes receiver. Bearing pointer number 2 on HSI indicates bearing of selected ADF station when HDG MODE switch is in TACAN or MAN position. Places the command radio in the T/R mode if the radio is on. ADF station is identified by increasing AUX volume and, if necessary, decreasing command radio volume. CMD – (MAIN T/R on ADF) – AUX receiver feeds audio signals through the intercommunication set to the headset on whichever channel is selected by the AUX CHAN selector. If the command radio is in operation, it is placed in ADF mode. GRD – (MAIN T/R on ADF) – feeds audio signals through the intercommunication set to the headset on guard frequency only (243.0 mc). If the command radio is operating, it is placed in the ADF mode.
2. AUX CHAN selector	Used to select desired channel (20 channels are preset). Selector functions only when function switch is in ADF or CMD.
3. SENS knob	Clockwise rotation increases receiver sensitivity and, consequently, increases audio level of background noise in the headset.
4. VOL control	Clockwise rotation increases ADF audio level.
5. Horizontal situation indicator	Indicates bearing of selected ADF station on pointer number 2.
6. HDG MODE switch	Switch must be in TACAN or MAN position to obtain ADF steering indication on HSI.
7. Guard Selector switch	NORM – allows normal operation of auxiliary receiver. GUARD – selects 243.0 MHz on auxiliary receiver for ADF operation on guard channel.
8. Intercommunication set AUX monitor knob	Pulled – connects ADF and/or command radio audio to headset.

75D119(2)–05–70

Figure 1–72 (Sheet 2)

VHF RADIO SET, FM-622A.

The FM-622A VHF Radio Set provides two-way, tactical communication between air-to-air and air-to-ground stations. The set operates on 920 communication channels within the VHF band of 30.00 to 75.95 megacycles.

Four major units make up the radio set. The units are a receiver-transmitter, a control panel, an antenna coupler, and a fin notch antenna. The fin notch antenna is located in the leading edge of the vertical stabilizer. The set is powered by the secondary dc bus.

The control panel, located on the right console, includes a mode selector switch, squelch switch, volume control, and four frequency selector switches and display windows. (See figure 1–73.)

The set may be used in conjunction with the Juliet-28 speech security system. When the Juliet relay box is not installed, a jumper cable is required to complete audio circuits to the AN/AIC-26(V) Intercommunication Set and between the Command Radio receiver and the ADF amplifier relay assembly.

OPERATION.

Power is applied to the set when the mode selector switch is moved from the OFF to the T/R position. To transmit, the intercom panel selector switch is set to the VHF position and the MIKE button is pressed. To receive, the VHF monitor knob on the intercom panel is pulled out. The RETRAN and HOME positions of the mode selector switch are inoperative. Desired frequencies are selected by rotating the frequency control knobs and are displayed in the frequency indicator windows.

The squelch switch is a rotary switch with positions of DIS, CARR, and TONE. In the DIS position, the squelch circuits are disabled and all audio is heard. The DIS position may improve readability of weak signals at the expense of constant noise in the headset. In the CARR position, which is the normal flight position, the squelch circuits operate normally in the presence of any carrier signal. The TONE position is used to eliminate reception of signals which do not contain a 150-cps tone.

TACAN SYSTEM, AN/ARN-52 (V).

The AN/ARN-52(V) TACAN is an airborne navigational system which operates in conjunction with a surface navigation beacon or with another aircraft equipped with a similar TACAN system. The operating range of the system is limited to line of sight. The system has 126 two-way operating channels spaced 1 megacycle apart. Transmitting and receiving frequencies for each channel differ by 63 megacycles. The set is powered by the primary ac, dc, and instrument buses.

Controls and indicators are illustrated in figure 1–74.

OPERATION.

The HDG MODE switch on the instrument panel must be in the TACAN or MAN position before TACAN information is displayed on the Attitude Director Indicator or the Horizontal Situation Indicator. With the switch in the TACAN position, steering commands to achieve and maintain the selected TACAN radial are furnished by the Flight Director Computer to the ADI vertical pointer. By setting the desired TACAN radial into the HSI with the COURSE SET knob and setting an intercepting magnetic heading into the HSI with the HEADING SET knob, a smoothly converging acquisition of the desired TACAN radial can be achieved. Prior to lateral beam sense, the ADI vertical pointer receives manual heading steering information from the Flight Director Computer until the TACAN deviation drops below the TACAN lateral beam sensor level. After lateral beam sense, the Flight Director Computer controls movement of the ADI vertical pointer to indicate an optimized turn into the desired radial. Bearing to the TACAN station is displayed on HSI bearing pointer number 1. The HSI range indicator displays line-of-sight range to the TACAN station or a cooperating aircraft. The HSI course deviation bar presents course displacement right or left of the TACAN radial. Bearing to an ADF station is presented on HSI bearing pointer number 2.

With the HDG MODE switch in the MAN position, TACAN station bearing and distance and ADF bearing information continue to be displayed. The HSI course deviation bar is inoperative and stowed, and the course bar flag is out of view. The TACAN switch on the intercom panel must be pulled to receive TACAN audio signals in the headset.

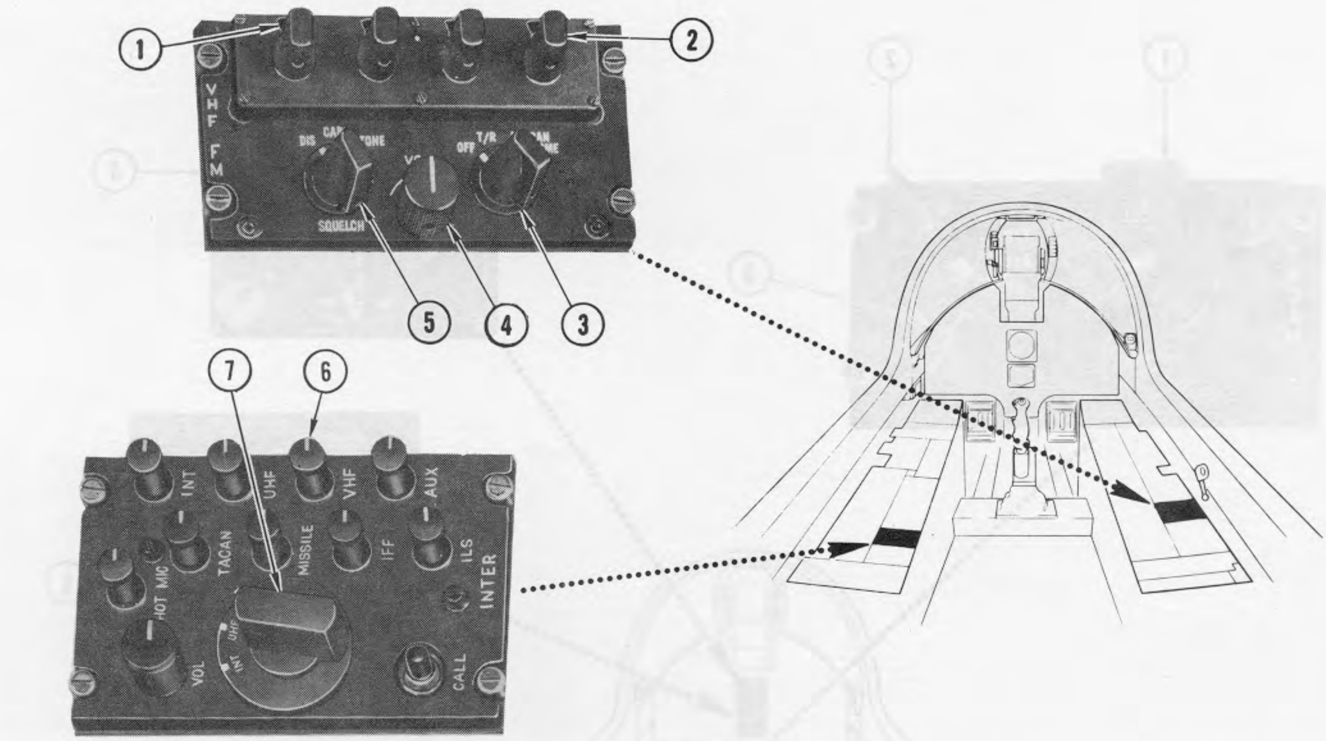
The set operates in three modes: receive, receive-transmit, and air-to-air. In the receive mode, the set provides a continuous indication of bearing relative to the selected ground station on bearing pointer number 1 of the HSI. In the receive-transmit mode, the HSI display includes line-of-sight distance and bearing to the TACAN station. In addition, when the set is in either the receive or receive-transmit mode, an audio signal is heard in the headset. In the air-to-air mode, only range information to a cooperating aircraft is displayed on the HSI.

Note

When operating in the air-to-air mode, if more than one aircraft in a formation is interrogating another distant aircraft on the same channel, the distance information may be unreliable.

If the IMS is off, or an internal malfunction causes the heading signal to be lost, bearing to the TACAN station will not be displayed, i.e., the pointer will be inoperative. Course deviation bar information and the TO-FROM indicator will still be valid.

VHF FM RADIO CONTROLS

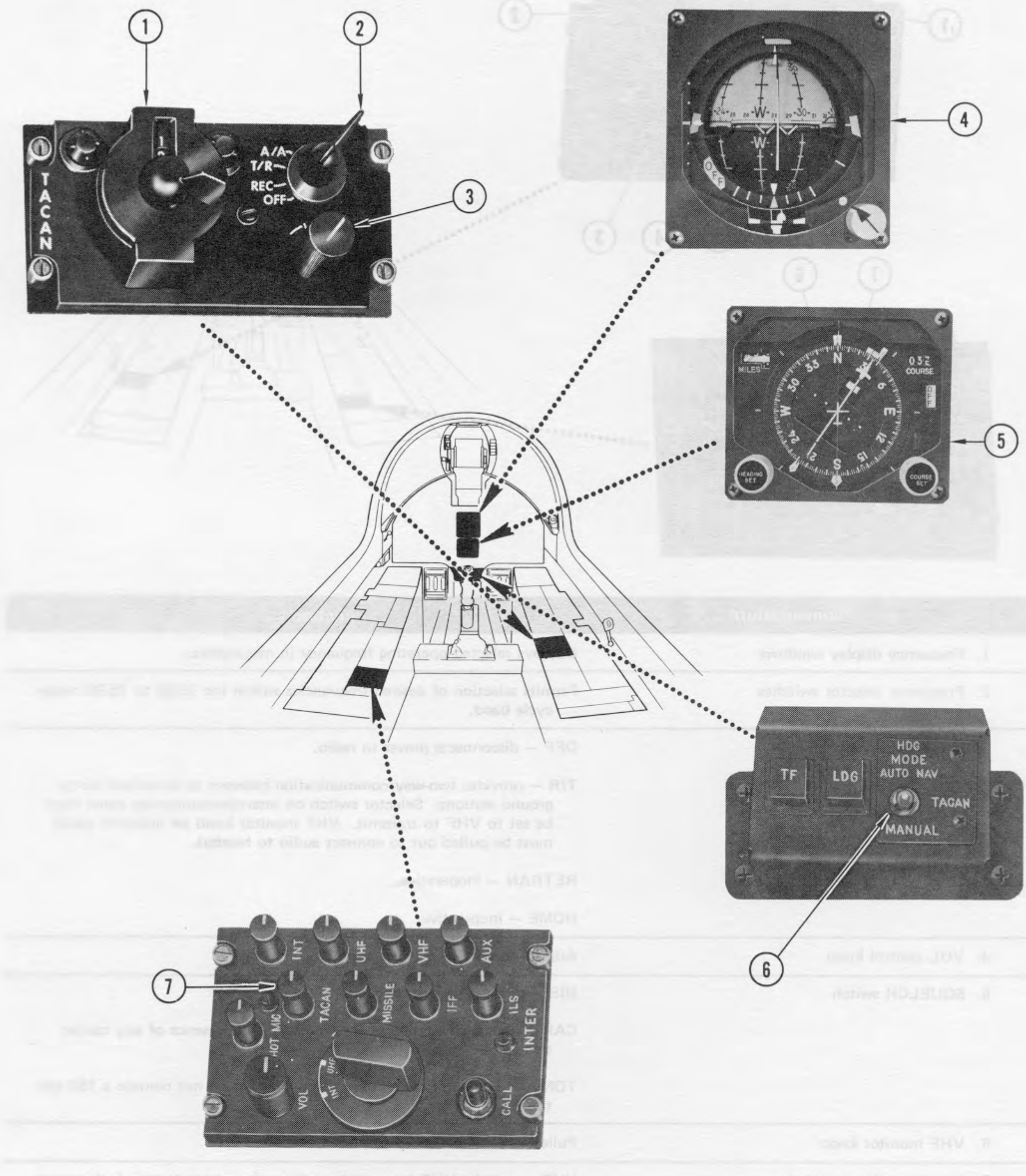


Nomenclature	Function
1. Frequency display windows	Displays selected operating frequency in megacycles.
2. Frequency selector switches	Permits selection of desired frequencies within the 30.00 to 75.95 megacycle band.
3. Mode selector switch	OFF – disconnects power to radio. T/R – provides two-way communication between air-to-air and air-to-ground stations. Selector switch on intercommunication panel must be set to VHF to transmit. VHF monitor knob on intercom panel must be pulled out to connect audio to headset. RETRAN – inoperative. HOME – inoperative.
4. VOL control knob	Adjusts volume of receiver audio.
5. SQUELCH switch	DIS – disables squelch circuits. CARR – squelch circuits operate normally in presence of any carrier signal. TONE – eliminates reception of signals which do not contain a 150 cps tone.
6. VHF monitor knob	Pulled – connects audio to pilot's headset.
7. Intercom selector switch	VHF – permits VHF transmission when microphone button is depressed.

75D114–02–70

Figure 1–73

TACAN CONTROLS



75D130(1)-02-70

Figure 1-74 (Sheet 1)

TACAN CONTROLS

Nomenclature	Function
1. Channel selector	Selects operating channel.
2. Mode switch	OFF – disconnects power to set. REC – permits display of continuous bearing information from selected surface station on Horizontal Situation Indicator bearing pointer number 1. HDG MODE switch in TACAN or MAN. T/R – permits display of continuous bearing and slant range distance information on HSI from selected surface station. HDG MODE switch in TACAN or MAN. A/A – permits cooperating aircraft to determine distance from each other. HDG MODE switch in TACAN. Cooperating aircraft must select TACAN frequencies 63 megacycles apart.
3. VOL control knob	Regulates volume of surface beacon identification signal.
4. Attitude director indicator	Vertical pointer receives steering commands from Flight Director Computer to maintain selected TACAN radial. HDG MODE switch in TACAN.
5. Horizontal situation indicator	With HDG MODE switch in TACAN and mode switch in T/R, displays bearing to station on pointer number 1, line-of-sight distance to station on range indicator, and course displacement right or left of station on course deviation bar. ADF bearing information displayed on bearing pointer number 2.
6. HDG MODE switch	TACAN – permits TACAN bearing and distance information to be displayed on HSI. Bearing to ADF station displayed on number 2 pointer. Prior to capture of the TACAN radial, ADI vertical pointer steering commands are based on the manually set intercept heading. After radial capture, vertical pointer displays steering commands to maintain the radial. MAN – TACAN station bearing and distance and ADF bearing information continue to be displayed in this mode. HSI course deviation bar is inoperative and course bar flag is out of view.
7. Intercommunication panel TACAN monitor switch	Pulled – allows TACAN station audio to reach headset. Rotation of switch controls volume.

75D130(2)–11–69

Figure 1–74 (Sheet 2)

Air-to-Air Mode of Operation.

To receive air-to-air range from a cooperating aircraft, the HDG MODE switch on the instrument panel must be set on TACAN, and the TACAN mode switch on the right console must be set to A/A (air-to-air). Cooperating aircraft must select TACAN frequencies 63 channels apart – for example: 1 and 64, 2 and 65, etc. A 2-minute warmup period must be allowed. Range in nautical miles to operating aircraft is displayed on the HSI range indicator. The range dial may rotate for a short period of time before stopping at the correct range.

Note

When operating in the air-to-air mode, if more than one aircraft in a formation is interrogating another distant aircraft on the same channel, the distance information may be unreliable.

Tacan Set Characteristics.

Improperly adjusted or malfunctioning ground or airborne TACAN equipment may lock-on to a false bearing. Usually the error is plus or minus 40 degrees but can be a multiple of 40 degrees (±80°, ±120°, etc). The possibility of an incorrect 40 degree lock-on is inherent in the TACAN system and can only be recognized with the use of other navigational devices in addition to TACAN. After takeoff, the TACAN should be cross-checked with ground radar or airborne radar. For instrument departures, penetrations, or letdowns, TACAN bearing information should be verified with the airborne or ground radar monitor.

RADAR BEACON, AN/APN-154(V).

The radar beacon extends the radar tracking range of a ground-based controller system as an aid in determining the range and azimuth of the aircraft. The ground-based radar transmits interrogating signals which may be either single pulse or one of five double, coded pulses. The beacon receives the interrogation, decodes it, and then replies on another frequency.

The set consists of a receiver-transmitter, duplexer, antenna, antenna adapter, two radio frequency cable assemblies, and a control panel. The set is powered by the secondary dc bus.

The control panel is illustrated in figure 1–75.

OPERATION.

The beacon is operated by placing the POWER switch in the STDBY position for about 5 minutes to permit warmup. The switch is then placed in POWER and the mode switch set to the required code. If the beacon is to reply to a noncoded, single pulse interrogation, the mode selector is placed in SINGLE. If the beacon is to respond to a double pulse, coded interrogation, the mode selector is placed in the applicable (1 through 5) DOUBLE position. When an interrogating signal is received which corresponds with the code selected with the mode switch, the beacon replies by transmitting a reply pulse.

AIRBORNE TRANSPONDER, AN/APX-72(IFF).

The AN/APX-72 IFF transponder system consists of a receiver-transmitter, control panel, transponder tester, antenna, UHF/IFF diplexer, and provisions for a Mark XII computer. The receiver-transmitter is used with auxiliary equipment to provide automatic radar identification to all suitably equipped challenging aircraft, surface ships, and ground facilities within operational range of the system. The range of the system is line of sight. The receiver operates on a frequency of 1,030 megacycles and the transmitter operates on 1,090 megacycles. Specially coded identification of position (IP) and emergency signals may be transmitted to interrogating stations should conditions warrant.

Interrogating signals, consisting of pairs of pulses spaced to form a code, are transmitted to the r-t unit which receives the coded signal and transfers it to a decoder. The decoder checks the incoming signal for valid code and proper mode. If valid, the decoded signal is sent to the encoder board which prepares the coded reply. The coded reply is sent through the transmitter and antenna to the interrogating source. During mode 4 operation with the Mark XII computer installed, the Mark XII computer encodes replies for the receiver-transmitter. During mode C operation, the Air Data Computer provides encoded altitudes to the IFF set. An emergency IFF switch is provided to automatically enable modes 1, 2, and 3/A when the pilot's seat is ejected.

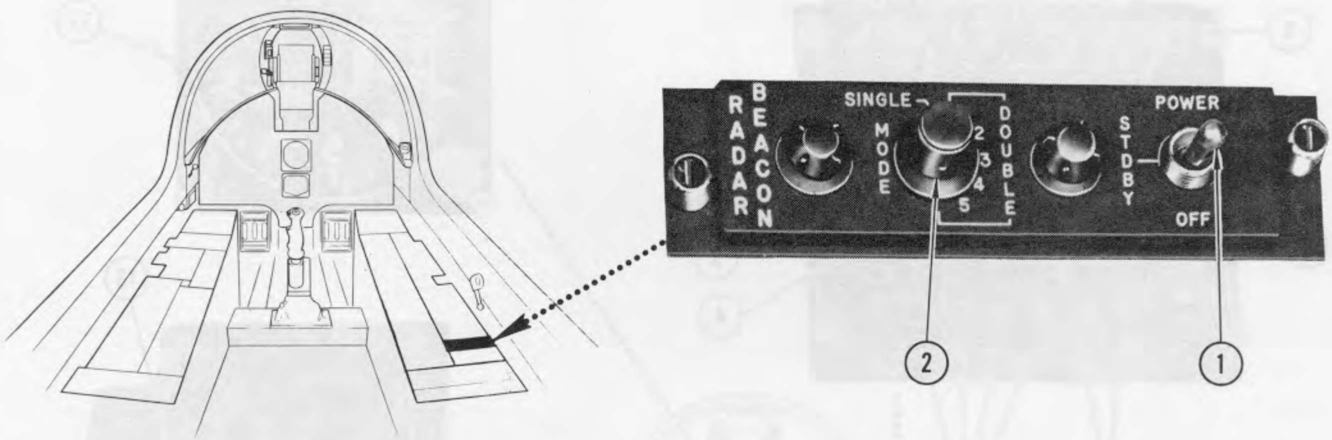
OPERATION.

The system can be operated in any one of the following categories, each of which can be selected on the control panel located on the left console:

- Low operation
- Normal operation
- Identification of position (IDENT-MIC)
- Emergency

Five independent coding modes are available to the pilot. The first three modes may be used independently or in combination. Mode 1 provides 32 possible code combinations, any one of which may be selected in flight. Mode 2 provides 4,096 possible code combinations but only one is available since the selection dials for this mode are on the receiver-transmitter and not accessible in flight. Mode 2 code combinations must be preset before takeoff. Mode 3/A provides 4,096 additional codes, any one of which may be selected in flight. Mode C, with AIMS incorporated, furnishes the pressure altitude of the aircraft when properly interrogated. Mode 4, which is connected to a Mark XII computer, can be selected to display any one of many classified operational codes for security identification.

RADAR BEACON CONTROLS



Nomenclature	Function
1. POWER switch	OFF – turns off all power to the beacon. STBY – places beacon in standby. Beacon will not reply to interrogation in this condition. POWER – places beacon in full operation.
2. MODE switch	SINGLE – limits beacon response to the single pulse of any code group received. DOUBLE – limits beacon response to one of five double-pulse interrogations. Codes No. 1 through 5 correspond to switch positions 1 through 5.

75D117–02–70

Figure 1–75

With the AIMS system incorporated and Mode C of the IFF transponder selected by the pilot, a capability is provided for automatic altitude reporting in 100-foot increments when properly interrogated by ground processing equipment. The AIMS altitude reporting system utilizes corrected pressure altitude information (referenced to 29.92 inches Hg) supplied by the Air Data Computer. Should the ADC light on the advisory panel illuminate, an Air Data Computer failure has occurred and AIMS altitude reporting operation is not possible.

Note

Altitude reported to the ground station will be the same as the altitude indicated on the cockpit-mounted (barometric) altimeter on aircraft equipped with an AAU-19/A altimeter and RESET position selected.

IFF controls are presented in figure 1–76.

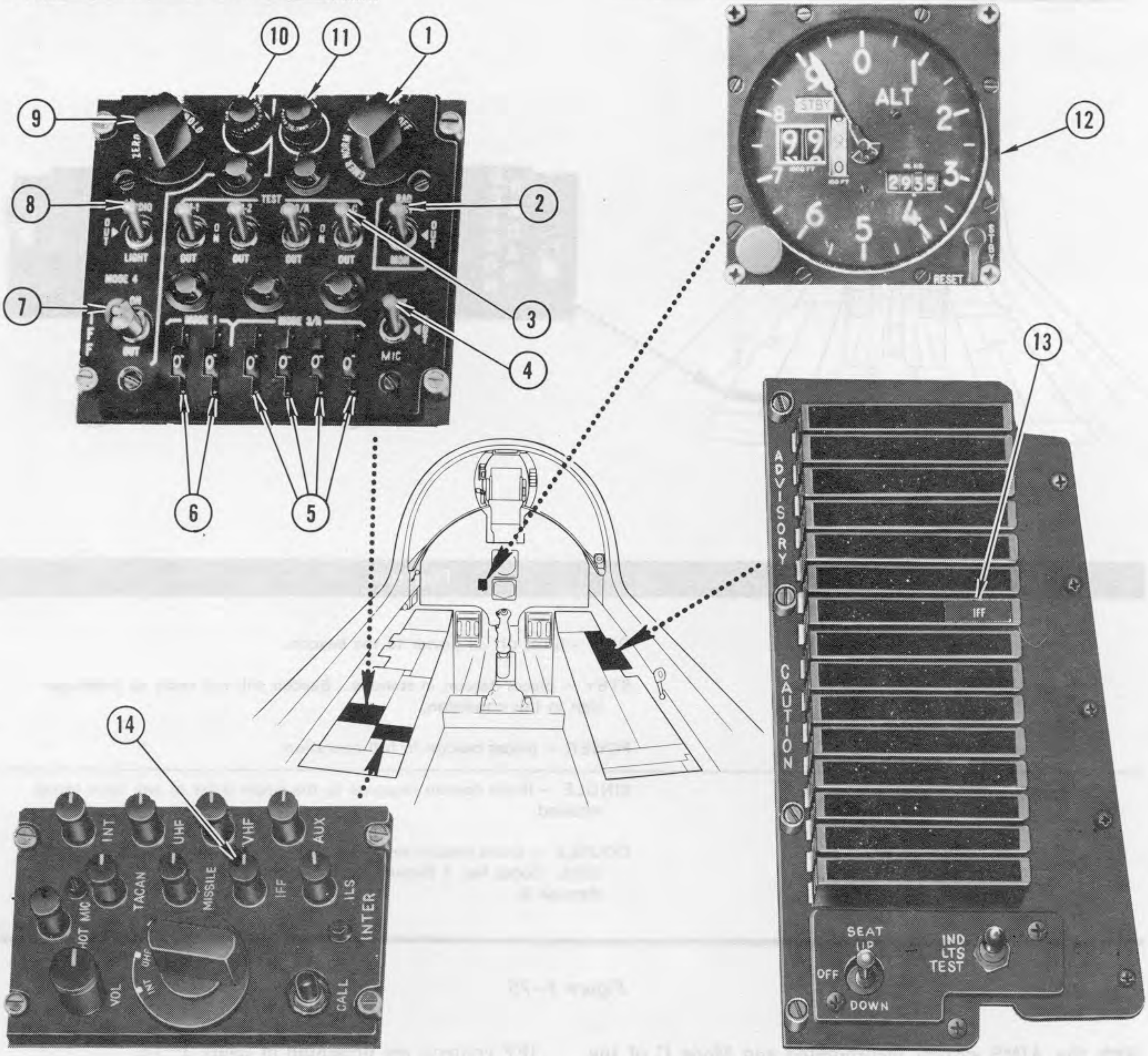
The IFF receiver-transmitter is powered by the primary ac and dc buses, control panel power is supplied by the primary dc bus, and the transponder tester is powered by the secondary dc bus.

To place the IFF system in operation, perform the following:

1. MASTER switch – STBY for 1 minute under standard temperature conditions (5 minutes under extreme ranges of operating temperatures) and then to NORM position.

2. Code selectors – SET

IFF CONTROLS



Nomenclature	Function
1. MASTER control switch	OFF – disconnects power to system. STBY – places receiver-transmitter in warmup (standby condition). Switch should remain in STBY a minimum of 1 minute for standard temperature conditions and 5 minutes under extreme ranges of temperature. LOW – applies power to receiver-transmitter, but at reduced receiver sensitivity. NORM – applies power to receiver-transmitter at normal receiver sensitivity. EMER – transmits emergency reply signals to mode 1, 2, or 3/A interrogations regardless of mode control setting.

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Figure 1–76 (Sheet 1)

IFF CONTROLS

Nomenclature	Function
2. RAD TEST-MON switch	RAD TEST – enables an appropriately equipped transponder to reply to TEST mode interrogations from test equipment. Other functions of this switch position are classified. In RAD TEST position, switch is spring loaded to return to the OUT position. MON – enables the monitor circuits of an internal test set. The test light will illuminate whenever replies are transmitted in response to interrogations in mode 1, 2, 3/A or C. OUT – deenergizes RAD TEST and MON.
3. Mode switches	ON – enables the receiver-transmitter to reply to mode 1, 2, 3/A or C interrogations. OUT – disables the reply capability to mode interrogations. TEST – enables a built-in test function in the receiver-transmitter to locally interrogate mode 1, 2, 3/A or C.
4. IDENT-MIC switch	IDENT – when momentarily actuated, (switch spring loaded to return), initiates identification of position reply for approximately 20 seconds. OUT – prevents triggering of identification of position reply. MIC – enables identification of position replies to be transmitted by pressing microphone switch.
5. Mode 3/A code select switches	Selects and displays the mode 3/A four-digit reply code number.
6. Mode 1 code select switches	Selects and displays the mode 1 two-digit reply code number.
7. Mode 4 ON-OUT switch*	ON – enables the receiver-transmitter to reply to mode 4 interrogations. OUT – disables the reply capability to mode 4 interrogations.
8. AUDIO-LIGHT switch*	AUDIO – enables aural and REPLY light monitoring of valid mode 4 interrogations and replies. LIGHT – enables REPLY light only monitoring of valid mode 4 interrogations and replies. OUT – disables aural and REPLY light monitoring of mode 4.
9. Code control*	ZERO – erases mode 4 from MK XII computer. B – selects a MK XII computer code. A – not used. HOLD – retains code in MK XII computer when landing gear is down.
10. REPLY indicator*	Illuminates when valid mode 4 replies are present.
11. TEST indicator	Illuminates when the receiver-transmitter responds properly to mode 1, 2, 3/A, and C test.
12. AAU-19/A altimeter	Displays to pilot the altitude information (AAU-19/A in RESET position) transmitted to interrogating station when mode C is activated. Altitude information is furnished to altimeter and IFF transponder by Air Data Computer.
13. IFF caution light	On (IFF) – with MK XII computer installed, indicates IFF set has received a mode 4 interrogation and has not generated a mode 4 reply.
14. Intercommunication panel IFF monitor switch	Pulled – enables IFF audio to reach pilot's headset.

*Mode 4 is operational only when MK XII computer is installed.

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Figure 1–76 (Sheet 2)

3. Mode switches — POSITION DETERMINED BY MISSION

4. IDENT-OUT-MIC switch — OUT

System Self-Test.

The system is provided with the following two means of checking the transponder:

1. Monitor (RAD TEST-MON Switch) — The switch in the MON position enables the monitor circuits of Internal Test Set TS-1843/APX. The test light will illuminate whenever replies are transmitted in response to interrogations in any IFF mode.

2. Test — Mode 1, 2, 3/A, or C may be tested by moving the mode switch to the TEST position and observing the test position light. If the system is functioning properly, the light illuminates each time a mode switch is moved to the TEST position.

Identification Of Position Operation.

The system transmits position identifying signals to all interrogating stations on modes 1, 2, and 3/A when the IDENT-MIC switch on the control panel is energized. Transmission of the identification of position signal occurs in these modes even if the mode enable switches are in the OUT position. The two types of identification of position are as follows:

1. Momentarily hold the IDENT-MIC switch in the IDENT position (spring-loaded return), and then release. This action causes the receiver-transmitter unit to transmit the identification signal for a period of 15 to 30 seconds to all interrogating stations on modes 1, 2, and 3/A. Repeat as required.

2. Place the IDENT-MIC switch to the MIC position. Identification of position signals is transmitted by pressing the switch button on the pilot's microphone. When the need for further identification signals has ended, return the IDENT-MIC switch to the OUT position.

Emergency Operation.

During an aircraft emergency or distress condition, the system is used to transmit specially coded emergency signals on modes 1, 2, and 3/A to all interrogating stations. These emergency signals are transmitted as long as the MASTER control rotary knob remains in the EMER position. For emergency operation, the control panel is set as follows:

1. The MASTER control knob is pulled outward and rotated to the EMER position.

2. The MASTER control knob is left in the EMER position for the duration of the emergency.

3. When the emergency has ended, the MASTER control knob is returned to the NORM or LOW position.

Note

If system is turned on when seat ejection is performed, emergency signal is automatically transmitted if interrogated.

Mode 4 Monitoring Operation.

Valid mode 4 interrogations and replies can be monitored either aurally and visually, or visually, by placement of the MODE 4 AUDIO-LIGHT switch on the control panel as follows:

1. Place the AUDIO-LIGHT switch in AUDIO. Mode 4 interrogating and reply pulses will be audible in the pilot's headset and visible on the REPLY light.

2. Place the AUDIO-LIGHT switch in LIGHT. Indication of mode 4 interrogating and reply pulses will be seen on the REPLY light.

3. If mode 4 interrogations are being received by the IFF, but no replies are transmitted, the IFF caution light will come on.

Note

Mode 4 is operative only when MK XII computer is installed.

INTERIOR LIGHTS.

The interior lighting system consists of flight and nonflight instrument lights, left and right console lights, chartboard lights, floodlights for additional console and instrument panel lighting, and approach indexer lights. Windshield bow lights are included on aircraft [17] [27] →. All interior lights are white except a selectable red or white utility light. Interior lights are controlled from an interior lights panel on the right console (figure 1—77).

USE OF INTERIOR LIGHTS CONTROLS.

Flight Instrument Lights Knob.

Rotation of the FLT INST knob clockwise from OFF applies power for illumination of the following flight instrument lights (further clockwise rotation increases light intensity):

Altimeter, AAU-19/A

Angle-of-attack indicator

Attitude director indicator

Clock

Fuel flow indicator

- Fuel quantity indicator
- Heading mode select panel
- Horizontal situation indicator
- Hydraulic pressure indicator
- Mach airspeed indicator
- Master function switches
- Oil quantity indicator
- Oil pressure indicator
- Radar altimeter
- Speed brake indicator
- Standby attitude director indicator
- Standby compass
- Tachometer
- Turbine outlet temperature indicator
- Trailing edge flap position indicator
- Vertical velocity indicator

Note

Rotation of the FLT INST knob past 20 degrees from OFF increases the brightness of flight instrument lights. It also provides step dimming for the IMS controls panel and NAV WD Computer controls panel. Rotation of the same knob past 20 degrees causes the warning, caution, and advisory lights to go to dim illumination.

Nonflight Instrument Lights Knob.

Rotation of the NON FLT INST lights knob clockwise from OFF supplies power for illumination of the following nonflight instrument lights (further clockwise rotation increases light intensity):

- Accelerometer
- APR-36/37 panel
- Armament release control panel
- Armament select panel
- Cabin pressure altimeter
- Fuel cell select panel
- Gear and flap panel
- Head-up display
- Land checklist
- Leading edge flap position indicator
- Liquid oxygen quantity indicator
- MCR BCN/low altitude warning panel
- Radarscope
- Speed brake position indicator
- Takeoff panel checklist
- Terrain clearance panel
- True airspeed indicator
- Turbine outlet pressure indicator
- UHF frequency/channel remote indicator

Console Lights Knob.

Right and left console lights are turned on by rotating the CONSOLE lights knob clockwise from OFF. Further rotation of the knob increases console light intensity and, at 20 degrees from OFF, auxiliary floodlights illuminate the instrument panel and both consoles. Auxiliary floodlight intensity is controlled with the AUX FLOOD switch.

Chartboard Light Knob.

Chartboard lights are illuminated by clockwise rotation of the CHART BD knob on the right console from OFF. Further rotation increases light intensity.

Floodlights Knob.

High intensity white floodlights above each console are illuminated by rotating WHITE FLOOD knob clockwise from OFF. Light intensity is increased by further rotation of the knob.

Utility Light.

The utility light is located on a snap-in bracket on the aft right console. Rotating the ON/OFF intensity control clockwise turns on the light and increases the intensity. The adjustable lens on the front provides for the light to be used as a floodlight or spotlight. The color (red or white) can be selected with the FILTER button on the light housing. A pushbutton located in the center of the ON/OFF control permits momentary illumination of the utility light. An auxiliary bracket is located on the right canopy sill.

Auxiliary Floodlights Switch.

The auxiliary floodlights are controlled by the AUX FLOOD switch, located on the right console. Intensity positions selectable are BRT, OFF, and DIM (DIM, OFF, and MED on aircraft → [74] after T.O. 1A-7D-584).

Approach Indexer Lights Knob → [16] [18] → [26]

Before T.O. 1A-7D-503, the approach indexer lights automatically come on when the landing gear handle is in WHLS DOWN. The APPROACH INDEXER knob is used to control light intensity.

Windshield Bow Lights Knob → [16] [18] → [26] After T.O. 1A-7D-503

The windshield bow lights knob controls the intensity of the windshield bow threat lights, the approach indexer lights, and the threat lights under the left cowling.

INTERIOR LIGHTS CONTROLS

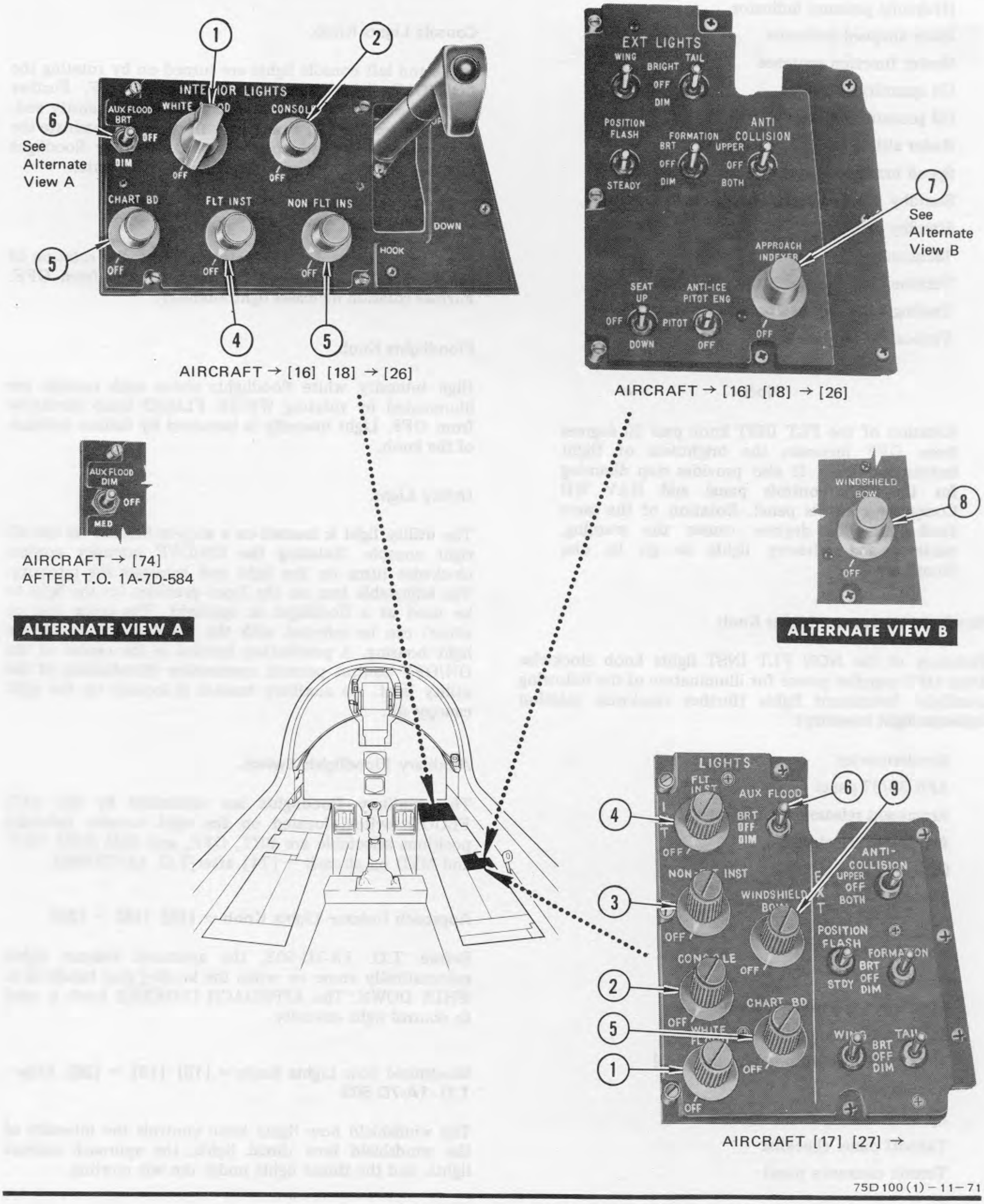

Figure 1–77 (Sheet 1)

INTERIOR LIGHTS CONTROLS

Nomenclature	Function
1. WHITE FLOOD lights knob	Clockwise rotation – turns on and controls intensity of white floodlights.
2. CONSOLE lights knob	Clockwise rotation – turns on and controls intensity of console lights. Rotated clockwise 20° or more from OFF, turns on AUX floodlights. Provides step dimming on ENTER light on NAV/WD.
3. NON FLT INST lights knob	Clockwise rotation – turns on and controls intensity of nonflight instrument lights.
4. FLT INST lights knob	Clockwise rotation – turns on and controls intensity of flight instrument lights. Rotated clockwise 20° or more from OFF, dims warning (except fire), caution, and advisory lights except those controlled by the windshield bow control knob.
5. CHART BD light knob	Clockwise rotation – turns on and controls intensity of chartboard light.
6. AUX FLOOD lights switch	Controls intensity of instrument panel and console auxiliary floodlights. Floodlights are turned on by rotating the CONSOLE lights knob past 20° from OFF. Intensity positions selectable are BRT, OFF, and DIM (DIM, OFF, and MED on aircraft → [74] after T.O. 1A-7D-584).
7. APPROACH INDEXER lights knob Aircraft → [16] [18] → [26] before T.O. 1A-7D-503	Clockwise rotation – controls intensity of indexer lights.
8. WINDSHIELD BOW lights knob Aircraft → [16] [18] → [26] after T.O. 1A-7D-503	Clockwise rotation – controls intensity of approach indexer lights. Applies power for and controls intensity of windshield bow threat lights and threat lights under left cowling
9. WINDSHIELD BOW lights knob [17] [27] →	Clockwise rotation – controls intensity of approach indexer lights. Applies power for and controls intensity of windshield bow threat lights, air refueling indicator lights, and threat lights under the left cowling.

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Figure 1–77 (Sheet 2)

Windshield Bow Lights Knob [17] [27] →

The windshield bow lights knob controls the intensity of the windshield bow threat lights, air refueling indicator lights, approach indexer lights, and the threat lights under the left cowling.

ELECTRICAL POWER.

The secondary ac bus powers the console and nonflight instrument lights. Auxiliary floodlights are powered by the battery bus. Flight instrument lights normally receive power from the inverter bus, and continue to receive power from the inverter bus during the interim between master ac generator failure and RAT extension. High intensity white floodlights are powered by the primary ac bus. Approach indexer lights receive power from the emergency dc bus, and the utility light receives power from the secondary dc bus. The primary dc bus powers the chartboard lights and the air refueling indicator lights. On aircraft [17] [27] →, the windshield bow lights except for the air refueling indicator lights are powered by the emergency dc bus.

SYSTEM CONTROLS.

Interior lights controls are illustrated and described in figure 1–77. Interior lights locations are illustrated in figure 1–78.

INTERIOR LIGHTS LOCATION

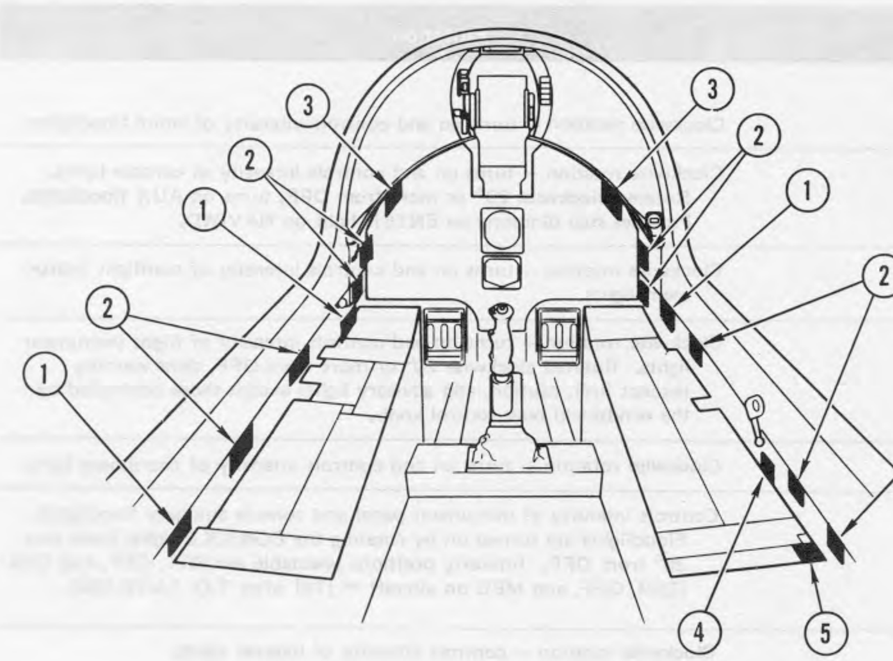

Figure 1–78

EXTERIOR LIGHTS.

Exterior lights are provided for aircraft illumination under various operating conditions. Formation lights, floodlights, position lights, and anti-collision lights are available for normal flight conditions. A land/taxi light is available for use when the landing gear handle is in the WHLS DOWN position. On aircraft → [16] [18] → [26], an air refueling probe light illuminates the refueling probe for night refueling operations. On aircraft [17] [27] →, slipway lights on the air refueling receptacle door provide illumination for the tanker boom operator during night air refueling operations.

EXTERIOR LIGHTS LOCATION AND USE.

Exterior lights cannot be turned on unless the exterior lights switch is first placed out of OFF position. On aircraft → [10], the switch is located above the left console. On aircraft [11] →, the switch is on the throttle and has three positions, BRT, OFF, and DIM.

Formation Lights And Floodlights.

Formation lights (one on each wingtip) and floodlights that illuminate both sides of the vertical fin and both sides of the outer fuselage section aid in night formation flight. All floodlights and the formation lights are switched on (DIM or BRIGHT) or OFF with the FORMATION lights switch.

Position Lights.

Position lights on each wingtip are switched on (DIM or BRIGHT) or OFF with the WING switch. Vertical fin position lights are switched on (DIM or BRIGHT) or OFF with the TAIL switch. Placing the POSITION switch in FLASH causes all position lights that are on to flash. The STEADY position results in constant illumination of all position lights previously turned on.

Anticollision Lights.

Anticollision lights (one on top, one on bottom of the fuselage) are controlled by the ANTICOLLISION switch. Both lights are turned on when the switch is placed in BOTH, but only the upper light when the switch is in UPPER position. These lights burn with a constant intensity, cannot be dimmed, and flash at a rate of 80 flashes per minute.

Land/Taxi Light.

With the landing gear handle in WHLS DOWN position, placing the land/taxi switch in LAND/TAXI turns on the land/taxi light. The light is turned off by returning the switch to OFF.

Air Refueling Probe Light → [16] [18] → [26]

The air refueling probe light illuminates the refueling probe when the AR PROBE switch is in EXTEND position (exterior lights switch must be ON).

Note

With the probe extended and the probe light on, subsequent movement of the AR PROBE switch to OFF causes the probe light to go out.

Slipway Lights [17] [27] →

Intensity of the slipway lights is controlled by the SLIPWAY LIGHT switch, located on the left console.

ELECTRICAL POWER.

The secondary ac bus powers the floodlights, formation lights, and anticollision lights. The emergency ac bus powers the position lights. Land/taxi light power is supplied by the secondary dc bus. The air refueling probe light and taillights are powered by the primary ac bus.

EXTERIOR LIGHTS CONTROLS.

Exterior lights controls are illustrated and described in figure 1–79.

WARNING, CAUTION, AND ADVISORY LIGHTS.

Warning, caution, and advisory lights are provided to enable the pilot to monitor the condition of aircraft systems, subsystems, and components. For aircraft → [16] [18] → [26], refer to figure 1–80 for location of the lights and panels. For aircraft [17] [27] →, refer to figure 1–81 for location of the lights and panels.

Note

During daylight operations, the flight instrument lights knob shall be rotated fully counterclockwise to off so that warning, caution, and advisory light circuits are set for bright operation.

Rotation of the FLT INST knob past 20 degrees from OFF increases the brightness of flight instrument lights. Rotation of the same knob past 20 degrees causes the warning, caution, and advisory lights to go to dim illumination.

WARNING LIGHTS.

Illumination of a warning light indicates the existence of a hazardous condition requiring immediate corrective action. Warning lights are installed near the monitored controls or indicators or in a conspicuous position on the instrument panel. Individual warning lights are explained as a part of the applicable system description.

Note

If the HUD is on and operating, six steady canted lines appear on the HUD whenever the FIRE warning light comes on. These canted lines are an indication to the pilot that his immediate attention is needed in the cockpit. The HUD warning symbol will not appear if the HUD TEST switch is in TEST.

CAUTION LIGHTS.

Illumination of a caution light indicates an impending dangerous condition requiring immediate attention but not necessarily immediate corrective action. The malfunctions which these lights indicate do not place the aircraft in a hazardous condition and in some circumstances can be corrected by the pilot while in flight. Individual caution lights are explained as a part of the systems which they monitor.

MASTER CAUTION LIGHT.

The master caution light comes on whenever any caution light comes on and is a signal to the pilot to refer to the caution light panel to identify the system causing trouble. The master caution light is turned off and reset to monitor subsequent malfunctions by pressing and releasing the light lens cover. Individual caution lights do not go out until the malfunction is corrected. The one exception is the STARTER caution light which is powered by the starter permanent magnet generator. Normal starter cutout or termination of starter operation by the starter abort switch will remove electrical power from the light when starter rotation stops.

Note

The master caution light is inoperative during engine starting cycle until the master generator comes on the line unless external ac power is being furnished to the aircraft.

Six flashing canted lines appear on the HUD whenever the master caution light comes on. These canted lines are an indication to the pilot that his immediate attention is needed in the cockpit.

ADVISORY LIGHTS.

An advisory light panel on the right console monitors systems and minor malfunctions not serious enough to warrant caution lights. Additionally, the armament

EXTERIOR LIGHTS CONTROLS

AIRCRAFT [17] [27] →

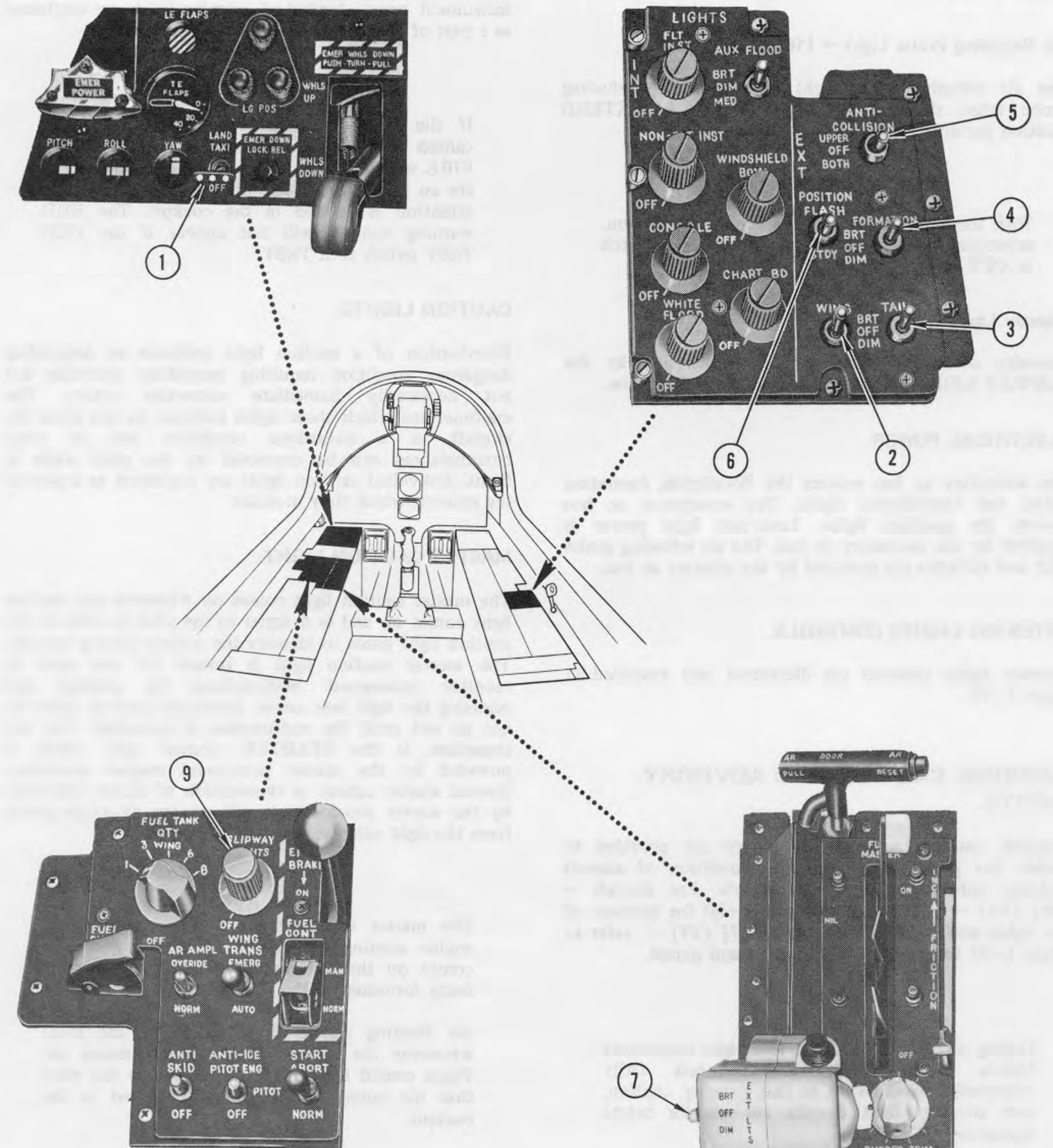

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Figure 1–79 (Sheet 1)

EXTERIOR LIGHTS CONTROLS

AIRCRAFT → [16] [18] → [26]

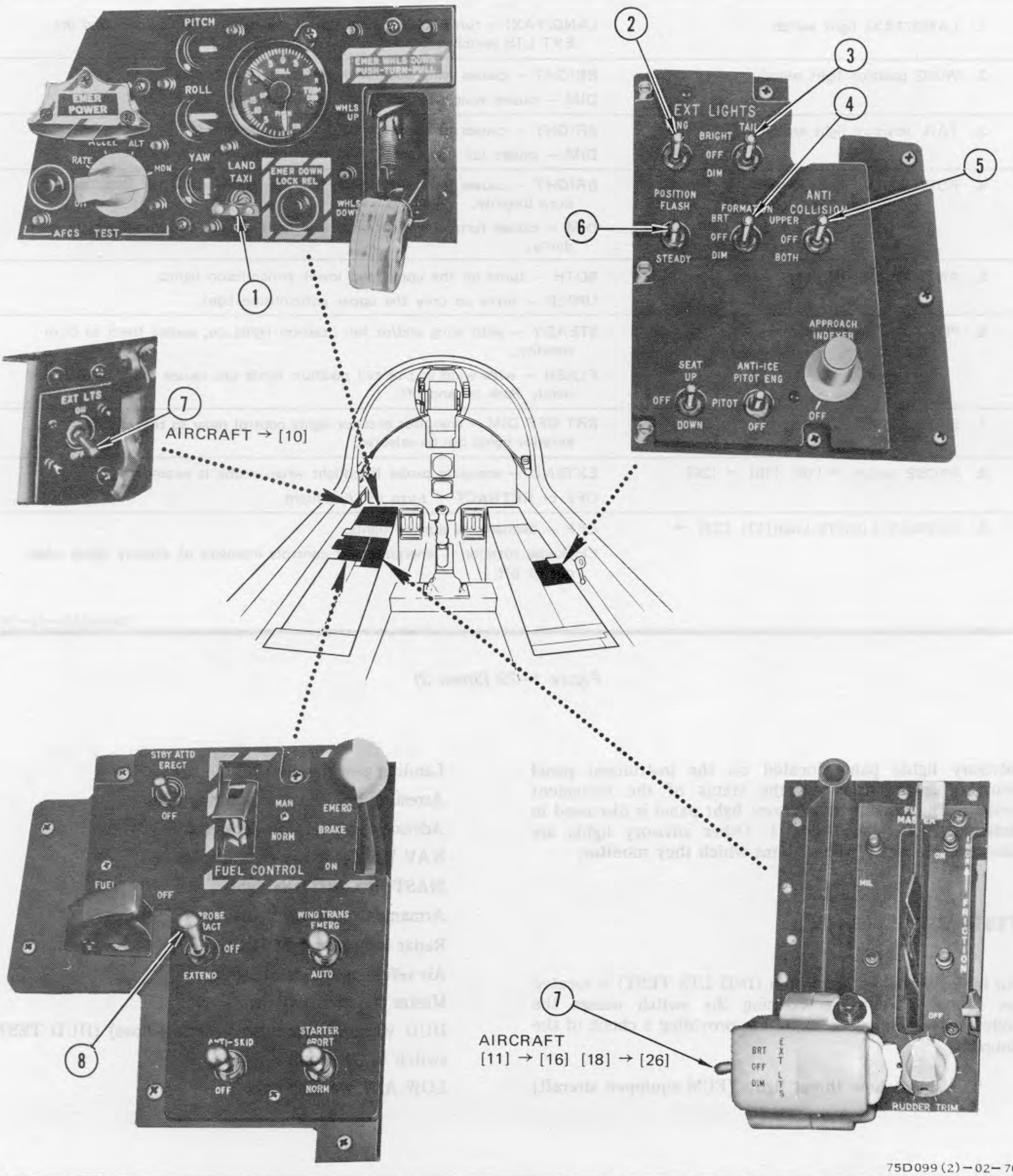

Figure 1–79 (Sheet 2)

EXTERIOR LIGHTS CONTROLS

Nomenclature	Function
1. LAND/TAXI light switch	LAND/TAXI – turns land/taxi light on if the gear handle is down and the EXT LTS switch is ON.
2. WING position light switch	BRIGHT – causes wing position lights to burn brightly. DIM – causes wing position lights to burn dimly.
3. TAIL position light switch	BRIGHT – causes tail position light to burn brightly. DIM – causes tail position light to burn dimly.
4. FORMATION lights switch	BRIGHT – causes formation lights, fuselage, and vertical tail floodlights to burn brightly. DIM – causes formation lights, fuselage, and vertical tail floodlights to burn dimly.
5. ANTICOLLISION lights switch	BOTH – turns on the upper and lower anticollision lights. UPPER – turns on only the upper anticollision light.
6. POSITION lights switch	STEADY – with wing and/or tail position lights on, causes them to burn steadily. FLASH – with wing and/or tail position lights on, causes them to alternately flash on and off.
7. EXT LTS switch	BRT OFF DIM – energizes exterior lights control relay so that desired exterior lights can be selected.
8. PROBE switch → [16] [18] → [26]	EXTEND – energizes probe floodlight when probe is extended. OFF or RETRACT – turns off floodlight.
9. SLIPWAY LIGHTS knob[17] [27] →	OFF – deenergizes slipway lights. Clockwise rotation – energizes and controls intensity of slipway lights when out or off.

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Figure 1–79 (Sheet 3)

advisory lights panel located on the instrument panel provides information on the status of the armament system. The armament advisory light panel is discussed in detail in T.O. 1A-7D-34-1-1. Other advisory lights are discussed as part of the systems which they monitor.

TESTING THE LIGHTS.

An indicator lights test switch (IND LTS TEST) is located on the right console. Pressing the switch causes the following indicators to come on, providing a check of the lamps:

Windshield bow threat lights (ECM equipped aircraft)
Landing gear handle warning light
Arresting hook handle warning light
Advisory and caution lights (all)
NAV WD computer data display
MASTER CAUTION light
Armament advisory lights
Radar indicator light (INRNG)
Air refueling indicator lights
Master function switches
HUD warning symbology (canted lines) (HUD TEST switch in OFF only)
LOW ALT warning light

WARNING, CAUTION, AND ADVISORY LIGHTS →[16] [18] →[26]

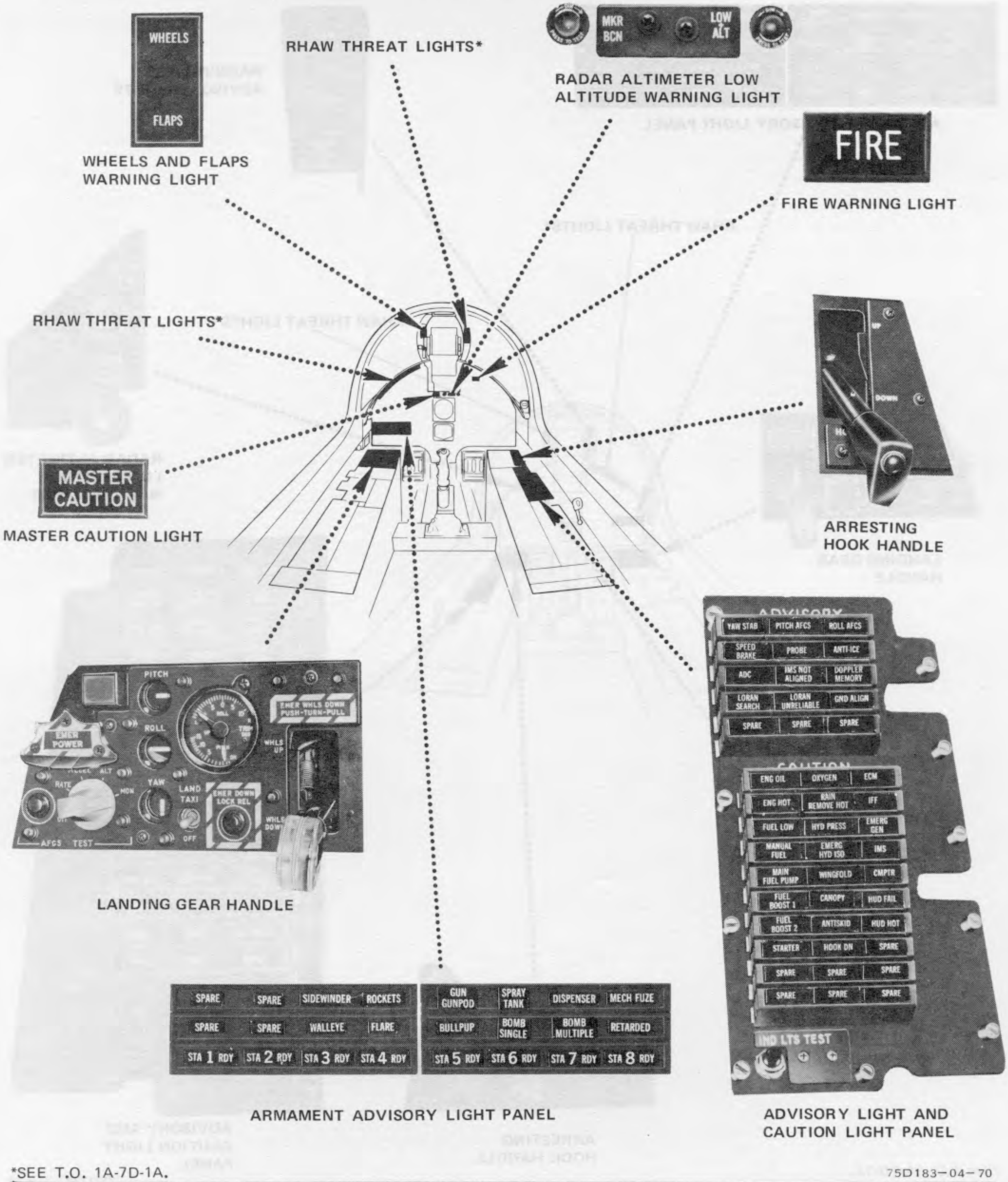
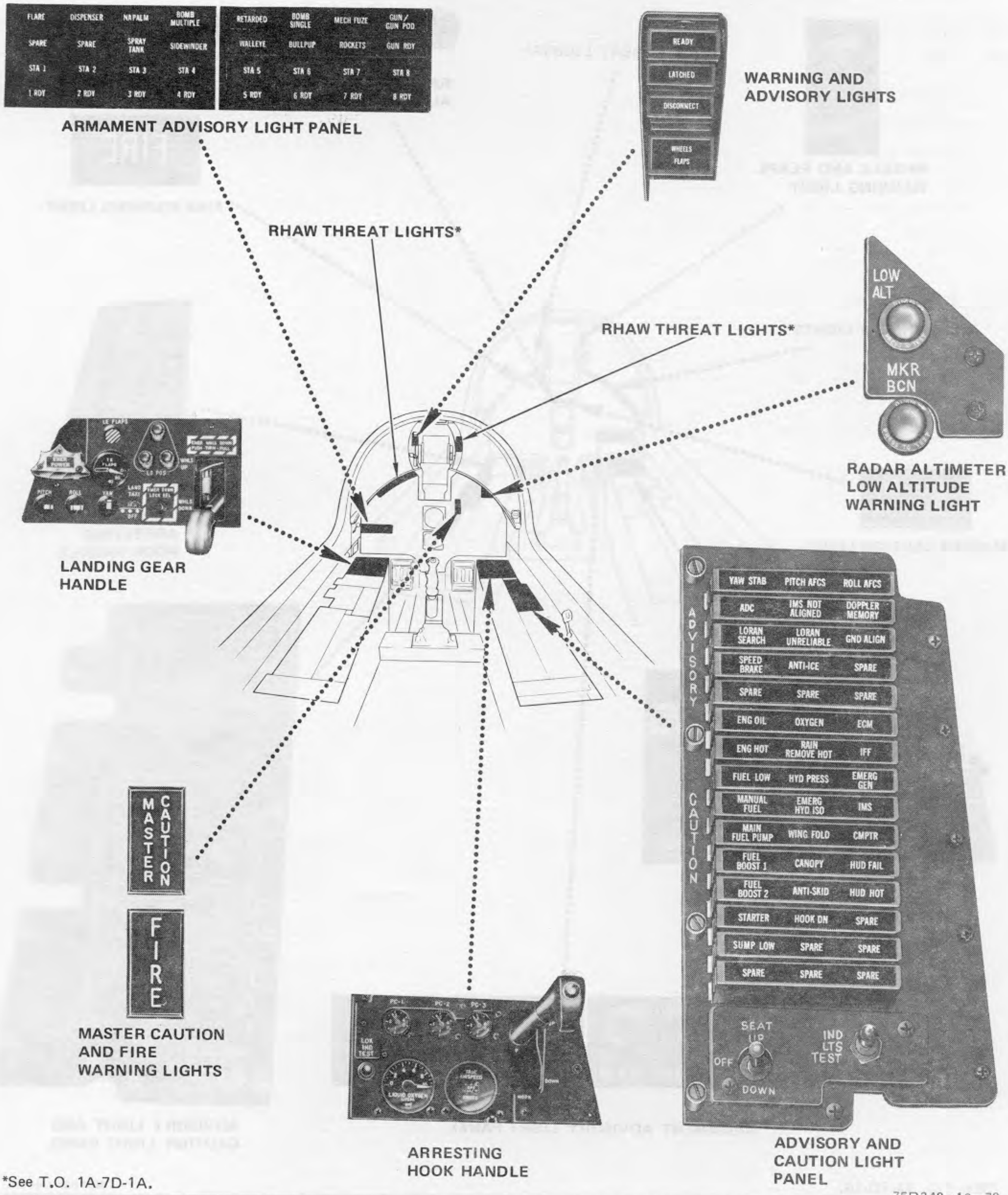


Figure 1–80

WARNING, CAUTION, AND ADVISORY LIGHTS [17] [27] →



*See T.O. 1A-7D-1A.

Figure 1–81

Note

Lights may be tested in dim mode by rotating FLIGHT INST knob clockwise 20 degrees out of OFF.

The following lights are tested by pressing the respective lens cover:

WHEELS FLAPS

FIRE warning

Landing gear position indicators

MKR BCN

IFF test and reply

Juliet 28

ELECTRICAL POWER SOURCE.

The WARNING, CAUTION, and ADVISORY lights receive power from electrical buses as follows:

Primary dc	*Secondary dc*
ADC advisory	CMPTR caution
CANOPY caution	DOPPLER MEMORY advisory
EMERG GEN caution	ECM caution
FUEL LOW caution	EMERG HYD ISO caution
IFF caution	HOOK DN caution
OXYGEN caution	HUD FAIL caution
PROBE advisory	HUD HOT caution
SPEED BRAKE advisory	Radar LOW ALT warning
	THREAT (ECM) warning
	WINGFOLD caution

Emergency dc	*Battery*
Hook handle warning	ENG HOT caution
ANTI-ICE advisory	FIRE warning
ANTI-SKID caution	MANUAL FUEL caution
ENG OIL caution	
FUEL BOOST 1 caution	Note STARTER caution light is powered by the starter PMG.
FUEL BOOST 2 caution	
GND ALIGN advisory	
HYD PRESS caution	
IMS caution	
IMS NOT ALIGNED advisory	
LANDING GEAR warning	
MAIN FUEL PUMP caution	
MASTER CAUTION warning	
PITCH AFCS advisory	
RAIN REMOVE HOT caution	
ROLL AFCS advisory	
WHEELS FLAPS warning	
YAW STAB advisory	

If the main generator fails and the RAT has been extended, lights on the secondary dc bus are lost if the EMER GEN switch is placed in CRUISE. With the switch in T.O. LAND, lights on the primary and secondary dc buses are lost.

FIRE DETECTION SYSTEM.

An indication of fire or an overheat condition in the engine compartment is detected by a sensing element similar to a coaxial cable. The element consists of an inner conductor, a layer of insulation, and an outer metal shield, and is routed in half circle arcs above the rear engine section and at three points beneath the engine. It also extends along the entire length of the engine on both sides. The sensing elements can actuate the FIRE warning light by wide area heat of approximately 600°C to small area heat of approximately 2000°C. The light remains on as long as the overtemperature condition exists.

Note

If the HUD is on and operating, six steady canted lines appear on the HUD whenever the FIRE warning light comes on.

A break in the sensing element does not prevent warning light illumination unless the center conductor has shorted to ground. A fault detector circuit disables the system in the event the center conductor shorts to ground, preventing a false fire warning.

On aircraft → [16] [18] → [26], system operation is checked by pressing the test switch above the light and observing light illumination. On aircraft [17] [27] →, system operation is checked by pressing the individual light lens cover. If the engine is not operating, the BATT switch must be in BATT. Power for system operation is supplied by the battery bus.

OXYGEN SYSTEM.

Breathing oxygen is supplied by a 10-liter liquid oxygen converter package located in the nose section of the aircraft. A liquid oxygen system supplies 100 percent oxygen in a gaseous state to a requlator in the cockpit. Buildup of pressure within the system and conversion of liquid oxygen to gaseous oxygen begins automatically following servicing. When the system is in use, gaseous oxygen flows through two heat exchangers to the oxygen regulator ON/OFF valve. The heat exchangers ensure complete conversion to a gaseous state and bring the oxygen to a breathable temperature. Oxygen pressure, flow, and air-to-oxygen mixture ratio (dilution) are automatically controlled by the regulator during normal operation. One-hundred percent oxygen and positive pressure breathing are manually selectable for emergencies. Also, an emergency oxygen supply bottle is available in the event the main system fails completely. The following illustration (figure 1-82) depicts oxygen system flow.

The oxygen system is serviced through a single point filler valve in the aircraft nose section. The oxygen package is normally filled while installed but can be removed and replaced to expedite servicing. See figure 1-83 for oxygen system duration.

OXYGEN SYSTEM FLOW

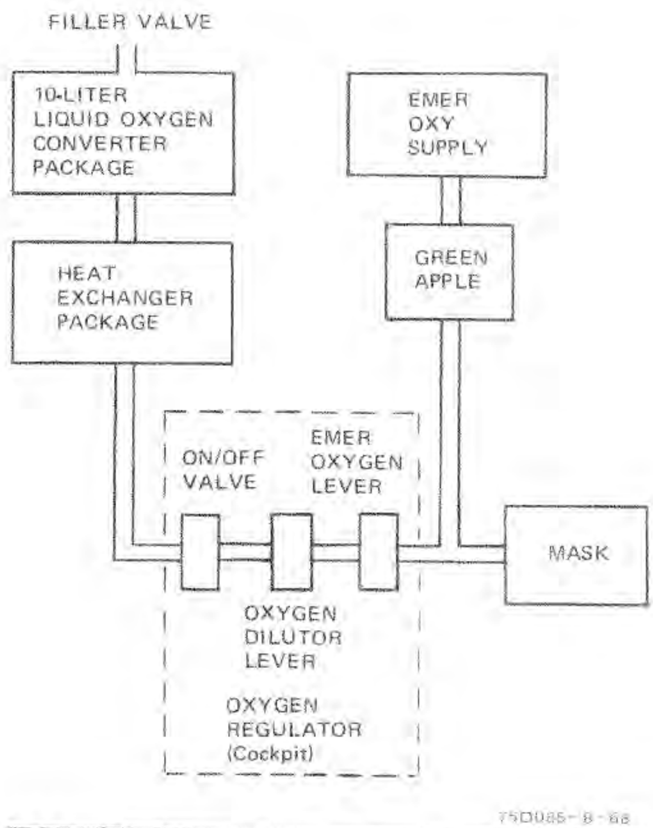


Figure 1-82

OXYGEN REGULATOR.

A CRU-68A oxygen regulator on the right cockpit console contains an ON/OFF valve, an oxygen diluter lever, EMERGENCY oxygen lever, FLOW indicator, and OXYGEN PSI indicator. The oxygen regulator controls the flow and pressure of the oxygen, and distributes it in the proper proportions to the mask. See figure 1-84 for an illustration of oxygen system controls and functions.

The CRU-73A oxygen regulator incorporates an interlock between the ON/OFF valve and the oxygen diluter lever. When the oxygen supply is turned off, the interlock automatically places the diluter lever in the 100% OXYGEN position, shutting off all cockpit air to the mask. By shutting off all air to the mask in this manner, the pilot is alerted immediately that his oxygen supply is off.

Note

The CRU-73A oxygen regulator is an improved replacement for the CRU-68A regulator and either may be installed in the aircraft.

The oxygen flow indicator is not readily visible with a knee board worn on the right leg.

OXYGEN DURATION CHART 100 PERCENT AND NORMAL REGULATION

COCKPIT ALTITUDE, FEET	GAGE INDICATION LITERS										
	10	9	8	7	6	5	4	3	2	1	BELOW 1
35,000 AND ABOVE	61:48	55:36	49:30	43:12	37:00	30:54	24:48	18:30	12:18	6:06	FLY BELOW 10,000 FEET
	61:48	55:36	49:30	43:12	37:00	30:54	24:48	18:30	12:18	6:06	
30,000	45:18	40:48	36:12	31:48	27:12	22:42	18:06	13:42	9:06	4:38	
	46:00	41:18	36:48	32:12	27:36	23:00	18:24	13:48	9:12	4:36	
25,000	35:00	31:24	28:00	24:24	21:00	17:30	14:00	10:18	7:00	3:30	
	43:24	39:06	34:48	30:24	26:06	21:42	17:24	13:00	8:42	4:18	
20,000	26:24	23:48	21:00	18:30	15:48	13:12	10:30	7:54	5:18	2:42	
	48:48	43:54	39:06	34:12	29:18	24:24	19:30	14:42	9:48	4.54	
15,000	21:12	19:06	17:06	14:54	12:48	10:36	8:30	6:24	4:18	2:08	
	59:42	53:42	47:48	41:48	35:48	29:48	23:54	17:54	11:54	6:00	
10,000	17:00	15:18	13:36	11:54	10:12	8:30	6:48	5:06	3:24	1:42	
	59:42	53:42	47:48	41:48	35:48	29:48	23:54	17:54	11:54	6:00	
5,000	13:30	12:06	10:48	9:30	8:06	6:42	5:24	4:00	2:42	1:24	
	59:42	53:42	47:48	41:48	35:48	29:48	23:54	17:54	11:54	6:00	
SEA LEVEL	11:06	9:48	8:54	7:36	6:36	5:30	4:24	3:18	2:12	1:06	
	59:42	53:42	47:48	41:48	35:48	29:48	23:54	17:54	11:54	6:00	

HOURS AND MINUTES OXYGEN REMAINING

SHADED FIGURES INDICATE DILUTER LEVER – 100% OXYGEN

UNSHADED FIGURES INDICATE DILUTER LEVER – NORMAL OXYGEN

NOTES

1. Consumption data per MIL-I-9475A (USAF)-1. Consumption data assumes use of properly fitted oxygen equipment. Leakage will decrease tabulated duration. Table is based on using a 10-liter liquid oxygen converter and 860 liters of gaseous oxygen per liter of liquid oxygen.

2. Because there is less ambient pressure acting upon the lungs at altitude, a lesser quantity of oxygen will expand the lungs to their normal size. Therefore, oxygen duration increases as cockpit altitude increases.

75D084–8–68

Figure 1–83

OXYGEN CONTROLS

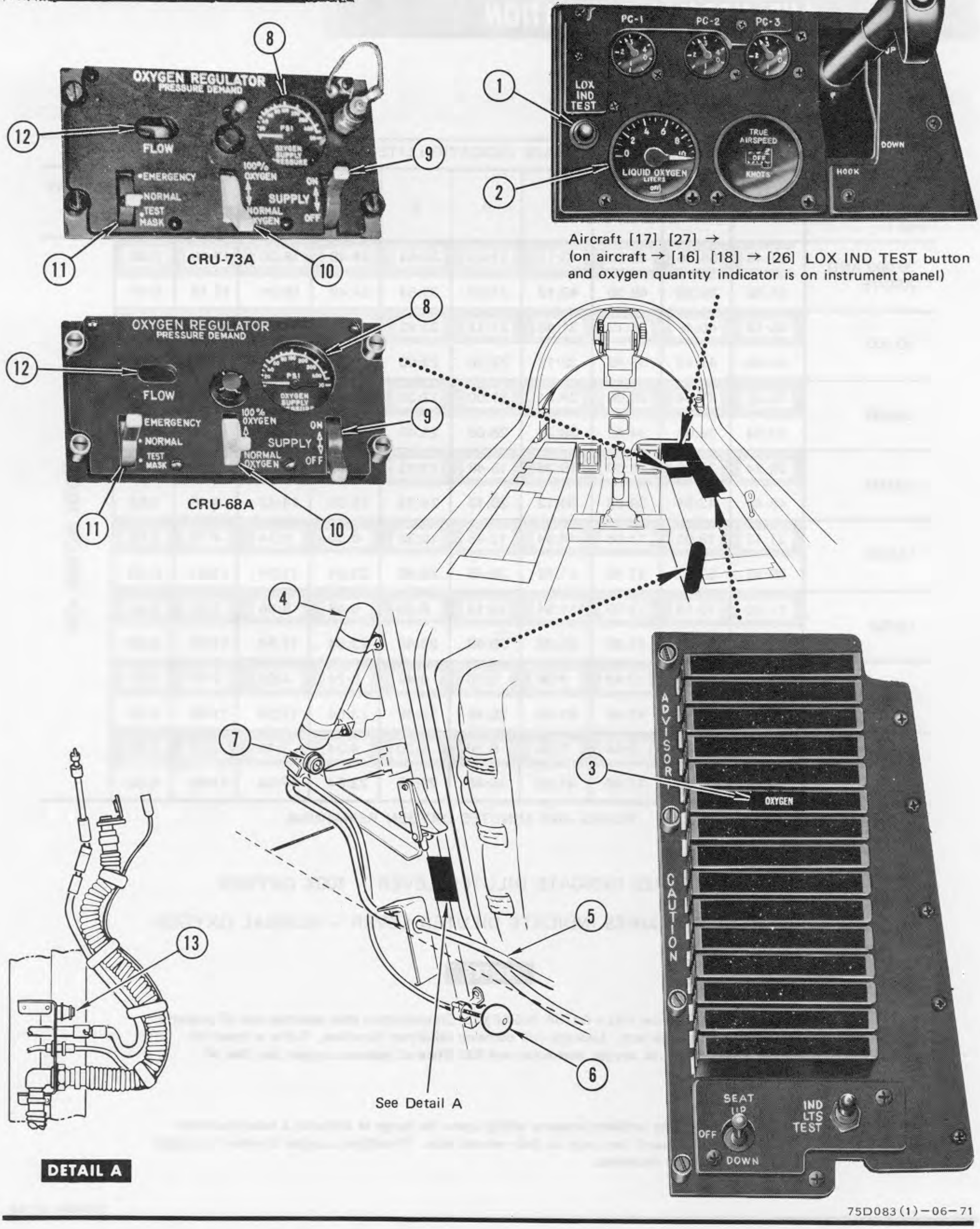


Figure 1–84 (Sheet 1)

OXYGEN CONTROLS

Nomenclature	Function
1. LOX IND TEST button	Depressed – oxygen quantity indicator drives to zero. Released – oxygen quantity indicator returns to actual indication.
2. Oxygen quantity indicator	Indicates quantity of liquid oxygen that can be converted to gaseous oxygen and supplied for breathing through the oxygen regulator. An OFF flag will appear in a window on the instrument face to indicate electrical power loss to the system.
3. Oxygen caution light	On (OXYGEN) – indicates quantity of liquid oxygen in converter is one liter or less.
4. Emergency oxygen bottle	Attached to aircraft structure. Provides emergency oxygen should normal system fail.
5. Emergency oxygen hose	Connects emergency oxygen supply to pilot's mask connection.
6. Emergency oxygen lanyard	Pulled – activates the emergency oxygen bottle supply. Flow of oxygen will continue until the supply is exhausted.
7. Emergency oxygen pressure gage	Indicates pressure in the emergency oxygen bottle.
8. Oxygen pressure indicator	Indicates gaseous oxygen pressure in psi at regulator.
9. ON-OFF valve	ON – allows gaseous oxygen flow through the oxygen regulator to the pilot's mask. OFF – CRU-68A: stops flow of gaseous oxygen through the oxygen regulator but allows cockpit air breathing through the oxygen mask. CRU-73A: shuts off all air to the oxygen mask.
10. Oxygen diluter lever	NORMAL OXYGEN – provides regulated mixture of cockpit air and oxygen determined by cockpit altitude. 100% OXYGEN – provides regulated 100% oxygen supply.
11. EMERGENCY oxygen lever	NORMAL – selects demand-type oxygen flow. Oxygen mixture diluted or 100% depends upon position of oxygen diluter lever. EMERGENCY – selects positive pressure oxygen flow. Oxygen mixture diluted or 100% depends upon position of oxygen diluter lever. TEST – selects increased positive pressure oxygen flow to test mask and hose for leaks. Oxygen mixture diluted or 100% depends upon position of oxygen diluter lever.
12. FLOW indicator	Blinks indicating oxygen-air flow during pilot's inhalation.
13. Oxygen hose dummy fitting	Provides safe stowage of oxygen hose and attached communications lead when not in use.

75D083 (2)–06–71

Figure 1–84 (Sheet 2)

OXYGEN SYSTEM FAILURE.

Failures And Remedies.

There are several instances when the pilot has to utilize the emergency features of the normal oxygen system. If the normal oxygen system fails completely, he has to utilize the emergency oxygen bottle for breathing oxygen.

Normal oxygen breathing is by demand. If the demand (NORMAL) feature fails to supply oxygen, the pilot shall move the EMERGENCY oxygen lever to the EMERGENCY position to obtain positive pressure flow from the oxygen supply. If cockpit air becomes contaminated or filled with smoke, he shall move the diluter lever to the 100% OXYGEN position to avoid the mixing of contaminated air with oxygen.

Emergency Oxygen Bottle.

The emergency oxygen bottle is attached to the ejection seat support structure on the right side of the cockpit. The bottle provides a temporary supply of steady flow breathing oxygen in case of inflight emergencies involving failure of the normal oxygen system. The duration of oxygen in the bottle is approximately 10 minutes.

Note

The emergency oxygen supply is not available for ejection, as the supply bottle is attached to the aircraft structure.

The bottle is activated by pulling an oxygen lanyard Green Apple located at the lower right edge of the ejection seat leg brace. Continuous oxygen flow is directed to the oxygen mask through an extension hose that joins the normal oxygen hose at the pilot's mask connection. A quick-disconnect in the hose line provides a means of separation during seat ejection, and the bottle remains with the aircraft.

QUANTITY AND LOW-LEVEL INDICATIONS.

An oxygen quantity indicator, located on the right side of the instrument panel, indicates converter liquid oxygen quantity. The indicator is ac powered. An oxygen low-level caution light is located on the right console.

OXYGEN SYSTEM MANAGEMENT.

Preflight Check.

Before each flight, perform the following P-R-I-C-E oxygen system check:

P — Pressure And Quantity

Pressure and quantity — Checked

Regulator ON/OFF valve — ON

Oxygen pressure — 75 (±25) PSI

Oxygen quantity — Sufficient for mission (figure 1–83)

Note

The liquid oxygen system shall not be permitted to deplete all oxygen or be exposed to surrounding atmosphere. Water vapor or other gases may condense in the converter, causing system malfunction or contamination. If exposure to atmosphere has occurred for an extended period, the system shall be purged with hot dry nitrogen prior to use.

R — Regulator

Check regulator supply ON. Hook up mask and perform a pressure check. Place the emergency lever to the EMERGENCY position; take a deep breath and hold it. If mask leakage occurs, readjust mask and reaccomplish the check. The oxygen should stop flowing. If the mask appears to be properly fitted, but oxygen continues to flow, the regulator, the hose, or the valve is not holding pressure and the cause of the leak shall be corrected. Return the emergency lever to NORMAL. If you cannot exhale, the valve has malfunctioned and the discrepancy shall be corrected.

I — Indicator

Connect mask to supply hose and breathe through mask. Indicator blinks during inhalation. Check mask by placing emergency test valve in TEST MASK position and hold breath. Flow indicator blinks if either the mask or supply hose is leaking. Return valve to NORMAL position.

C — Connections

Test quick-disconnect for proper release and connection. Check emergency oxygen hose connected.

CAUTION

To prevent damage to the connector, do not disconnect the quick-disconnect on the emergency oxygen line.

E — Emergency

Check emergency oxygen bottle pressure 1,800 psi minimum.

Inflight Checks.

During flight, make frequent checks of the following:

Oxygen quantity

Oxygen pressure

Oxygen flow

Oxygen hose connection

Postflight.

Upon completion of flight:

Oxygen leads — Disconnected at CRU-60/P connector and stowed on dummy fitting

Oxygen ON/OFF valve — ON

AIRCRAFT WEAPON RELEASE SYSTEM.

Weapon delivery is achieved by means of the Navigation/Weapon Delivery System and the Aircraft Weapon Release System. The Navigation/Weapon Delivery System is separately described in this section and in the A-7D Aircrew Weapon Delivery Manual (Nonnuclear), T.O. 1A-7D-34-1-1. The Aircraft Weapon Release System, suspension and jettison systems, combat weapons, fuzes, training equipment, and mission capabilities are also described in T.O. 1A-7D-34-1-1. The following paragraphs describe weapon-related systems only insofar as necessary to understand the function of cockpit-mounted controls and indicators.

The weapon release system consists of all equipment required to release, fire, or jettison stores mounted on the wing and fuselage stations. Control of the aircraft-mounted gun is also provided by the system.

The weapon release system utilizes the four attack mode master function switches (VISUAL (NORM) ATTACK, RADAR BOMB, OFFSET, and NAV BOMB), an ARMT select panel, armament advisory light panel, ARMAMENT RELEASE panel, stick grip release switches, interlocks, and an Armament Station Control Unit (ASCU). Paired pushbutton ASCU switches are provided for each wing station. The type of store being carried on each wing station is preset into the ASCU before flight to allow the ASCU to select proper circuits for release, to provide stores information to the NAV WD Computer, and to illuminate proper armament advisory lights. The ASCU is located in the left avionic bay. Selection and operation of weapon deployment is provided by the ARMT select and ARMAMENT RELEASE panels and the switches on the stick grip. Armament controls for aircraft → [16] [18] → [26] are illustrated in figure 1–85. Armament controls for aircraft [17] [27] → are illustrated in figure 1–86.

Placing the desired station select switch to the RDY position applies a selected station signal to the ASCU. The ASCU identifies the weapon loaded on that station, as set on the ASCU store type switches. The ASCU then returns a signal to the armament advisory light panel to illuminate the appropriate store identification light and the MECH FUZE light, if a mechanically fuzed weapon is loaded on the selected station. On aircraft → [16] [18] → [26], a green STA RDY light comes on when the station is ready for armed release or firing of the weapon. On aircraft [17] [27] →, a yellow, numbered, station selected (STA 1) light comes on when the station is ready for armed release or firing and MASTER ARM switch is in OFF position. Placing the MASTER ARM switch in the ARM position turns off the yellow station selected light and turns on a green, numbered, station ready (1 RDY) light. Armament advisory lights go off after weapon release or firing, or when the station select switch is placed in OFF.

When weapon delivery is manual ripple or computed, the ASCU identifies to the computer the store type, as selected on the store type switches, the type of ballistics required (in the case of retarded weapons), and provides the computer with a release enable signal. The computer generates the number of release pulses set on the QUANTITY thumbwheel at the spacing set on the INTERVAL thumbwheel, and supplies the ASCU with a computer fire ready signal. When the computer release signal, computer fire ready, and the release enable signal, provided by the pilot with the armament release switch, are present at the ASCU, the ASCU routes the release pulses to selected stations. The routing of the release pulses and priority of station release is determined by store and station priority and the position of the SINGLE-PAIRS-SIMULT switch. The QUANTITY and INTERVAL thumbwheels and the SINGLE-PAIRS-SIMULT switch are located on the ARMAMENT RELEASE panel.

The M61A1 20mm internal gun is controlled by the ARMT select panel GUN switch. The gun is fired using the stick grip trigger switch. All other munitions are released or fired using the stick grip armament release switch. The MASTER ARM switch must be in the ARM position to release or fire any munition or fire the gun.

WARNING

The gun blast port must be plugged if the aircraft is to be flown without the gun installed. Flight without the M61A1 gun or a blast port plug installed will allow pressurization of the gun and ammunition drum compartments and may cause failure of gun gas shroud components. This will, in turn, allow gun gas seepage into other aircraft compartments upon reinstallation and firing of the gun.

Jettison Controls.

The aircraft is equipped with three armament jettison switches:

Salvo jettison (SALVO JETT)

Select jettison (SEL JETT)

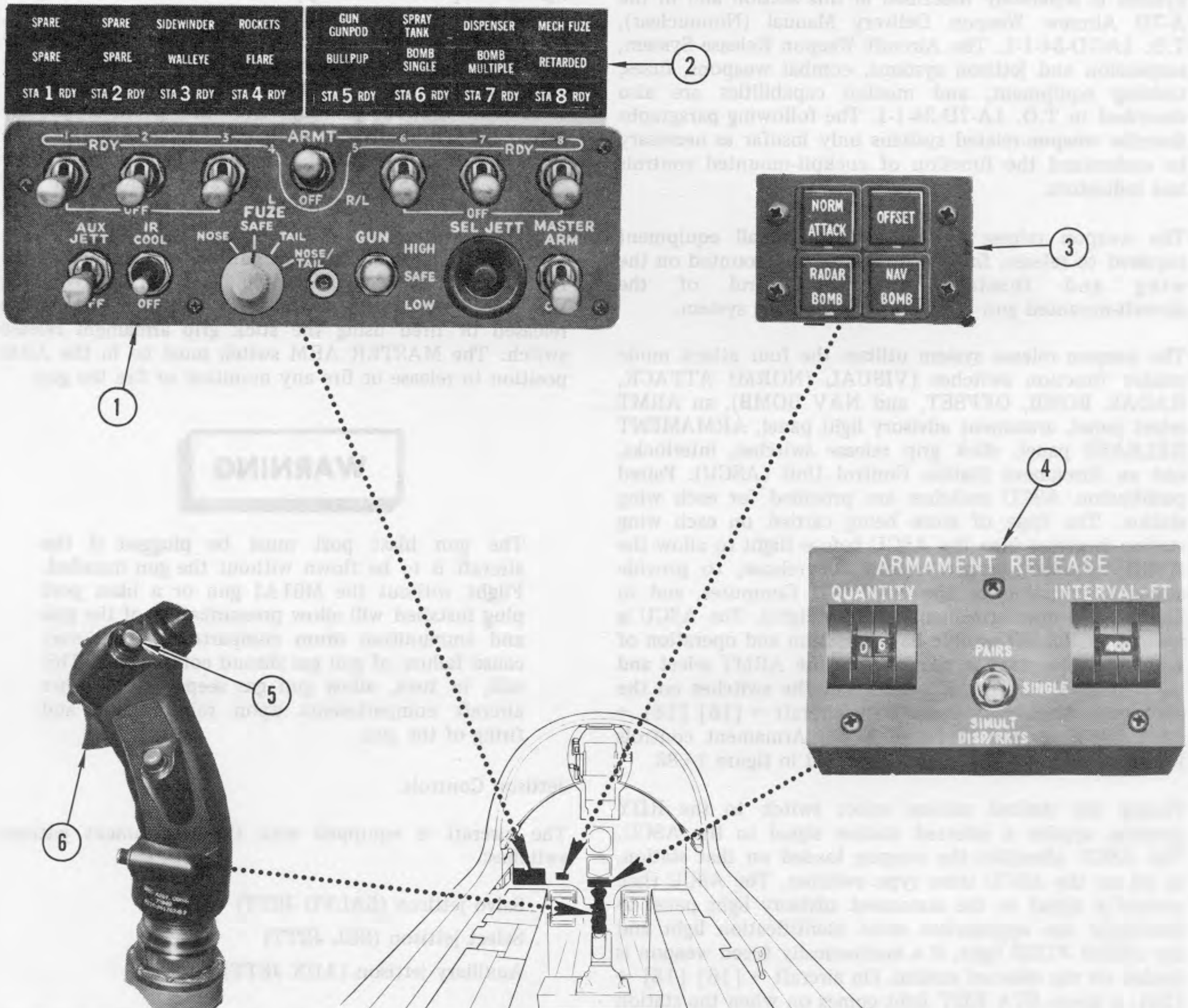
Auxiliary jettison (AUX JETT)

The switches are illustrated in figure 1–87. Depression of the SALVO JETT switch permits the release of all stores and supplementary racks from pylon-mounted MAU-12B/A ejector racks. MAU-12B/A racks are not released during jettison. The MASTER ARM switch does not have to be in the ARM position to effect a salvo jettison. Actuation of the SALVO JETT switch disables fuzing.

A 2.1-second hold-in circuit is incorporated in the system. With the switch actuated after the gear is up and locked, stations 1 and 8 will release after 0.2 second, stations 2 and 7 will release after 0.7 second, and stations 3 and 6 will release after 1.2 seconds. If the gear is not up and locked when the SALVO JETT switch is actuated,

WEAPON RELEASE INDICATORS AND CONTROLS

→ [16] [18] → [26]



1. Armament select panel
2. Armament advisory light panel
3. Attack switches
4. Armament release panel
5. Armament release switch
6. Trigger switch

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Figure 1–85

WEAPON RELEASE INDICATORS AND CONTROLS [17] [27] →

1. Armament select panel
2. Armament advisory light panel
3. Attack switches
4. Armament release panel
5. Armament release switch
6. Trigger switch

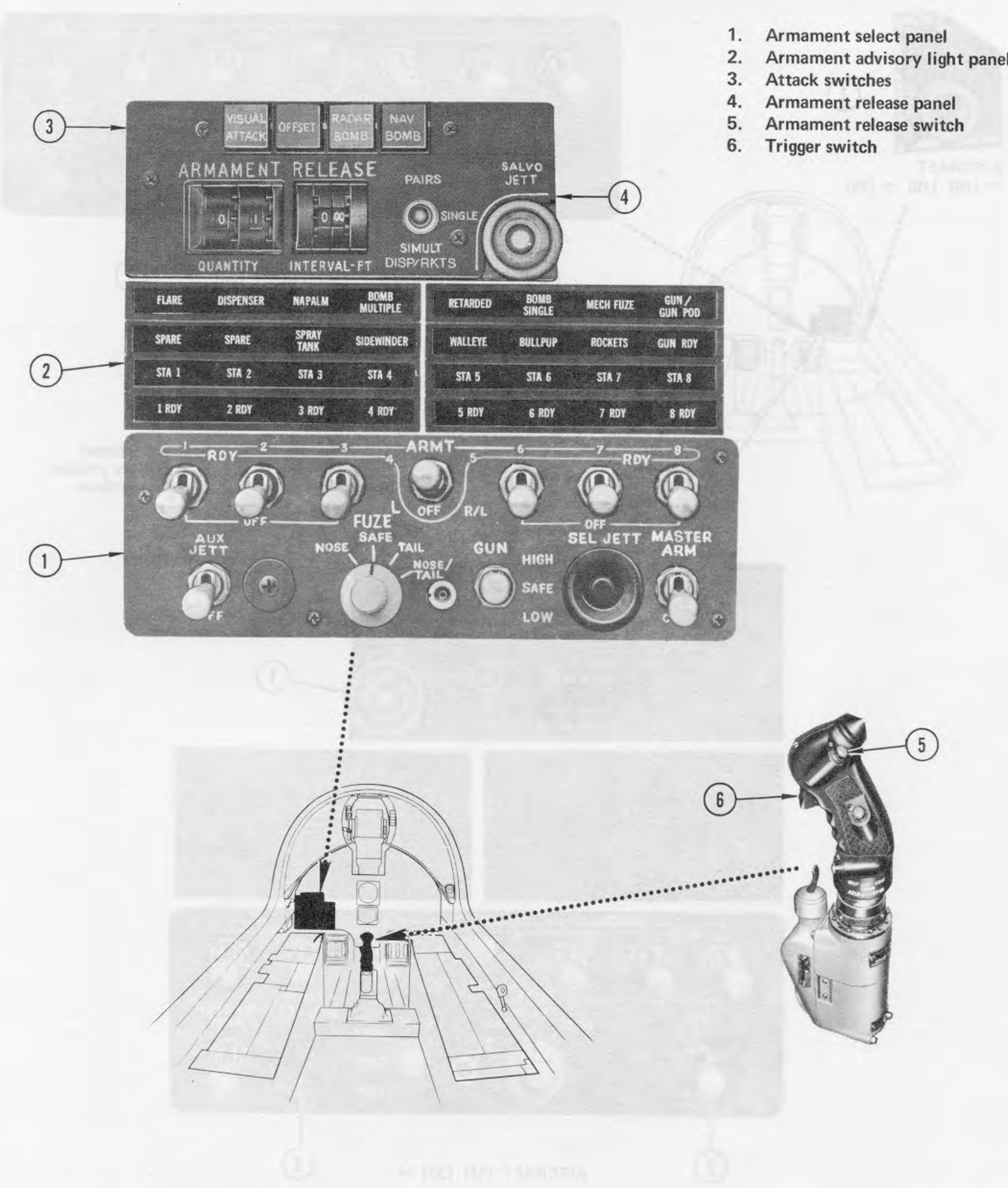

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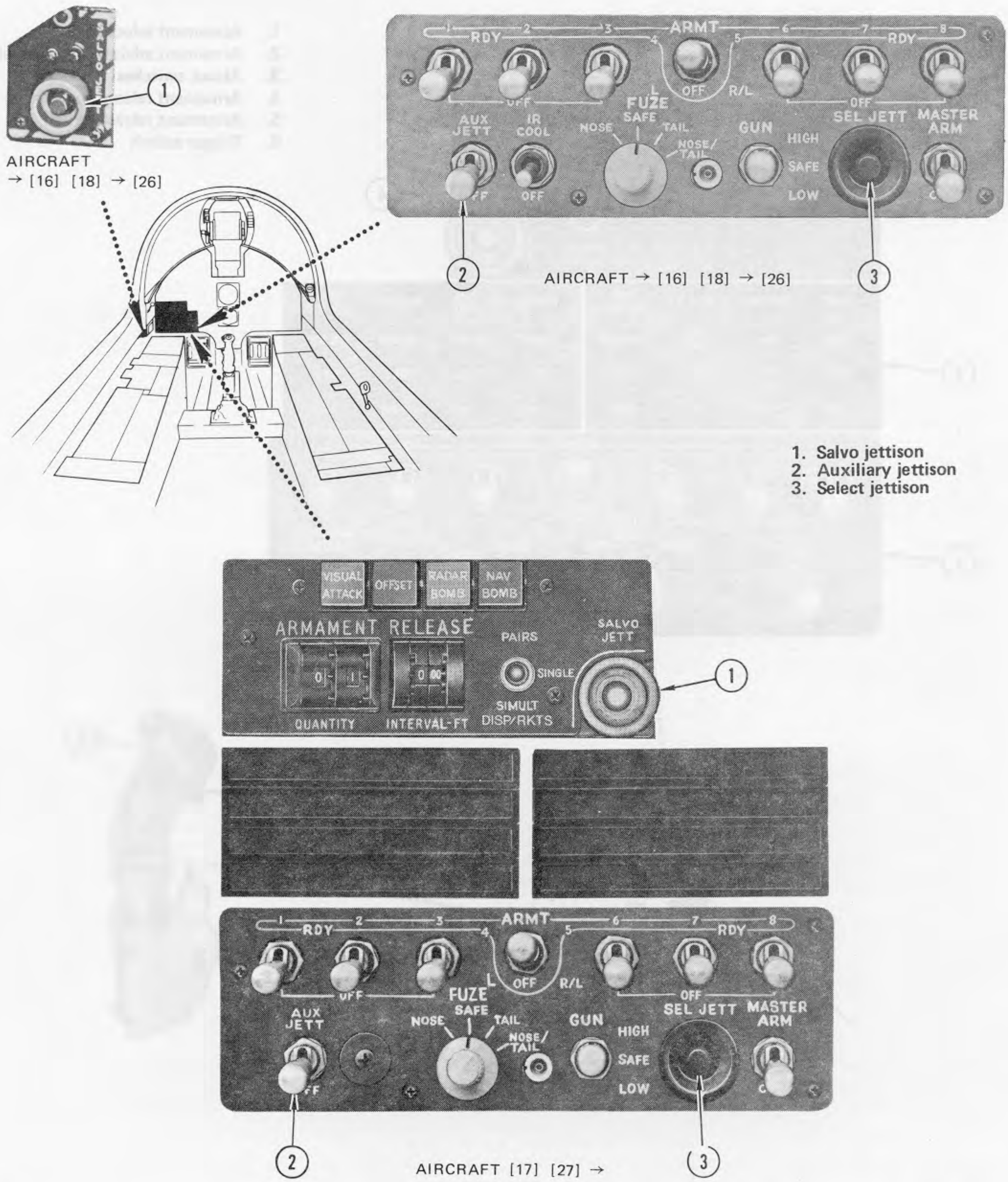
Figure 1–86

JETTISON CONTROLS



1. Salvo jettison
2. Auxiliary jettison
3. Select jettison

Figure 1–87

stations 1, 2, 7, and 8 release their stores. Stations 3 and 6 release also, provided the gear reaches the up-and-locked position prior to 2.1 seconds after switch actuation; otherwise, jettison power is removed and stations 3 and 6 do not jettison. The SALVO JETT switch does not provide jettison power to the fuselage stations.

Note

On aircraft → [16] [18] → [26], external stores cannot be jettisoned from wing stations with aircraft weight on the landing gear. On aircraft [17] [27] →, stations 1, 2, 7, and 8 can be jettisoned with aircraft weight on the landing gear. On all aircraft the main gear must be up and locked for stations 3 and 6 to be jettisoned.

The SEL JETT switch has the same functions as the SALVO JETT switch but the pilot must select the station or stations to be jettisoned. The MASTER ARM switch does not have to be in the ARM position. Fuzing is disabled and all selected stations jettison in a safe condition. Fuselage stations can be selectively jettisoned, but station transfer is not provided. The position of the fuselage station select switch determines which missile is released. Fuselage mounted missiles are fired in an unarmed and unguided condition. The SEL JETT button must be held depressed until release occurs.

The AUX JETT switch is for release of stores from MER's or TER's while retaining the MER or TER. The switch is momentary and must be actuated once for each weapon released. The MASTER ARM switch must be in the ARM position to enable the AUX JETT circuit. Depression of the AUX JETT switch does not disable mechanical fuzing. The pilot may jettison any store from a MER or TER starting with the highest priority station or pair of stations selected following SINGLE and PAIRS priority. Station priority is 1 and 8, 2 and 7, and 3 and 6. Rocket pods on a MER or TER jettison in single sequence if the release sequence switch on the ARMAMENT RELEASE panel is in the SIMULT position. No other type of stores are released if the release sequence switch is in the SIMULT position.

KB-18A STRIKE CAMERA SYSTEM.

A KB-18A strike camera system is located on the lower right side of the forward section of the engine compartment. The camera is used to record weapon effectiveness and to aid in bomb damage assessment and is positioned to provide photographic coverage along and 20 degrees to each side of the flightpath. Film is provided for 300 exposures. Camera settings that must be made before takeoff include automatic exposure index, overrun time from 0 to 32 seconds, and a cycling rate of 1, 2 or 4 frames per second. Operation is automatic, after the MASTER ARM switch is placed in ARM, when the trigger switch is pressed to the first or second detent or when the armament release switch is pressed for selected wing stations that have been readied for release. The preset overrun time and frame cycle rate will determine the number of times the camera can be operated. The pilot must estimate the amount of remaining film as no film counter is installed in the cockpit. An end of film switch in the camera stops camera operation when all film is expended.

NAVIGATION/WEAPON DELIVERY SYSTEM.

The system integrates many of the aircraft's avionic subsystems. The subsystems are described separately immediately following this system discussion. The objective of the Nav/Weapon Delivery System is navigation to the target, release of armament on target, and return. The primary navigational mode utilizes the Doppler and Inertial Measurement Set simultaneously for maximum accuracy. Loss of Doppler or Inertial Measurement Set does not interrupt the navigation function, as reversion to submodes occurs automatically. System displays appear on the Attitude Director Indicator (ADI), Horizontal Situation Indicator (HSI), and Head-Up Display (HUD). The following paragraphs describe only the navigation function. The weapon delivery function of the system is described in the A-7D Aircrew Weapon Delivery Manual (Nonnuclear), T.O. 1A-7D-34-1-1.

Subsystems of the NAV/Weapon Delivery System follow:

- NAV WD Computer Set
- Inertial Measurement Set (IMS)
- Doppler Radar Set (DRS)
- Forward-Looking Radar System (FLR)
- Air Data Computer System (ADC)
- Head-Up Display Set (HUD)
- Armament Station Control Unit (ASCU)
- Projected Map Display Set (PMDS)

Nav/Weapon Delivery System associated equipment follows:

- Radar Altimeter
- Angle-of-Attack Transducer
- Remote Compass Transmitter
- TACAN Navigational Set
- Instrument Landing System (ILS)
- Flight Director Computer
- Intercommunication System
- Attitude Director Indicator (ADI)
- Horizontal Situation Indicator (HSI)
- Bullpup Controller
- Thumbwheel Encoder
- Pylons
- Racks

Figure 1—88 illustrates control panels and displays for the navigation portion of the system. Figure 1—89 lists equipment utilized during each navigation mode. Figure 1—90 illustrates equipment interface.

THE NAVIGATION FUNCTION.

The navigation function permits navigation of the aircraft to the target without ground based navigation aids. The prime and degraded navigation modes, illustrated in figure 1—91, are referred to as dead-reckoning modes.

Initial Entries and Alignment.

With computer power on, present position and destinations are entered on the NAV WD computer panel on the right console. Procedures for entering this information are presented in the NAV WD COMPUTER SET discussion. The Inertial Measurement Set can be aligned on the ground or, if the Doppler is functioning, when airborne. Azimuth alignment of the IMS platform is provided in the following modes:

Computer Controlled.

Ground Align (land-based gyrocompassing)

Normal (Doppler-gyrocompassing in the air)

Manually Controlled.

Grid (manual heading set)

Azimuth Alignment (using HUD)

Detailed information on IMS platform alignment is contained in the INERTIAL MEASUREMENT SET system discussion.

Navigation Modes.

Normal Mode (Doppler-Inertial Gyrocompassing).

This is the primary navigation mode which utilizes the Doppler, Inertial Measurement Set, Air Data Computer, NAV WD Computer, and associated controls and displays. The normal mode (IMS MODE switch in NORM) is used following ground alignment of the IMS and requires valid data from the IMS and Doppler. If takeoff is made before IMS ground alignment is complete, when reliable Doppler signals are available the NAV WD Computer uses the Doppler signals as a reference to fine align the IMS. True aircraft velocity and present position are computed from IMS horizontal velocities slaved to average groundspeed and drift angle from the Doppler, and IMS vertical velocities damped by the ADC barometric altitude. Wind speed and direction are computed continuously from IMS velocity, heading, attitude, angle of attack, and ADC true airspeed. The wind velocity is stored for use in weapon delivery or degraded navigation modes and displayed for pilot information.

Note

Unreasonable wind information could indicate either faulty ADC operation which will not affect navigation accuracy or faulty operation of the IMS or Doppler which will degrade navigation accuracy.

To maintain the IMS platform in a local level condition, the NAV WD Computer constantly provides torquing corrections for gyro drift, earth's rotation, and earth relative rate. In addition, the NAV WD Computer compares Doppler and IMS velocities and provides torquing signals for airborne gyrocompassing to maintain accurate azimuth alignment of the IMS. In this mode the IMS NOT ALIGNED light normally comes on whenever the velocity difference between the IMS and Doppler exceeds a nominal value. The light goes off after the difference has been corrected. Illumination of the IMS NOT ALIGNED light for short periods does not indicate a malfunction.

Doppler-Inertial Mode.

The Doppler-Inertial Mode is used when the IMS MODE switch is placed in INERTIAL (or NORM at latitudes above 70 degrees) and requires valid data from the IMS and Doppler. True aircraft velocity, present position computations, and torquing corrections to maintain the IMS platform in a local level condition are the same as described for the Normal (DIG) mode. However, the torquing signals for airborne gyrocompassing are not provided and the IMS operates as a free gyro in azimuth. Navigation accuracy will degrade slightly as small azimuth errors increase with elapsed time, particularly during violent tactical maneuvering. Navigation in this mode will, on the average, be less accurate after 30 to 60 minutes elapsed time than in the Normal (DIG) mode.

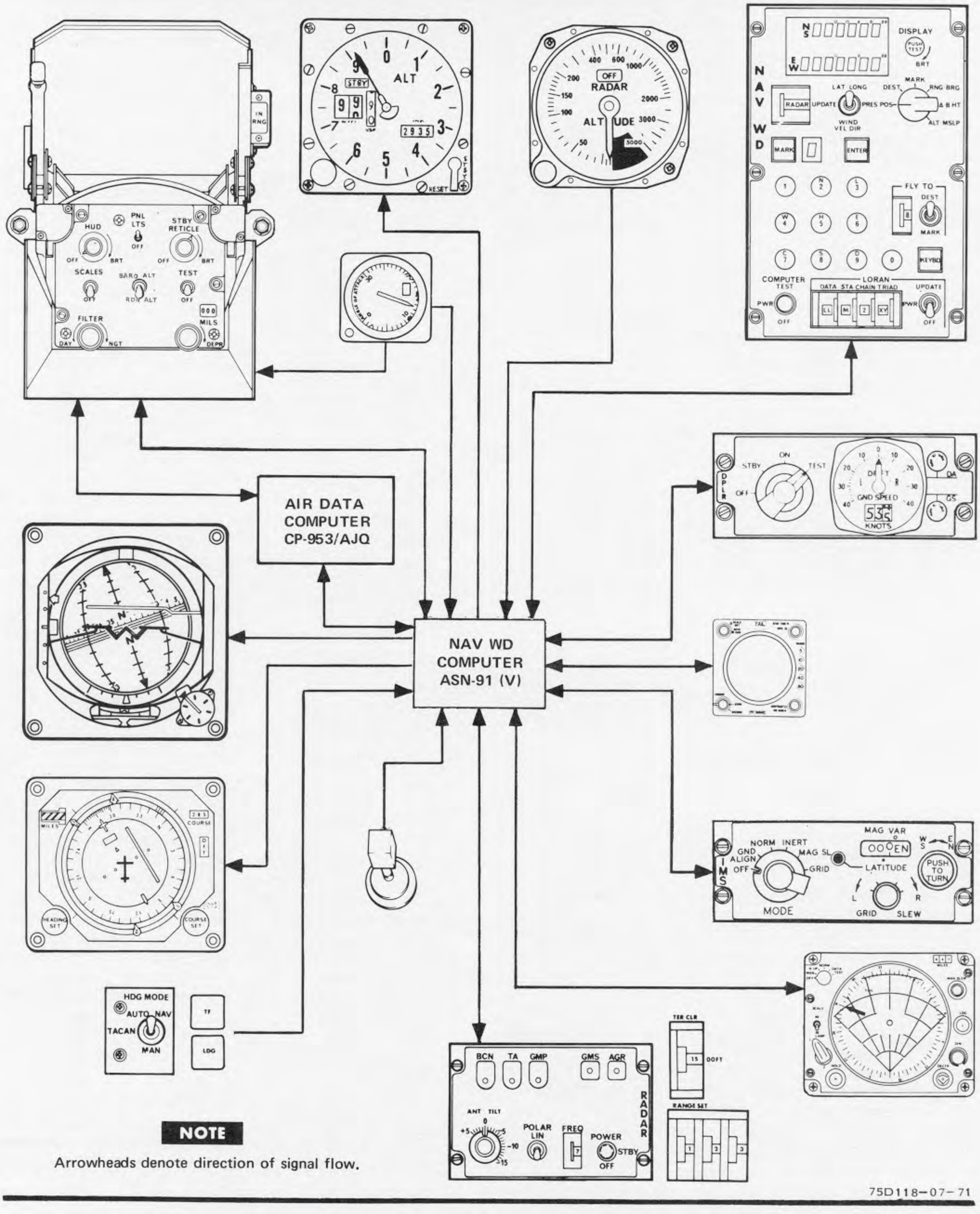
Inertial Mode.

The pure Inertial Mode is used when the Doppler is not available and the IMS MODE switch is in either NORM or INERTIAL. An inoperative Doppler system causes a DOPPLER MEMORY light to illuminate on the advisory panel. The pilot may also select to operate in this mode by switching the Doppler to the STBY position. True aircraft velocity and present position are computed from undamped IMS horizontal velocities and IMS vertical velocities damped by ADC barometric altitude. Torquing signals for airborne gyrocompassing are not provided and the IMS operates as a Schuler tuned platform. Navigation accuracy will degrade slightly and will, on the average, be less accurate after 25 to 50 minutes elapsed time than the Normal (DIG) mode.

Doppler/Air Mass Mode.

The Doppler/Air Mass mode is engaged manually by selection of MAG SL or GRID on the IMS mode selector switch or automatically upon receipt of an IMS-failed signal. (The IMS-failed signal illuminates the IMS caution

NAV/WEAPON DELIVERY SYSTEM — NAV PORTION



NOTE

Arrowheads denote direction of signal flow.

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Figure 1–88

NAVIGATION MODES VS EQUIPMENT UTILIZED

		NAV WD COMPUTER	IMS	FLR	ADC	DOPPLER RADAR	ADI	HSI	HUD	RADAR ALTIMETER	TACAN	PMDS	MISCELLANEOUS CONTROLS**
NAVIGATIONAL MODES	DOPPLER-INERTIAL	X	X		X	X	X	X	X	X		X	X
	DOPPLER-AIR MASS	X	*		X	X	X	X	X	X		X	X
POSITION UPDATE MODES	VISUAL (HUD)	X	X	X	X				X				X
	RADAR	X	X	X	X								X
	FLYOVER	X	X										X
	LORAN (future)	X	X										X
	TACAN (future)	X	X								X		X
	MAP	X										X	X
IMS ALIGNMENT MODES	GROUND	X	X										
	AIR	X	X			X							
	HUD AZIMUTH	X	X						X				X

*IMS Backup mode

**Miscellaneous controls include pilot's stick grip, master function switch, Bullpup controller, and thumbwheel controller.

75D111-11-71

Figure 1–89

NAV WD SYSTEM SIGNAL FLOW

FROM ↓ / TO →	NAV WD COMPUTER	INERTIAL MEASUREMENT SET	FORWARD-LOOKING RADAR	AIR DATA COMPUTER	ARMAMENT STATION CONTROL UNIT	FLIGHT DIRECTOR COMPUTER
NAV WD COMPUTER SET		Azim Gyro Torque East Gyro Torque North Gyro Torque Gyro Torque Clock Scale-Fac Change Cal in Prog Computer Control Computer Fail Lat > 70° N or S Slew Commands	Ant. Slave Ant. Azim Comm Ant. Elev Comm Drift Angle Cursor Commands Computer Fail Ground Velocity Flight Path Angle Cursor Enable	Potentiometer Excitation	Bomb Release Pulses Fire Ready	
INERTIAL MEASUREMENT SET	Azimuth True Hdg, Roll Pitch, Mag Hdg Inc North Vel Inc East Vel Inc Vert Vel Mode Select (5) IMS Fail Cal Mode Comm IMS Ready		Roll Pitch IMS Fail			Roll Pitch
FORWARD-LOOKING RADAR	Radar Lock On Slant Range To Target			Baro. Altitude Pot. Excitation		
AIR DATA COMPUTER	ADC Fail, Bar. Alt True Airspeed Mach Number		Barometric Altitude			
ARMAMENT STATION CONTROL UNIT	Release Enable Wpn Type/Sta Multiple Loading Guns Selected SUU-20 Bomb Sel		TV Video TV Available			
DOPPLER RADAR SET	Groundspeed, Drift Angle Doppler Status					
TACAN SET						Course Deviation Flag
RADAR ALTIMETER SET	Radar Altitude		Radar Altitude Radar Altimeter Fail			Radar Altitude Radar Altitude Fail
ANGLE-OF-ATTACK TRANSDUCER	Angle of Attack					
MISC CONTROL INTERFACE*	Norm, Terr Foll Nav Bomb Radar Bomb Offset, Target Desig Single/Pairs Wpn Qty Wpn Spacing High Drag Weight On Gear PMDS Slew Up/Down PMDS SlewLeft/Right Bombfall Line Pulse 1 and 2		TF Position AGR Ready Range Change Target Reject		Arm. Release Trigger Designate Release Mode Delivery Mode Safety Interlocks Salvo Jettison Select Jettison Aux Jettison Station Select Master Arm Nose/Tail Arming	Mode Select
FLIGHT DIRECTOR COMPUTER						
HEAD-UP DISPLAY	HUD Fail or Off			Potentiometer Excitation		
HORIZONTAL SITUATION INDICATOR						HSI Heading Error HSI Course Error
INSTRUMENT LANDING SYSTEM						Localizer Dev. Localizer Flag Glide Slope Dev. Glide Slope Flag
PROJECTED MAP DISPLAY SET	Hold Scale North Up Decenter					

*Miscellaneous control interface includes: Pilot's stick grip, master function switch, heading mode switch, Bullpup controller, and thumbwheel controller.

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Figure 1-90 (Sheet 1)

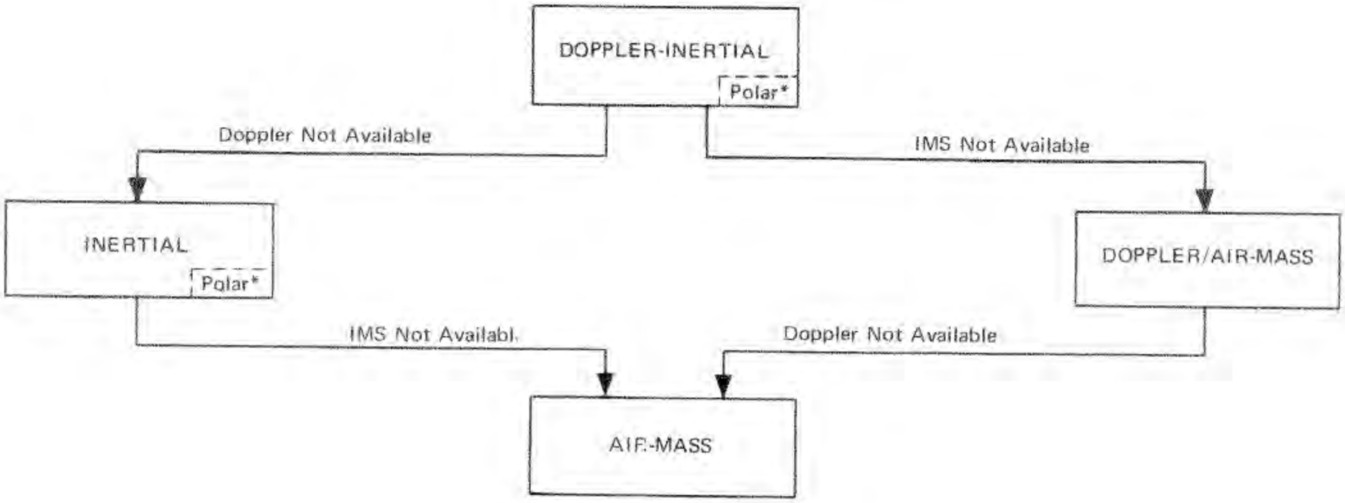
FROM ⇨ / TO ⇧	AUTOMATIC FLIGHT CONTROL SYSTEM	DOPPLER RADAR SET	TACAN SET	HEAD-UP DISPLAY	ATTITUDE DIRECTOR INDICATOR	PROJECTED MAP DISPLAY	HORIZONTAL SITUATION INDICATOR
NAV WD COMPUTER SET ➡	Heading	Clock Signal		Flight-Path Marker Bombfall Line Steering Error Solution Cues Pull-Up Command Mag Hdg Pitch Angle Vertical Velocity Aiming Reticle Pull-Up Antic Roll Angle Baro, Alt Flight Director	Steering Error Computer Fail	Present Position Dest Range Dest Pointer Ground Speed Drift Angle Mag Heading Slew Azimuth Ring	Relative bearing to Destination Grd Track Rng Units Rng Tens Rng Hundreds Rng 1,000-NM Digit
INERTIAL MEASUREMENT SET ➡	Roll Pitch Clutch Heading Clutch Inhibit	Roll Pitch IMS Fail	Mag or GRID Hdg		Mag or GRID Hdg Roll Pitch IMS Fail		Mag or GRID Hdg
FORWARD-LOOKING RADAR ➡				Pitch Command Range Set TF Fail	TF Fail Pitch Commands		
AIR DATA COMPUTER ➡	Baro Altitude			Indicated Airspeed			
ARMAMENT STATION CONTROL UNIT ➡							
DOPPLER RADAR SET ➡				Drift Angle			
TACAN SET ➡							Range Bearing Range Fail To/From Course Resolver
RADAR ALTIMETER SET ➡				Radar Altitude			
ANGLE-OF-ATTACK TRANSDUCER ➡				Angle of Attack			
MISC CONTROL INTERFACE* ➡				Comp-Att Select Landing Select TF Select	Hdg Mode Select		Hdg Mode Select
FLIGHT DIRECTOR COMPUTER ➡				Landing-Director Dot and Lines Validity	Command Flags Steering Comm Glide Slope and Flags		Course Bar Course Bar Flag
HEAD-UP DISPLAY ➡		Potentiometer Excitation					
HORIZONTAL SITUATION INDICATOR ➡	Man, Heading						

*Miscellaneous control interface includes: Pilot's stick grip, master function switch, heading mode switch, Bullpup controller, and thumbwheel controller.

75D113(2)-06-71

Figure 1–90 (Sheet 2)

PRIME AND DEGRADED NAVIGATION MODES



*Polar computational routine assumed automatically at latitudes greater than 80 degrees.

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Figure 1–91

light.) Provision is made for entering magnetic variation via the IMS panel. True aircraft velocity, present position and wind data are computed from Doppler groundspeed and drift angle, IMS magnetic heading and hand-set variation, and ADC true airspeed and barometric altitude. Navigation is degraded because of inaccuracies in heading and lack of IMS velocities. If the ADC fails, navigation is not affected but computed weapon delivery cannot be performed in this mode without valid true airspeed.

Air-Mass Mode.

The Air-Mass mode is in effect in case of unreliable or unreasonable Doppler while in the Doppler/Air-Mass mode (MAG SL or GRID selected on the IMS mode selector switch or IMS-failed signal received). Valid data must be available from the ADC. True aircraft velocity and present position are computed from ADC true airspeed, IMS magnetic heading and the stored value of wind speed and direction. The pilot may enter estimated wind via the NAV WD Computer panel if preferred to last computed wind. Navigation accuracy is degraded because of inaccuracies in heading and lack of IMS or Doppler velocities.

Navigation Accuracy Data.

Data on the navigation accuracy that can be obtained in each of the five modes are presented in figure 1–92. This information is given in terms of both expected and single flight acceptable performance. Any performance in excess of the single flight acceptable level would require mandatory maintenance action. Expected level values are 50-percentile numbers and may be exceeded on individual flights. Consistent performance above this level indicates maintenance action is required and will adversely affect weapon delivery accuracy in the Normal, Doppler-Inertial, or Inertial modes.

Values assigned to Inertial modes assume a complete ground alignment was performed before takeoff. Longitude criteria, except in the pure Inertial mode, require that the error rate in minutes per hour be divided by the cosine of the latitude.

A cosine table and a sample calculation of error rate are included in figure 1–92.

Guidance Modes.

Guidance modes control the type of display appearing on the HSI, ADI, or HUD. Modes are selected by means of the Heading Mode or master function switches on the instrument panel and are described in detail in the Heading Mode and Master Function Switch System discussion. Guidance modes are as follows:

- Navigation (Enroute) Mode
- Auto Nav Mode
- TACAN Mode
- Manual Heading Mode
- Landing (Instrument Landing System) Mode
- Terrain-Following Mode

Position Update Modes.

Computed present position can be updated by means of a flyover update, visual update, or radar update on a point of known coordinates. The computed present position can also be updated by flyover of landmarks displayed on the map of the Projected Map Display. The coordinates of the landmark need not be known. Updating procedures are contained in the NAV WD Computer Set discussion.

In the visual update mode, the computed present position is updated by use of the HUD on a known visually acquired fix point. The HUD aiming symbol appears initially over the computer-calculated fix point location, from where it must be slewed over the actual fix point for designation. In the radar update mode, it is possible to update the computed present position by use of a radar target of known latitude and longitude. The flyover and map update capability makes it possible to update the present position by visually flying over a known fix point.

Marks.

If the pilot desires to record the latitude and longitude of the point on the ground over which he is presently flying, he can store the present position by pressing the MARK button on the NAV WD control panel. Up to nine positions can be recorded; an indicator on the panel shows the number of the last Mark entered.

CONTROLS.

Controls are illustrated and described in the individual subsystem descriptions in this section.

NAV WD COMPUTER SET, AN/ASN-91(V).

The aircraft is equipped with a NAV WD Computer set capable of computed weapon delivery and enroute navigational guidance, including a navigational capability in polar regions. The Computer is a subsystem of the Nav/Weapon Delivery system and, as such, integrates navigation data provided by the Inertial Measurement Set, Doppler Radar Set, and Air Data Computer for navigational computations. Navigation solutions are displayed on the NAV WD computer control panel, Head-Up Display, Horizontal Situation Indicator, and Attitude Director Indicator and Projected Map Display.

The weapon delivery portion of the NAV WD Computer is described in T.O. 1A-7D-34-1-1.

NAV WD Computer controls are described and illustrated in figure 1–93.

NAVIGATION ACCURACY DATA

MODE	AXIS	EXPECTED PERFORMANCE	SINGLE FLIGHT ACCEPTABLE PERFORMANCE	REMARKS
Normal (Doppler-Inertial-Gyro-Compassing)	Latitude Longitude	2 min/hr $\frac{2\ \text{min/hr}}{\cos\ (\text{latitude})}$	5 min/hr $\frac{5\ \text{min/hr}}{\cos\ (\text{latitude})}$	
Doppler-Inertial	Same as Normal (DIG)			
Inertial	Latitude Longitude	3 min/hr 3 min/hr	8 min/hr 8 min/hr	
Doppler/Air-Mass	Latitude Longitude	8 min/hr $\frac{8\ \text{min/hr}}{\cos\ (\text{latitude})}$		Accuracy depends upon amount of time Doppler is in. Therefore no acceptable error rate listed.
Air-Mass	Latitude Longitude	15 min/hr $\frac{15\ \text{min/hr}}{\cos\ (\text{latitude})}$		Accuracy depends on the accuracy of pilot inserted wind. Therefore no acceptable error rate listed.

NOTE

1. During Normal (DIG) and Doppler-Inertial, the Doppler must be in 90% of the time.
2. Performance assessments should not be made for elapsed times of less than 45 minutes.

COSINE TABLE:

LAT°	COSINE	LAT°	COSINE	LAT°	COSINE	LAT°	COSINE	LAT°	COSINE
0	1.000	19	0.946	38	0.788	57	0.545	76	0.242
1	1.000	20	0.940	39	0.777	58	0.530	77	0.225
2	0.999	21	0.934	40	0.766	59	0.515	78	0.208
3	0.999	22	0.927	41	0.755	60	0.500	79	0.191
4	0.998	23	0.921	42	0.743	61	0.485	80	0.174
5	0.996	24	0.914	43	0.731	62	0.470	81	0.156
6	0.995	25	0.906	44	0.719	63	0.454	82	0.139
7	0.993	26	0.899	45	0.707	64	0.438	83	0.122
8	0.990	27	0.891	46	0.695	65	0.423	84	0.105
9	0.988	28	0.883	47	0.682	66	0.407	85	0.087
10	0.985	29	0.875	48	0.669	67	0.391	86	0.070
11	0.982	30	0.866	49	0.656	68	0.375	87	0.052
12	0.978	31	0.857	50	0.643	69	0.358	88	0.035
13	0.974	32	0.848	51	0.629	70	0.342	89	0.017
14	0.970	33	0.839	52	0.616	71	0.326	90	0.000
15	0.966	34	0.829	53	0.602	72	0.309		
16	0.961	35	0.819	54	0.588	73	0.292		
17	0.956	36	0.809	55	0.574	74	0.276		
18	0.951	37	0.799	56	0.559	75	0.259		

EXAMPLE:

1. Mode: Normal (DIG)
2. Time of flight: 1 hr 12 minutes
3. Latitude: 32°44'
4. Error in digital data display window at update: Latitude 02' 21''; Longitude 02' 12''

Error rate calculation:

Latitude: $\frac{2.35\ \text{min}}{1.2\ \text{hr}} = 1.95$ min/hr

Longitude: $\frac{2.2\ \text{min}}{\cos 32°44' \times 1.2\ \text{hr}} = \frac{2.2\ \text{min}}{0.84 \times 1.2\ \text{hr}} = 2.18$ min/hr

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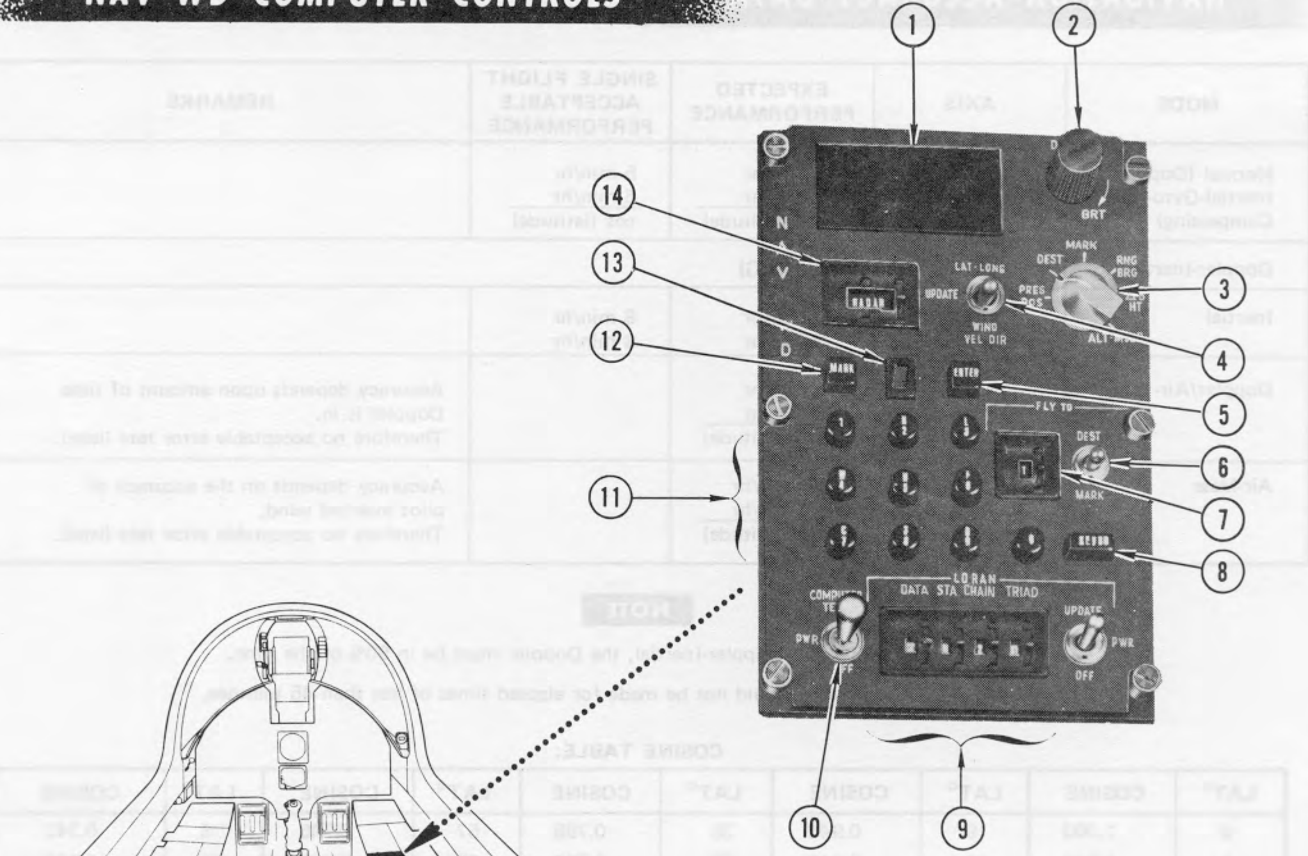
Figure 1–92

NAV WD COMPUTER CONTROLS



Nomenclature	Function
1. Digital data display windows	Displays data as appropriate to the position of the panel controls. Can be used, in conjunction with keyboard buttons, to insert operational information into computer.
2. Display light control	Rotation controls brightness of display windows and MARK numeric indicator (item 13).

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Figure 1–93 (Sheet 1)

NAV WD COMPUTER CONTROLS

Nomenclature	Function
3. Rotary mode selector switch	PRES POS – used in conjunction with three-position toggle switch to permit display, entry, or updating of present position data. DEST – causes display of selected destination coordinates previously entered and stored in the computer. MARK – permits display of latitude and longitude of marked positions selected in flight. RNG-BRG – permits entry and display of range and true bearing from offset aiming point (OAP) to target for offset bombing. Desired target number and range and bearing values are entered into computer by way of the keyboard pushbuttons. △ BHT – permits entry and display of difference in height between OAP and target or burst height above target. Values are entered by way of the keyboard. ALT-MSLP – permits entry and display of destination or target elevation and mean sea level pressure. Values are entered by way of the keyboard.
4. Present position toggle switch	LAT-LONG – used to display coordinate information in degrees, minutes, and seconds when the rotary mode selector switch is in PRES POS. UPDATE – with rotary mode select switch in PRES POS, permits updating of present position. Updating input depends on position selection of UPDATE thumbwheel. WIND VEL-DIR – with rotary mode select switch in PRES POS, permits display of present position wind velocity in knots and direction in relation to true north. Information is displayed in digital data display windows. Same switch positions plus keyboard pushbuttons enable insertion of estimated wind velocity and direction into computer in the event of Doppler, IMS or ADC failure.
5. ENTER pushbutton (ENT on some aircraft)	Pressed – enables computer to accept data inputs. Will update present position when depressed in an UPDATE mode. Also used for loading of an OFP tape into the computer.
6. FLY TO toggle switch	DEST – the number (1 through 9) displayed adjacent to the thumbwheel selector determines destination to be used in computer flight calculations. In any attack mode that requires target data (target altitude, mean sea level pressure, delta height, burst height) the computer will use target data corresponding to the FLY TO destination number. MARK – the number (1 through 9) displayed determines the marked position to be used in computer flight calculations.
7. FLY TO thumbwheel	Enables selection of numbers for destination or marked position use.

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Figure 1–93 (Sheet 2)

NAV WD COMPUTER CONTROLS

Nomenclature	Function
8. KEYBD pushbutton	Pressed — pushbutton becomes illuminated and enables 0 to 9 keyboard buttons to accept data.
9. LORAN data panel	Information to be furnished later.
10. COMPUTER OFF-POWER-TEST switch	OFF — deenergizes panel. PWR — applies secondary dc bus power to panel. TEST — (momentary) initiates system self-test.
11. Keyboard panel	Pushbuttons numbered 0 through 9 used for insertion of operational data. Letters N, S, E, and W represent direction for latitude and longitude coordinates. Letters L, C, D, and H apply to LORAN operation and will be described when LORAN is installed. Numerals 1 through 9 also used to address computer memory to call up previously inserted data. The 0 is used for plus, and the E/6 is used for minus.
12. MARK pushbutton	Pressed — commands computer to store coordinates of present position being overflown. Can be used to mark from 1 to 9 sets of coordinates.
13. Mark indicator light	When MARK pushbutton is pressed, the indicator light illuminates and displays a number. The number represents the present number in the chain of marked coordinates.
14. Update thumbwheel (10 positions)	HUD — enables updating of present position latitude and longitude using aiming symbol on head-up display and radar ranging. RADAR — enables updating of present position latitude and longitude using radar range and bearing cursors. FLYOVER — enables updating of present position latitude and longitude while flying over a known fix point. LORAN — presently inoperative. TAC L-L — presently inoperative. TAC MV — presently inoperative. IMS-HUD — permits inertial measurement set azimuth alignment by aligning HUD aiming symbol with known reference bearing. SINS X-Y — not operational. Z-Δ HDG — not operational. DATA — permits insertion and readout of data in specific core storage locations.

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Figure 1—93 (Sheet 3)

OPERATIONAL FLIGHT PROGRAM (OFP).

An operational flight program (OFP) must be fed into the computer by ground personnel before the computer can be used for navigation and weapons delivery. The OFP is carried on a punched tape which is run through a loader-verifier for electronic transfer into the computer in the aircraft. A given OFP tape is identified by T.O. number and by an effective date. Only the latest tape should be used. Its effective date can be determined by reference to the General Tape Manual, T.O. 33D1-1-3. The effective date of the OFP programmed into the computer can be verified by placing the rotary mode selector switch in PRES POS, the present position toggle switch in UPDATE, the update thumbwheel iin DATA, and by entering 99 on the keyboard panel by twice depressing the number 9 keyboard pushbutton. The upper row of digital display windows will read OFP-A7 and the lower windows will display the effective date by day, month, and last digit of the year, respectively.

NAVIGATION COMPUTATIONS.

Great circle computations are used in all modes for distances greater than 32 nautical miles. For less than 32 nautical miles, a flat earth approximation is assumed by the computer. The system presents continuously computed present position latitude and longitude, present ground track, range and bearing to selected destination, and lateral steering. Range and bearing to destination and present ground track are displayed on the Horizontal Situation Indicator. Lateral steering error is displayed on the HUD and Attitude Director Indicator.

Present position is displayed on the system control panel in latitude and longitude coordinates when the rotary selector switch is in PRES POS and the present position toggle select switch is in the LAT-LONG position. In conjunction with the Inertial Measurement Set at latitudes greater than 80 degrees, the NAV WD Computer system automatically assumes a computational routine suitable for platform control in polar regions. The computer continues to operate the platform in the inertial submode or in the Doppler-inertial mode. Latitude and longitude are displayed. Pilot action is required to return from polar computations to normal computations. The NAV WD computer rotary select switch must be set in the MARK position and the ENTER button on the NAV WD computer control panel depressed.

COMPUTER SYSTEM TURNON.

The control panel for the NAV WD Computer system is located on the right console. Power to the computer is applied by placing the COMPUTER OFF-POWER-TEST switch in the lower left corner of the control panel to the PWR position.

Entry of present position latitude and longitude into the computer by way of the control panel is accomplished by placing the rotary mode selector switch to PRES POS, placing the present position toggle switch to LAT-LONG, and pressing the KEYBD button. The KEYBD button illuminates and enables the 0 to 9 keyboard pushbuttons to accept latitude and longitude information for insertion into the computer. Dependent upon the aircraft's hemispheric location, the N or S keyboard pushbutton is pressed. Then the pushbuttons corresponding to present position latitude are pressed in order of degrees, minutes, and seconds. The next step is to press the E or W pushbutton and insert the present position longitude by pressing the appropriate pushbuttons in order of degrees, minutes, and seconds.

Note

> The same keyboard pushbuttons are used to store hemispheric location (N, S, E, W) as are used to store numeric coordinates.

The inserted numbers are displayed in the digital data display windows at the top of the control panel. After the values have been verified as correct, they are entered into the computer by pressing the ENT pushbutton. If an error is made during data insertion, press the KEYBD button a second time and repeat the entry procedure.

ENROUTE DESTINATION SELECTION AND STORAGE.

Nine enroute destinations may be stored in the computer. Computer information is displayed on the HSI, ADI, and HUD. Range, bearing, and true ground track to destination are displayed on the HSI. Steering error is displayed on the ADI and HUD. The NAV WD computer provides barometric altitude inputs for navigation and landing modes, based on barometric pressure set in for the fly-to destinations. The rotary mode selector switch must be placed in the DEST position and, to give the computer memory the numerical identity of the first selected destination, the digit 1 pushbutton on the keyboard is pressed and the LAT LONG of the destination presently stowed is displayed. The KEYBD button which causes the KEYBD button to illuminate and enables the keyboard pushbuttons to accept the coordinates of the first selected destination is then pressed. The same latitude and longitude entry procedures as used in entering present position are followed. After visual verification of the first destination coordinates, the ENT pushbutton is pressed and the latitude and longitude are stored in the computer. The second and all subsequent desired destinations also must be assigned numerical identity. This is done by first pressing the keyboard pushbutton bearing the digit related to the destination number. For example, before inserting the coordinates of destination number 2, the keyboard pushbutton bearing the digit 2 must be pressed. The same procedure is employed to identify destinations 3 through 9, if the total available destination capability is to be used.

Note

> Avoid assigning data to a previously selected destination.

COMPUTER UPDATE PROCEDURES.

In the event all nine destinations are not utilized, the unused storage spaces can be employed to store coordinates for prominent enroute checkpoints that can update the computer during flight. A hypothetical situation follows: During route planning a pilot notices that, after passing destination number 2, his flightpath passes slightly to the right of a large bridge. While setting up the computer before takeoff, the pilot presses keyboard pushbutton number 3 and then enters the coordinates of the bridge into the computer.

HUD (Visual) Update.

After inflight passage of destination number 2, the pilot sights the bridge ahead and left of track. The update check is begun by placing the rotary mode selector switch to PRES POS, the present position toggle switch to UPDATE, and the update thumbwheel to HUD. The next required action is to press keyboard button No. 3 which directs the computer to display the coordinates of the fix point (the bridge) in the digital data display windows. This action causes the HUD aiming symbol to overlay the computed fix point position, when the computed range is less than 20 nautical miles, also causes the FLR to enter automatically air to ground ranging if within 10 nautical miles, and slaves the radar antenna to the HUD aiming symbol. If computed range is greater than 10 nautical miles, the FLR remains in AGR standby and will begin radiating at ranges of 10 nautical miles or less. If the computed destination is not within the field of view of the HUD, the aiming symbol will not be in view. After verifying the accuracy of the bridge coordinates, the Bullpup control handle on the left console is used to slew the HUD aiming symbol to overlay the bridge. When the aiming symbol is properly placed, the designate switch on the pilot stick grip is pressed. The digital data display windows display any difference between the updated present position and the computed present position coordinates in minutes and seconds. The ENT pushbutton may be pressed to correct the present position coordinates. The pilot can reject the update option by placing the present position toggle switch in LAT-LONG without pressing the ENT pushbutton, thereby returning the system to normal operation.

Radar Update.

Should an undercast obscure the checkpoint fix, the Forward-Looking Radar can be used to update the computer system. With the rotary mode selector switch in PRES POS, the present position toggle switch is placed in UPDATE and the update thumbwheel turned to RADAR. Then the number 3 keyboard pushbutton is pressed. The Forward-Looking Radar enters the ground map mode, and range and bearing cursors are displayed on the radar indicator if the computed range is less than 20 nautical miles and the bearing to the computed destination is within 45 degrees of the aircraft heading. The range and bearing cursors overlay the computed fix point. The digital data display windows display the coordinates of the bridge. The coordinates should be verified as correct. If necessary, the Bullpup control handle on the left console is used to move the range and bearing cursors until they overlay the bridge. When the cursor displacement is complete, the designate switch on the pilot stick grip is pressed to bring any present position error into view in the digital data display windows. The ENT pushbutton may be pressed to update the computer present position. The update option can be rejected by placing the present position toggle switch to LAT-LONG to return the system to normal operation.

Flyover Update.

If the planned route takes the aircraft directly over a prominent checkpoint, this point can be used for computer updating. Before takeoff, the checkpoint is assigned a numerical identity by pressing the appropriate keyboard pushbutton. The coordinates of the checkpoint are entered into the computer in the previously described manner. After coordinate verification in the digital data display windows, the ENT pushbutton is pressed to store the coordinates. As the actual flightpath approaches the chosen checkpoint, the rotary mode selector switch is placed to PRES POS, the present position toggle switch to UPDATE, and the update thumbwheel turned to read FLYOVER. The identifying keyboard pushbutton for the checkpoint is pressed to bring the fix coordinates into the display windows. The displayed fix coordinates should be verified as correct. When the aircraft is over the fix point, the designate switch on the pilot stick grip is pressed. This directs the computer to display any latitude and longitude error in the digital data display windows.

The ENT pushbutton may be pressed to update the computer coordinates. The pilot retains the option to reject any difference by placing the present position toggle switch to the LAT-LONG position to resume normal computer operation.

Map Update.

The computed aircraft position can be updated by flyover of a landmark displayed on the map of the PMDS. The coordinates of the landmark need not be known. To perform this update procedure, all master function attack mode switches must be deselected and the PMDS mode selector switch placed in NORM or N UP. With the rotary mode selector switch in PRES POS, the present position toggle switch is placed in UPDATE and the update thumbwheel turned to FLYOVER. When the aircraft is directly over the landmark, the designate switch on the pilot stick grip is pressed. When the designate switch is pressed, map movement will stop and the window display of latitude and longitude will change to zeros. The Bullpup control handle on the left console is used to slew the landmark under the aircraft position marker. If in DECTR on the PMDS, the apex of the triangle is used; otherwise the center of the circle is used. Position error in latitude and longitude will be displayed in the computer digital data display windows. The pilot may accept or reject the update information as in previous procedures.

MARK FUNCTION.

The MARK function of the computer provides the capability to accept and store up to nine sets of present position coordinates. The purpose is to record the latitude and longitude of points of interest that might be overflown during flight. Insertion of a mark position into the computer is a one-pushbutton operation. Only the MARK button need be pressed. At the same time the MARK button is pressed, an illuminated number appears in the window to the immediate right of the MARK pushbutton. The number bears a corresponding relationship to the marked coordinates. This number and a description of the sighting should be transcribed by the pilot. In flight, if the pilot elects to overfly a previously marked position, the FLY TO toggle switch is placed in the MARK position and the FLY TO thumbwheel is rotated until the appropriate marked number appears. The computer then begins calculations to direct the aircraft toward the marked coordinates. Any previously marked positions can be called up for display in the digital data windows by placing the rotary mode selector switch to MARK and selecting the number of the desired marked position by means of the keyboard pushbuttons.

PRESENT POSITION WIND INFORMATION.

The present position wind velocity (knots) and direction (true North) from inertial measurement system can be read directly from the digital data display windows of the computer control panel. When the rotary mode selector switch is placed in PRES POS, and the present position toggle switch is placed in WIND VEL-DIR, the wind velocity (knots) and direction (true North) appear in the display windows. Wind values are derived from the IMS and Air Data Computer. (See figure 1-94.) Example: Present position wind velocity is 30 knots and the direction is 240 degrees. The upper set of windows displays velocity as 000030 and the lower set of windows displays the direction as 2400000.

WIND VALUE DISPLAY

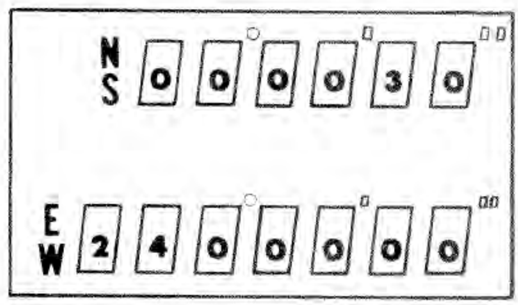

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Figure 1-94

FLY TO SWITCH AND THUMBWHEEL.

The position of the FLY TO toggle switch (DEST or MARK) and the number (0 through 9) selected on the FLY TO thumbwheel have a functional relationship with master function switch selection or nonselection. This relationship is illustrated in tabular form in figure 1-95.

SPECIAL FUNCTIONS OF MASTER FUNCTION AND FLY-TO SWITCHES

MODE \ FLY TO SWITCH	ZERO DEST.	ZERO MARK	NUMBERED MARK
VISUAL (NORM) ATTACK	A	A	A and C
VISUAL (OFFSET NORM) ATTACK	B	B	B
RADAR BOMB OFFSET	B	B	B
NAV BOMB	B	B	A and C
RADAR BOMB	A and D	B	A and C
Enroute Navigation (No Selection)	E and F	E and F	F and C
TF	F and G	F and G	F and C
Guns (air to ground) or Rockets (Any Computed Mode)	H	H	H and C

A — Nominal values assumed for target altitude, target MSLP, and bomb burst height.*

B — HUD attack symbology not displayed; enroute-navigation computations in progress, but flight director not displayed.

C — Steering information to reach stored latitude and longitude provided on HUD, ADI and HSI.†

D — Radar cursors set initially at 4 NMI along ground track and not ground-stabilized.

E — Flight director fixed in flightpath marker.

F — Nominal value assumed for MSLP of destination or mark.*

G — Flight director azimuth same as flightpath marker.

H — Nominal values assumed for target altitude and target MSLP.*

*Nominal Values: Target Altitude — 512 feet
Target MSLP — 29.92 in. Hg
Bomb Burst Height — 0

†Attack symbology displayed on HUD in VISUAL (NORM) ATTACK and in Guns or Rockets mode.

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Figure 1-95

MANUAL INSERTION OF WIND DATA.

In the event computed wind data is not available, estimated present position wind velocity (knots) and direction (true North) can be manually inserted into the computer. The rotary mode selector switch is placed to PRES POS, and the present position toggle switch to WIND VEL-DIR. The digital data windows will display the last computed wind values. The KEYBD button is pressed; it illuminates and also enables the 0 to 9 keyboard pushbuttons to accept the estimated wind information. If the estimated wind velocity is 50 knots and the direction is 270 degrees true North, the order of keyboard depression is 000050, and then 2700000. The displayed values should be verified before the ENT button is pressed to insert the values into the computer.

TRUE HEADING INFORMATION.

To read true headings as determined by the computer, place the rotary mode selector switch to PRES POS, the present position toggle switch to UPDATE, and turn the update thumbwheel to the IMS-HUD position. The upper row of display windows on the computer control panel displays the true heading derived from the Inertial Measurement Set platform. The lower row of display windows are blank.

CAUTION

Do not press the designate button with the computer in the previously mentioned configuration; the platform heading will be slewed if the aircraft has weight on the gear.

Figure 1–96 shows a sample true heading display for 315°00'.

TRUE HEADING DISPLAY

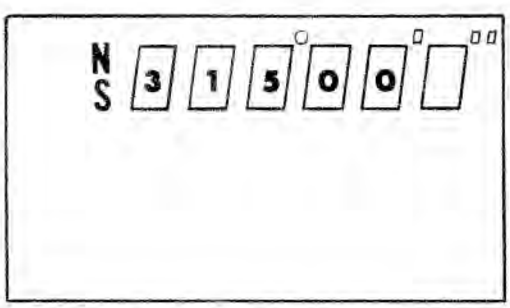

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Figure 1–96

RNG-BRG FUNCTION.

The RNG-BRG function of the computer provides the capability to enter and display range and bearing from the offset aimpoint (OAP) to the target. The following procedures are used to insert range and bearing into the computer. Set the rotary mode selector switch to RNG-BRG, and enter the desired destination or target number on the appropriate pushbutton. Depress the KEYBD switch to illuminate the keyboard and to enable the 0 through 9 pushbuttons for data insertion. Enter the range and true bearing from OAP to the target. Range in feet is displayed in the NS display windows, and bearing is displayed in the EW display windows in degrees, minutes, and seconds. The range in feet must be within the maximum computer offset bombing capability of 131,072 feet. The entered data is displayed to the pilot for verification. To store this data, depress the ENTER pushbutton. A RNG-BRG display is illustrated in figure 1–97. The range is 7,500 feet, and the bearing is 291°30'05".

RNG-BRG DISPLAY

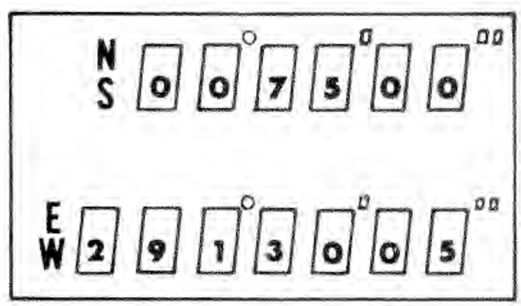

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Figure 1–97

ΔB HT FUNCTION.

The ΔB HT function of the computer provides the capability to enter and display difference in height between the OAP and the target and burst height above the target. To enter this information into the computer, set the rotary mode selector switch to ΔB HT. Enter desired destination or target number on the appropriate pushbutton. Depress the KEYBD switch to illuminate the keyboard and to enable the pushbuttons for data insertion. Enter desired information. Insert the Δ height in feet for display in the NS display. Targets with elevation above the OAP are plus values, and those below the OAP are minus values. If Δ height is a minus value, press the 6 pushbutton before entering the height. The first window in the display will then display a minus (-) sign. The difference in height between the OAP and the target is displayed in the NS display windows, and burst height above target is in the EW display windows. Limitations are ±10,000 feet difference between OAP height and target height and 0 to 16,000 feet burst height above target. The entered data is displayed to the pilot for verification. Depress the ENT pushbutton to store the data. A ΔB HT display is illustrated in figure 1–98. The difference between OAP height and target height is +500 feet, and the burst height above target is 1,000 feet.

ΔB HT DISPLAY

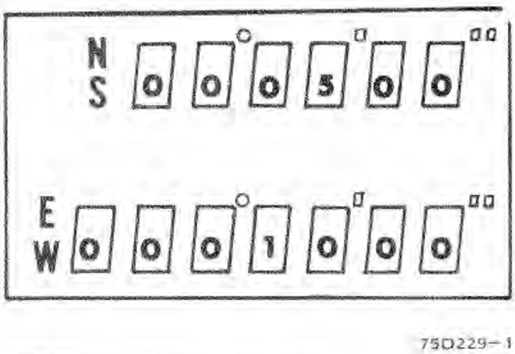


Figure 1–98

ALT-MSLP FUNCTION.

The ALT–MSLP function of the computer provides a capability to enter and display a destination or a target elevation and mean sea level pressure. Set the rotary mode selector switch to ALT-MSLP to enter this information into the computer. Enter the desired data in the appropriate position, verify the data, and depress the ENTER pushbutton to store the data. Altitude is displayed in the NS display windows and MSLP on the EW display windows. An ALT-MSLP display is illustrated in figure 1–99. The altitude is 200 feet and MSLP is 29.80.

SYSTEM SELF-TEST.

The NAV WD Computer system has a built-in self-test capability which monitors integral portions of the computer continuously throughout system operation. The letters CMPTR on the caution panel illuminate when a malfunction is detected in the self-test circuitry. The computer continues to operate and process incoming data when the detected failure does not affect program operation.

ALT-MSLP DISPLAY

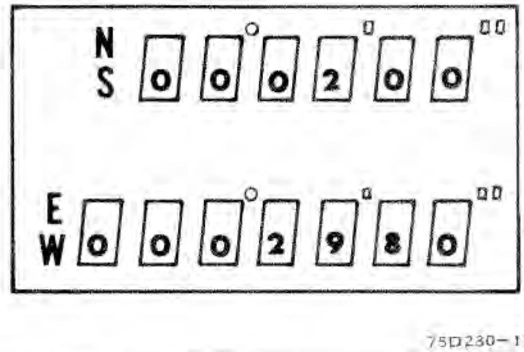


Figure 1–99

A more comprehensive computer self-test, which also provides a check of HUD symbology and computer interface with the HSI and PMDS, can be pilot selected before flight. The test is initiated by selecting any attack mode, placing the HDG MODE switch in AUTO NAV, and placing the NAV WD Computer switch momentarily in TEST. A rough azimuth check of the HUD can be made during the test by turning on the standby reticle (0 mils depression angle) and observing that the bomb fall line is centered over the aiming dot. HSI and PMDS interface is verified by the following indications at the time indicated:

Time	*HSI and PMDS Range Indications*	*HSI Bearing Pointers Number 1 and 2**
0	555	—
4 seconds	553	225°
8 seconds	535	225°
12 seconds	355	225°
16 seconds	—	—

*Position in relation to aircraft lubber line

Approximately 17 seconds after the computer switch is momentarily placed in TEST, the digital data display windows must display all 8's for 4 seconds, and the CMPTR caution light must not illuminate. Information cannot be entered into the computer during the test.

CAUTION

Do not place the NAV WD Computer switch in TEST position during or after IMS fine alignment or all fine alignment will be lost. Fine alignment will be reinitiated when the NAV WD computer has completed the self test.

During the test, the HUD presents the following display:

Flightpath Marker — Positioned in the center of the HUD field of view.

Aiming Symbol — Overlaid on the Flightpath Marker.

Bombfall Line — Positioned perpendicular to the horizontal reference, through the Flightpath Marker and through the standby reticle aiming dot.

Solution Cue No. 1 — Positioned at the bottom of the aiming symbol.

Solution Cue No. 2 — Positioned at the top of the aiming symbol.

Pullup Anticipation Cue — Positioned to intersect the Flightpath Marker.

The Flightpath Marker and Aiming Symbol should be centered about the standby reticle aiming dot within ±3 mils.

A malfunction in the HUD is indicated by the displacement of one or more symbols. A malfunction within the computer is indicated by illumination of the CMPTR light on the caution panel.

Power for the computer is supplied by the secondary ac and dc buses and the primary instrument bus.

INERTIAL MEASUREMENT SET, AN/ASN-90(V).

The Inertial Measurement Set (IMS) is the aircraft's primary gyrocompassing platform. The set senses aircraft heading, attitude, and incremental velocity and provides these as outputs to associated avionic equipment as follows:

The NAV WD Computer receives incremental velocity signals along the East-West, North-South and vertical axes, heading information, pitch and roll signals, and an IMS fault signal. Pitch, roll, heading, and velocity signals are used to compute present position, distance to destination, and bearing to destination. The IMS NOT ALIGNED light on the advisory panel is illuminated until the NAV WD Computer completes fine alignment of the IMS.

The Attitude Director Indicator (ADI) receives pitch, roll, and magnetic heading signals and, in case of IMS failure or power off condition, receives an IMS fail signal. Receipt of the IMS fail signal causes the OFF flag to appear on the ADI and the IMS caution light to come on.

The Horizontal Situation Indicator (HSI) and the TACAN receive magnetic heading. The TACAN set receives magnetic heading information to determine bearing to the selected station.

The Automatic Flight Control System (AFCS) receives pitch and roll signals, a heading reference signal, and an IMS fail signal. If the IMS fail signal is received, the AFCS cycles to the control augmentation mode and the IMS light on the cockpit caution panel comes on.

The Flight Director Computer receives pitch and roll signals.

The Forward-Looking Radar and the Doppler radar receive IMS fail signals and pitch and roll signals for antenna stabilization. If the IMS fails in the TF mode, the ADI OFF flag appears and the ADI horizontal pointer and the flight director symbol on the HUD indicate a climb command. If the IMS fails in any mode, the Forward-Looking Radar antenna has no pitch or roll stability.

Components comprising the Inertial Measurement Set are an Inertial Measurement Unit (IMU), an IMU Adjustable Mount, an Adapter/Power Supply, and a Control Panel.

The Inertial Measurement Unit is a four-gimbal, all-attitude unit containing gyroscopes, accelerometers, and associated electronic equipment. The gyroscopes are used to stabilize the platform on which the accelerometers are mounted. The accelerometers provide the basic inertial measurements necessary for navigation computations. The four-gimbal structure allows the accelerometers to be maintained in their proper orientations through all aircraft maneuvers. The boresighting of the adjustable mount permits removal and replacement of IMU's without the necessity of any additional mechanical adjustments.

The adapter/power supply provides regulated power to the IMU and attitude information derived from the IMU to other avionic systems. The adapter/power supply also provides magnetic heading information to appropriate flight instruments by utilizing IMU and ML-1 Remote Compass Transmitter inputs. Logic circuitry to sequence the IMS through various modes of startup and operation is included in the adapter/power supply. A self-contained battery assures continuous operation up to 30 seconds, if power is interrupted, to provide time to extend the RAT. If generator power is lost, the IMS mode switch should be placed in the MAG SL position before restoring the

generator. This action will assure that the NAV WD computer is provided with the information that the IMS is not fine aligned and will not attempt to use the inertial velocity that was present at the time of generator failure.

WARNING

IMS alignment and all attitude indications are lost 30 seconds after master generator failure if the RAT is not extended or generator operation is not regained. Under IFR conditions, do not attempt to reset the generator until after extending the RAT.

CAUTION

Failure to turn off the IMS prior to engine shutdown results in excessive drain on the IMS battery.

Attitude signals to the ADI originate in the IMS. In the event of master generator failure, an IMS internal battery supplies power to maintain the IMS platform in an erect condition for 30 seconds. The internal battery is automatically shut off after 30 seconds by time delay relays. The master generator must be reset or the RAT extended within 30 seconds after generator power failure, or the IMS platform and the ADI become unreliable and an additional 2-minute IMS align sequence will be initiated upon resumption of power. Also, IMS alignment is lost if RAT extension is delayed. If the IMS self-contained battery automatically shuts off after 30 seconds of operation, regaining the generator resets the time delay relay and the IMS self-contained battery is again available for a 30-second period. The battery is good for five to six 30-second periods of operation before requiring ground maintenance recharging. The battery has an internal charger for inflight recharging the battery after use. The charger is temperature sensitive and is effective at surrounding temperatures of up to 40°C.

Note

If the IMS is shut down, or power interruption for more than 30 seconds occurs during flight, a complete realignment is required to regain IMS operation. Since the ADI is caged during the first phase of realignment, level flight attitude should be maintained for approximately 2 minutes after power restoration. If the ADI uncages during other than level flight, the ADI erects at the rate of approximately one degree per minute. Turn switch to OFF; then to MAG SLAVE to insert erect cycle.

The standby attitude indicator is powered by the primary ac bus. Loss of the master generator affects the reliability of the standby attitude indicator immediately. Accurate standby attitude indications are restored upon return of main generator power or by extending the RAT.

The control panel, located on the right console, is used to initiate IMS operation and coarse alignment. Controls are also provided to select the desired mode, and to insert magnetic variation or latitude information into the set. The control panel includes the following: a mode switch with OFF, GND ALIGN, NORM, INERTIAL, MAG SL, and GRID positions; a Grid Slew Knob; a LATITUDE indicator light; and a Magnetic Variation/Latitude Set Knob and readout counter. Controls and functions are illustrated in figure 1—100.

The IMS NOT ALIGNED and GND ALIGN lights on the cockpit advisory panel are related to IMS operation and are discussed under ground align mode of operation.

The IMS is powered by the inverter instrument bus and the emergency ac bus.

OPERATION.

Integrated operation of the IMS, the NAV WD Computer, and the Doppler Radar provides accurate navigation information. The NAV WD Computer receives signals from both the IMS and the Doppler Radar. By constantly comparing these signals, the NAV WD Computer computes the proper torquing signals to maintain the inertial platform properly oriented.

The IMS operates in five modes — ground align, normal, inertial, magnetic slave, and grid. Operation in the ground align, normal, and inertial modes is controlled by the NAV WD Computer. The magnetic slave and grid modes are self-contained within the IMS.

In addition to the discussion that follows, navigation and alignment modes in the various IMS MODE switch positions are summarized in figure 1—101.

Ground Align (GND ALIGN) Mode.

Ground alignment is done in two phases, coarse alignment and fine alignment. Coarse alignment is self-contained while fine alignment is computer controlled. Under routine operating conditions, alignment is completed before the aircraft is taxied. The aircraft must remain stationary with the wings spread throughout the alignment sequence.

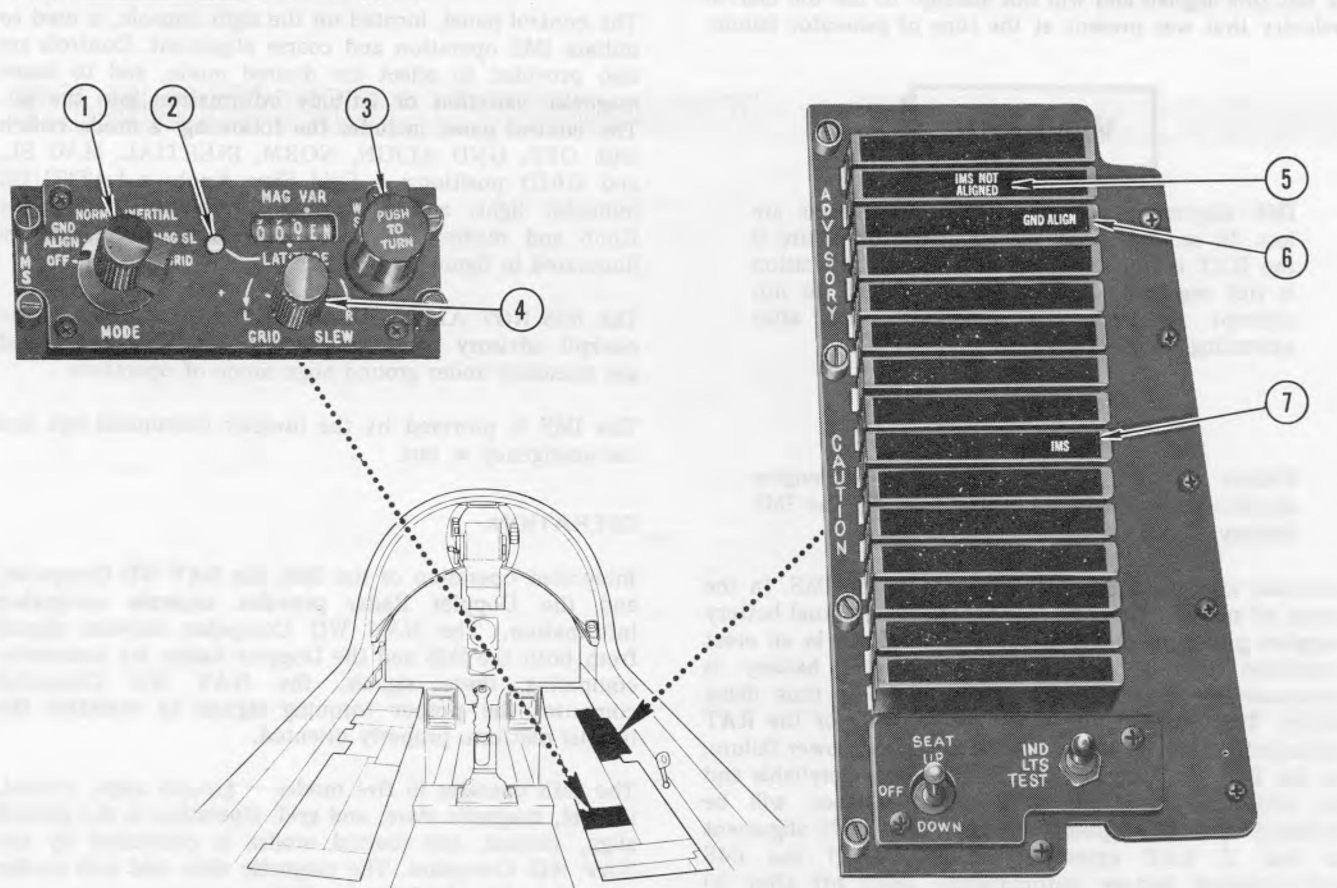
Coarse Alignment.

Coarse alignment is initiated when the MODE switch is placed in any operating mode and is completed in approximately 2 minutes. The sequence of events during coarse alignment is as follows:

1. Prior to IMS turnon, set magnetic variation.
2. Place MODE switch from OFF to any other position.

   IMS caution light comes on.

IMS CONTROLS



Nomenclature	Function
1. MODE switch	OFF — deenergizes IMS. GND ALIGN — initiates alignment of IMS. Self-test automatically obtained during initial stages of operation. NORM — places IMS in normal mode. Used when NAV WD Computer is operating normally and Doppler input is available. INERTIAL — IMS operates as a Doppler damped level, north-slaved platform. Doppler gyrocompassing is not available. This mode should not be entered until after alignment is completed in either GND ALIGN or NORM. MAG SL — places IMS in magnetic slaved mode. Entry into this mode is automatic when NAV WD Computer fails between 70° N and 70° S. Primarily used as back-up mode. GRID — places IMS in grid mode of operation. Similar to MAG SL except that platform azimuth is compensated for by earth's rate of rotation only and platform may be positioned to any desired heading through use of GRID SLEW knob. Mode is entered automatically when NAV WD Computer fails above 70° latitude. Like MAG SL mode, primarily used as backup mode..
2. LATITUDE indicator light	On — indicates latitude should be inserted into MAG VAR/LATITUDE counter. Light is illuminated only in GRID mode.

75D129(1)—08—70

Figure 1—100 (Sheet 1)

IMS CONTROLS

Nomenclature	Function
3. MAG VAR/LATITUDE set	Used to insert magnetic variation or latitude into counter. Counter will accept latitude or magnetic variation from 0.0° to 89.9°.
4. GRID SLEW knob	Used to slew azimuth gimbal. Placed in first detent either side of center, slews gimbal at approximately 10° per minute. Second detent position slews gimbal at approximately 90° per minute. Knob is spring-loaded to center.
5. IMS NOT ALIGNED advisory light	ON – indicates IMS has not completed fine alignment when under NAV WD Computer control, or IMS and Doppler north components of velocity differ by more than 10 feet per second.
6. GND ALIGN advisory light	ON – indicates mode switch is in GND ALIGN position. Will go out when mode switch is placed in any other position.
7. IMS caution light	ON – indicates IMS system failure; or, IMS coarse alignment in progress (first two minutes of operation). OFF – indicates IMS operating normally and coarse align phase complete.

75D129(2)-12-70

Figure 1–100 (Sheet 2)

ADI snap erects to 30 degrees pitch and 30 degrees roll (with IBM P/N 6870000-7 and subsequent NAV WD computers) and to 0 degrees pitch and 0 degrees roll with prior configuration.

HSI and ADI heading begins to align with ML-1 remote compass at 300 degrees per minute.

IMS fail signal is fed to ADI, FLR, Doppler, and AFCS.

3. At approximately 43 seconds after turnon

ADI sphere snap erects to approximately 0 degrees pitch and 0 degrees roll, indicating cage termination and start of erection to the vertical reference at low gain rate of 1.3 degrees per minute.

4. At approximately 61 seconds after turnon

HSI and ADI heading may drive off and return to ML-1 reference heading at 300 degrees per minute.

ADI roll and pitch erects to vertical at high gain rate of 25 degrees per minute. (It will track the dynamic vertical if subjected to maneuvering flight from 61 seconds to 122 seconds resulting in vertical errors.)

5. At approximately 102 seconds after turnon

HSI and ADI heading may exhibit another transient, after which readouts should be a valid reflection of ML-1 reference.

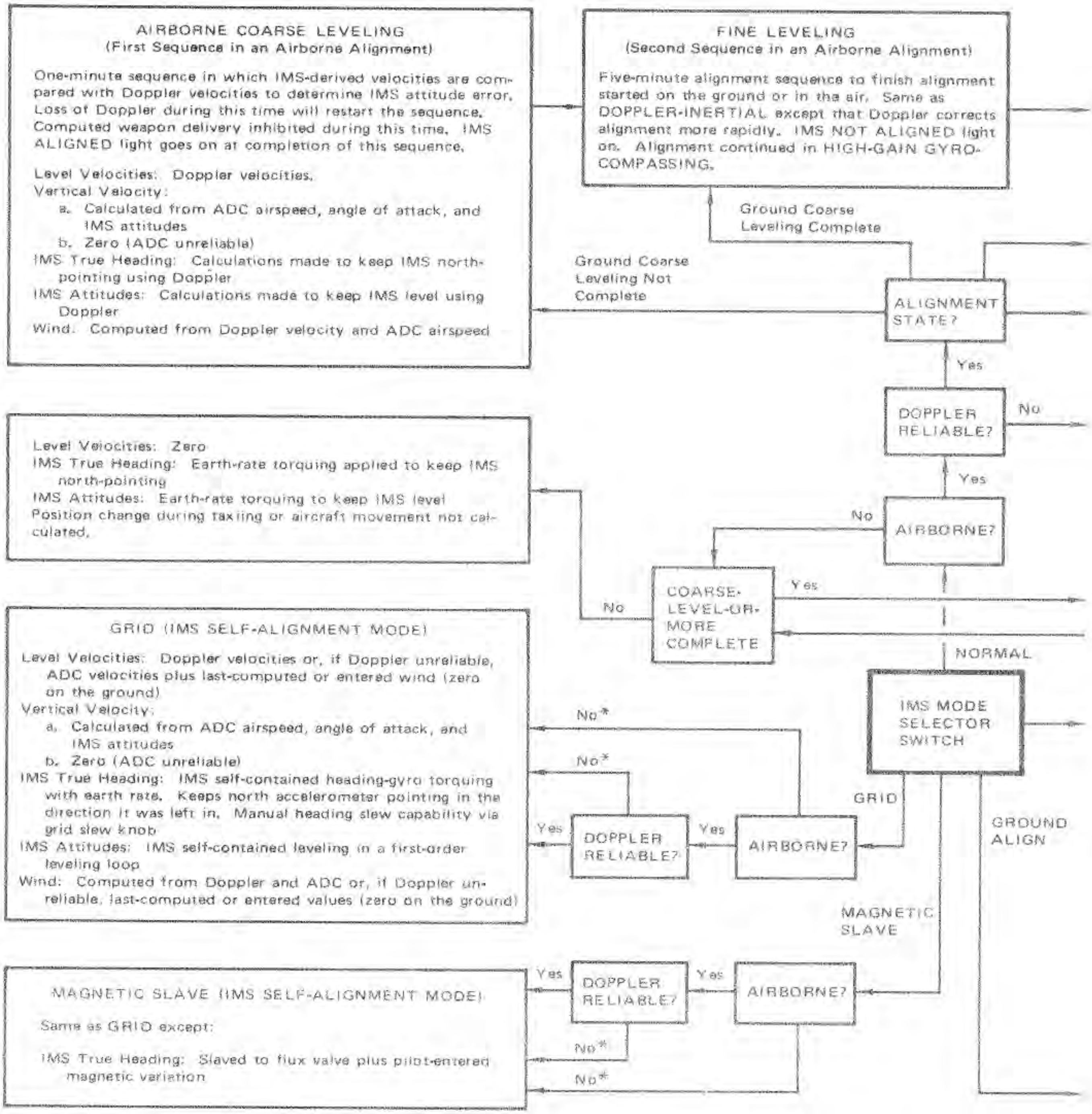
6. At approximately 122 seconds after turnon

Level loops revert to 1.3 degrees per minute maximum rate and magnetic heading loop to 2.4 degrees per minute maximum rate.

ADI OFF flag retracts.
IMS caution light goes off.
System ready discrete signal sent to computer and IMS fail signals to other equipments are retracted.

During the coarse alignment phase, built-in test equipment (BITE) checks are automatically made. If a fault is detected, the BITE indicators on the IMU and/or adapter/power supply trip and the IMS caution light on the caution panel will remain on.

NAVIGATION AND ALIGNMENT MODES FLOW CHART



NOTE

Headings displayed by HUD, HSI, and ADI are slaved to flux valve except (1) in GRID, wherein these displays are IMS true heading; (2) in GND ALIGN, NORM, or INERTIAL on the ground with computer control, wherein the displays are synthetic magnetic heading (IMS true heading minus magnetic variation).

* Refer to GRID block for differences for pretakeoff or Doppler unreliable.

75D270(1)-11-71

Figure 1–101 (Sheet 1)

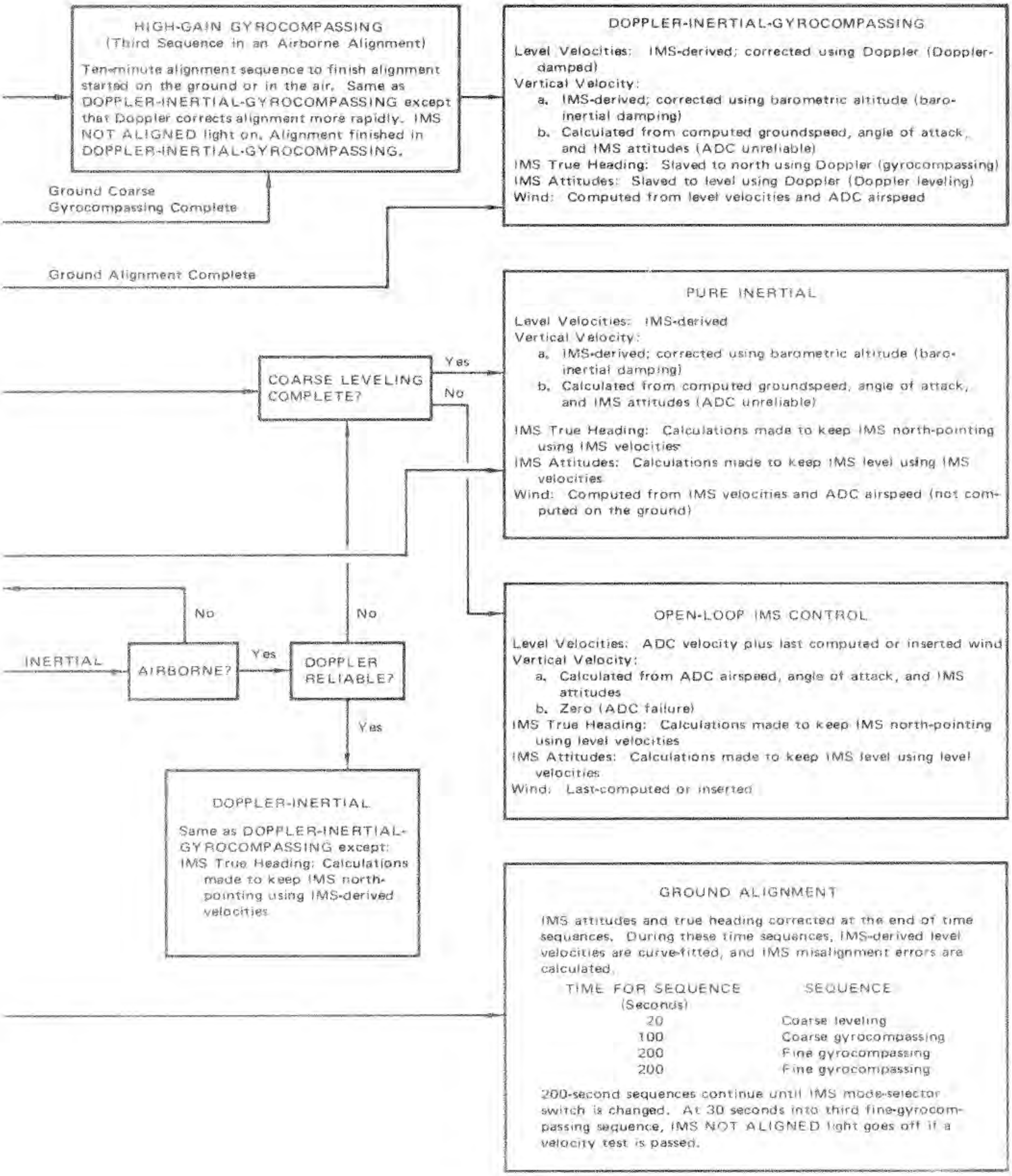


Figure 1-107 (Sheet [illegible])

NAVIGATION AND ALIGNMENT MODES FLOW CHART

SPECIAL FUNCTIONS

IMS UNRELIABLE

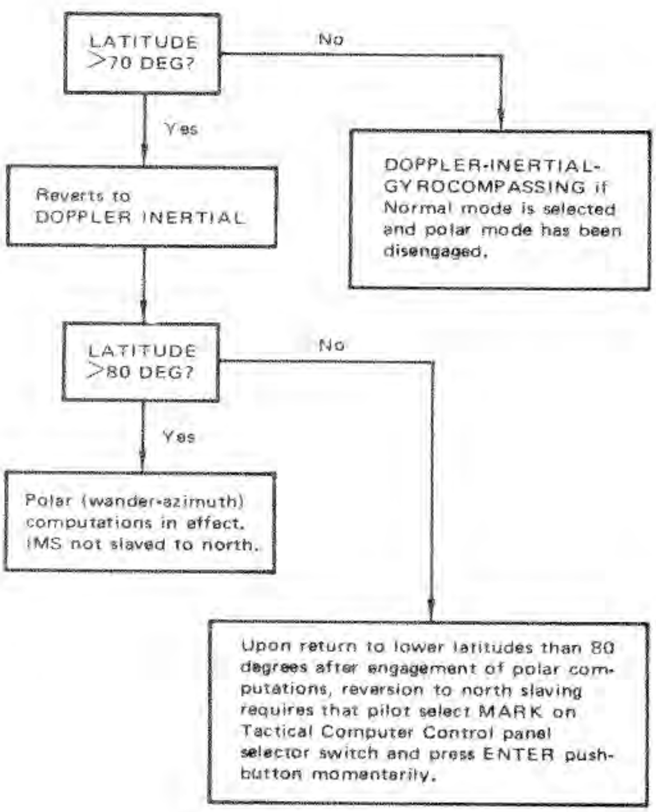
Level Velocities: Doppler velocities or, if Doppler unreliable, ADC plus last-computed or entered wind. (Zero on the ground.)
Vertical Velocity: Zero.
IMS True Heading: Calculated in the computer from magnetic heading and magnetic variation. IMS places magnetic variation in IMS true-heading synchro during unreliable condition.
IMS Attitudes: In the computer, roll is set to zero, and pitch is set to angle of attack.
Wind: Computed from Doppler and ADC airspeed or, if Doppler unreliable, last-computed or entered value.

Computed weapon delivery is inhibited. The heading displays on ADI, HSI, and HUD revert to unfiltered flux valve. The ADI and HSI attitudes will be unreliable.

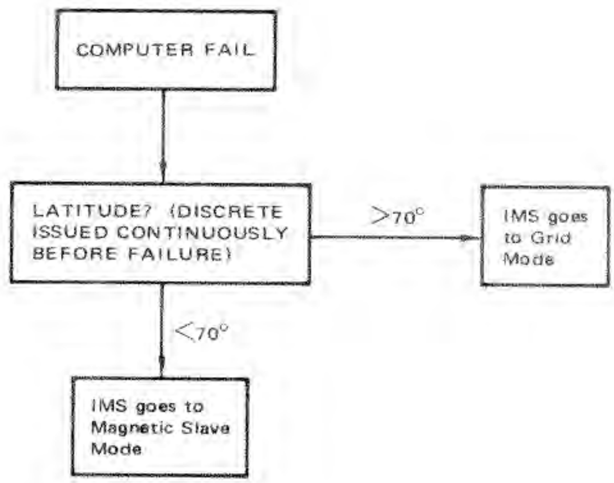
FAST MAGNETIC-HEADING UPDATE

Fast magnetic-heading update is used to obtain an IMS coarse heading alignment while airborne, using the flux valve. It is initiated by selecting Grid or Magnetic Slave mode while airborne and then switching to Normal or Inertial mode. The computer places the IMS in a condition similar to Magnetic Slave except that the IMS true heading is slaved to the flux valve plus magnetic variation at a higher rate. Fast magnetic-heading update is inhibited at aircraft roll angles greater than 5 degrees. When the computer determines that the IMS is slaved to the proper heading, the fast magnetic-heading update is terminated. Computed weapon delivery is inhibited for the duration of the update, which is 12 seconds plus 2 seconds for every degree of IMS heading error.

GYROCOMPASSING INHIBITION AND POLAR (WANDER-AZIMUTH) COMPUTATIONS



COMPUTER FAILURE



75D270(3)–11–71

Figure 1–101 (Sheet 3)

IMS NOW FULLY OPERATIONAL IN COARSE ALIGN AND READY FOR FINE ALIGNMENT.

CAUTION

Do not place the NAV WD computer switch in TEST during or after IMS fine alignment or all fine alignment will be lost. Fine alignment will be reinitiated when the NAV WD computer has completed the self-test.

Note

Do not initiate IMS GND ALIGN with the wings folded because the ML-1 remote compass transmitter, located in the outer right wing panel, is in a vertical orientation and will not provide the IMS with a correct magnetic heading reference. Alignment of the ADI, HSI and HUD will be to this erroneous heading reference during the initial coarse alignment. After the wings are spread, the IMS will correct to the proper magnetic heading at the rate of 2.4 degrees per minute. The erroneous heading condition can also be corrected by cycling the IMS to OFF and back on again after the wings are spread. However this will reinitiate the coarse alignment and will require an additional 2 minutes before usable outputs are obtained.

Do not taxi in GND ALIGN as any alignment will be lost. Always move switch to NORM or INERTIAL before moving aircraft.

Fine Alignment.

When the IMS MODE switch is placed in GND ALIGN, the GND ALIGN advisory light comes on and the IMS automatically sequences through a coarse alignment if not previously accomplished in another MODE switch position.

The NAV WD Computer assumes control, turns the IMS NOT ALIGNED advisory light on, and completes the fine alignment sequence. When fine alignment is complete (approximately 9 minutes of fine alignment, 11 minutes total in GND ALIGN), the IMS NOT ALIGNED advisory light goes out. The MODE switch may then be moved to NORM or INERTIAL. Rotating the MODE switch to NORM or INERTIAL turns off the GND ALIGN advisory light and permits the aircraft to be taxied without disturbing alignment.

Note

Proper ground alignment is contingent upon NAV WD Computer operation. If the NAV WD Computer is on and contains correct present position information, an accurate alignment is achieved.

If it is necessary to have the aircraft airborne before alignment is complete, the MODE switch must be rotated to NORM or INERTIAL before the aircraft is taxied or all existing alignment will be lost. After takeoff, the NAV WD Computer uses Doppler Radar signals to align the IMS. The IMS NOT ALIGNED light remains on until the NAV WD Computer fine alignment of the IMS is complete.

If takeoff is made with the MODE switch inadvertently left in the GND ALIGN position, the NAV WD Computer automatically sequences the IMS to the normal mode as soon as weight is off the gear. In this event, any initial fine alignment is lost and the IMS platform may be torqued off level by 2 or 3 degrees. This condition would eventually be corrected without pilot action; however, a rapid recovery can be achieved if the Doppler is reliable by switching the IMS mode switch to MAG SL, then back to NORM. A NAV WD Computer present position update is recommended to negate the errors accumulated under these conditions.

WARNING

Do not take off with MODE switch in GND ALIGN under IFR conditions as significant attitude reference errors can be accrued.

IMS Alignment Alternatives.

Option 1.

Platform level and coarse alignment complete before takeoff.

1. Switch to NORM before taxi.

   Take off and proceed on course.

Option 2.

Platform level but azimuth alignment grossly in error during flight.

1. Switch momentarily to GRID or MAG SL and back to NORM (with fast mag update features).
2. If step 1 does not correct situation, switch to GRID.
3. Set approximate true heading with the GRID SLEW knob.
4. Return switch to NORM and proceed on course.

Option 3.

Platform attitude not proper during flight or takeoff before platform is level.

1. Switch momentarily to GRID or MAG SL and back to NORM (with fast mag update features).
2. Computer should relevel IMS after approximately 1-1/2 minutes (including 1 continuous minute of good Doppler).
3. If step 2 does not correct the situation, select a period when stabilized flight can be sustained for at least 2 minutes.
4. Switch IMS off for at least 10 seconds. The ADI flag and IMS caution light will appear.
5. Switch IMS back to NORM. This permits the IMS self-contained analog circuits to self-erect the platform to the local vertical and rapid coarse azimuth alignment of the platform.

It is necessary to remain stabilized in level flight until the ADI off flag retracts and the IMS caution light goes out.

Presetting correct MAG VAR is desired in all cases, but is particularly desirable in the case of Option 3.

When the IMS is off, the AFCS reverts to the control augmentation mode.

Normal (NORM) Mode.

Normally, alignment is obtained in GND ALIGN prior to taxi; however, alignment can be obtained totally in flight or partially on the ground and partially in flight in NORM.

Placing the MODE switch in the NORM mode directly from the OFF position causes the IMS to sequence through the same initial coarse alignment functions as in the GND ALIGN mode, but the BITE checks are not made. As in the GND ALIGN mode, completion of coarse alignment sends a system ready signal to the NAV WD Computer. The computer assumes control and aligns the IMU platform when reliable Doppler signals are available after the aircraft is airborne. Any time the Doppler becomes unreliable, airborne alignment is inhibited and will not begin again until the Doppler has been reliable for approximately five seconds.

If takeoff is to be made before an IMS ground alignment is complete, the MODE switch is rotated to NORM before taxi. When reliable Doppler signals are available, the NAV WD Computer uses the Doppler signals as a reference to fine align the IMS. If at least 20 seconds of fine alignment had not been completed, minimize aircraft maneuvering after takeoff to obtain one minute of continuous valid Doppler. If Doppler radar is lost while in the NORM mode, the IMS automatically assumes the pure inertial mode of operation.

In the NORM mode, an absence of reliable Doppler information places the azimuth gyro in a north slaved mode. The only corrections applied to the azimuth gyro are earth rate and convergency corrections. The pitch and roll gyros operate in the pure inertial mode.

Should the NAV WD Computer fail while in the NORM mode, the IMS reverts to the magnetic slaved or grid mode, dependent upon present position latitude.

INERTIAL Mode.

Doppler Operating.

The inertial mode is similar to the normal mode, except that airborne azimuth alignment is not performed. The inertial mode should not be selected until the IMS has completed system fine alignment (11 minutes in GND ALIGN on ground or approximately 20 minutes in the air in NORM with reliable Doppler radar). After alignment is complete, the IMS performs satisfactorily in this mode during normal flight duration. Doppler damping of the platform level loops occurs.

Doppler Not Operating.

If Doppler radar is lost while in this mode, the IMS automatically assumes a mode of operation identical to that in NORM without Doppler.

NAV WD Computer Not Operating.

Should the NAV WD Computer fail while in the inertial mode, the IMS reverts to the magnetic slaved or grid mode, dependent upon present position latitude.

Magnetic Slaved (MAG SL) Mode.

The MAG SL mode is a backup mode of operation. In the MAG SL mode, the azimuth of the IMU platform is slaved to true North. This is derived from the Remote Compass Transmitter corrected for magnetic variation (MAG VAR) as set on the IMS control panel. The magnetic slaved mode is entered automatically if the NAV WD Computer fails at latitudes between 70 degrees north and 70 degrees south as determined by the NAV WD Computer. The MAG SL mode may also be entered by rotating the MODE switch to MAG SL. All provisions for operating in the magnetically slaved mode are self-contained within the IMS. Manually-set MAG VAR should be periodically updated when operating in this mode in conjunction with the NAV WD Computer.

Note

> Heading outputs to the HSI and ADI are subject to transient errors if the NAV WD computer fails and the MAG VAR setting is appreciably in error.

Grid (GRID) Mode.

The GRID mode is a backup mode of operation and is entered automatically if the NAV WD Computer fails at latitudes above 70 degrees. Provisions for operating in the grid mode are self-contained within the IMS. The grid mode may also be entered manually by rotating the MODE switch on the IMS control panel to the GRID position. The LATITUDE light on the IMS control panel comes on to advise the pilot of grid mode operation. In the grid mode, the platform azimuth is torqued to compensate for earth rate of rotation only, and the platform may be slewed manually to any desired heading. The GRID SLEW knob on the IMS control panel is used to insert any desired heading into the system. Once set to an angle to a meridian, the IMS platform maintains the angle to the meridian. Present position latitude must be set and periodically updated on the IMS control panel for stable long-term heading operation in this mode. The NAV WD Computer when operating in conjunction with the IMS with the grid mode selected assumes that the grid heading is true North for navigation computations.

Note

In the event of a NAV WD Computer failure above 70 degrees latitude, the MODE switch must be positioned to GRID to obtain fast slew operation with the GRID SLEW knob.

Polar Operation.

Inertial Measurement Set operation at latitudes above 70 degrees normally requires no pilot action, and there are no external cues to indicate a change in system operation. The NAV WD Computer discontinues gyrocompassing at latitudes above 70 degrees; however, the IMS platform is maintained north slaved as in the Doppler-damped inertial mode.

At latitudes of 80 degrees or higher, the NAV WD Computer automatically assumes a computational routine suitable for platform control in the Doppler-Inertial mode, but north slaving is not required. Latitude and longitude is available for display purposes. Upon return to lower latitudes than 80 degrees after engagement of polar computations, reversion to north slaving requires that the pilot set the mode selector switch on the NAV WD panel to MARK and then press the ENTER pushbutton momentarily.

Azimuth Alignment Using HUD.

The Head-Up Display (HUD) can be used to achieve IMS azimuth alignment prior to takeoff. To use this technique, the IMS must be operating in the GND ALIGN, NORM, or INERTIAL mode with the rotary mode selector switch in PRES POS and the present position toggle switch in UPDATE. The UPDATE thumbwheel on the NAV WD computer control panel is rotated to the IMS-HUD position, and the azimuth of a known reference point is inserted into the NAV WD Computer by way of the NAV WD Computer keyboard. By slewing the HUD aiming symbol over the reference point, the azimuth can be updated by pressing the designate switch on the stick grip. Actual aircraft true heading, determined from a complete IMS alignment, can be used in lieu of azimuth to a known reference point. This method of azimuth alignment is not dependent on adequate outside visibility and eliminates HUD aiming symbol inaccuracies by the pilot. Excellent bombing and navigation accuracy can be expected following IMS-HUD alignment procedures.

Note

Accidental pressing of the designate switch with computer control panel set up for HUD align and aircraft weight on the gear can also destroy azimuth alignment.

IMS Failure Not Involving Magnetic Servo Loop.

In the event of an IMS failure which does not involve the adapter/power supply heading repeater module or its excitation voltages, a backup magnetic heading capability will be retained. The backup heading consists of a lightly damped compass repeater which is slaved to the ML-1 flux valve at a maximum rate of 300 degrees/minute and exhibits dynamic performance similar to a magnetic compass. The IMS must be left on regardless of the fail light indication for this backup heading to be operative. Under IMS failed conditions, the backup heading function operation should be verified by comparison with the Standby Compass before placing reliance on the heading indications. During operation under such a condition, the magnetic variation displayed on the IMS control panel is fed only to the NAV WD Computer. Magnetic variation changes must be periodically updated manually to maintain optimum navigation accuracy.

Fast Magnetic Heading Update.

Moving the IMS MODE switch from either GRID or MAG SL to NORM or INERTIAL after the aircraft is airborne results in a fast update of the IMS magnetic heading outputs to the HUD, ADI and HSI, and coarse alignment to true north. The IMS slews out heading error at 30 degrees per minute if the aircraft attitude is within a ±5 degree bank angle (from GRID mode, magnetic variation is also corrected at a 300 degree per minute rate). Then after 1 minute of continuous good Doppler, a computer controlled airborne alignment will begin.

DOPPLER RADAR NAVIGATION SET AN/APN-190(V).

The AN/APN-190(V) Doppler radar continuously measures and indicates groundspeed and drift angle of the aircraft. This data is displayed on a Doppler control panel on the right console and is fed into the NAV WD Computer for use by the Nav/Weapon Delivery System.

The Inertial Measurement Set provides pitch and roll information to permit leveling of the Doppler antenna to local vertical for aircraft attitudes within ±20 degrees pitch and ±30 degrees roll so that the most accurate data can be provided. Loss of the pitch and roll information (due to loss of Inertial Measurement Set or any other cause) will cause the antenna to level to aircraft axis. In that mode, the groundspeed and drift angle information provided by the Doppler is degraded except when aircraft is in level flight. The degradation increases with aircraft roll/pitch. The degraded mode is provided primarily as a backup navigation mode.

Primary system components consist of a receiver-transmitter, antenna, and control panel. A DOPPLER MEMORY light on the advisory light panel illuminates when the system is not tracking and is in the memory mode. The Doppler radar receives power from the secondary ac and dc buses.

Two beams of microwave energy are transmitted downward at one time, one beam looking forward, the other aft. Groundspeed is determined from the Doppler-shifted energy reflected back from these beams. An upshifted and downshifted Doppler return results from the forward and aft beam respectively. The two returns are beat together to produce a Doppler return at twice the Doppler shift in either return. Each beam is switched left and right of ground track for drift sensing, and in turn beam-lobed for terrain compensation, including overwater shift error.

Doppler information is considered unreliable and is not used by the NAV WD Computer when:

1. Doppler is in memory (Doppler MEMORY advisory light on).
2. Doppler antenna reaches either limit of stabilization (aircraft attitude exceeds ±20 degrees pitch, ±30 degrees roll).
3. Doppler has been locked on for less than 5 seconds.

System controls are illustrated in figure 1–102.

OPERATION.

Rotating the selector switch from OFF to STBY, ON, or TEST applies power to the system. In the STBY position, power is applied to all parts of the system except that transmitter power is off.

In the ON position, power is applied to all parts of the system including the transmitter (a 30-second delay will occur if equipment is turned ON directly from the OFF position). Under normal flight conditions, signal acquisition and tracking will occur in about 30 seconds or less after the transmitter is turned on.

SELF-TEST.

Placing the selector switch in the TEST position activates the system self-test function. In the TEST position, power is applied to all parts of the system and self-test is activated. After a short delay (less than 1 minute), the groundspeed counter should go to 534.5 (±3) knots and the drift angle indicator should read 0 degrees (±1 degree). Indicators must remain within tolerances for at least 1 minute before selecting ON position. The groundspeed reading may read low for the first 6 minutes of equipment operation (no effect on tracking actual ground signals).

AIR DATA COMPUTER.

The Air Data Computer (ADC) system consists of the Air Data Computer, a total temperature probe, and a true airspeed indicator. The computer contains three modules — an altitude module, a Mach module, and a true airspeed module. Output distribution is presented in figure 1–103.

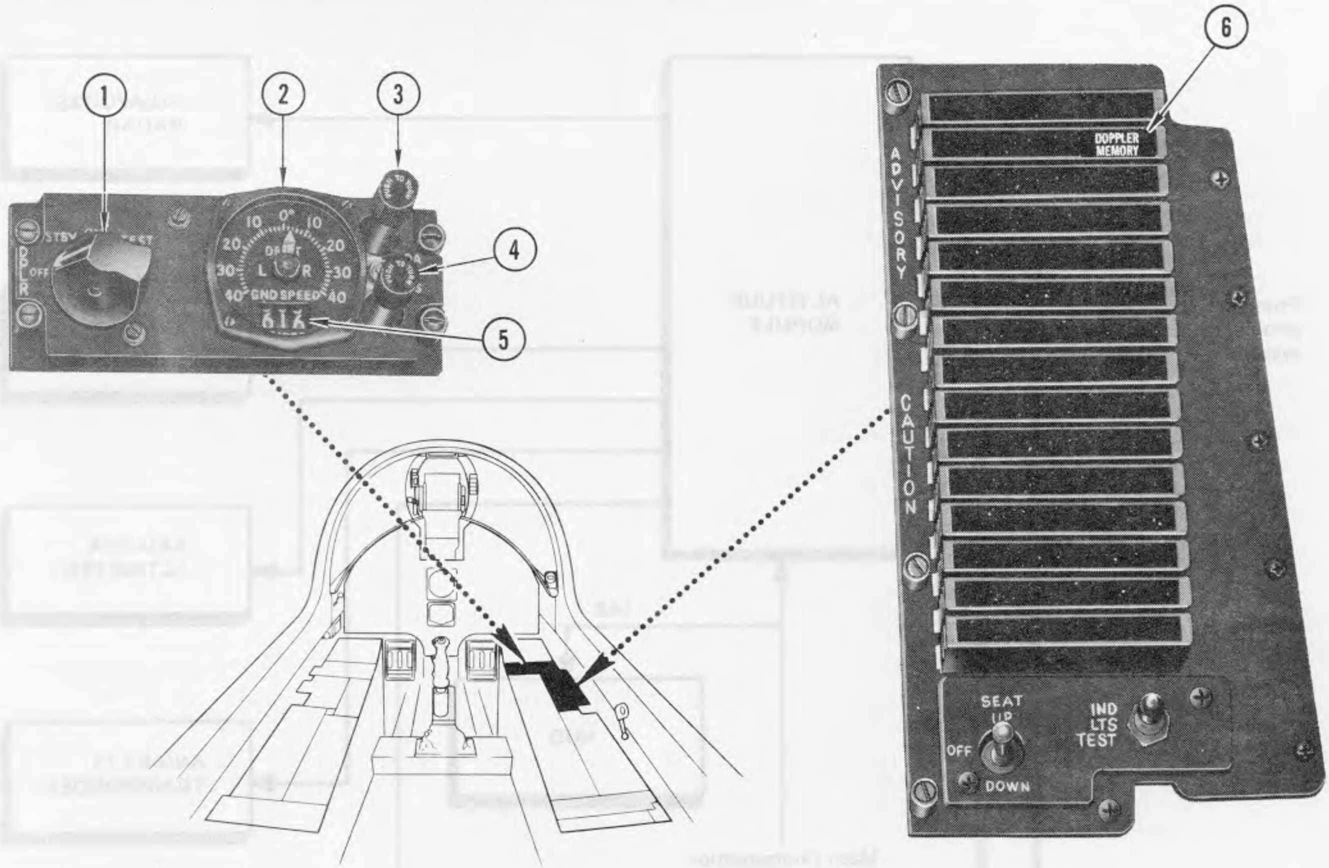
OPERATION.

The altitude module converts static pressure into an electrical signal which is combined with a Mach effect signal from the Mach module. The resultant signal, which represents calibrated altitude, is supplied to the AAU-19/A altimeter to give the pilot an accurate indication of altitude, and to the IFF transponder when Mode C altitude interrogations are initiated by control centers.

The Mach module converts pitot and static pressure into an electrical signal. The resultant signal is transmitted to the NAV WD Computer, to the Head-Up Display in the form of indicated airspeed, to the altitude module for Mach compensation of static pressure, and to the true airspeed module.

The true airspeed module converts the Mach number input which is combined with a temperature signal from the total temperature probe into true airspeed signals for the NAV WD Computer and the true airspeed indicator. The Air Data Computer receives power from the primary ac bus, the primary dc bus, and the primary instrument bus.

DOPPLER RADAR SET CONTROLS



Nomenclature	Function
1. Selector switch	OFF – removes all power from system. STBY – applies warmup voltages to system (30-second warmup period). All voltages applied except transmitter is off. ON – applies all power necessary for system operation (30-second delay on transmitter). TEST – enables self-test Tolerances for test are 534.5 (±3.0) knots groundspeed, and 0 (±1) degree drift.
2. Drift angle indicator	Scale reads to 40 degrees left or right, but system capability is 30 degrees left or right drift angle.
3. DA (drift angle) set knob	Can be used to manually set flight-path marker on HUD in azimuth in computer failed mode (if Doppler selector switch is in OFF position).
4. GS (groundspeed) set knob	Inoperative.
5. Groundspeed counter	Indicates groundspeed up to 999 knots.
6. DOPPLER MEMORY advisory light	On (DOPPLER MEMORY) – indicates system is not providing current or reliable groundspeed and drift information.

75D116–12–70

Figure 1–102

AIR DATA COMPUTER SYSTEM

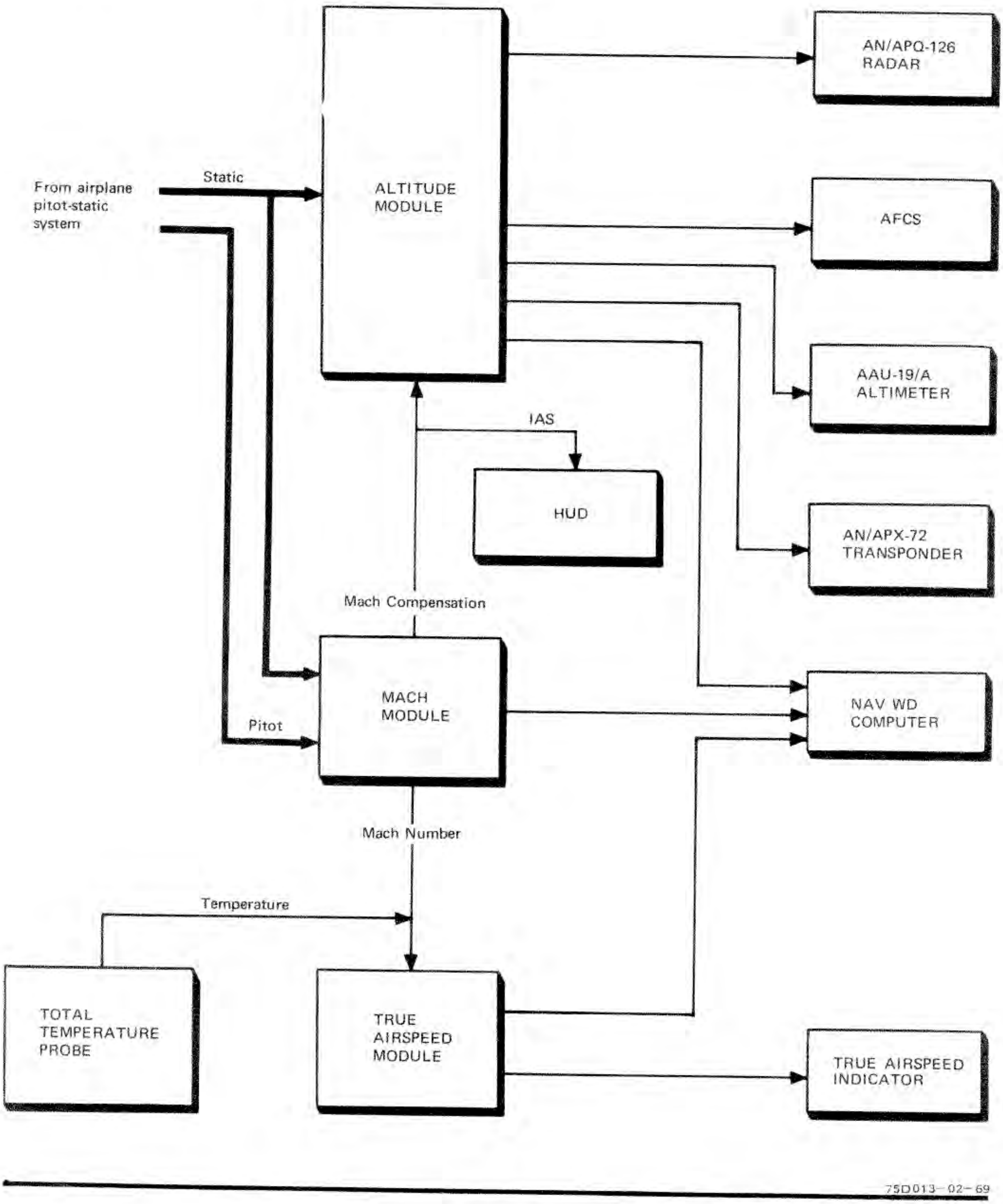


Figure 1–103

LOSS OF AIR DATA COMPUTER.

Loss of the Air Data Computer is indicated by illumination of the ADC light on the cockpit advisory panel. When the computer fails, the AAU-19/A altimeter reverts to barometric operation and altitude reporting in Mode C of the IFF is suspended. Failure of the Air Data computer also affects true airspeed indication, calibrated altitude to the NAV WD Computer, indicated airspeed display on the HUD, and the altitude hold function of the Automatic Flight Control System.

Loss of the Air Data Computer while in a degraded Navigation mode causes wind computation to cease and navigation computation will be based on last computed wind until a new wind value is inserted manually.

Note

With Air Data Computer failure, an altitude position error correction must be applied to the altimeter for calibrated altitude determination. (Calibrated altitude is barometric altitude plus altitude position error correction.) This position error correction is found in tabular form in T.O. 1A-7D-1CL-1 and is derived from the Position Error Chart (altitude correction) in Appendix I.

FORWARD-LOOKING RADAR SET, AN/APQ-126(V).

The functions of the AN/APQ-126(V) Radar Set are ground mapping, air-to-ground ranging for weapon delivery, and air refueling rendezvous. A terrain avoidance capability is also provided to permit maneuvering away from terrain obstacles during low-level flight. The set is powered by the secondary ac and dc buses.

The radar can be operated in any of the following modes:

- Beacon (BCN)
- Terrain Avoidance (TA)
- Ground Map, Pencil (GMP)
- Ground Map, Shaped (GMS)
- Air-to-Ground Ranging (AGR)
- Terrain Following (TF)
- Combined Terrain Following and Terrain Avoidance (CSTA)
- Combined Terrain Following and Ground Mapping (CSGMP)
- Television Display (TV)

OPERATING MODE SELECTION.

Radar mode selection can be achieved manually or automatically. An automatic mode selection takes priority over a manual mode selection. Automatic mode selection takes place in the computed attack modes and in the HUD and RADAR update modes.

Modes of operation are selected with a rotary-type selector switch on aircraft → [10] and with pushbutton-type switches on aircraft [11] →. Pressing the applicable switch selects the mode. Pressing another mode switch deselects the mode and selects the new mode. (See figure 1–105.)

Beacon (BCN).

In the BCN mode the radar antenna scans 45 degrees left and right of the aircraft ground track. Transmitted radar energy interrogates airborne AN/APN-134 beacon equipment. Beacon replies, in the form of coded pulses, are displayed on the radar scope. The position of the pulses on the scope indicates range and bearing to the beacon. The coded pulses also provide identification of the airborne beacon. The beacon reply consists of no more than six pulses. The beacon mode of operation is the only mode of the radar in which the transmitter operates on a frequency different than the radar receiver. The frequency (FREQ) selector on the radar control panel is not effective in the beacon mode. The antenna may be tilted between plus 5 and minus 15 degrees to improve readability of the coded pulse.

Terrain Avoidance (TA).

The radar sweeps 45 degrees either side of aircraft ground track, and displays all terrain at or above the aircraft altitude. Only 5- and 10-mile ranges are available. Receiver gain is preset to prevent inadvertently missing terrain returns due to lowered manual gain. The VID GAIN knob on the indicator should be near fully clockwise in this mode. The radar antenna sweeps in azimuth and is stabilized in pitch, roll, and drift. Noseup attitudes do not cause the target to disappear until the aircraft is above the terrain. The FAIL light on the indicator display illuminates if radar components malfunction.

WARNING

Terrain avoidance should not be attempted over terrain where deep snow is the predominant target such as snow covered mountains above the tree line.

Ground Map, Pencil (GMP).

This mode presents a sector sweep of 45 degrees either side of aircraft ground track. Terrain display falls within a pencil beam sweep area. The ANT TILT control may be used to position the pencil beam to obtain an optimum display of the terrain. The radar receiver gain may be manually adjusted with the RCVR GAIN control knob on the indicator display. When mapping, this mode is recommended at altitudes up to approximately 10,000 feet.

Ground Map, Shaped (GMS).

The radar beam sweeps 45 degrees either side of aircraft ground track. The antenna is tilted down through use of a separate feed guide to provide the shaped beam pattern necessary to obtain approximately equal return from targets regardless of target range from the aircraft. At low altitudes, range selection of 5 or 10 miles provides the best ground map presentation. The antenna may be tilted manually to obtain optimum display.

Air-To-Ground Ranging (AGR).

This mode presents air-to-ground range on the indicator display and supplies target range information to the NAV WD Computer.

Note

> After target designation, AGR is displayed in all radar mode positions when the NORM ATTACK master function pushbutton on the instrument panel is pressed.

The AGR display is a vertical sweep with a horizontally deflected range strobe. The vertical trace represents slant range to the target. The range strobe, a 3/8-inch deflection to the right, represents target range. In the absence of a target lock-on, the range strobe searches from far range (top of the scope) to near range, and then rapidly returns to far range. If locked onto a target, the radar may be made to break lock by pressing the target reject button labeled RDR on the throttle. The range strobe then returns to far range and locks on the first target detected as the strobe searches toward near range.

Clutter or point target determination is made by a target gate in the sweep generator of the Forward-Looking Radar.

FLR usage is limited to a -4° grazing angle in AGR. When the center of the radar beam strikes the surface of the earth at an angle of less than 4°, AGR is considered invalid.

Combined Terrain Following And Terrain Avoidance (CSTA).

This mode is obtained by pressing the TF master function switch on the instrument panel and selecting TA on the radar control panel. By combining the two modes, flight around and/or between protruding terrain at preselected terrain clearance (TER CLR) altitudes is possible. The TA presentation on the scope shows terrain at or above the airplane altitude, 20 degrees either side of ground track.

The azimuth scan in this mode is reduced to 20 degrees either side of centerline to allow the necessary time for the TF portion of the cross scan. Terrain following commands are supplied to the horizontal needle of the Attitude Director Indicator (ADI) and to the Head-Up Display (HUD). Range selection in this mode is 5 or 10 nautical miles. Manual tilt is not available.

Combined Terrain Following And Ground Mapping (CSGMP).

This mode is obtained by pressing the TF master function switch on the instrument panel and selecting GMP on the radar control panel. This provides terrain following with a ground map pencil presentation. As in CSTA, the azimuth scan is reduced to 20 degrees either side of centerline to allow the antenna to scan in elevation to obtain terrain following information. Terrain following information is displayed on the horizontal needle of the ADI and on the HUD. Range selection in this mode is 5 or 10 nautical miles. Tilt control is available to spotlight areas of interest in ground map presentation, but does not affect the terrain following scan pattern.

Terrain Following (TF).

This mode is selected by pressing TF master function switch on the instrument panel and selecting BCN, GMS, or AGR on the radar control panel.

WARNING

> Terrain following should not be attempted over terrain where deep snow is the predominant target such as snow covered mountains above the tree line.
>
> The terrain following mode of the existing configuration of the forward-looking radar shall not be used under actual instrument conditions when moderate or heavy turbulence conditions exist.

In the TF mode, terrain following information is presented on the horizontal needle of the ADI, on the HUD, and on the radarscope display to enable the pilot to maintain the aircraft at a preset altitude above the terrain. If interference is encountered, change frequency until interference is removed.

WARNING

Due to the mechanization used to process above-boresight video, the radar may not see guy wires of large towers.

The desired clearance altitude is set with the terrain clearance (TER CLR) thumbwheel. The radar antenna scans vertically and is alternately offset to the right and left of the flightpath to provide the required azimuth coverage. The display presents antenna elevation scan position vertically and on an expanded range, horizontally. Vertical and horizontal scales are calibrated in degrees and nautical miles, respectively. The mileage scale is exponential, the 1-mile marker being at the center of the scope, and the remaining markers being in the right half of the indicator display. During TF operation, a test target appears on the upper right portion of the display, indicating that all radar receiver components are operating normally.

WARNING

This system can employ circular polarization to reject rain return. However, rainfall may cause excessive signal attenuation even though rain return is not seen by radar. Linear or circular polarization can be selected by the pilot.

Over calm water or flat terrain, as dry lake beds, etc, there will be little energy returned to the radar. When forward video is lost, commands will be generated by the radar altimeter. The altimeter looks only below the aircraft and cannot assure safe flight if the terrain rises sharply.

Over land the E-scope display should be monitored regularly for weak video to assure safe flight in rain and over terrain at low reflectivity.

Radar displays and operating characteristics in each mode are illustrated in figure 1–104.

Television Display (TV).

Selection of a wing pylon carrying a Walleye weapon illuminates a TV light on the radar scope and automatically relays a television picture from a closed-circuit television camera in the weapon to the radar display. The NORM/OVERRIDE switch on the indicator is assumed to be in the NORM position. The radar set, exclusive of the display, continues to operate in the mode selected (except AGR) by the radar mode selector switch. The TV display can be overridden by placing the NORM/OVERRIDE switch in the OVERRIDE position. This action restores the display of the selected radar mode. The RANGE light on the indicator indicates the range selected for the radar mode. When the Walleye weapon is locked on a target, the television display does not move. Following the launch of the Walleye, the TV presentation disappears and the selected radar mode is displayed.

TEST MONITOR CIRCUITS.

Test monitor circuits continuously monitor critical functions of the AN/APQ-126(V) radar set. Should an equipment failure occur, the test monitor circuits provide an immediate fail warning and full climb indication to the pilot. Five basic system functions are monitored; antenna elevation scan, transmitter power, receiver automatic frequency control, composite receiver-computer operation, and computer test pulse. The outputs from all five test monitor comparators must indicate safe (FAIL lamp on indicator not illuminated) before the radar set can be used for terrain following operation.

RANGE SELECTION/TARGET REJECTION.

Range selection is accomplished by pressing the range/target reject switch on the throttle. Each depression incrementally decreases the range until the 5-mile range is displayed, and then increases again to maximum range. The same switch, when pressed in the AGR mode, causes target rejection if target lock-on has occurred.

RADAR CONTROLS.

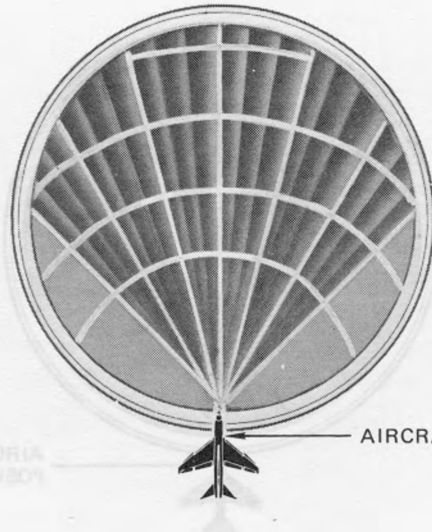
Radar controls on the indicator and associated controls are illustrated and described in figure 1–105. Refer to Section II for system turnon and pre-takeoff checks.

RADAR NIGHT FILTER.

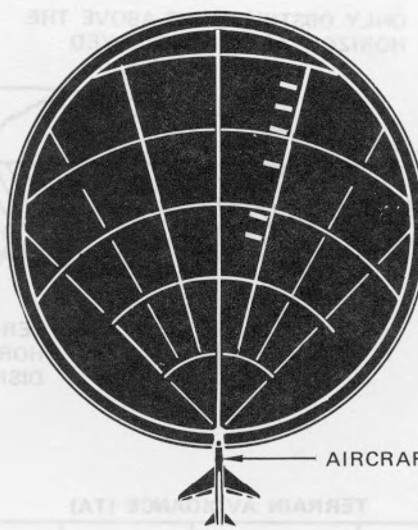
A radar night filter is provided to dim the radar display at night. The filter can be readily installed and removed. The filter clips may be adjusted to any desirable tension. However, tension required to remove the filter should be no less than three pounds in order to prevent inadvertent loss under acceleration. A storage pouch is provided for accessibility of the filter at all times.

RADAR DISPLAYS

SPOKING DISPLAY



BEACON MODE DISPLAY AND OPERATING CHARACTERISTICS



BEACON (BCN)

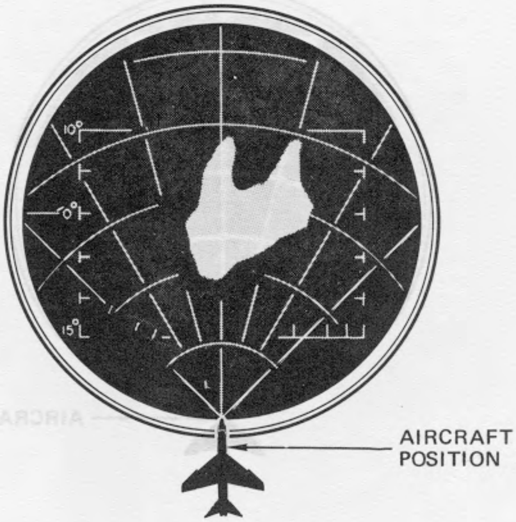
RADAR MODE SWITCH	MASTER FUNCTION SWITCH	RADAR DISPLAY	RANGE SELECTION	POLAR-IZATION	TILT AVAIL-ABLE	FREQ SELECT-ABLE	CURSORS
BCN	NONE	± 45° PPI	5, 10, 20, 40, 80	CIRC	YES +5° to −15°	NO	NONE
	LDG						

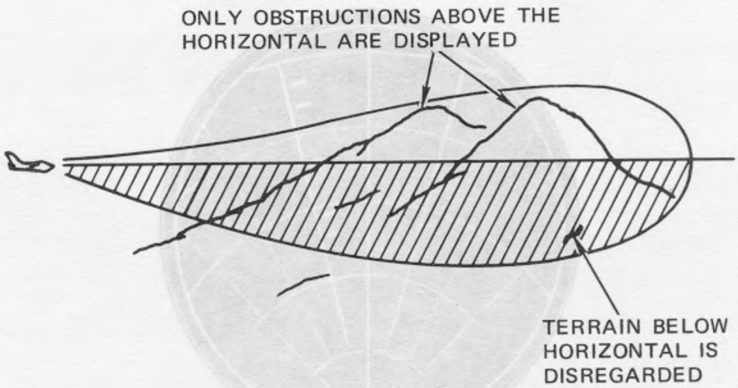
75D190(7)−01−70

Figure 1–104 (Sheet 1)

RADAR DISPLAYS

TERRAIN AVOIDANCE MODE DISPLAY AND OPERATING CHARACTERISTICS





TERRAIN AVOIDANCE (TA)

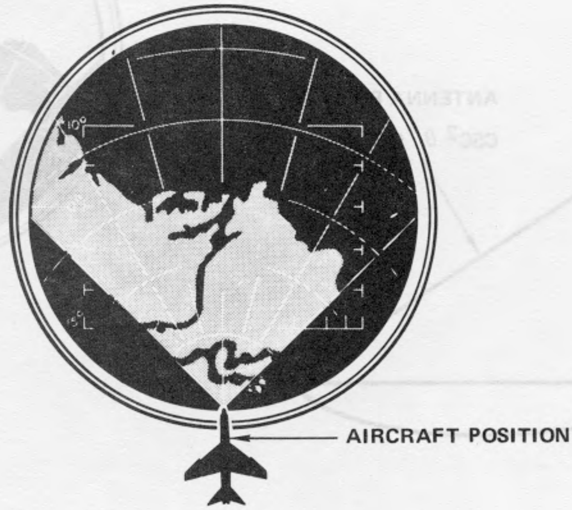
RADAR MODE SWITCH	MASTER FUNCTION SWITCH	RADAR DISPLAY	RANGE SELECTION	POLAR-IZATION	TILT AVAIL-ABLE	FREQ SELECT-ABLE	CURSORS
TA	NONE	±45° PPI	5, 10	SELECT	NO	YES	NONE
	LDG						

75D190(1)–01–70

Figure 1–104 (Sheet 2)

RADAR DISPLAYS

GROUND MAP PENCIL MODE DISPLAY AND OPERATING CHARACTERISTICS



GROUND MAP, PENCIL (GMP)

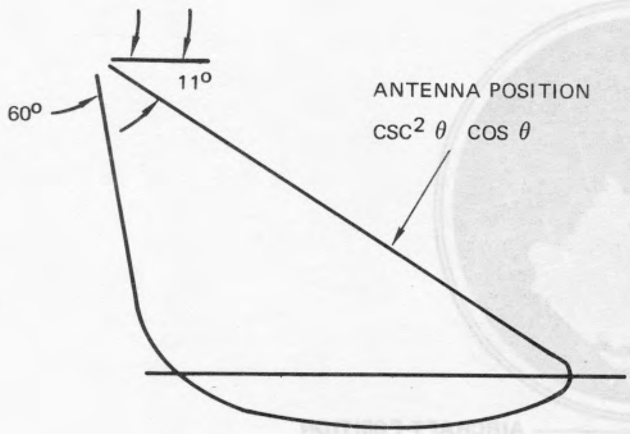
RADAR MODE SWITCH	MASTER FUNCTION SWITCH	RADAR DISPLAY	RANGE SELECTION	POLAR-IZATION	TILT AVAIL-ABLE	FREQ SELECT-ABLE	CURSORS
GMP	NONE	± 45° PPI	5, 10, 20 40, 80	SELECT	YES	YES	MANUAL RANGE
	LDG						
GMP	RADAR BOMB	± 45° PPI	5, 10, 20, 40, 80	SELECT	YES	YES	DRIVEN RANGE & AZIMUTH
TA							
BCN							
AGR							

75D190(2)–01–69

Figure 1–104 (Sheet 3)

RADAR DISPLAYS

GROUND MAP SHAPED MODE DISPLAY AND OPERATING CHARACTERISTICS



GROUND MAP, SHAPED (GMS)

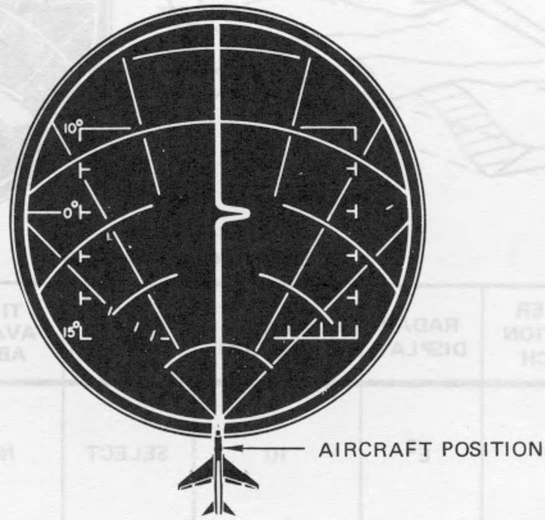
RADAR MODE SWITCH	MASTER FUNCTION SWITCH	RADAR DISPLAY	RANGE SELECTION	POLAR-IZATION	TILT AVAIL-ABLE	FREQ SELECT-ABLE	CURSORS
GMS	NONE	±45° PPI	5, 10, 20 40, 80	N/A	YES	YES	MANUAL RANGE
	LDG						
	RADAR BOMB	±45° PPI	5, 10, 20 40, 80	N/A	YES	YES	DRIVEN RANGE & AZIMUTH

75D190(3)–01–69

Figure 1–104 (Sheet 4)

RADAR DISPLAYS

AIR-TO-GROUND RANGING MODE DISPLAY AND OPERATING CHARACTERISTICS



AIR-TO-GROUND RANGING (AGR)

RADAR MODE SWITCH	MASTER FUNCTION SWITCH	RADAR DISPLAY	POLAR-IZATION	TILT AVAIL-ABLE	FREQ SELECT-ABLE	CURSORS
AGR	NONE	AGR	LINEAR	YES	NO	NONE
	LDG					
ANY	NORMAL ATTACK	AGR	LINEAR	NO	NO	NONE
	NAV BOMB *					
	RADAR BOMB OFFSET*					

*When within 10 NM radar slant range and OAP designated in radar bomb offset.

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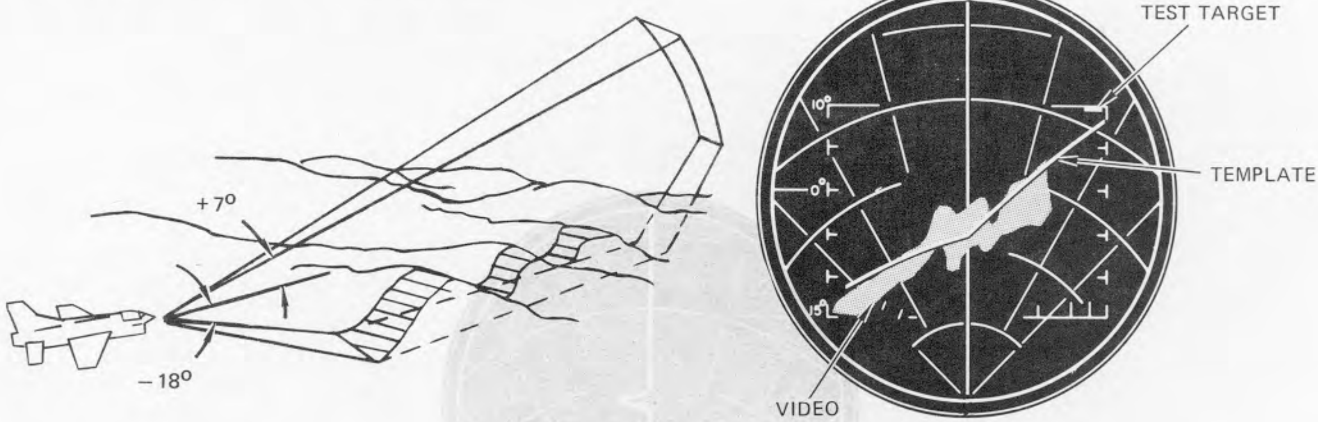
Figure 1–104 (Sheet 5)

RADAR DISPLAYS

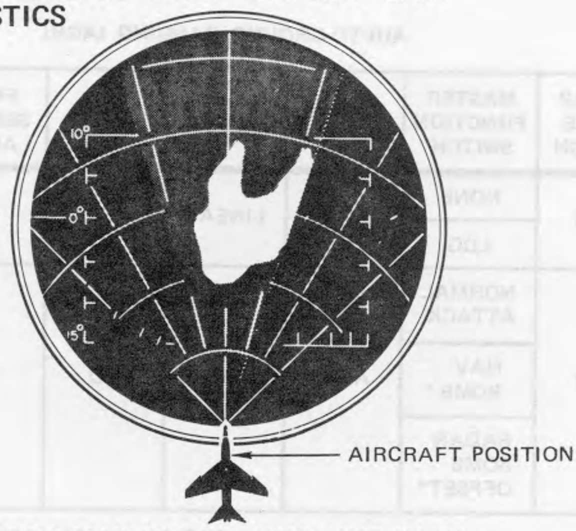
TERRAIN FOLLOWING MODE DISPLAY AND OPERATING CHARACTERISTICS



TERRAIN FOLLOWING (TF)

RADAR MODE SWITCH	MASTER FUNCTION SWITCH	RADAR DISPLAY	RANGE SELECTION	POLAR-IZATION	TILT AVAIL-ABLE	FREQ SELECT-ABLE	CURSORS
BCN	TF	E^2	10	SELECT	NO	YES	NONE
GMS							
AGR							

CROSS SCAN TERRAIN AVOIDANCE MODE DISPLAY AND OPERATING CHARACTERISTICS



CROSS SCAN TERRAIN AVOIDANCE (CSTA)

RADAR MODE SWITCH	MASTER FUNCTION SWITCH	RADAR DISPLAY	RANGE SELECTION	POLAR-IZATION	TILT AVAIL-ABLE	FREQ SELECT-ABLE	CURSORS
TA	TF	±20° PPI	5, 10	SELECT	NO	YES	NONE

75D190(5)−01−69

Figure 1–104 (Sheet 6)

RADAR DISPLAYS

CROSS SCAN GROUND MAP PENCIL MODE DISPLAY AND OPERATING CHARACTERISTICS

CROSS SCAN GROUND MAP, PENCIL (CSGMP)

RADAR MODE SWITCH	MASTER FUNCTION SWITCH	RADAR DISPLAY	RANGE SELECTION	POLAR-IZATION	TILT AVAIL-ABLE	FREQ SELECT-ABLE	CURSORS
GMP	TF	±20° PPI	5, 10	SELECT	YES	YES	MANUAL RANGE

75D190(6)-01-69

Figure 1–104 (Sheet 7)

RADAR CONTROLS AND INDICATOR

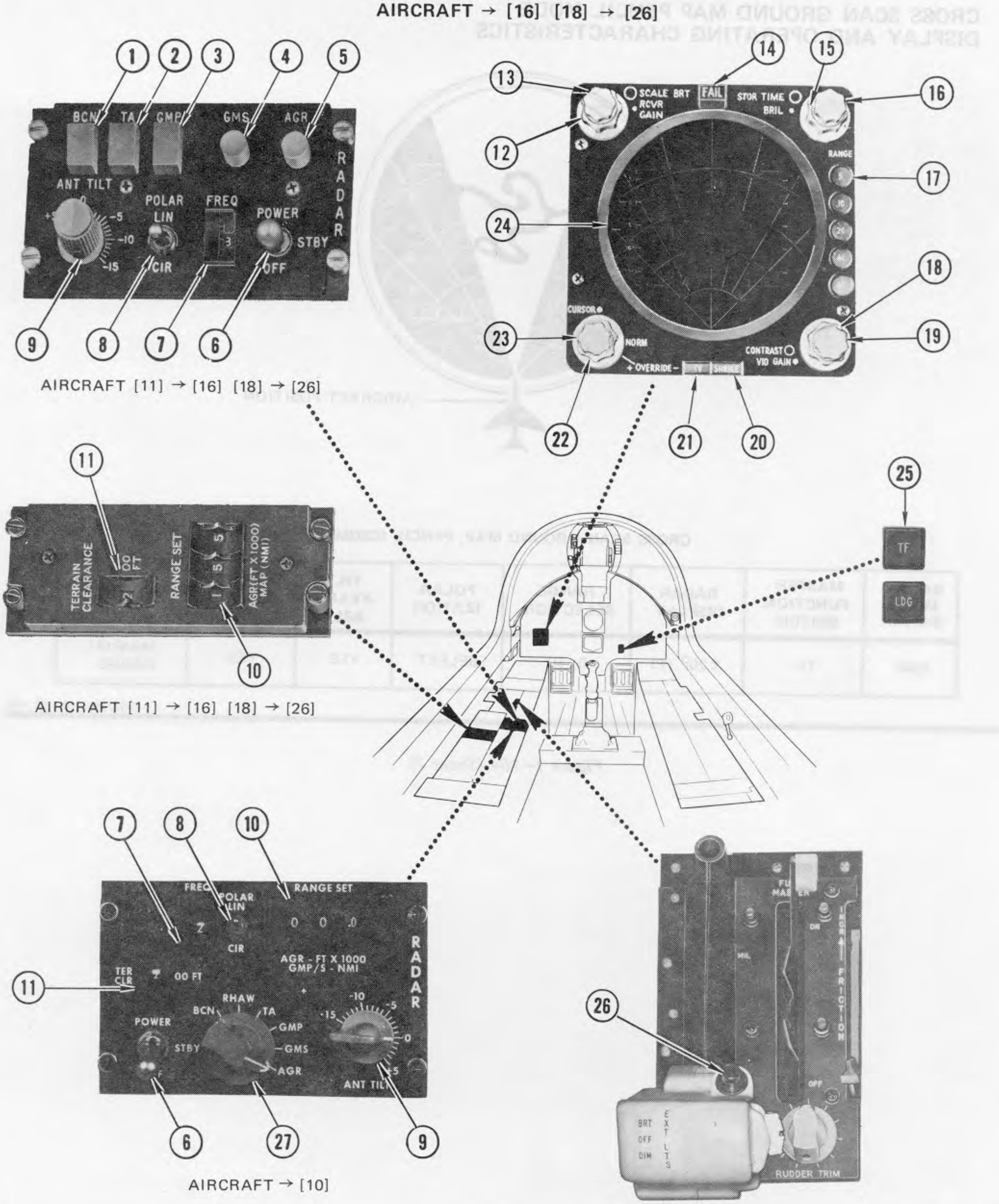
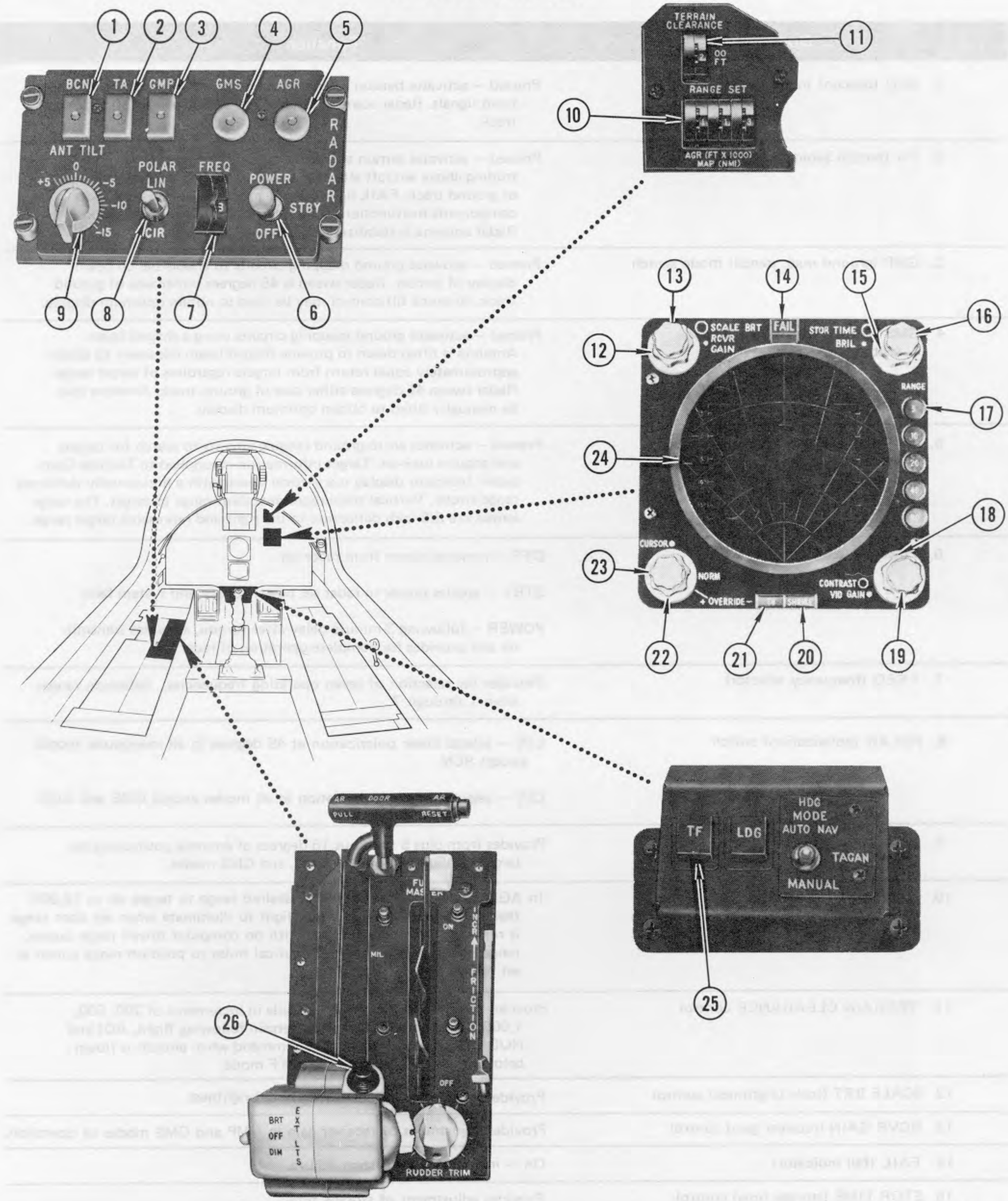


Figure 1–105 (Sheet 1)

RADAR CONTROLS AND INDICATOR

AIRCRAFT [17] [27] →



75D115(4)-10-71

Figure 1–105 (Sheet 2)

RADAR CONTROLS AND INDICATOR

Nomenclature	Function
1. BCN (beacon) mode switch	Pressed – activates beacon interrogation circuits for reception of beacon band signals. Radar scans 45 degrees either side of aircraft ground track.
2. TA (terrain avoidance) mode switch	Pressed – activates terrain avoidance circuits to detect terrain protruding above aircraft altitude. Radar sweeps 45 degrees either side of ground track. FAIL light on indicator will illuminate if radar components malfunction. Only 5- and 10-mile ranges available. Radar antenna is stabilized in pitch, roll, and drift.
3. GMP (ground map, pencil) mode switch	Pressed – activates ground mapping circuits to enable pencil beam display of terrain. Radar sweep is 45 degrees either side of ground track. Antenna tilt control may be used to obtain optimum display.
4. GMS (ground map, shaped) mode switch	Pressed – activates ground mapping circuits using a shaped beam. Antenna is tilted down to provide shaped beam necessary to obtain approximately equal return from targets regardless of target range. Radar sweep 45 degrees either side of ground track. Antenna may be manually tilted to obtain optimum display.
5. AGR (air-to-ground ranging) mode switch	Pressed – activates air-to-ground ranging circuits to search for targets and acquire lock-on. Target information is supplied to Tactical Computer. Indicator display is a vertical sweep with a horizontally deflected range strobe. Vertical trace represents slant range to target. The range strobe is a 3/8-inch deflection to the right and represents target range.
6. Power switch	OFF – removes power from radar set. STBY – applies power to radar set power supply and system fans. POWER – following 3-minute delay after turnon, activates transmitter and provides for complete operation of radar set.
7. FREQ (frequency selector)	Provides for selection of seven operating frequencies. Selection ranges from 1 through 7.
8. POLAR (polarization) switch	LIN – selects linear polarization at 45 degrees in all monopulse modes except BCN. CIR – selects circular polarization in all modes except GMS and AGR.
9. ANT TILT (antenna tilt) control	Provides from plus 5 to minus 15 degrees of antenna positioning for target highlighting in BCN, GMP, and GMS modes.
10. RANGE SET control	In AGR mode, provides setting of desired range to target up to 19,900 feet to cause HUD IN RANGE light to illuminate when set slant range is reached. In mapping mode with no computer driven range cursor, range may be set up to 19.9 nautical miles to position range cursor at set range.
11. TERRAIN CLEARANCE control	Provides selection of flight-path altitude in increments of 200, 500, 1,000, 1,500 and 2,000 feet for terrain following flight. ADI and HUD will display climb or dive command when aircraft is flown below or above preset altitude in TF mode.
12. SCALE BRT (scale brightness) control	Provides adjustment of overlay lighting brightness.
13. RCVR GAIN (receiver gain) control	Provides adjustment of receiver gain in GMP and GMS modes of operation.
14. FAIL (fail indicator)	On – indicates radar system failure.
15. STOR TIME (storage time) control	Provides adjustment of storage time.

75D115(2)–10–71

Figure 1–105 (Sheet 3)

RADAR CONTROLS AND INDICATOR

Nomenclature	Function
16. BRIL (brilliance) control	Provides adjustment of display brightness.
17. RANGE (range indicators)	Illuminated numeral indicates operating range.
18. CONTRAST (contrast) control	Provides adjustment of TV video gain.
19. VID GAIN (video gain)	Provides adjustment of radar video gain.
20. SHRIKE indicator	Not used.
21. TV indicator	On – indicates that television display is available.
22. NORM-OVERRIDE (normal-override) switch	NORM – allows TV display when available. OVERRIDE – permits overriding of TV display.
23. CURSOR control	Provides adjustment of cursor brightness.
24. Filter	Full clockwise rotation provides neutral filter for video display.
25. TF (terrain following) mode	Pressed – activates terrain following circuits. Desired clearance altitude is set with TERRAIN CLEARANCE thumbwheels. Flight information is presented on horizontal needle of the ADI, on the HUD, and on the radar display to enable pilot to maintain aircraft at a preset altitude above terrain. Antenna scans vertically and is alternately offset right and left of flight path to provide required azimuth coverage. Radar display presents antenna elevation scan position vertically and on expanded range, horizontally. The mode selector switch must be in BCN, GMS, or AGR mode. When mode selector switch is in GMP or TA, a combined mode (CSGMP or CSTA) will be provided with a display of ground map or terrain avoidance 20 degrees either side of ground track and terrain following command supplied to the horizontal needle of the attitude director (ADI) and to the HUD.
26. Range/target reject switch	Depression of switch changes ranges in indicator displayed increments. Also functions as target reject switch in AGR mode.
27. Mode select switch → [10]	BCN – same as Item 1. RHAW – not used. TA – same as Item 2. GMP – same as Item 3. GMS – same as Item 4. AGR – same as Item 5.

75D115(3)–02–78

Figure 1–105 (Sheet 4)

HEAD-UP DISPLAY (HUD), AN/AVQ-7(V).

The AN/AVQ-7(V) Head-Up Display (HUD) supplies flight information in symbolic form on a combiner glass in the pilot's forward field of view. The display is in line with the aircraft flightpath and is optically focused at infinity. Symbology is formed on the combiner glass through a series of collimating lenses.

HUD displays are available for enroute navigation, terrain following, attack, and landing phases of flight. Appropriate HUD symbology is determined by the position of the master function switches (VISUAL (NORM) ATTACK, RADAR BOMB, OFFSET, NAV BOMB, TF, and LDG). Nonselection of any master function switch results in a display of enroute navigation symbology. Depression of the TF master function switch does not appreciably change the enroute symbology except that a climb or descend indication is displayed on the HUD when the aircraft is flown below or above a preset terrain clearance. Selection of an attack mode master function switch (VISUAL (NORM) ATTACK, RADAR BOMB, NAV BOMB) causes weapon delivery symbology to be displayed on the HUD. Selection of the LDG master function switch causes landing symbology to be displayed on the HUD.

The combiner glass has two positions, forward and aft. The forward position is used for enroute navigation, the aft position for attack and landing. The aft position moves the apparent position of the display downward to align it more closely with the pilot's field of view during attack and landing. A standby reticle is provided as a backup in event of HUD failure.

A scales switch on the HUD control panel also controls portions of HUD symbology. With the switch placed in the SCALES position, the HUD displays altitude, indicated airspeed, vertical velocity, and magnetic heading.

The HUD receives power from the secondary ac and dc buses and the primary dc bus.

HUD symbology is illustrated in figure 1–106. HUD controls are illustrated in figure 1–107.

SYMBOLOGY FUNCTIONS.

Horizon And Flightpath Angle Lines.

The horizon and flightpath angle lines represent the horizon and each 5 degrees of pitch angle between plus and minus 90 degrees. Not less than two nor more than three lines are displayed in the instantaneous field of view. Positive pitch lines are solid lines and appear above the horizon line. Negative pitch lines are dashed lines and appear below the horizon line. Each line is numbered, except the horizon line. Negative pitch line numbers are preceded by a minus sign. The HUD displays aircraft pitch and roll information upon receipt of valid NAV WD Computer inputs. The flightpath angle and roll display are the same in all modes of operation.

HUD SYMBOLOGY

ENROUTE NAVIGATION AND LANDING (AIRCRAFT [51] → AND AIRCRAFT [4] → [6], [8] → [50] WITH T.O. 1A-7D-570)

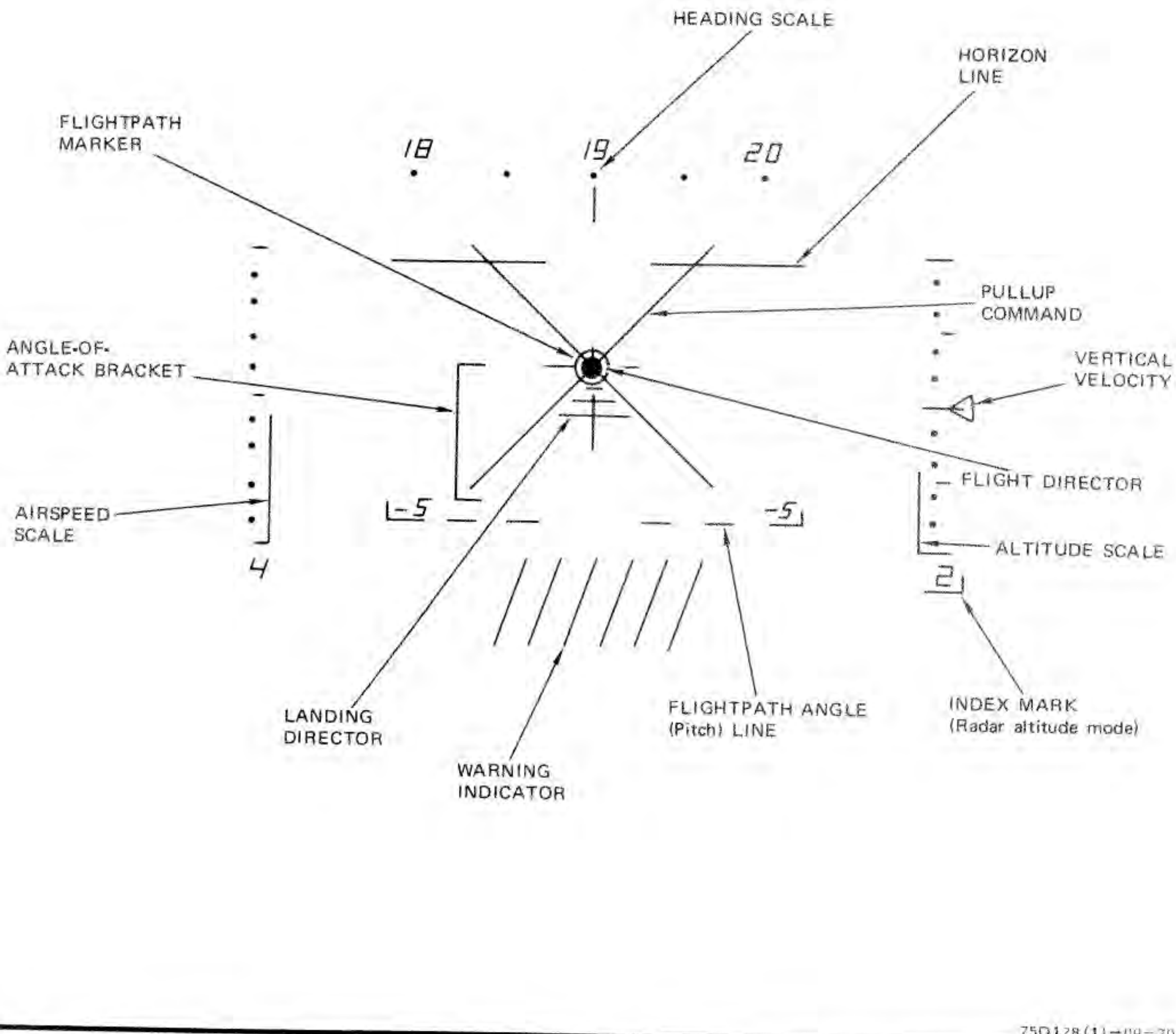
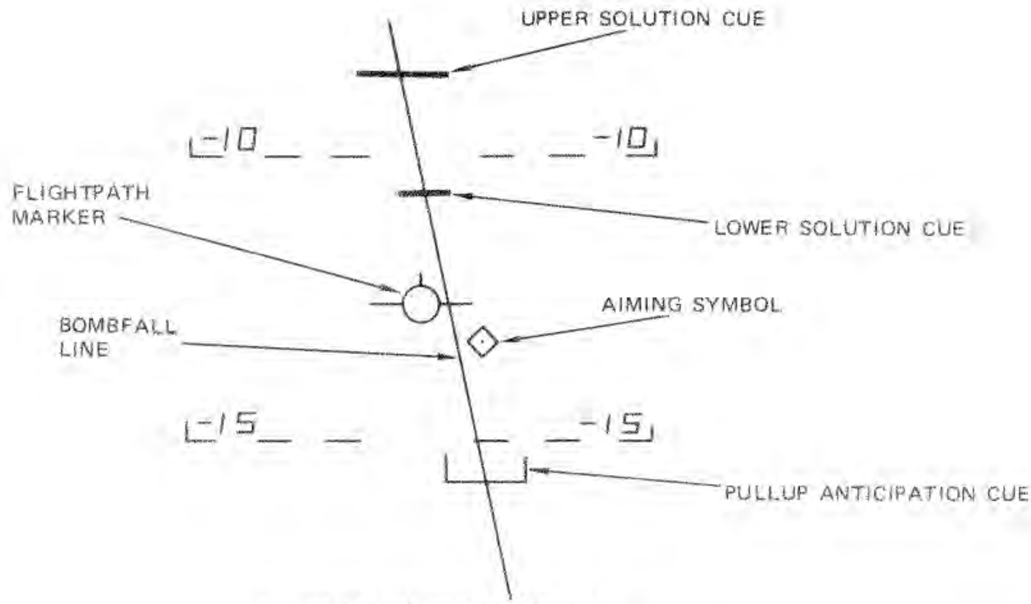


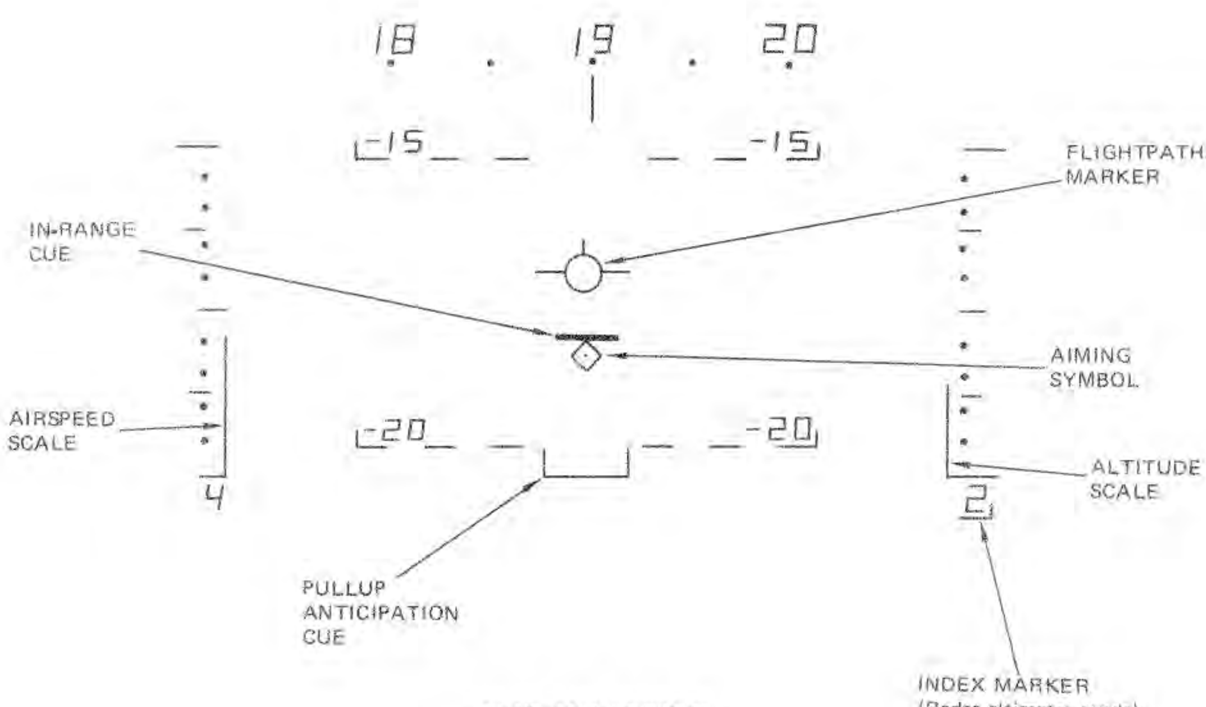
Figure 1–106 (Sheet 1)

HUD SYMBOLOGY

ATTACK MODES (AIRCRAFT [51] → AND AIRCRAFT [4] → [6], [8] → [50] WITH T.O. 1A-7D-570)



VISUAL (NORM) ATTACK MODE
(without scales)



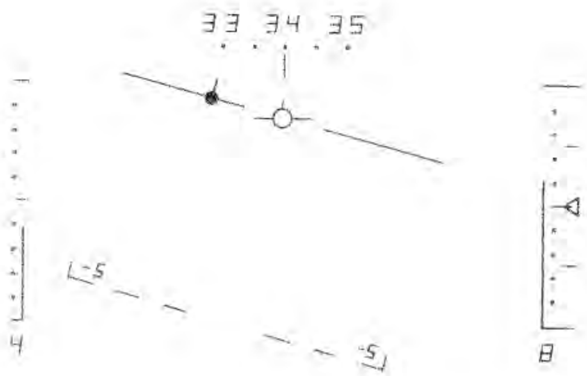
GUNS AND ROCKETS
(with scales)

75D128(2)-09-70

Figure 1–106 (Sheet 2)

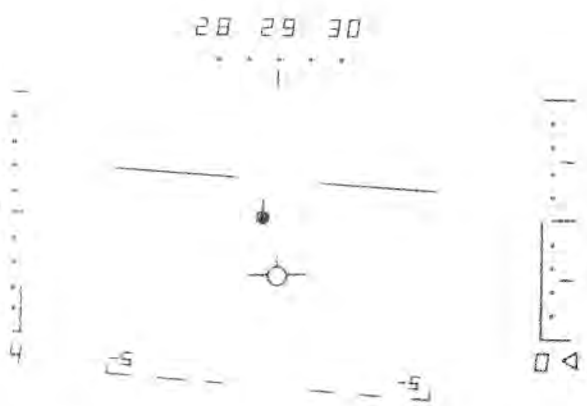
HUD SYMBOLOGY

NAVIGATION MODE (AIRCRAFT [51] → AND AIRCRAFT [4] → [6], [8] → [50] WITH T.O. 1A-7D-570)



ENROUTE NAVIGATION

1. Lateral displacement of Flight Director from FPM represents a command to turn left to correct steering error.
2. Pilot has responded by making left turn.



ENROUTE NAVIGATION WITH TERRAIN FOLLOWING

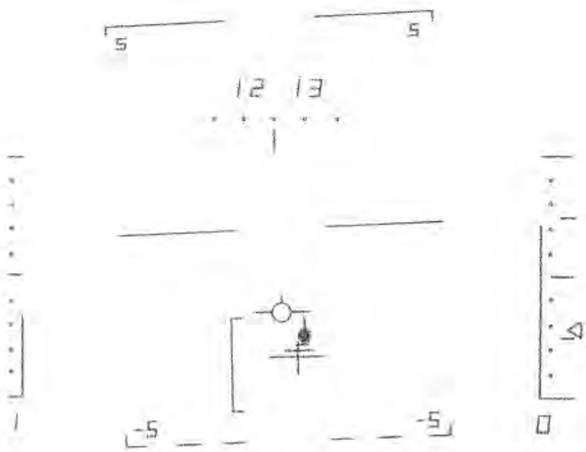
1. Lateral displacement of the Flight Director represents a command, supplied by the NWDS Computer, to turn left to correct a lateral steering error.
2. Vertical displacement of the Flight Director represents a command, supplied by the FLR, to climb to correct a vertical steering error.

75D128(3)-09-70

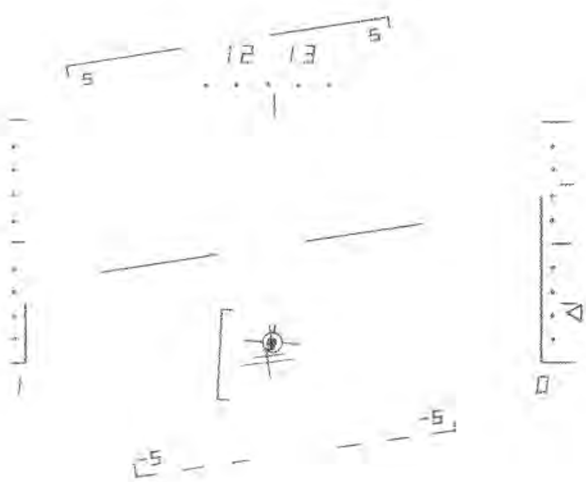
Figure 1-106 (Sheet 3)

HUD SYMBOLOGY

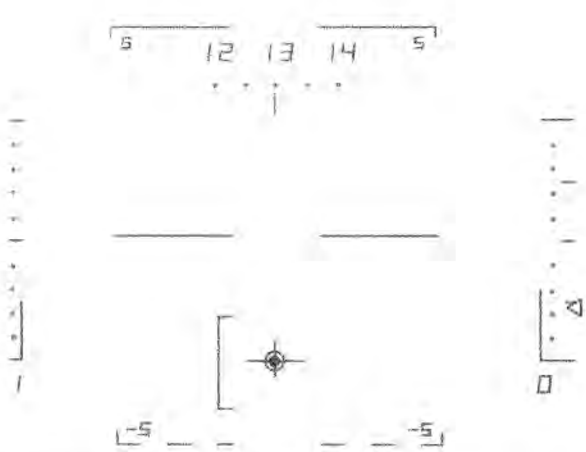
LANDING MODE (AIRCRAFT [51] → AND AIRCRAFT [4] → [6], [8] → [50] WITH T.O. 1A-7D-570)



1. Approach too flat.
2. Perspective lines indicate that aircraft is above glide slope and right of centerline.
3. Angle of attack is less than the optimum value of 17.5 units.
4. Airspeed too fast.
5. Landing Director positioned below and right of FPM represents a command to turn right and increase sink rate to effect glide path intercept.



1. Pilot responds by reducing power, increasing angle of attack and banking right.
2. Landing Director centered in the FPM indicates that the pilot has initiated the proper control movements to effect glide path intercept.
3. Perspective lines indicate that aircraft is situated above glide slope and to the right of centerline.
4. Angle of attack is approaching the optimum value of 17.5 units.



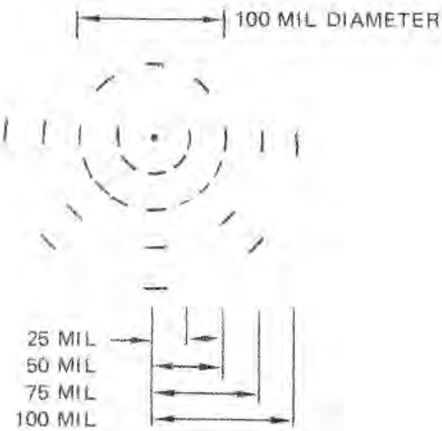
1. Aircraft is on glide path with proper sink rate.
2. Angle of attack is optimum at 17.5 units.

75D128(4)−10−73

Figure 1−106 (Sheet 4)

HUD SYMBOLOGY

STANDBY RETICLE



A standby reticle is provided as part of the HUD for munitions delivery in the event of HUD failure. The standby reticle can be used in computed and manual ripple deliveries when the NAV WD Computer is operative.

75D128(5)-09-70

Figure 1-106 (Sheet 5)

Bombfall Line.

The bombfall line, used in all computed bomb modes, is parallel to, but not necessarily coincident with, a line on the HUD which passes through the flightpath marker and the computed bomb impact point. After target designation, the bombfall line serves to provide azimuth steering error information and moves over the flightpath marker when the azimuth steering error is eliminated.

Flightpath Marker.

The flightpath marker represents the aircraft velocity vector in all modes within the capability of display on the combiner glass and is positioned by the NAV WD Computer. The velocity vector represents the point toward which the aircraft is flying at all times. When the generated information is nonvalid or if data is not present or is incorrect, the HUD automatically uses the Doppler drift angle input to position the flightpath marker in azimuth, and the angle-of-attack transducer to position the flightpath marker in elevation.

Note

At airspeeds above 0.96 IMN the flightpath marker may be displaced slightly as the NAV WD Computer reverts to a backup vertical velocity calculation. When the ADC returns to a reliable condition below 0.96 IMN, the damping of errors by the NAV WD Computer will cause the flightpath marker to oscillate at a low rate above and below the correct values for approximately 5 minutes.

Solution Cues.

Two solution cues appear at the top of the bombfall line when the aircraft flies within computer range of the target and target designation has been completed. The cues move down the bombfall line as range between target and aircraft decreases. Intersection of the lower solution cue with the flightpath marker indicates the computed weapon release point for delivery tactics other than high-angle loft. For high-angle loft delivery, the lower solution cue is bypassed with release made when the upper solution cue intersects the flightpath marker.

HEAD UP-DISPLAY (HUD) CONTROLS

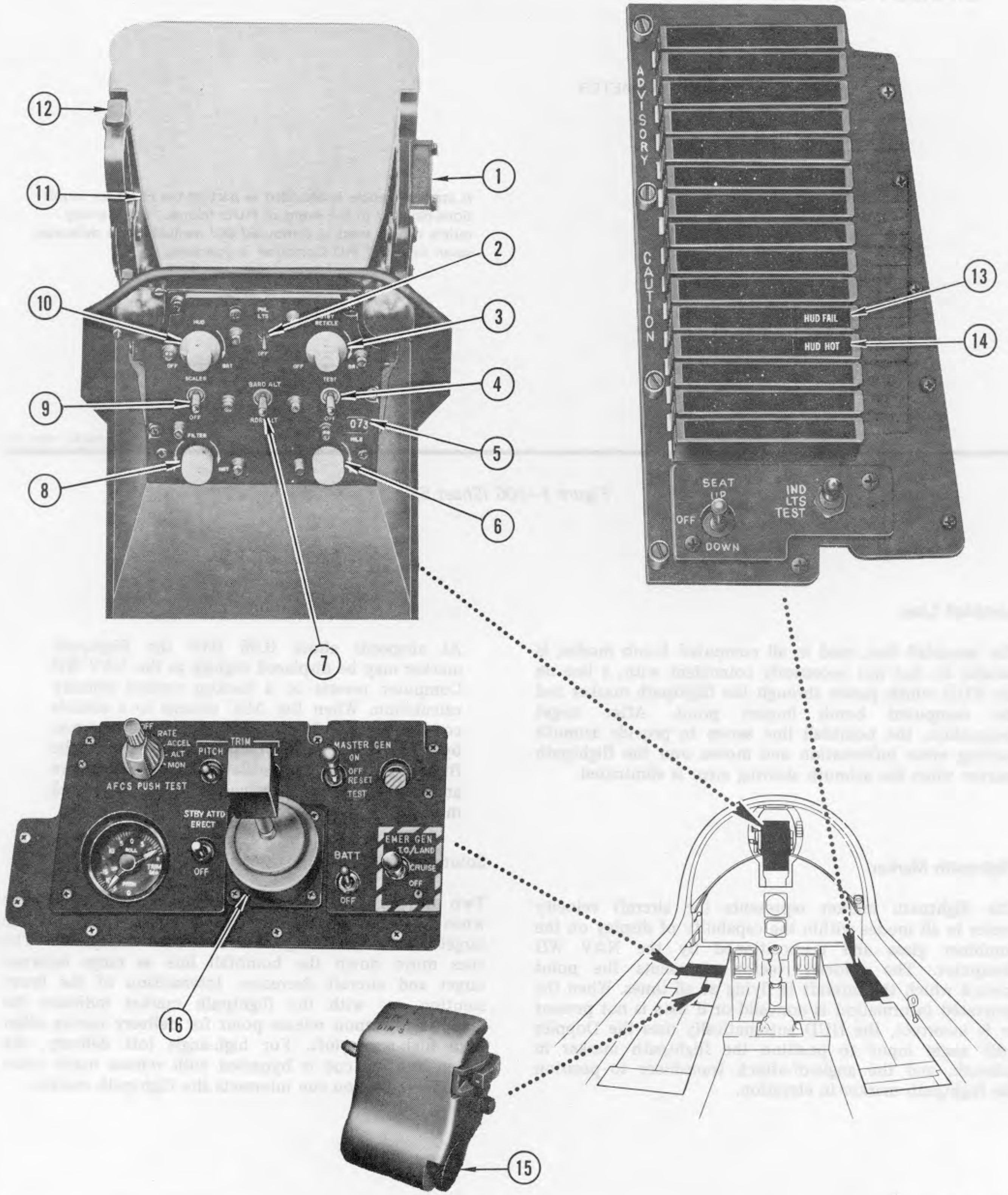


Figure 1–107 (Sheet 1)

HEAD-UP DISPLAY (HUD) CONTROLS

Nomenclature	Function
1. IN RNG indicator	On (IN RNG) – indicates when aircraft is within a preselected range of target. Range is set on the RANGE SET thumbwheel control on left console.
2. PNL LTS switch	PNL LTS – turns on HUD panel lights. OFF – turns off HUD panel lights.
3. STBY RETICLE power and brightness control	BRT – Clockwise rotation increases standby reticle brightness. OFF – full counterclockwise rotation turns off standby reticle lamps.
4. TEST switch	TEST – initiates built-in self-test. OFF – disconnects self-test.
5. MILS indicator	Indicates depression angle of standby reticle in milliradians.
6. Standby reticle depression knob	DEPR – clockwise rotation adjusts the standby reticle depression angle from zero to optical reference axis to 210 mils. Two detent positions are provided, one at the zero position and one at approximately 87 mils.
7. BARO ALT/RDR ALT switch Aircraft [51] → and aircraft [4] → [6], [8] → [50] after TCTO 1A-7D-570	BARO ALT – causes barometric altitude to be displayed on the altitude scale. RDR ALT – causes radar altitude to be displayed on the altitude scale when below 5,000 feet, and causes an index mark to be displayed to the lower right of the scale numeral.
8. FILTER knob	DAY – removes night filter from field of view. NIGHT – inserts filter in front of lens.
9. SCALES switch	SCALES – displays airspeed, altitude, vertical velocity, and heading symbology. OFF – removes scales from display.
10. HUD power and brightness control	BRT – clockwise rotation increases symbol brightness. OFF – full counterclockwise rotation turns off the HUD except for the standby reticle.
11. Combiner glass	Reflects HUD symbols from cathode ray tube into pilot's line of vision.
12. Combiner position lever	Permits fore and aft movement of combiner glass. Glass is moved toward pilot in landing mode to enable better view over aircraft nose. Position optional in other modes.
13. HUD FAIL caution light	On (HUD FAIL) – indicates HUD system failure.
14. HUD HOT caution light	On (HUD HOT) – indicates a thermal overload within the system. Continued operation under this condition will result in complete system failure.
15. Thumbwheel control (RETICLE SLEW)	Permits movement of HUD aiming symbol along bombfall line in range only.
16. Bullpup controller	Permits movement of HUD aiming symbol in range and azimuth.

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Figure 1–107 (Sheet 2)

Pullup Anticipation Cue.

The pullup anticipation cue appears at the bottom of the bombfall line during the delivery attack and moves up the bombfall line as aircraft range to the target decreases. Intersection of the pullup anticipation cue with the flightpath marker indicates an immediate pullup requirement. The pullup anticipation cue is controlled by the NAV WD Computer.

Pullup Command.

A cross, flashing 5 times per second, appears on the Head-Up Display to command an immediate pullup in attack and terrain following situations. In the attack mode, the pullup command symbol is controlled by a NAV WD Computer input. In the terrain following mode, the symbol is controlled by the Forward-Looking Radar terrain following circuit.

Flight Director.

The flight director symbol indicates horizontal and vertical steering error information in terrain following and navigation modes with respect to the flightpath marker. In terrain following, the radar positions the flight director vertically to indicate climb or dive commands and the NAV WD Computer positions the director horizontally, indicating heading steering error. In the navigation modes the NAV WD Computer positions the flight director symbol to indicate steering error.

Magnetic Heading Indicator.

Magnetic heading is displayed on a moving tape across the top of the HUD in enroute navigation and landing modes. The heading is displayed on the bottom of the HUD in the attack and terrain following modes. The heading indication is positioned by NAV WD Computer inputs and displays a total of 20 degrees of heading at any given time. On aircraft [51] → and [4] → [6] [8] → [50] after T.O. 1A-7D-570, all magnetic heading displays appear across the top of the HUD.

Landing Director.

The landing director consists of the landing director dot (identical to flight director) and three perspective lines which are displayed in the landing mode only and are positioned vertically and horizontally by raw ILS localizer and glide slope signals. On aircraft [51] → and aircraft [4] → [6] [8] → [50] after T.O. 1A-7D-570, an azimuth reference line perpendicular to and bisecting the bottom perspective line is displayed in the landing director. When the aircraft is on the proper flightpath with respect to localizer and glide slope, the landing director dot is centered within the flightpath marker and the perspective lines are all superimposed upon one another in the center of the flightpath marker. Receipt of an unreliable localizer or glide slope signal causes the HUD to remove the landing director symbol. The landing director dot is positioned by the flight director computer to indicate steering commands.

Altitude Scale and Indicator.

Barometric or radar altitude is displayed on a thermometer-type scale on the right side of the HUD. A full scale indication represents 1,000 feet. The number at the bottom of the scale indicates 1,000-foot increments. The NAV WD Computer provides barometric altitude inputs based on barometric pressure set in for the FLY TO destination. If flying to a MARK, altitude is based on a mean sea level pressure of 29.92 inches of mercury. The radar altimeter provides altitude information for modes below 5,000 feet. On aircraft [51] → and aircraft [4] → [6] [8] → [50] after T.O. 1A-7D-570, radar altitude will be displayed on the HUD only when the BARO ALT/RDR ALT switch is in the RDR ALT position. On these aircraft an index mark is displayed beneath the altitude numeric to indicate the radar altimeter mode.

During preflight checks, the altitude displayed on the HUD has a maximum allowable error of ±115 feet from field elevation when the pressure setting has been entered into the computer. When airborne with the ADC operating properly, the altitude displayed on the HUD at low altitudes and at low airspeeds may vary by a maximum of ±105 feet from that displayed on the AAU-19/A altimeter in RESET. At airspeeds above 0.20 IMN, the variance between the altitude displayed on the HUD and the AAU-19/A altimeter will increase significantly, with the HUD reading always higher than that of the AAU-19/A. Altitude readings between the HUD and the AAU-19/A altimeter in STBY may vary as much as 1,000 feet. When radar altitude is displayed below 5,000 feet (RDR ALT position), the altitude displayed will be within ±7% of the actual altitude.

Airspeed Scale and Indicator.

Indicated airspeed is displayed on a thermometer-type scale on the left side of the HUD. A full scale indication represents 100 knots. The number at the bottom of the scale indicates 100-knot increments. The Air Data Computer provides the airspeed input.

The maximum deviation in the airspeed displayed by the HUD and the Mach/Airspeed indicator is 8 knots +1.0% of the airspeed displayed on the HUD as follows:

HUD Airspeed Indicator	*Mach/Airspeed Indicator*
200 KIAS	200 (±10) KIAS
300 KIAS	300 (±11) KIAS
400 KIAS	400 (±12) KIAS
500 KIAS	500 (±13) KIAS

Vertical Velocity Indicator.

The aircraft's vertical velocity is displayed by a triangular-shaped symbol along the altitude scale. The top half of the scale represents up to 1,000 feet per minute of climbing velocity and the bottom half represents up to 1,000 feet per minute of descending velocity. The position of the vertical velocity symbol is controlled by the NAV WD Computer.

Angle-of-Attack Indicator.

The angle-of-attack indicator is a bracket positioned to the left of the flightpath marker. The indicator bracket is present in all modes but is displayed only when the angle of attack exceeds 12 units. In landing, the angle of attack is at the optimum approach value when the bracket is centered opposite the wing of the flightpath marker. When the angle of attack is too high (aircraft slow), the center of the bracket is above the wing of the flightpath marker. The angle-of-attack bracket is driven by the angle-of-attack transducer.

Note

The angle-of-attack bracket is the only display that is not a fly-to command. The pilot flies away from the center of the bracket to obtain centering of the flightpath marker. This mechanization is required due to the size of the HUD field of view.

Sideslip Indicator.

The sideslip indicator displays lateral acceleration of the aircraft in the attack mode. With a zero input, the indicator is centered on the lubber line. Inputs furnished by a lateral accelerometer displace the indicator either right or left of the lubber line, dependent upon the direction of slip. Full scale displacement of the indicator represents 0.5 lateral g. The sideslip indicator has been removed on aircraft [51] → and aircraft [4] → [6] [8] → [50] after T.O. 1A-7D-570.

Warning Indication.

The warning indicator displays a signal of critical aircraft condition in all modes. The symbology consists of six canted lines that appear at the bottom of the display in enroute, terrain following, and attack modes. The canted lines appear at the top of the display in the landing mode. The canted lines are displayed upon receipt of a signal from the master caution circuitry or the fire warning circuitry.

Note

The HUD warning symbol will not appear if the HUD TEST switch is in TEST.

Aiming Symbol.

In attack modes, a diamond shaped symbol called the aiming symbol is displayed. When an attack mode is selected, the aiming symbol is displayed within the flightpath marker and remains stationary until slewed by either the Bullpup controller or the thumbwheel controller. On aircraft [51] → and aircraft [4] → [6] [8] → [50] after T.O. 1A-7D-570, a dot is added in the center of the aiming symbol.

Standby Reticle.

The standby reticle is focused at infinity and can be depressed manually from 0 to 210 mils in elevation with respect to the aircraft datum line. Procedures for using the standby reticle are described under Navigation/Weapon Delivery System in T.O. 1A-7D-34-1-1.

HUD CAUTION PANEL LIGHTS.

The HUD HOT light on the caution panel illuminates when a thermal overload occurs in the system. If possible, the HUD system should be turned off when the light illuminates.

The HUD FAIL light on the caution panel illuminates when the built-in test equipment detects a HUD failure.

PROJECTED MAP DISPLAY SET (PMDS), AN/ASN-99A.

DESCRIPTION.

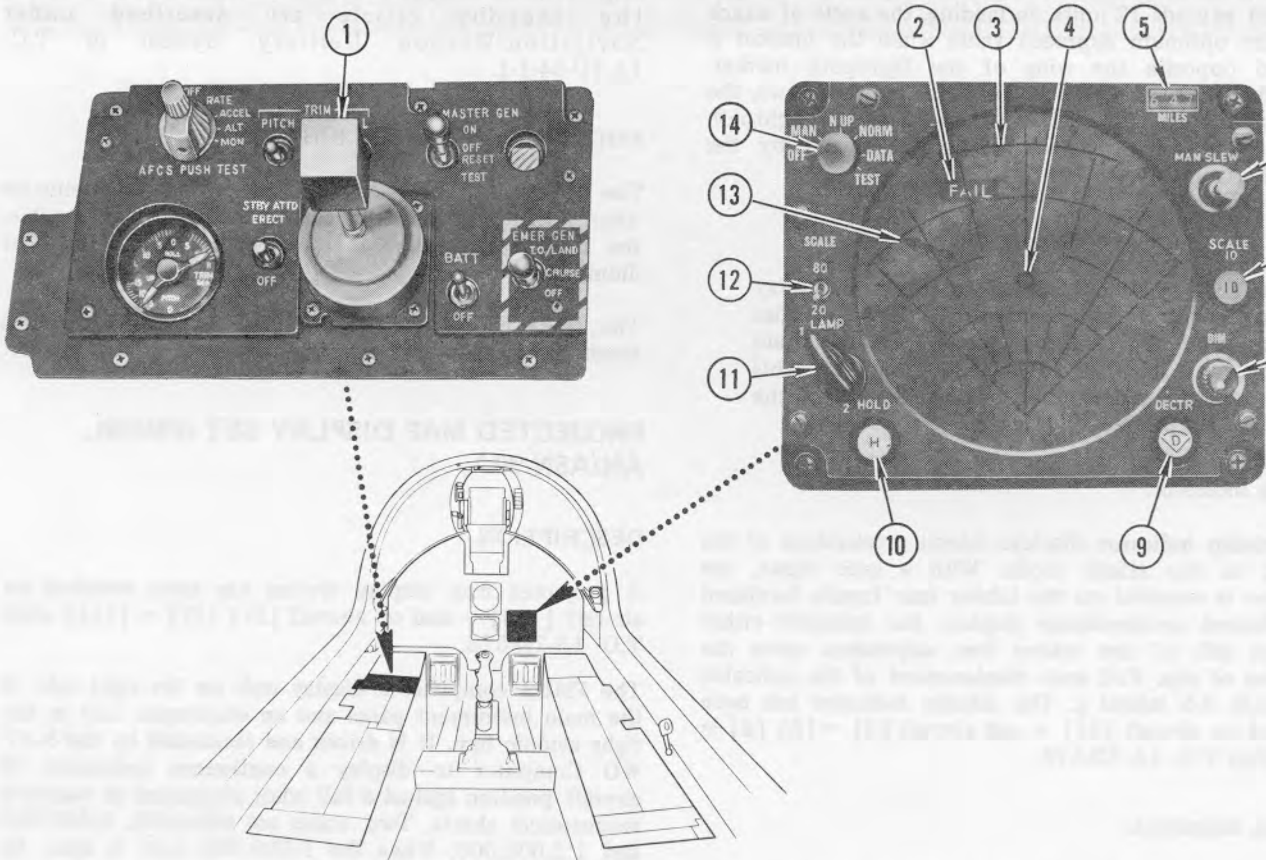
A projected map display system has been installed on aircraft [115] → and on aircraft [17] [27] → [114] after T.O. 1A-7D-578.

The PMDS comprises a display unit on the right side of the main instrument panel and an electronics unit in the right avionic bay. It is driven and controlled by the NAV WD Computer to display a continuous indication of aircraft position against a full color projection of standard aeronautical charts. Two scales are selectable, 1:500,000 and 1:2,000,000. When the 1:500,000 scale is used, an area of approximately 25 miles in diameter is visible on the screen. When in 1:2,000,000, the diameter is approximately 100 miles. In all modes except TEST and MAN, the ground track is shown by the lubber line of the grid, read against the compass rose. The destination pointer points to the selected destination or mark in all modes except TEST and MAN. Turning the aircraft to vertically align the destination pointer with the lubber line puts the aircraft ground track on course to the selected mark or destination. See figure 1–108. Zero mark or destination causes the pointer to be caged vertical.

The map display may be oriented track upward (NORM) or north upward (N UP). In NORM, the pilot can select the Decenter (DECTR) button, which causes the apex of the triangular grid to be the reference position. A distance of approximately 22 miles ahead of the aircraft can be viewed in the DECTR mode on the 1:500,000 scale.

The PMDS uses a straight line optical path without the need for mirrors. This results in an image brightness completely visible in direct sunlight. Two projection lamps are provided and are selected by a switch on the display panel. A control on the panel permits brightness to be adjusted as necessary.

PROJECTED MAP DISPLAY SET (PMDS)



Nomenclature	Function
1. Bullpup controller	Used to slew map in NORM and N UP. HOLD must be selected for map to remain at position of slew termination, except during map update.
2. FAIL indicator	When on, indicates failure in PMDS.
3. Azimuth scale	Indicates aircraft ground track under lubber line at top of display in all modes except TEST.
4. Center reference symbol	Indicates aircraft present position superimposed on map display except in NORM mode when DECTR switch is pressed.
5. MILES counter	Displays range in nautical miles to Mark or Destination.
6. MAN SLEW control	Operative only in MAN or DATA modes. Used to slew map in a direction opposite to control movement at a rate proportional to control displacement in MAN and one frame at a time in DATA.
7. SCALE 10 switch	Inoperative at this time.
8. DIM knob	Provides variable display brightness.

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Figure 1–108 (Sheet 1)

PROJECTED MAP DISPLAY SET (PMDS)

Nomenclature	Function
9. DECTR (decenter) switch/indicator	Used only in NORM. When pressed with mode selector switch in NORM causes aircraft present position to be displayed at the bottom center of the display and the aircraft ground track to be oriented at the top. When selected it is illuminated yellow. Deselection is made by pressing the switch a second time.
10. HOLD switch/indicator	When pressed causes the NAV WD Computer to hold the map in its current position and allows it to remain at the position of termination of Bullpup controller slew. When pressed, the HOLD switch/indicator is illuminated yellow. Deselection is made by pressing the switch a second time.
11. LAMP select switch	Selects either of two lamps. Used in event one burns out.
12. SCALE control	80 — places map in a scale comparable to the 80 mile radar range and selects map scale and drive speed for 1:2,000,000 map. 20 — places map in a scale comparable to the 20 mile radar range and selects map scale and drive speed for 1:500,000 map.
13. Destination pointer	Points to the magnetic bearing from the aircraft to the Destination or Mark selected on the NAV WD Computer control panel.
14. Mode selector switch	OFF — removes electrical power from PMDS. MAN — removes PMDS from control of NAV WD Computer, allows use of manual slew control to slew map display. N UP — orients map to present true north at top center of display. Aircraft present position is under center reference symbol. NORM — present position is under either reference symbol depending on position of DECTR switch with ground track shown at top center of display. DATA — automatically advances film strip to the middle of special data frames. TEST — initiates self-test function

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Figure 1–108 (Sheet 2)

Behind the screen are azimuth and bearing shadow markers. They are mounted on rotating ring gears to cast a shadow against the screen face. The markers indicate magnetic track at the top of the display and bearing to the destination as set in the NAV WD Computer. A FAIL flag will be visible on the screen in case of failure.

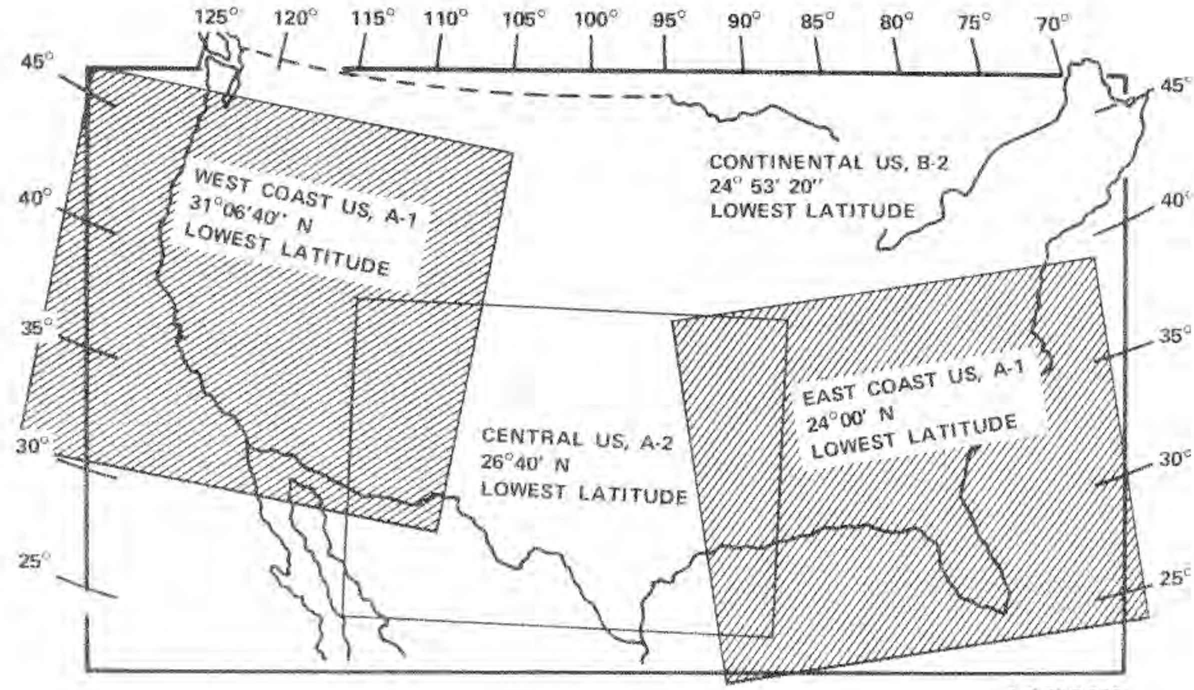
A MILES counter at the upper right corner of the front panel indicates distance to the destination or mark as set in the NAV WD Computer.

Filmstrips.

Standard aeronautical charts are cut into strips placed end to end, and photographed on 35 mm filmstrips for the PMDS. Each filmstrip contains maps of two areas. Area A is composed of two maps, one at 1:2,000,000 map scale and the other at 1:500,000, covering as nearly the same area as possible. They have the same central longitude and lowest latitude. Each row is approximately 53 miles wide. They are alternate scales, starting at the left (west) end of the filmstrip. Area B is a single map at a scale of 1:2,000,000 and is not constrained in any way by Area A. Area B may duplicate all, only a part, or none of Area A coverage. Area B is arranged in strips, approximately 220 miles wide, at the right (east) end of Area A. Area A covers approximately 800 by 950 miles and Area B covers approximately 1,500 by 2,400 miles. Continental United States map coverage is illustrated in figure 1–109.

Each row has lines at the top, bottom, and each end. The border of the map is indicated by a red line. The pilot must realize that he has run out of map when he crosses

PMDS FILMSTRIP COVERAGE



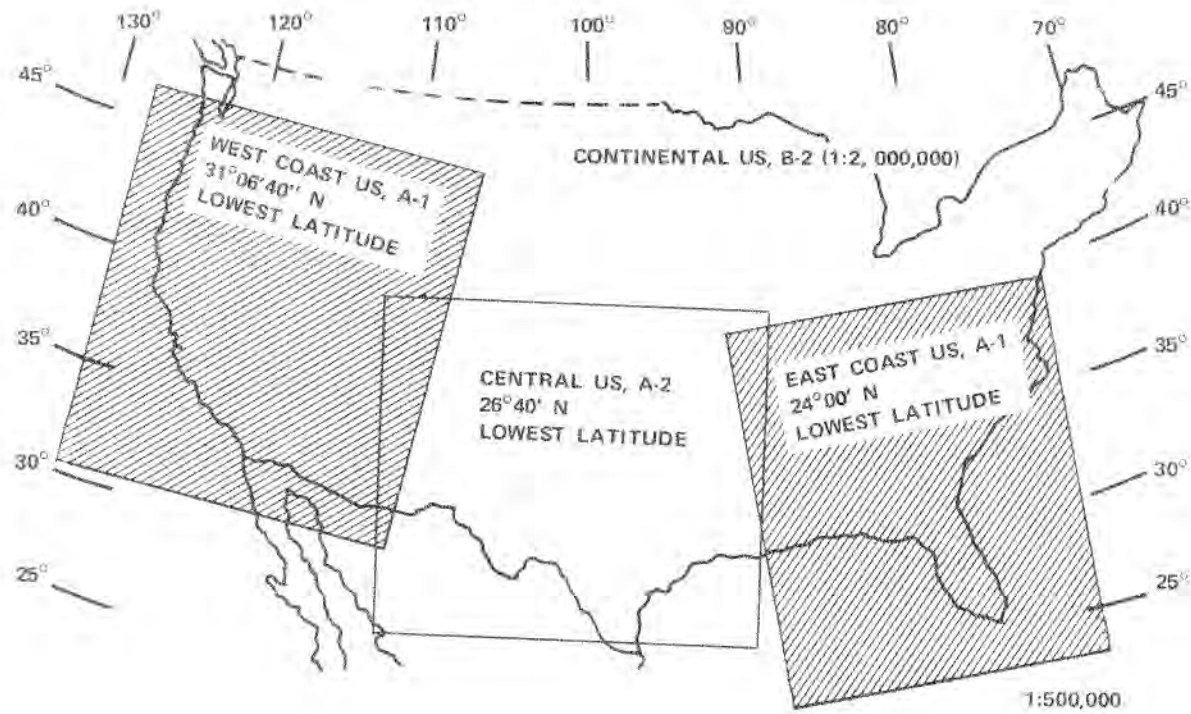


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Figure 1–109

a red line. An orange line, which appears only on the top and bottom of a row, means that an automatic shift to the next row will be made when the centered aircraft reference symbol reaches this line.

The film is on two motor-driven spools within a cassette. East-west flight is represented by film winding from one spool to the other; north-south flight, by motion of the cassette carriage; and orientation, by cassette rotation through 360 degrees. Azimuth, east-west, and north-south movement of the film is automatic.

OPERATION.

The PMDS is a subsystem of the NAV WD Computer. If the computer is inoperative, only the MAN and TEST modes will operate.

PMDS Initialization.

Each time a new NAV WD Computer program is loaded or when a filmstrip covering new areas is placed in a display unit, six constants which are displayed on the test frame must be entered into the computer by ground personnel.

Normal Operation.

The NORM position on the PMDS mode selector switch aligns aircraft ground track, as shown on the map, with the top center lubber line. The aircraft present position on the map is displayed and tracked under the center reference symbol, unless the DECTR button has been pressed, in which case the aircraft position will be displayed at the bottom center of the presentation. Latitude and longitude will appear in the NAV WD Computer display windows.

North Up Mode.

With the mode selector switch in N UP, true north is aligned at the top of the display and the map projection will be similarly oriented. The aircraft present position is under the center reference symbol and the latitude and longitude will be indicated in the NAV WD Computer windows. Destination pointer and azimuth ring are referenced to ground track as in NORM; however, reference will continue to be north up.

Data Mode.

There is a minimum of 11 data frames available on the film for future use. Selection of the DATA position results in the automatic positioning of the film to the index (center) frame.

Manual Mode.

Selection of MAN on the mode selector switch removes the PMDS from control of the NAV WD Computer and orients the display to N UP. In this mode the manual slew control can be used to slew the map presentation as desired. When NORM is again selected, the map will return to its position appropriate to controls settings.

Numbered arrows are located across the top and bottom of each row to aid slewing. Starting with 1 on the left (west) end, the numbered arrows point to the right at the top and to the left on the bottom of each row. The arrows indicate the direction the pilot must slew in order to find the next row of that map. The pilot locates the same general area on the next row by slewing until he locates the matching row arrow number.

Test Mode.

When the TEST mode is selected, the film is automatically slewed to the test frame, the miles counter will indicate 555, and the self-test function is initiated. Failure is indicated by no test frame and the FAIL flag in view. The destination pointer shall align with the test pattern's right leg, and compass rose "N" shall align with the pattern's left leg. The leg not associated with the 90-degree angle shall align upward with the lubber line (position of the center circle is not significant). "Align" means falling within the width of the leg in question at the circumference of the screen. This test will not reveal incorrect operation due to NAV WD Computer malfunction, for it is strictly PMDS-hardware oriented.

Hold Mode.

The HOLD mode allows the pilot to stop map movement and slew with the Bullpup controller. It is entered in Norm or N UP by pressing the HOLD switch/indicator which will be illuminated yellow while depressed. In this mode the map will move only when slewed by the Bullpup controller and will remain in its last position at the time of slew termination. Slew rate in this mode is at least 1 inch per second in any direction and 48 inches per second in the direction of frame advance. Deselection is made by pressing the HOLD switch/indicator a second time. When HOLD is selected and the map has been slewed by the Bullpup controller, the display windows will display the latitude-longitude under the PMDS reference symbol if the rotary mode selector is in DEST or MARK. If it is in PRES POS, the aircraft present position is displayed.

Destination/Mark Display.

The map can be made to automatically slew to and display a location stored under a destination or mark. Perform as follows:

1. Select NORM or N UP.
2. Deselect HOLD.
3. Place NAV WD Computer rotary mode selector switch in DEST or MARK.
4. Call up desired destination or mark number, causing its display.

Selection of HOLD removes the automatic slew. The pilot can select HOLD and slew from the point displayed with the Bullpup controller.

Map Destination Selection.

The pilot can change the destination stored under any number except zero. The latitude or the longitude of the new destination need not be known. Perform as follows:

1. Select NORM or N UP on PMDS.
2. Place NAV WD Computer rotary mode selector switch in DEST.
3. Select HOLD, causing display windows to illuminate.
4. Use the Bullpup controller to slew the map to the destination to be stored. Latitude-longitude of this point will appear in display windows.
5. Select destination number under which new destination is to be stored. Old destination latitude-longitude appears in display windows.
6. After viewing, if pilot decides not to destroy the old destination, he can select another destination number by selecting on the keyboard.
7. If pilot decides to store the new destination under a number entered into the computer, he presses the KEYBD pushbutton.
8. Destination change is accomplished when ENTER pushbutton is pressed.

This procedure can be used with the destination display mode automatic slew, if the destination to be stored is near a destination already stored. The stored destination can be attained by destination display and the HOLD mode selection. Follow preceding steps 4 through 8.

Map Update.

The computed aircraft position can be updated within the computer by flyover of landmarks on the map. The latitude-longitude of the landmark need not be known. Update procedures are described in Computer Update Procedures, Section I.

Switching Between Areas A and B.

When power is applied to the NAV WD Computer, Area A positions are computed.

When the 1:2,000,000 scale is selected (80 on PMDS) and the point to be displayed (selected by present position, mark, destination, or Bullpup controller slew) is out of Area A, the computer automatically switches to Area B. If the desired point is out of Area B, the display is incorrect.

If the 1:500,000 scale is selected and the desired point is out of Area A, the display is incorrect, even if the desired point is in Area B.

There is no automatic changeover from Area B to Area A. The pilot can change from Area B to Area A by selecting the 20 position. Reselecting the 80 position will cause Area A 1:2,000,000 to be displayed. The pilot can obtain a point on Area B that is not on Area A by Bullpup controller slew, mark display, destination display, or present position and switch from Area A 1:2,000,000 to Area B.

HEADING MODE AND MASTER FUNCTION SWITCH SYSTEM.

The system consists of a HDG MODE switch, six master function switches, and related relays and circuitry. The HDG MODE switch, located to the right of the HSI, controls the display of steering information on the HSI and ADI. Three display modes, AUTO NAV, TACAN, and MAN, are selectable with the HDG MODE switch. The type of display appearing on the HUD is controlled by the master function switches. Two of the master function switches control guidance mode displays (TF and LDG). The other four master function switches control attack mode displays (VISUAL (NORM) ATTACK, OFFSET, RADAR BOMB, and NAV BOMB). Refer to figure 1–106 for the appearance of any of the HUD displays.

GUIDANCE MODES.

Navigation (Enroute) Mode.

In the Navigation (Enroute) mode, lateral steering error to a selected destination is displayed on the HUD by means of a flight-director symbol, as illustrated in figure 1–106. This mode shall be in effect: (1) when no Master Function mode is selected, or (2) during the Terrain Following mode. When no Master Function mode is selected, the flight-director symbol is capable of being fixed in the FPM (Flight-Path Marker) by selection of 0 FLY TO destination or MARK. During the Terrain Following mode, the flight-director symbol is capable of being fixed in azimuth by selection of 0 FLY TO destination or MARK. The flight-director symbol is not displayed when a computed attack mode is selected, but navigational computations by the NAV WD Computer are continued.

Note

With no master function switch pressed, and regardless of the position of the HDG MODE switch, the HUD is in the navigation mode and enroute HUD symbology is displayed.

Auto Nav Mode.

The AUTO NAV mode provides range and steering information for display on the HSI and ADI. It is the guidance mode utilized when in any navigation mode provided by the Navigation/Weapon Delivery System. In AUTO NAV, the aircraft is flying toward a selected earth coordinate rather than a fixed ground station.

Selecting AUTO NAV with the HDG MODE switch causes range to selected destination on the NAV WD Computer to be displayed on the HSI. Relative bearing to destination is presented on HSI bearing pointer No. 1. Relative ground track is presented on HSI bearing pointer No. 2. A NAV WD Computer reliable indication (ADI vertical pointer flag stowed out of view) and lateral steering error are presented on the ADI if the LDG (ILS) mode is not engaged.

Tacan Mode.

The TACAN mode is selected by placing the HDG MODE switch in the TACAN position and selecting a TACAN frequency. Steering commands to maintain the selected TACAN radial are furnished by the Flight Director Computer to the ADI bank steering bar (vertical pointer). Bearing to a selected TACAN station is presented on HSI bearing pointer No. 1. The HSI range indicator displays line-of-sight range to the selected TACAN station or to cooperating aircraft (another aircraft equipped with air-to-air TACAN) when in the A/A mode. The HSI course deviation bar presents course displacement right or left of the TACAN radial. Bearing to the ADF station is presented on HSI bearing pointer No. 2.

If range information is unreliable, a flag appears on the HSI range window. If the TACAN course deviation signal is of insufficient strength, a red course deviation bar flag appears.

Manual Heading Mode.

Manual heading mode permits the pilot to select any heading and receive steering commands required to manually turn to and maintain the heading. The desired heading is selected by adjusting the position of the HSI heading marker by rotating the HEADING SET knob. The mode engages when the HDG MODE switch is placed in MAN. Steering commands from the Flight Director Computer are presented on the ADI bank steering bar (vertical pointer). TACAN station bearing and distance, and ADF bearing information continue to be displayed when the pilot switches to manual heading mode. The HSI course deviation bar is inoperative and centered, and the course bar flag is out of view.

Terrain Following Mode.

The terrain following (TF) mode provides forward looking radar pitch steering commands which are displayed on the ADI and on the HUD. The TF master function switch affects only the horizontal pointer and horizontal pointer flag indications on the ADI and has no effect on HSI indications. Other ADI and HSI displays (such as steering and range) are dependent upon the position of the HDG MODE switch. The TF mode is initiated by momentarily pressing the TF master function switch. The light behind the switch comes on green to indicate TF mode operation. The Head-Up Display for the terrain following mode is presented in figure 1–106.

Landing Mode (ILS).

The landing (LDG) mode provides Flight Director Computer and Instrument Landing System (ILS) localizer and glideslope steering commands and raw deviation information. The LDG mode is initiated by momentarily pressing the LDG master function switch. The light behind the switch comes on to indicate LDG mode operation. After selection of an ILS frequency, steering commands are fed from the Flight Director Computer to the horizontal and vertical pointers of the ADI and to the HUD flight director symbol. Raw glideslope deviation is provided on the HUD landing perspective lines and the ADI glideslope displacement indicator. Raw deviation from the ILS localizer beam is displayed on the HUD landing perspective lines and the course deviation bar of the HSI. The Head-Up Display for the landing mode is presented in figure 1–106.

ATTACK MODES.

Four pushbutton switches, located below and to the left of the HSI, control the attack modes used in weapon delivery. The attack modes are: visual (normal and normal offset bomb, guns, and rockets); radar (radar bomb and radar offset bomb); navigation bomb; and manual. Manual release of weapons requires the use of the standby aiming reticle on the HUD.

Visual modes are used to fire guns and rockets and deliver bombs with visual designation on target or on Offset Aiming Point (OAP) known with respect to the target. Radar modes provide for limited all-weather attacks against targets designated from radar data. The navigation mode is a "bomb on cooordinates" type mode, and the manual mode is a backup mode to be used at pilot option or in the event of computed mode failure.

Only a brief description of the attack modes is presented in the following paragraphs and in the Head-Up Display writeup. Detailed information on the attack modes is presented in the A-7D Nonnuclear Munitions Delivery Manual, T.O. 1A-7D-34-1-1.

Normal Bomb Mode.

The normal (visual) bomb mode is the primary weapon delivery mode for the aircraft. Target identification and acquisition are accomplished visually, and steering cues to the computed solution are provided on the HUD, with weapon release occurring automatically. The mode is entered by pressing the VISUAL (NORM) ATTACK pushbutton. Appropriate armament switches must also be set up in preparation for the attack.

As the visual bomb mode is initiated, the attack symbology is presented on the HUD. The pilot's selection of station(s) feeds weapon type inputs to the NAV WD Computer.

Normal Offset Bomb Mode.

Offset bombing is used to attack a target that is not visible but is located close enough to a prominent landmark that can be used as an identification point. The pilot enters the range from OAP to target, the bearing, and the altitude difference between the OAP and the target into the NAV WD Computer. The mode is entered by pressing the VISUAL (NORM) ATTACK and OFFSET switches.

Radar Bomb Mode.

The pilot presets the target coordinates of the destination into the Tactical Computer. When within radar mapping range, the RADAR BOMB attack switch is pressed. This places the radar in the ground map mode. When the target is sighted on the indicator, the pilot slews the cursors with the Bullpup control handle until the cursors overlay the target. After designation, the cursors become ground stabilized and the HUD displays steering error to the release point. (With AUTO NAV selected on the heading mode switch, the ADI displays the same steering error as the HUD.) The pilot may refine the cursors with the Bullpup controller.

Radar Offset Bomb Mode.

If the target does not show up on radar, but is located near a reflective terrain or cultural feature, radar offset may be used. The range from OAP to target, the bearing, and the altitude difference between the OAP and target must again be preset into the NAV WD Computer.

Navigation Bomb Mode.

The NAV BOMB mode is a computerized "navigate to target and release" type of delivery sometimes referred to as "bomb on coordinates". The target latitude and longitude are entered into the NAV WD Computer and stored as a normal destination. The HUD symbology displayed when this mode is selected is identical to that displayed in the visual mode after target designation. This mode is primarily intended for use with precision navigation aids such as LORAN (future). More accurate delivery can be accomplished if target altitude and mean sea level pressure are preset into the computer. Terrain following may be flown enroute to the target; however, NAV BOMB must be selected before reaching the target.

Manual Mode.

The manual mode of weapon delivery compasses the firing of all guns and rockets and the delivery of bombs in a situation in which an electrical failure of portions of the NAV WD Computer eliminates the use of one or all of the computed modes. The manual mode also permits the pilot a choice of this type of delivery. The manual mode is initiated by not selecting a computed mode. The pilot must turn on the standby reticle of the HUD. Retention of HUD symbology, including SCALES presentation, is optional. The standby reticle is set as required from the bombing tables for the desired type of manual delivery. Weapon release occurs immediately when the armament release switch is pressed.

CONTROLS.

Heading Mode and Master Function controls are illustrated and described in figure 1–110.

ATTITUDE DIRECTOR INDICATOR (ARU-21/A).

The Attitude Director Indicator (ADI) displays heading, attitude, rate of turn, slip, glideslope deviation, and pitch and bank information and failure indications. Included in the ADI are an attitude and azimuth sphere, pitch and bank steering bars, rate of turn and slip indicators, displacement pointer, a miniature aircraft, warning flags, and a pitch trim knob. The attitude sphere displays pitch, bank, and heading in relation to the miniature aircraft. Signals for pitch, bank, and heading display are provided by the Inertial Measurement Set, and the other displays are controlled by the NAV WD Computer system, turn rate gyrotransmitter, the APQ-126 radar, or the Flight Director Computer.

The ADI is powered by the inverter bus.

The instrument is illustrated and all functions described in figure 1–111.

HORIZONTAL SITUATION INDICATOR (AQU-6/A).

The Horizontal Situation Indicator (HSI) is presented in figure 1–112. The Horizontal Situation Indicator (HSI), located on the instrument panel, displays course, heading, distance, and bearing information. The indicator provides selected course outputs to the TACAN and Flight Director Computer, and selected heading to the Automatic Flight Control System and the Flight Director Computer.

Integral parts of the HSI include a compass card, course and heading set knobs, course arrow, to-from indicator, lubber lines, two bearing pointers, course deviation indicator and scale, range indicator, a course selector window, warning flags, and an aircraft symbol.

HEADING MODE AND MASTER FUNCTION CONTROLS

AIRCRAFT → [16] [18] → [26]

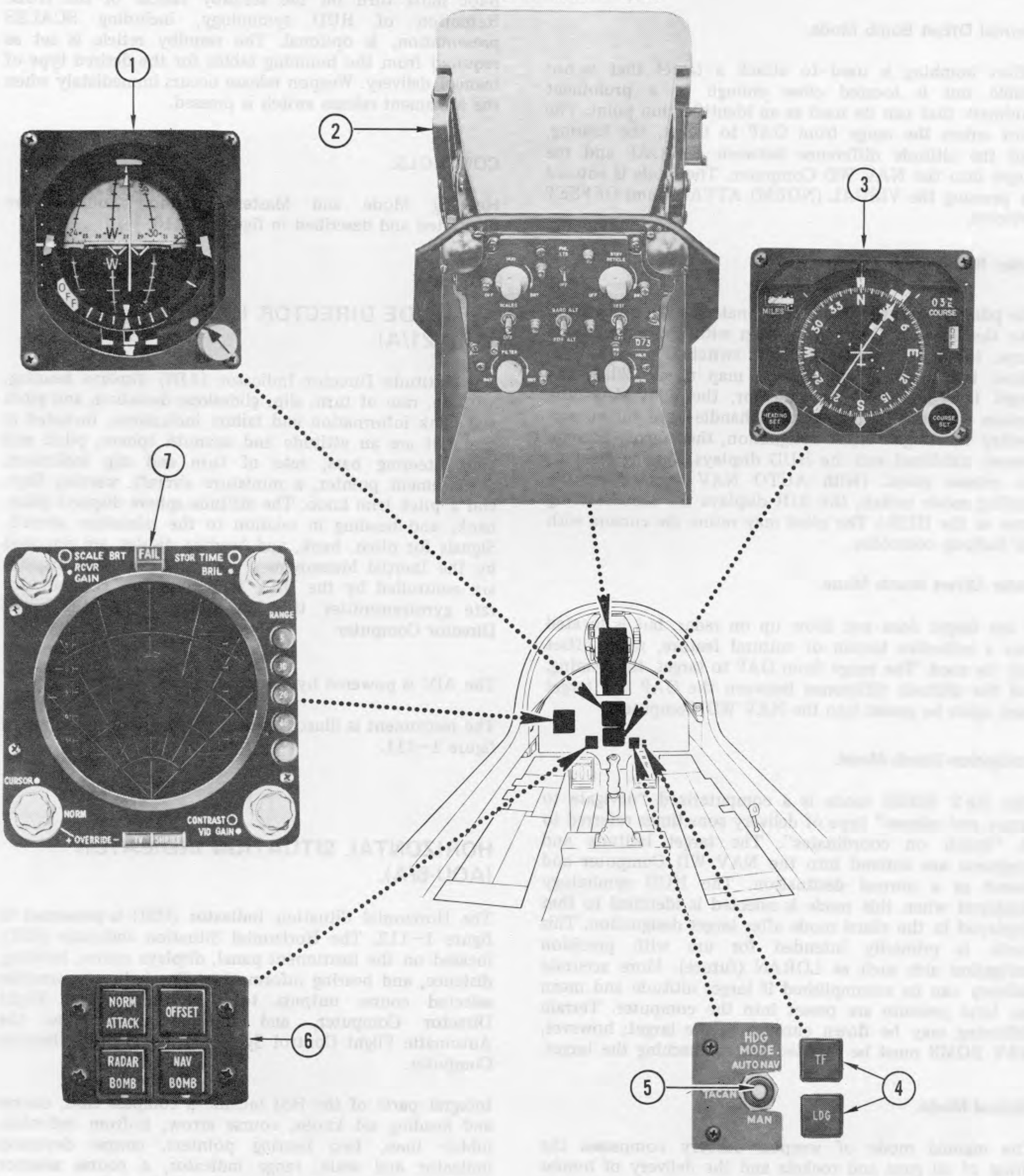
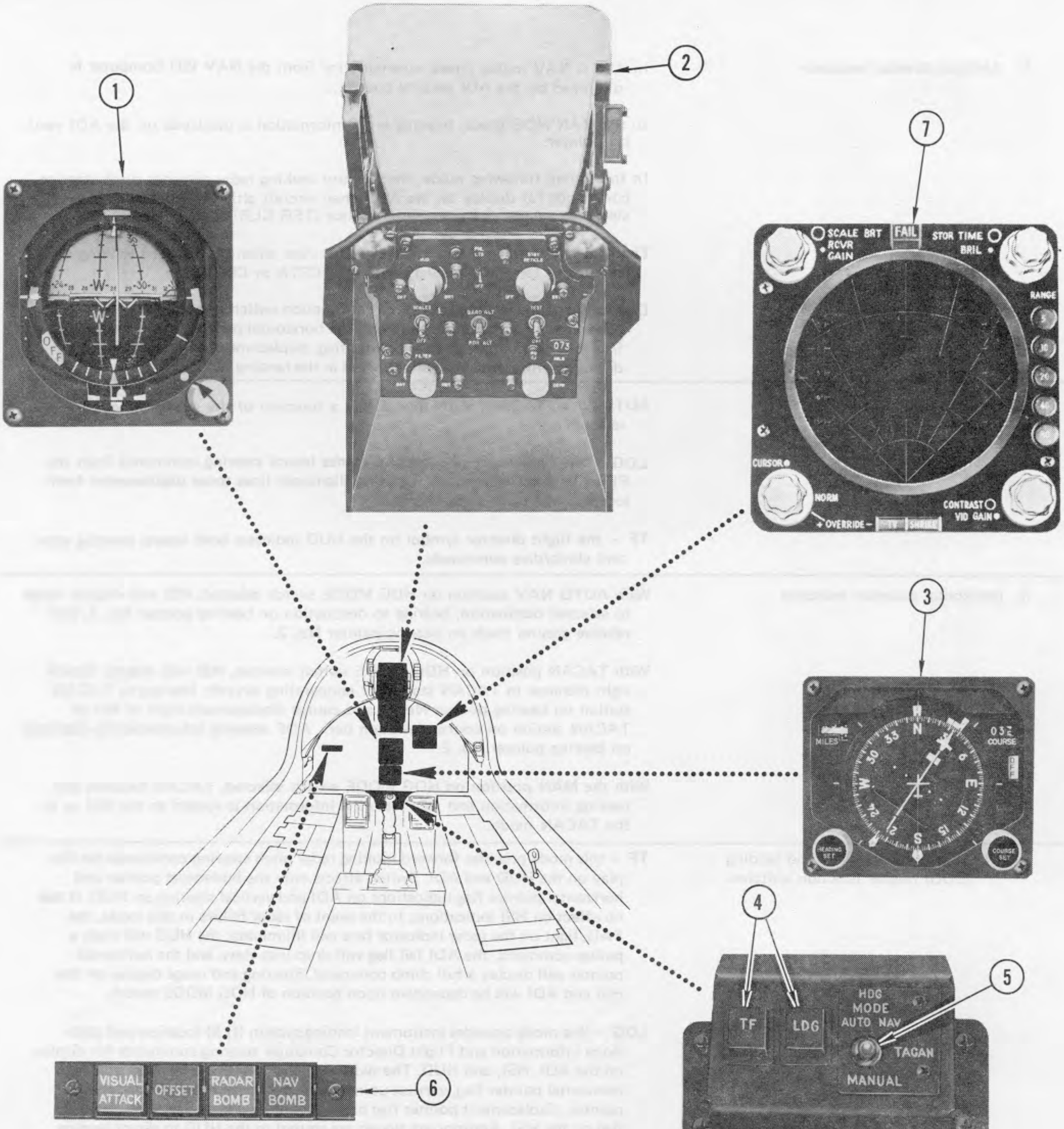


Figure 1−110 (Sheet 1)

HEADING MODE AND MASTER FUNCTION CONTROLS

AIRCRAFT [17] [27] →



75D124(4)–09–70

Figure 1–110 (Sheet 2)

HEADING MODE AND MASTER FUNCTION CONTROLS

Nomenclature	Function
1. Attitude director indicator	In AUTO NAV mode, lateral steering error from the NAV WD Computer is displayed on the ADI vertical pointer. In the MAN HDG mode, heading error information is displayed on the ADI vertical pointer. In the terrain following mode, the forward looking radar provides pitch steering commands for display on the ADI when aircraft altitude is below or above clearance values set by terrain clearance (TER CLR) thumbwheels. The ADI horizontal pointer flag drops into view when the forward looking radar fails in any terrain following mode (TF, CSTA or CSGMP). Depression of the landing (LDG) master function switch provides localizer and glideslope information on the ADI. The horizontal pointer, horizontal pointer flag, vertical pointer, vertical pointer flag, displacement pointer, and displacement pointer flag are affected in the landing mode.
2. Head-up display (HUD)	AUTO NAV, TACAN, MAN modes – is a function of the master function mode selected only. LDG – the flight director symbol provides lateral steering commands from the Flight Director Computer. Landing flightpath lines show displacement from localizer and glide slope beams. TF – the flight director symbol on the HUD indicates both lateral steering error and climb/dive commands.
3. Horizontal situation indicator	With AUTO NAV position on HDG MODE switch selected, HSI will display range to selected destination, bearing to destination on bearing pointer No. 1, and relative ground track on bearing pointer No. 2. With TACAN position on HDG MODE switch selected, HSI will display line-of-sight distance to TACAN station or cooperating aircraft, bearing to TACAN station on bearing pointer No. 1, and course displacement right or left of TACAN station on course deviation bar. ADF steering information is displayed on bearing pointer No. 2. With the MAN position on HDG MODE switch selected, TACAN distance and bearing information and ADF steering information is routed to the HSI as in the TACAN mode.
4. Terrain following (TF) and landing (LDG) master function switches	TF – this mode provides forward looking radar pitch steering commands for display on the HUD and ADI. Switch affects only the horizontal pointer and horizontal pointer flag indications on ADI and vertical steering on HUD. It has no effect on HSI indications. In the event of radar failure in this mode, the FAIL light on the radar indicator face will illuminate, the HUD will flash a pullup command, the ADI fail flag will drop into view, and the horizontal pointer will display a full climb command. Steering and range display on the HSI and ADI will be dependent upon position of HDG MODE switch. LDG – this mode provides instrument landing system (ILS) localizer and glide slope information and Flight Director Computer steering commands for display on the ADI, HSI, and HUD. The switch affects only the horizontal pointer, horizontal pointer flag, vertical pointer, vertical pointer flag, displacement pointer, displacement pointer flag on ADI and the course deviation bar and flag on the HSI. Appropriate signals are routed to the HUD to direct landing symbol movement in this mode. Other ADI and HSI displays are dependent upon the position of the HDG MODE switch.

75D124(2)–10–69

Figure 1–110 (Sheet 3)

HEADING MODE AND MASTER FUNCTION CONTROLS

Nomenclature	Function
5. Heading mode (HDG MODE) switch	AUTO NAV – provides range and steering information to destination on the ADI and HSI. Relative bearing to destination is displayed on bearing pointer No. 1, relative ground track is displayed on bearing pointer No. 2, and distance to destination is displayed on HSI range indicator. NAV WD computer reliable indication and lateral steering error are displayed on ADI if LDG (ILS) mode is not engaged. TACAN – provides HSI with TACAN station bearing information on bearing pointer No. 1, course displacement right or left of TACAN station on the course deviation bar, and distance information from station or cooperating aircraft. Selected ADF station bearing is displayed on HSI bearing pointer No. 2. A course deviation bar flag appears when TACAN course deviation signal is not of sufficient strength to indicate accurate course. If range information from TACAN is unreliable, distance flag will be displayed. MAN – provides TACAN station distance, TACAN station bearing and ADF bearing information on HSI. Heading error information is displayed on ADI vertical pointer. ADI vertical pointer is fully deflected until within approximately 10 degrees of selected heading. HSI course deviation bar inoperative and zeroed, and course bar flag is out of view.
6. Master function attack mode switches	VISUAL (NORM) ATTACK – when depressed and after target designation, provides steering commands on HUD. OFFSET – can be pressed in conjunction with NORM ATTACK or RADAR BOMB to provide capability to bomb nonvisible target using visible offset aiming point. After designation of aiming point, HUD displays steering error. RADAR BOMB – when depressed provides PPI display and radar cursors for target location refinement. Cursors become ground stabilized after designation. HUD displays steering error. Cursor aiming refinement accomplished with Bullpump controller or thumbwheel. NAV BOMB – with target coordinates preset into computer, a "navigate to target and release" capability is provided. Primarily a computerized mode with NAV WD Computer delivering steering information to HUD and HSI. HUD Symbology is identical to that displayed in NORM ATTACK mode after target designation. Terrain following may be flown enroute to target but NAV BOMB must be selected before reaching target.
7. Forward looking radar	Used in enroute navigation and target attack. In the event of radar failure in the TF, CSTA, or CSGMP mode, the FAIL light on the indicator face will illuminate, the HUD will flash a pullup command, the ADI horizontal pointer flag will drop into view and a full pullup command will be displayed by the horizontal pointer of the ADI. Used for target or OAP refinement and designation in radar attack modes.

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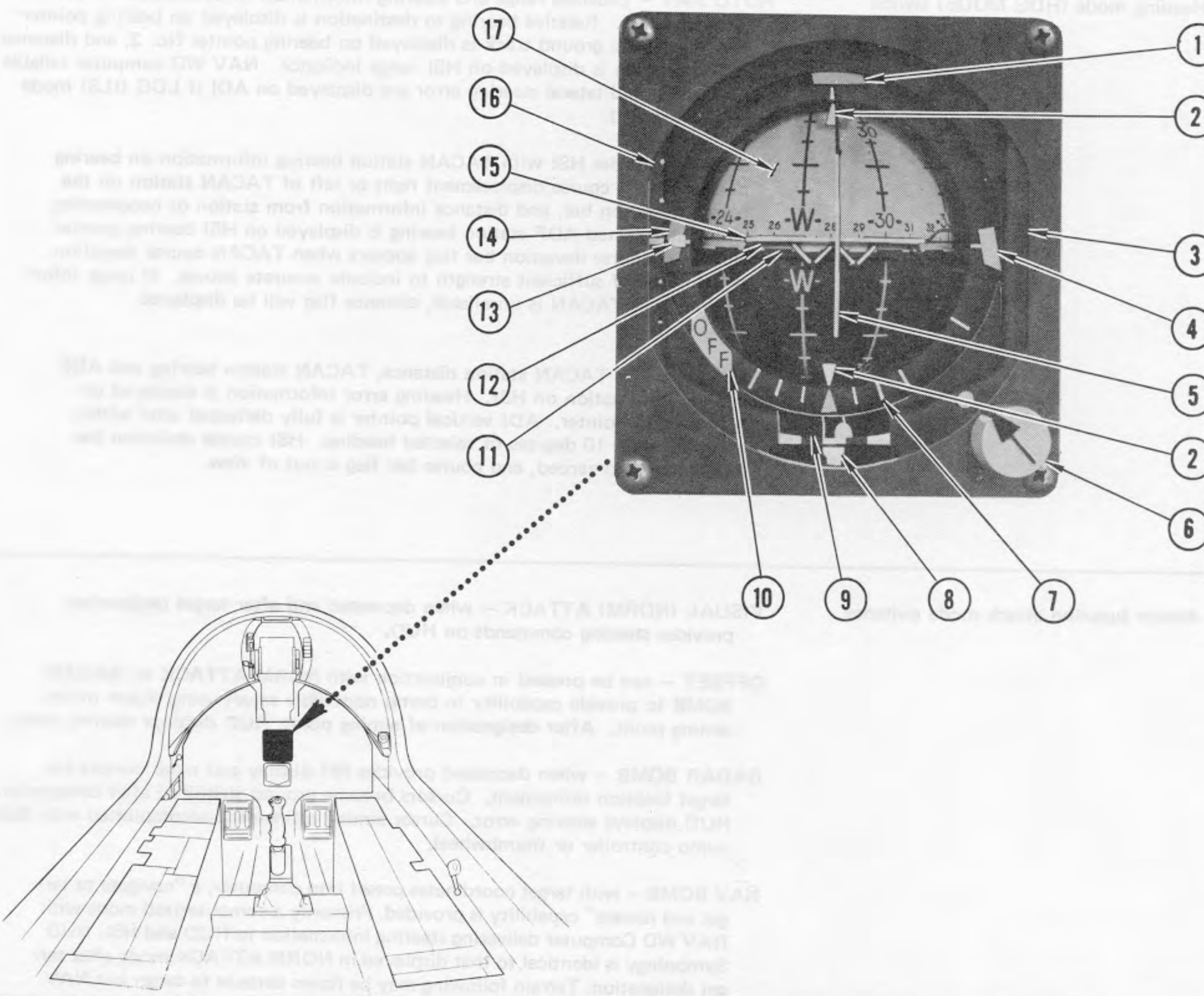
Figure 1–110 (Sheet 4)

ATTITUDE DIRECTOR INDICATOR (ARU-21/A)



Nomenclature	Function
1. Course warning flag or vertical pointer alarm flag	In view if ILS localizer signal is not adequate for a reliable display, or if flight director computer malfunctions during landing phase. In view if tactical computer signal is not adequate for a reliable display while flying in automatic navigation mode. In view if TACAN signal is not adequate for a reliable display, or if flight director computer malfunctions during landing phase. In view if flight director computer malfunctions while flying in manual heading mode.
2. Bank angle indexes	Indicates angle of bank on bank scale.

75D131(1)−05−70

Figure 1–111 (Sheet 1)

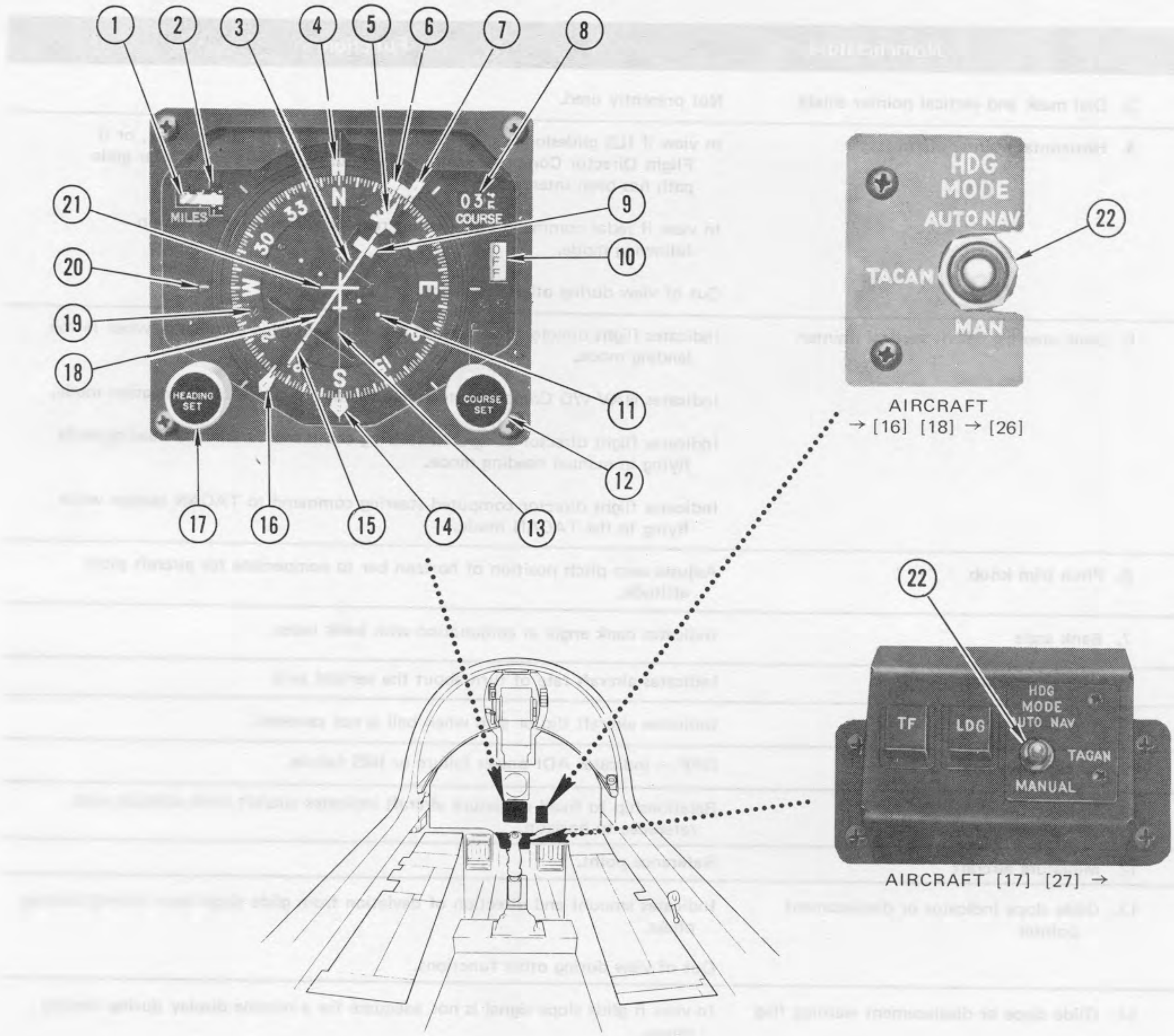
ATTITUDE DIRECTOR INDICATOR (ARU-21/A)

Nomenclature	Function
3. Dial mask and vertical pointer shield	Not presently used.
4. Horizontal pointer alarm flag	In view if ILS glideslope signal is not adequate for a reliable display, or if Flight Director Computer malfunctions during landing phase after glide path has been intercepted. In view if radar command signal is not reliable while flying in terrain following mode. Out of view during other functions.
5. Bank steering bar or vertical pointer	Indicates flight director computed ILS localizer steering commands when in the landing mode. Indicates NAV WD Computer steering error during automatic navigation mode. Indicates flight director computed steering command to selected heading while flying in manual heading mode. Indicates flight director computed steering command to TACAN station while flying in the TACAN mode.
6. Pitch trim knob	Adjusts zero pitch position of horizon bar to compensate for aircraft pitch attitude.
7. Bank scale	Indicates bank angle in conjunction with bank index.
8. Rate-of-turn indicator	Indicates aircraft rate of turn about the vertical axis.
9. Slip indicator	Indicates aircraft slip or skid when ball is not centered.
10. Attitude warning flag	OFF – indicates ADI power failure or IMS failure.
11. Horizon bar	Relationship to fixed miniature aircraft indicates aircraft pitch attitude with reference to horizon.
12. Miniature aircraft	Reference point.
13. Glide slope indicator or displacement pointer	Indicates amount and direction of deviation from glide slope beam during landing phase. Out of view during other functions.
14. Glide slope or displacement warning flag	In view if glide slope signal is not adequate for a reliable display during landing phase. Out of view during other functions.
15. Pitch steering bar or horizontal pointer	Indicates ILS glide slope steering commands when in the landing mode. Provides obstacle avoidance steering commands while flying in terrain following mode. Out of view during other functions.
16. Glide slope deviation scale or displacement pointer scale	Indicates amount of displacement above or below glide slope. Each dot represents approximately 1/2 degree.
17. Attitude sphere	Used in conjunction with miniature aircraft to indicate aircraft attitude in relation to horizon and aircraft heading.

75D131 (2)–05–70

Figure 1–111 (Sheet 2)

HORIZONTAL SITUATION INDICATOR (AQU-6/A)



Nomenclature	Function
1. Range warning flag	Conceals range indicator when TACAN distance signal is not adequate for reliable indication. Out of view when HDG MODE switch is in AUTO NAV position or reliable TACAN range is available.
2. Range indicator	Displays range to destination when HDG MODE switch is in AUTO NAV position. Displays range to TACAN station when HDG MODE switch is in TACAN or MAN position.

75D123(1)–02–70

Figure 1–112 (Sheet 1)

HORIZONTAL SITUATION INDICATOR (AQU-6/A)

Nomenclature	Function
3. To-From indicator	Indicates whether selected course is to or from TACAN station in relation to aircraft position. Out of view except when HDG MODE switch is in TACAN position. (Indicator out of view in photo.)
4. Reciprocal bearing pointer number 2	Indicates reciprocal of bearing pointer number 2 indication.
5. Course arrow (head)	Indicates course selected with course set knob.
6. Heading marker	Indicates heading selected with HEADING SET knob.
7. Reciprocal bearing pointer number 1	Indicates reciprocal of bearing pointer number 1 indication.
8. Course selector window	Displays course selected with COURSE SET knob.
9. Course deviation bar flag	Red flag appears if TACAN bearing signal is not adequate for correct bearing when HDG MODE switch is in TACAN position. In view if ILS localizer is not adequate for a reliable display during landing. Out of view during other functions.
10. Power OFF warning flag	Display of OFF word indicates power or indicator failure. Solid black when indicator is operative.
11. Course deviation scale	Each dot indicates 5 degrees of course deviation from selected TACAN radial. When used with ILS, each dot represents approximately 1 1/4 degrees of localizer deviation.
12. COURSE SET knob	Sets course display and course arrow.
13. Lubber line	Indicates aircraft heading on compass card.
14. Bearing pointer number 2	Indicates bearing to selected ADF station when HDG MODE switch is in TACAN or MAN position. Indicates tactical computer ground track when HDG MODE switch is in AUTO NAV position.
15. Course arrow (tail)	Indicates reciprocal of course arrow (head) indication.
16. Bearing pointer number 1	Indicates bearing to destination when HDG MODE switch is in AUTO NAV position. Indicates bearing to TACAN station when HDG MODE switch is in TACAN or MAN position.
17. HEADING SET knob	Positions heading marker which provides heading select to the Flight Director Computer and the Automatic Flight Control System.
18. Course deviation indicator (Deviation bar)	Indicates amount and direction of deviation from selected course when HDG MODE switch is in TACAN position. Indicates amount and direction of deviation from ILS localizer beam during landing. Indicator inoperative and centered in other operating modes.
19. Compass card	Indicates aircraft heading in degrees under lubber line.
20. Fixed marker (one of six)	Provides reference in 45-degree increments from lubber line.
21. Aircraft symbol	Reference point to relate HSI displays to aircraft heading.
22. HDG MODE switch	Switch position determines displays on horizontal situation indicator, except for course deviation bar and flag when landing mode is selected.

75D123(2)-12-69

Figure 1-112 (Sheet 2)

The compass card is servo driven and receives heading signals from the magnetic compass through the Inertial Measurement Set. Range to destination, bearing pointers, course deviation bar, and warning flags display information from the Tactical Computer, TACAN, ADF, and ILS localizer depending upon guidance mode selected.

The HSI is powered by the primary instrument bus and the primary ac bus.

INSTRUMENT LANDING SET, AN/ARN-58A.

WARNING

Raw ILS information must be monitored during all approaches. If command steering ever disagrees with the raw ILS information, disregard the command steering and fly the approach using only the raw information. False command steering may be encountered due to internal/external equipment malfunction.

Note

The FDC ILS steering commands should be monitored for premature sensing of the localizer beam. Cycle the LDG master function switch if sensing is premature.

The Instrument Landing System is used with the Flight Director Computer to display ILS localizer and glide slope information and steering commands. The ILS localizer and glide slope receiver feed their respective signals to the Flight Director Computer. The Flight Director computer feeds steering commands and signal conditioned raw localizer and glide slope deviations which are presented on the HUD. Steering commands and raw glide slope deviation are also presented on the ADI. Raw localizer deviation is presented on the HSI.

The ILS set is composed of two receiver units, a control panel, and three antennas. One receiver unit accepts localizer signals while the other unit accepts glide slope and marker beacon signals. The three antennas are for localizer, glide slope, and marker beacon. The marker beacon receiver section provides aural and visual identification of passage over a ground-based marker beacon. The MKR BCN light is located on the instrument panel. The localizer receiver operates in the frequency range of 108.1 to 111.9 megacycles. Localizer frequencies are paired with glide slope frequencies.

OPERATION.

To obtain ILS indications, the LDG master function switch on the instrument panel must be pressed. The Flight Director Computer activates relays which connect ILS localizer radio deviation and flag signals to the HSI course deviation bar and flag, and to the Flight Director Computer lateral channel circuitry. The same relays connect the ILS glide slope deviation and flag signals to the ADI displacement pointer and flag, and to the Flight Director Computer pitch channel circuitry. Additional information concerning the Flight Director Computer is presented in the Flight Director Computer discussion, this section.

The ILS is powered by the secondary dc bus.

ILS controls are illustrated in figure 1–113.

FLIGHT DIRECTOR COMPUTER, CPU-80A.

WARNING

Raw ILS information must be monitored during all approaches. If command steering ever disagrees with the raw ILS information, disregard the command steering and fly the approach using only the raw information. False command steering may be encountered due to internal/external equipment malfunction.

The Flight Director Computer furnishes the pilot with fly-to steering commands in pitch and roll. Steering commands are furnished in the TACAN, MAN HDG, and LDG modes of Heading Mode and Master Function Switch system operation. Commands are displayed on the Head-Up Display (LDG mode only) and the Attitude Director Indicator (ADI). Flying the aircraft to center the ADI steering needle(s) or HUD flight director symbol results in a smooth approach to the desired path.

The computer has pitch and roll channels. The roll channel analyzes roll, heading error, course error, and deviation supplied by the ILS or TACAN and calculates the proper HUD flight director symbol and ADI vertical needle steering command signals. The lateral channel radial deviation signal is amplified and filtered to provide a suitable signal for the HUD to display raw localizer deviation by lateral displacement of the landing flightpath lines. The pitch channel combines glide slope deviations and pitch signals to calculate the proper HUD flight director symbol and ADI horizontal needle steering commands. The glide slope deviation signal is amplified and filtered to provide a suitable signal for the HUD to display raw glide slope deviation by vertical displacement of the landing flightpath lines. The Flight Director Computer is powered by the primary dc bus.

OPERATION IN THE HEADING MODES.

In the MAN mode, the Flight Director Computer provides the pilot with steering commands on the ADI vertical pointer for any desired heading. The heading is manually set by means of the HSI HEADING SET knob. When the MAN position of the HDG MODE switch is selected, the ADI vertical pointer deflects to provide the steering command required to turn to and maintain the selected

ILS CONTROLS

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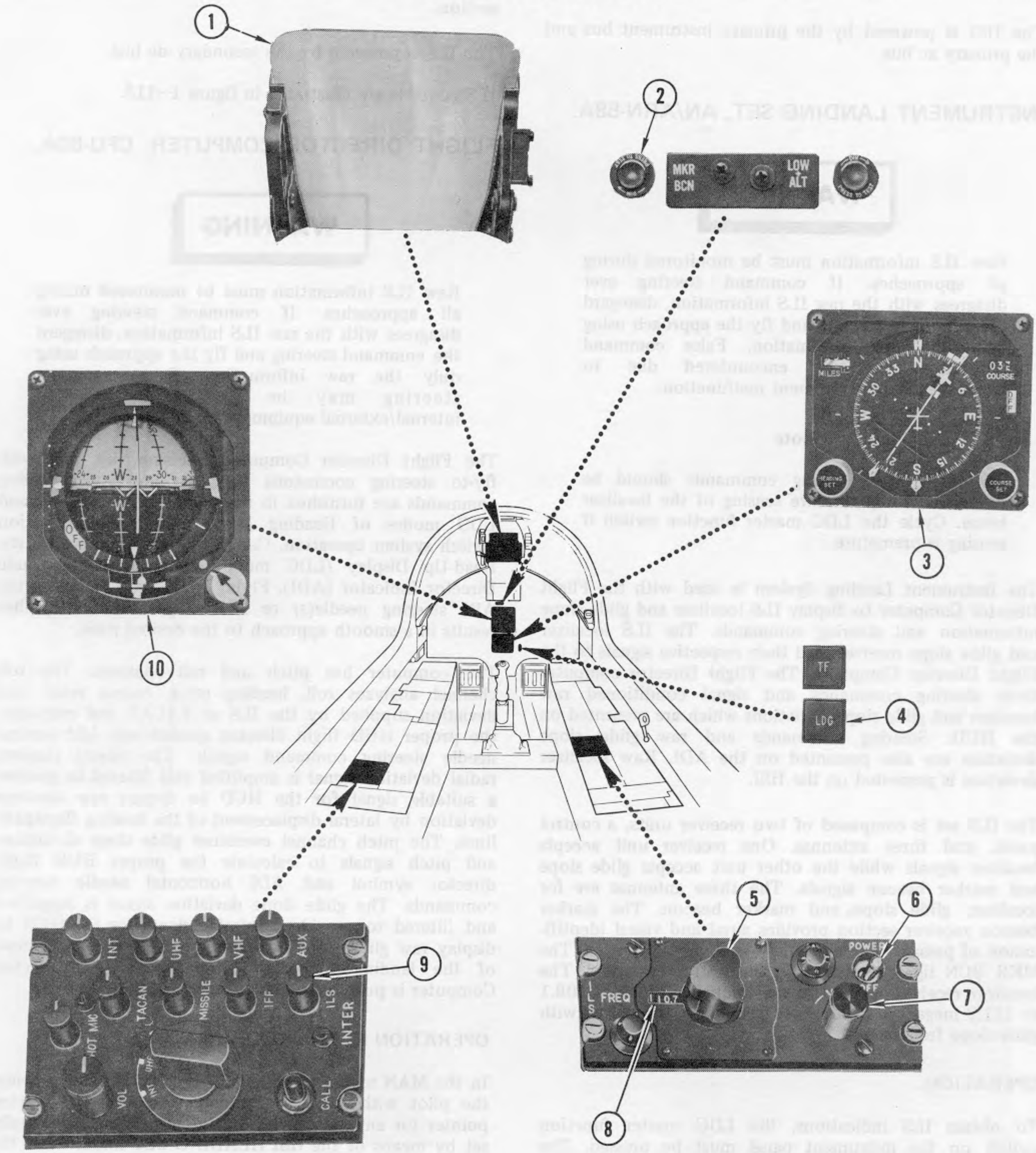

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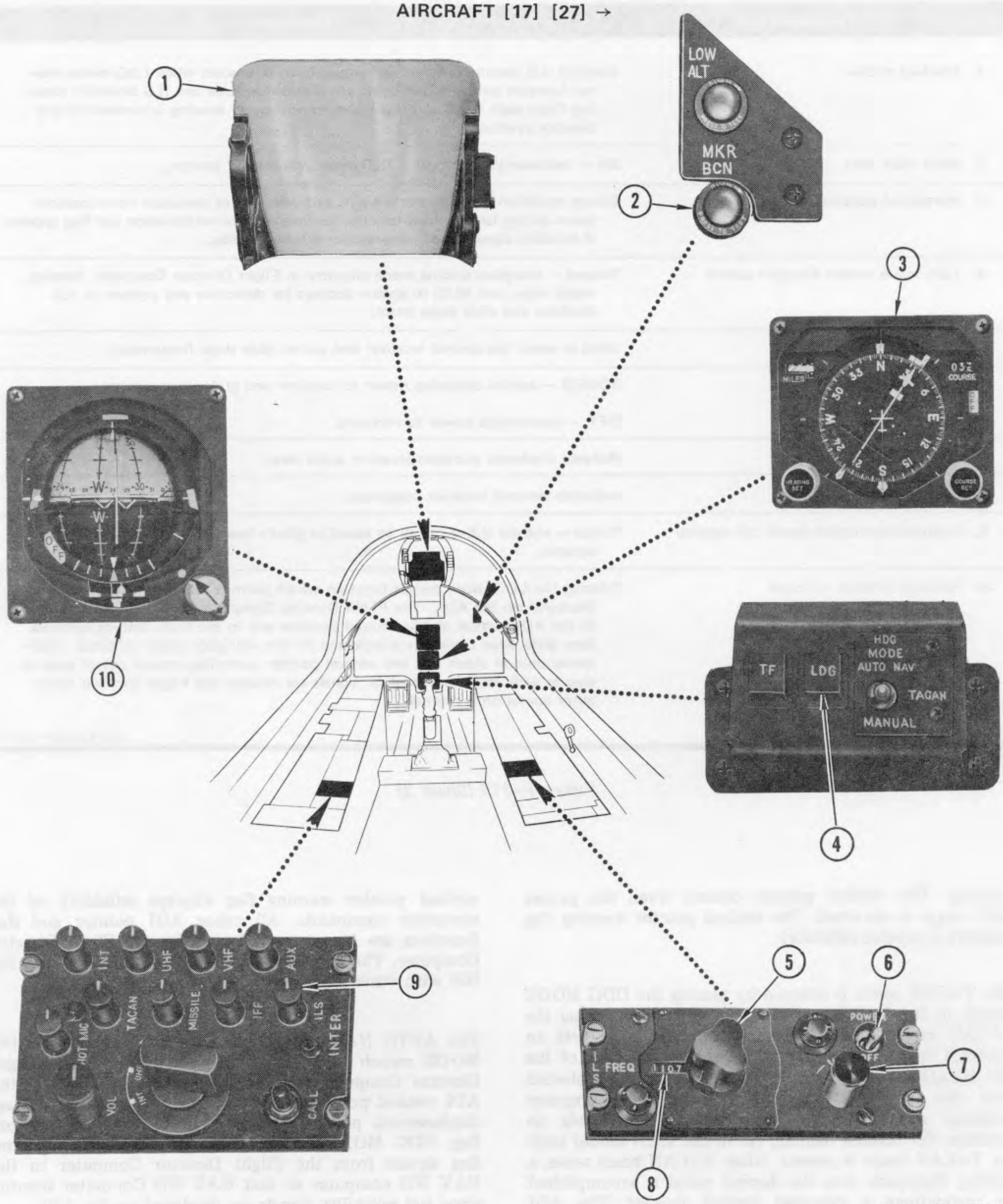
Figure 1−113 (Sheet 1)

ILS CONTROLS

AIRCRAFT [17] [27] →



75D132(3)–02–70

Figure 1–113 (Sheet 2)

ILS CONTROLS

Nomenclature	Function
1. Head-up display	Displays ILS landing symbols and angle-of-attack bracket when LDG mode master function switch is depressed. Indications include raw ILS deviation (landing flight path lines) and flight director computer steering commands (flight director symbol).
2. MKR BCN light	On – indicates passage over a 75.0 megacycle marker beacon.
3. Horizontal situation indicator	Course deviation bar indicates amount and direction of deviation from localizer beam during landing (raw localizer deviation). Course deviation bar flag appears if localizer signal is not adequate for reliable display.
4. LDG mode master function switch	Pressed – energizes landing mode circuitry in Flight Director Computer, heading mode relay, and HUD to enable displays for detection and capture of ILS localizer and glide slope beam.
5. Frequency selector	Used to select the desired localizer and paired glide slope frequencies.
6. POWER switch	POWER – applies operating power to localizer and glide slope receivers. OFF – disconnects power to receivers.
7. VOL control	Rotated clockwise increases localizer audio level.
8. FREQ indicator	Indicates selected localizer frequency.
9. Intercommunication panel ILS monitor	Pulled – enables ILS audio to be heard in pilot's headset. Turned to adjust volume.
10. Attitude director indicator	Pressing the LDG mode master function switch permits ILS information to be displayed on the ADI. The Flight Director Computer issues steering commands to the ADI vertical and horizontal pointers and to the HUD landing symbols. Raw glide slope deviation is indicated on the ADI glide slope indicator. Horizontal pointer alarm flag and vertical pointer alarm flag stowed out of view as long as glide slope and localizer signals are reliable and Flight Director Computer operation is normal.

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Figure 1–113 (Sheet 3)

heading. The vertical pointer centers when the proper bank angle is obtained. The vertical pointer warning flag displays computer reliability.

The TACAN mode is selected by placing the HDG MODE switch in the TACAN position. Prior to approaching the TACAN radial (lateral beam sense), the pilot sets an intercept heading to the TACAN radial by means of the HSI HEADING SET knob. The TACAN radial is selected with the HSI COURSE SET knob. The computer furnishes ADI vertical pointer steering commands to maintain the manual heading (as in the MAN mode) until the TACAN beam is sensed. After TACAN beam sense, a curving flightpath into the desired radial is accomplished by maintaining a centered vertical pointer. The ADI vertical pointer warning flag displays reliability of the computer commands. All other ADI pointer and flag functions are biased out of view by the Flight Director Computer. The raw TACAN deviation is displayed on the HSI with other TACAN and ADF indications.

The AUTO NAV mode is selected by placing the HDG MODE switch in the AUTO NAV position. The Flight Director Computer furnishes an out of view signal for the ADI vertical pointer and flag, horizontal pointer and flag, displacement pointer and flag, and the HSI course bar flag. HDG MODE relays switch the vertical pointer and flag signals from the Flight Director Computer to the NAV WD computer so that NAV WD Computer steering error and reliability signals are displayed on the ADI.

LANDING MODE.

The computer has three stages of operation during the landing mode:

1. Prior to selecting the landing mode, the pilot sets an intercept heading with the HEADING SET knob of the HSI and then sets the runway course in the course window with the HSI COURSE SET knob. The mode is selected by pressing the LDG master function switch. Prior to computer sensing interception of the localizer beam, the Flight Director Computer provides a heading command to the ADI vertical pointer and the HUD landing director symbol, based on the manually set heading. The computer also provides stowing (out of view) voltage to the ADI horizontal pointer and flag. The HSI displays raw localizer deviation on the course deviation bar.

2. When the proper localizer beam is intercepted, the computer provides a lateral steering command to the HUD landing director symbol and to the ADI vertical pointer to smoothly direct the aircraft to the localizer beam centerline. The ADI horizontal pointer and flag remain out of view and the HUD landing director symbol does not give pitch commands until the glide slope beam is detected by the Flight Director Computer.

3. A logic circuit requires the following conditions be satisfied before the vertical beam (glide slope) is captured by the Flight Director Computer:

   — LDG (ILS) master function switch pressed.

   — Lateral beam sense — localizer beam capture has occurred.

   — Glide slope deviation at programmed level within beam parameters.

   — Valid glide slope and localizer flag signals.

Note

Proper glide slope command information requires that the radar altimeter be on and operating. With the radar altimeter not operating, glide slope commands are provided in a slightly degraded mode.

When the preceding conditions are satisfied, the computer provides HUD landing director symbol and ADI horizontal pointer steering commands for a smooth intercept into the glide slope. The ADI horizontal pointer alarm flag remains out of view as long as the glide slope signal is adequate and Flight Director Computer operation is normal. The ADI vertical pointer alarm flag remains out of view as long as the localizer beam signal is reliable and Flight Director Computer operation is normal.

Note

Refer to Section VII, All-Weather Operation, for ILS approach procedures.

ACA CPU-80/A OPERATION DIFFERENCES.

The preceding discussion of Flight Director Computer operation in the Heading and Landing Modes is based on the characteristics displayed by units manufactured by United Control Corporation (UC). CPU-80/A Flight Director Computers manufactured by Astronautics Corporation of America (ACA) have certain operational differences from UC units which are described in the succeeding paragraphs.

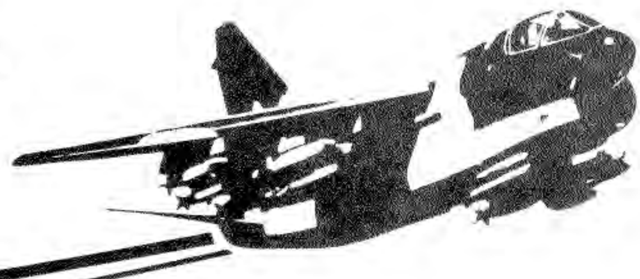
The ACA Flight Director Computer will not switch to the LDG (ILS) or TACAN mode unless three conditions exist: The LDG master function switch must be depressed or the HDG MODE switch must be in the TACAN position; localizer or TACAN deviation signals must be below a fixed value; and localizer or TACAN reliable signals must be present. Unless the latter two conditions are met, the ACA Flight Director Computer will remain in the MANUAL (MAN) heading mode when the HDG MODE switch is placed in the TACAN position. Unlike the UC unit, where the ADI vertical pointer flag comes into view when the system is functioning properly and a reliable signal is not present, units manufactured by ACA will cause the ADI vertical pointer flag to be displayed only after a reliable signal has been present and lost. If the ACA Flight Director Computer is not in the LDG (ILS) or TACAN mode, turning the ILS POWER or TACAN control switches respectively to the OFF position will not cause the ADI vertical pointer flag to come into view.

The course cut angle for the ACA Flight Director Computer is 40° ($+6^\circ$, -2°) instead of 17° for the UC unit. This means that if beam capture is being made at an intercept angle of less than 40°, the pilot will get a heading change command on the ADI vertical pointer to correspond to a 40° intercept angle. This would appear to the pilot as an apparent "turn away" command.

Should the pilot desire to intercept the localizer at an angle less than 40°, he may safely disregard the bank steering pointer until the aircraft has crossed the localizer centerline (refer to course deviation indicator on HSI); shortly after crossing the centerline, the steering pointer will command a turn towards the intended point of landing at which time normal steering procedures may be resumed. It may be noted that if all steering commands are followed a satisfactory approach will result; however, use of the above procedure with a small intercept angle will result in smaller overshoots and corresponding reduced pilot workload.

For strange field turnaround procedures, refer to Section II.

NORMAL PROCEDURES



SECTION II

TABLE OF CONTENTS.

PREPARATION FOR FLIGHT.

FLIGHT RESTRICTIONS.

Refer to Section V for the operating limitations imposed on the aircraft.

FLIGHT PLANNING.

Refer to Appendix I to determine takeoff, climb, cruise, fuel management, descent, and landing data.

TAKEOFF AND LANDING DATA.

Before each flight, refer to Appendix I for information necessary to fill out the Takeoff and Landing Data Card, located in the checklist, T.O. 1A-7D-1CL-1.

WEIGHT AND BALANCE.

Refer to Section V for weight limitations and to the current Form 365F for landing and cg information.

CHECKLIST.

This Flight Manual contains only amplified procedures. Flight Crew Checklist T.O. 1A-7D-1CL-1 is issued as a separate document.

CAUTION

The flap handle can safely be placed in any position except ISO UTILITY with the aircraft on the ground. If the flap handle is inadvertently left in ISO UTILITY and the engine is running, normal braking is not available. On aircraft → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685, up to four brake applications are available before the utility brake accumulator is depleted. A gradual bleed off of the utility accumulator occurs regardless of brake application. On aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →, if the ANTI-SKID switch is in BRAKE ACCUM, up to four brake applications are available before the utility brake accumulator is depleted. On all aircraft with the accumulator depleted, emergency braking is the only source to stop the aircraft. With the flap handle in ISO UTILITY, nose gear steering is not available.

PREFLIGHT CHECK.

BEFORE EXTERIOR INSPECTION.

1. Form 781 — Check for aircraft status and release.

2. Publications — Check for required flight publications.

EXTERIOR INSPECTION.

The exterior inspection procedures are based on the fact that maintenance personnel have completed all requirements of the technical manual of inspection requirements for preflight and postflight. Duplicate inspections by the pilot have been eliminated except for certain items required in the interest of safety of flight. During the walkaround inspection, the aircraft shall be checked for general condition as inspection steps are followed. The exterior inspection is presented in figure 2–1. For ASCU settings, refer to figure 2–2.

WARNING

During the exterior inspection, be alert to the presence of combustible materials, particularly spilled fuel under the aircraft. If any such material is discovered, it must be removed before engine start is attempted. If the aircraft battery is in a low state of charge, the starting cycle can be intermittently interrupted. As a result, small amounts of burning fuel may be expelled by the Jet Fuel Starter, either from its intake or exhaust. This creates a potential fire hazard.

COCKPIT ENTRY.

Entry into the cockpit is gained from the left side by extending the integral boarding ladder and steps. The canopy is opened manually using the release handle located on the left side just below the canopy. Release the handle latch and rotate the handle counterclockwise to unlock the canopy. The canopy is pneumatically raised and manually lowered.

WARNING

Do not unbuckle parachute leg straps before entering cockpit. Unbuckled straps may become entangled with the primary ejection handle and fire the seat.

CAUTION

Do not allow the boarding ladder to free-fall to the extended position as damage may result. Assure that the ladder is fully extended before mounting to avoid possible injury to the pilot.

Note

To prevent damage to the exterior release handle, it should be returned to the stowed position before entering the cockpit and operating the interior release handle.

INTERIOR INSPECTION.

Before entering cockpit:

1. Fault locator, radar set AN/APQ-126(V) — Check OFF

2. Ejection control safety handle — DOWN (safe)

3. Ejection seat — Inspect; check ejection seat initiator safety pin and canopy actuated initiator safety pin removed (2)

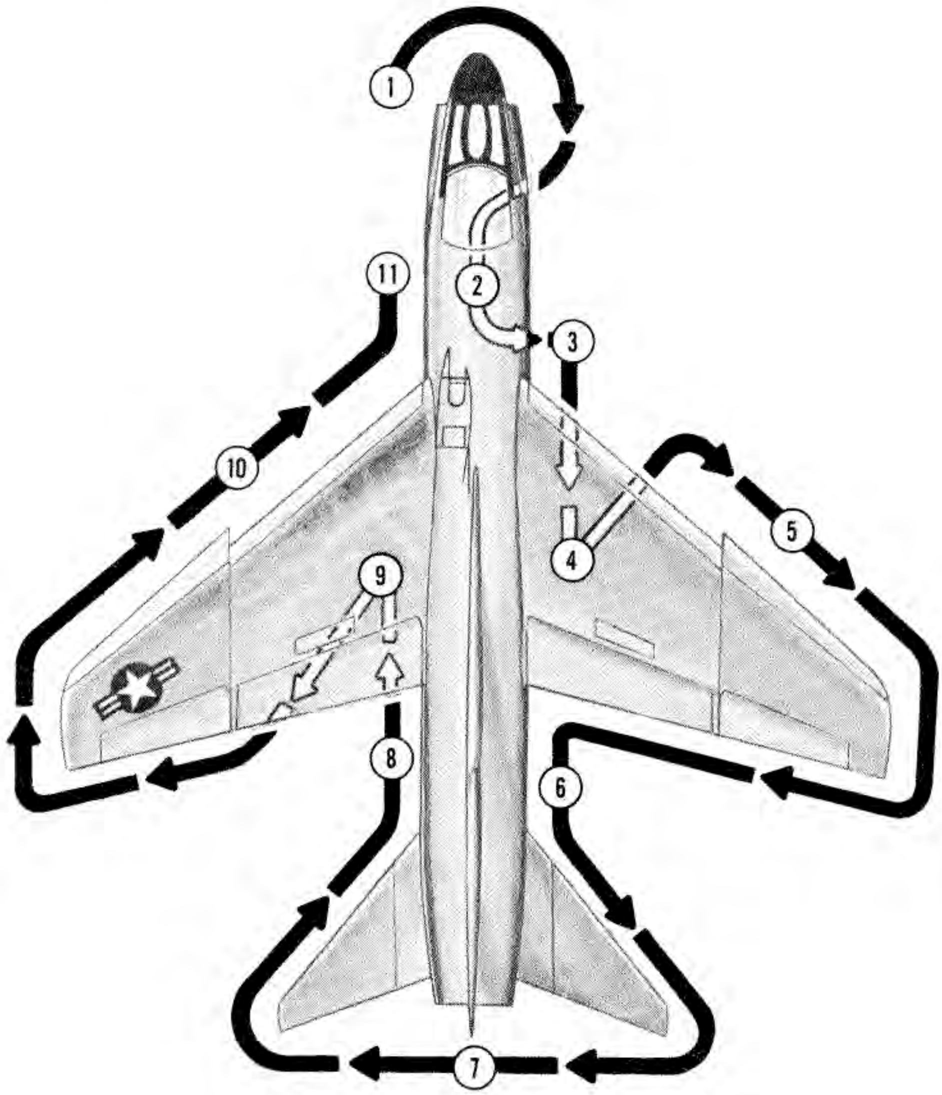
   Inspect seat as outlined in Ejection Seat Inspection, figure 2–3.

4. Canopy jettison initiator safety pin — Check removed (1)

5. Survival kit mode select switch — MANUAL/AUTO

   On aircraft [11] → [26] [28] → [37] and [41] before T.O. 1A-7D-589, the survival kit mode select switch shall be set in MANUAL and the automatic deployment cartridge not installed. On aircraft [11] → [26] [28] → [37] and [41] after T.O. 1A-7D-589 and [27] [38] → [40] [42] →, the automatic cartridge can be installed and the survival kit mode select switch set to MANUAL or AUTO as desired.

EXTERIOR INSPECTION



NOTE

Check all covers removed, access doors secure, and general condition of the aircraft during inspection

(1) NOSE SECTION

(2) NOSEWHEEL WELL

DOWNLOCK PIN (1) -- INSTALLED

75D023-05-70

Figure 2–1 (Sheet 1)

EXTERIOR INSPECTION

(3) RIGHT FORWARD FUSELAGE

FUSELAGE PYLON, LAUNCHER AND STORE ---------- PERFORM REQUIRED CHECKS

(4) RIGHT MAIN WHEEL WELL

DOWNLOCK (1) ---------- INSTALLED
EMERGENCY ACCUMULATOR ISOLATION VALVE ---------- OPEN

(5) RIGHT WING

WINGFOLD WARNING FLAGS ---------- AGREEMENT WITH WING POSITION
WING STORES ---------- PERFORM REQUIRED CHECKS
EXTERNAL FUEL TANK SAFETY PIN ---------- REMOVED

(6) RIGHT AFT FUSELAGE

(7) EMPENNAGE AND TAIL CONE

TAIL CONE LATCHES (4) ---------- FLUSH

(8) LEFT AFT FUSELAGE

OIL QUANTITY AND CAP SECURE ---------- CHECKED

(9) LEFT MAIN WHEEL WELL

DOWNLOCK (1) ---------- INSTALLED

(10) LEFT WING

WINGFOLD WARNING FLAGS ---------- AGREEMENT WITH WING POSITION
WING STORES ---------- PERFORM REQUIRED CHECKS
EXTERNAL FUEL TANK SAFETY PIN ---------- REMOVED

(11) LEFT FORWARD FUSELAGE

FUSELAGE PYLON, LAUNCHER AND STORE ---------- PERFORM REQUIRED CHECKS
ASCU ---------- SET (REFER TO FIGURE 2-2)
RUDDER PEDAL SHAKER SWITCH ---------- CHECK ON
STATIC PORTS ---------- CLEAR
AOA TRANSDUCER VANE ---------- NO DAMAGE

75D023(2)-04-78

Figure 2–1 (Sheet 2)

After entering cockpit:

1. Rudder pedals — Adjusted
2. Shoulder and hip harness — Connected
3. All pilot's equipment — Attach and secure

   Refer to Section I for pilot's equipment location.

4. Oxygen system — Check (PRICE), then oxygen diluter lever 100% OXYGEN

   Refer to Section I for oxygen system PRICE check and oxygen duration chart.

LEFT CONSOLE.

1. VENT AIR controls — Set (suit temperature)

   Set air flow and temperature control as desired.

2. ADF/Auxiliary UHF receiver — Set and OFF
3. RHAW — PWR OFF [17] [27] →
4. INTER — Set

   To place the interphone system in operation for ground communication, place the INTER panel selector switch in INT. To monitor the UHF radio during intercom operation, pull out the UHF knob and adjust volume as necessary. For normal two-way communication of the UHF radio, place the INTER panel selector switch in UHF position.

5. IFF — Set and OFF
6. UHF radio — Set and ON

   To place the AN/ARC-51BX UHF radio in operation for normal two-way communication, place the selector switch in UHF on the intercom panel, place

STORE/ASCU CODE SUMMARY

MAJOR CHANGE

ASCU CODE	STORE
AK	No wing store loaded – OFF
	BOMBS
GT	Mk 84 LGB (KMU 351)
GT	Mk 82 LGB (KMU 388)
GO	Mk 82
JQ	Mk 82 Internal fuze
GP	Mk 82 SE LD
GQ	Mk 82 SE HD
GR	Mk 82 SE HD/LD
GT	Mk 84
FK	M117A1 with M131A1 fin
FL	M117A1 with MAU-103A/B fin
FM	M117A1 RET HD
FN	M117A1 RET HD/LD
IO	M118
GQ	Mk 36 DESTRUCTOR (HD)
GP	Mk 36 DESTRUCTOR (LD)
JN	Mk 20 ROCKEYE
JK	CBU-24, CBU-49, CBU-52 CBU-58
IQ	BLU-52
	DISPENSERS
CL	CBU-12
CQ	CBU-30
CP	CBU-38
CM	CBU-46

ASCU CODE	STORE
AK	ECM PODS
	FIRE BOMBS
IK	BLU-1 finned
IL	BLU-1 unfinned
IM	BLU-27 finned
IN	BLU-27 unfinned
	FLARES
BO	SUU-25/SUU-42 flare launcher
BL	Flares on MER/TERS
AK	FUEL STORES
	ROCKETS
AM	LAU-3, LAU-68, LAU-95 launchers
	GUN PODS
BN	SUU-23
	TRAINERS
DR	SUU-20 RKTS with BDU-33 bombs
DT	SUU-20 RKTS with Mk-106 bombs
HR	Practice bombs on MER/TERS

NOTE

This table is a list of ASCU codes for current or programmed munitions/stores. It does not necessarily reflect approved weapon types nor weapon types implemented by computer software (OFP's). Refer to Section V, Operating Limitations, for latest approved weapon types and configurations. Refer to the latest Operational Supplement dealing with OFP tape characteristics and anomalies for weapon types implemented by OFP's.

75D222-09-72

Figure 2–2

EJECTION SEAT INSPECTION

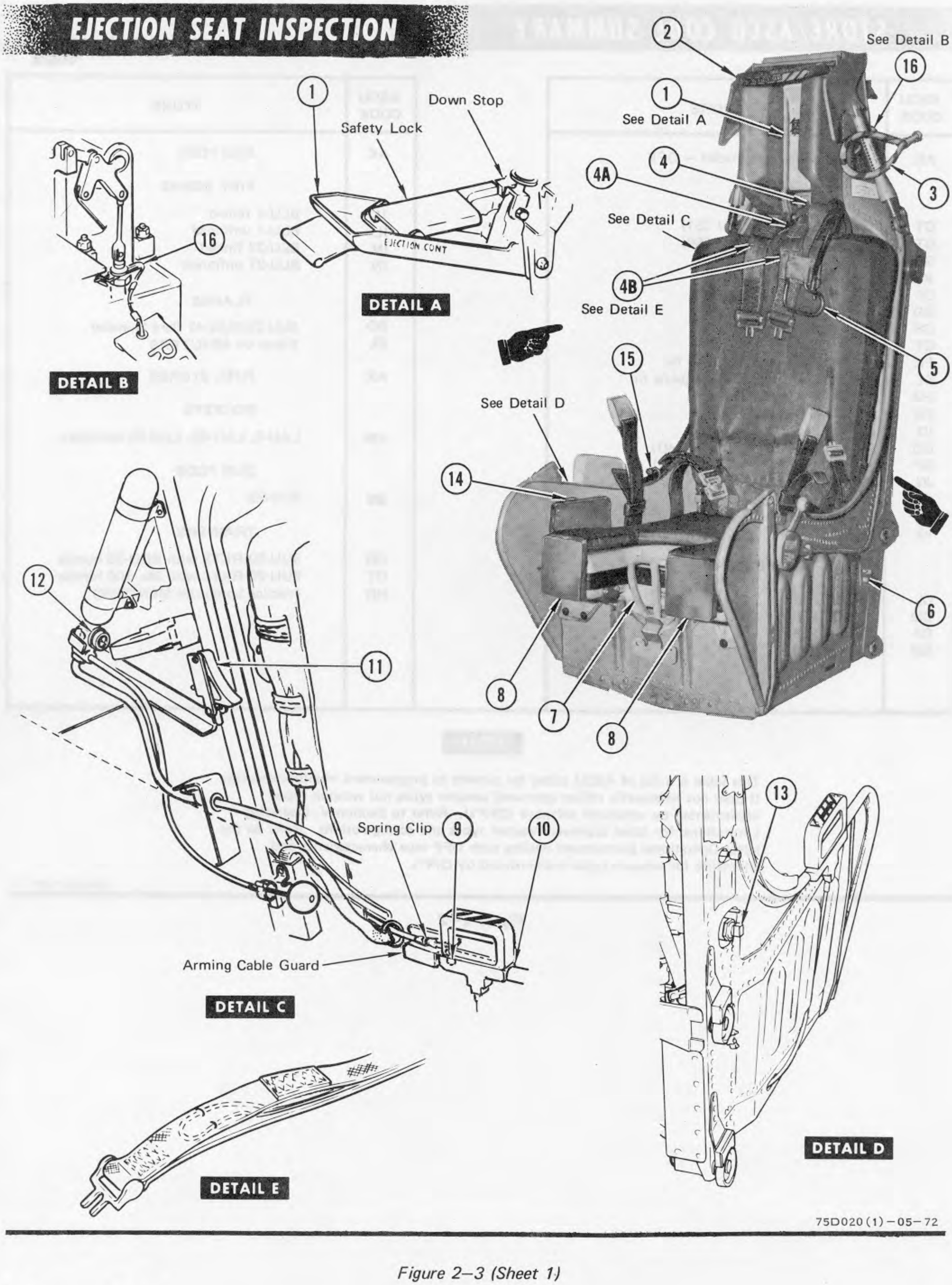


Figure 2–3 (Sheet 1)

EJECTION SEAT INSPECTION

INDEX NO.	SAFETY CHECK
1.	Ejection controls safety handle SAFE (DOWN) position
2.	Face curtain ejection control handle stowed
3.	Canopy jettison override control handle stowed → 10
4.	Shoulder harness retaining pin secure. Retaining pin should protrude through fitting by 1/16 inch minimum at full diameter.
4A.	Pull parachute forward and check the condition of the NB-10 parachute for a deployed chute, condition of the separation bladder container and the inertia reel retaining straps.
4B.	Check that four-line jettisoning lanyard is securely tacked and line is not protruding from straps.
5.	Parachute D-ring stowed
6.	Lapbelt retaining pins extended 1/16 inch outboard of seat structure
7.	Primary ejection handle stowed
8.	Hooks on front of survival kit engaged by rollers on front of seat and hooks and rollers not damaged **WARNING** Distorted hooks could impair seat/kit separation during ejection sequence.
9.	Swaged ball on parachute actuator arming cable properly installed. The parachute actuator arming cable should be installed in the retaining clip and the swaged ball inserted through the hole and secured in the emergency harness release handle holder. Check security of swaged ball by placing fingers around and under retaining spring clip on end of cable and moving cable up and down and then pulling towards parachute. **WARNING** Do not pull arming cable away from parachute or the explosive cartridge within the parachute may be fired.
10.	Check harness release handle to insure forward protrusion on forward edge of handle is engaged in handle holder.
11.	Harness release striker plate in the forward position
12.	Emergency oxygen bottle pressure 1,900 (±100) PSI
13.	Check harness release actuator firing pin sear secure
14.	Emergency kit release handle properly stowed
15.	Zero delay arming lanyard attached to parachute arming lanyard and securely attached to ejection seat rail
16.	Check ejection seat initiator safety pin removed
17.	Check canopy-actuated initiator safety pin removed (on canopy deck) 11 →

75D020(2)–05–72

Figure 2–3 (Sheet 2)

the UHF function switch in T/R or T/R+G and allow a 2-minute warmup time before attempting to transmit, and place the UHF mode switch in PRESET or MAN. Select desired channel with the preset channel knob if the mode switch is in PRESET CHAN, or with the manual frequency selector knobs if the mode switch is in MAN. Adjust volume and squelch disable as desired.

To receive on guard frequency (243.00 mc), the function switch must be in T/R+G. To transmit on guard frequency, the mode selector must be in GD XMIT. With the mode selector in GD XMIT, the function switch may be in either T/R or T/R+G to receive guard frequency transmissions.

Note

A 400-cps tone is heard anytime the command radio frequency is changed during normal operation. When switching from a frequency on a preset channel to the same frequency set in manually, absence of this tone indicates a properly preset channel.

To monitor UHF audio when the intercommunication set selector switch is in the INT or VHF position, the UHF monitor knob on the intercom panel must be pulled out.

7. EMER flap switch — NORM (cover down)
8. Flap handle — FLAP UP
9. ALTERNATE FUEL FEED (left longeron) NORMAL [17] [27] →
10. AFCS yaw STAB switch — OFF
11. RADAR — OFF
12. RUDDER TRIM knob — Center
13. Throttle FRICTION — Set
14. FUEL MASTER handle — ON and check latched
15. Throttle — OFF
16. Exterior lights switch (throttle) — BRT

    The exterior lights switch turns on and off all exterior lights selected on the EXT LIGHTS control panel.

17. Speed brake (SP BK) switch — CLOSE
18. STARTER ABORT switch — NORM
19. ANTI-ICE switch — OFF [17] [27] →

Note

On aircraft → [16] [18] → [26], the ANTI-ICE switch is located on the EXT LIGHTS panel on the right longeron.

20. ANTI SKID switch — OFF

Note

The antiskid system may be used only for takeoff and landing.

21. FUEL DUMP switch — OFF (cover down)
22. AR AMPL OVERRIDE switch — NORM [17] [27] →
23. PROBE RETRACT switch — OFF → [16] [18] → [26]
24. WING TRANS switch — AUTO
25. FUEL CONT switch — NORM (cover down)
26. EMERG BRAKE — Check OFF
27. SLIPWAY LIGHTS switch — OFF [17] [27] →
28. AR DOOR handle — Check in [17] [27] →
29. EMER GEN switch — CRUISE
30. BATT switch — OFF
31. STBY ATTD ERECT switch — OFF
32. MASTER GEN switch — ON
33. TRIM (PITCH and ROLL switches) — ON
34. AFCS PUSH TEST knob — OFF
35. EMER POWER handle (RAT) — Check in
36. LAND TAXI light — OFF
37. Landing gear handle — WHLS DOWN

INSTRUMENT PANEL.

1. ARMT switches — OFF and SAFE
2. Clock — Set
3. RADAR ALTITUDE — OFF

4. HUD – Checked

   a. HUD – OFF

   b. PNL LTS – OFF

   c. STBY RETICLE – OFF

   d. HUD TEST – OFF

   e. FILTER – As desired

5. HDG MODE – As desired

6. Radar scope – NORM

7. Accelerometer – Reset

RIGHT CONSOLE.

1. Arresting HOOK handle – UP

2. DPLR selector switch – OFF

3. ECM – OFF

4. NAV WD Computer switch – OFF

5. INTERIOR LIGHTS – As desired

Note

It is particularly important to rotate the flight instrument lights knob fully counterclockwise (to OFF) to ensure full bright operation of warning, caution, and advisory lights for daylight operations.

6. EXT LIGHTS – As required

7. APPROACH INDEXER – As desired → [16] [18] → [26]

8. WINDSHIELD BOW lights switch – As desired [17] [27] →

9. Foot vent control – As desired (up for foot air)

10. EMERGENCY VENT AIR KNOB – Open

Note

The EMERGENCY VENT AIR KNOB should be open to prevent overpressurization and canopy shear pin failure during opening and closing of the canopy.

11. TACAN, ILS, VHF FM – Set and OFF

12. Juliet 28 control, RADAR BEACON – OFF

13. IMS MODE switch – OFF

14. AIR COND – Set

   a. AUTO MAN switch – AUTO

   b. Cockpit temperature knob – As desired

   c. Cockpit pressure switch – CABIN PRESS

   d. RAIN REMOVE switch – OFF

   e. DEFOG switch – OFF

15. WINGFOLD lock lever – Matches wing position

   Match wingfold lock lever with position of the wings to prevent wing movement during start.

BEFORE STARTING ENGINE.

Refer to Section V for starting limits. Refer to Section VII for cold weather operation.

1. Fire guard standing by

2. BATT switch – BATT

   The battery switch must be placed in BATT for battery or external dc electrical power starting.

Note

Starts utilizing external dc power are presently restricted to emergency situations only.

3. TOT off flag – Out of sight

4. Engine fire detect circuit – TEST

5. MAN FUEL CAUTION light – Out

Danger areas are presented in figure 2–4

STARTING ENGINE.

1. Throttle – Inboard to CRANK

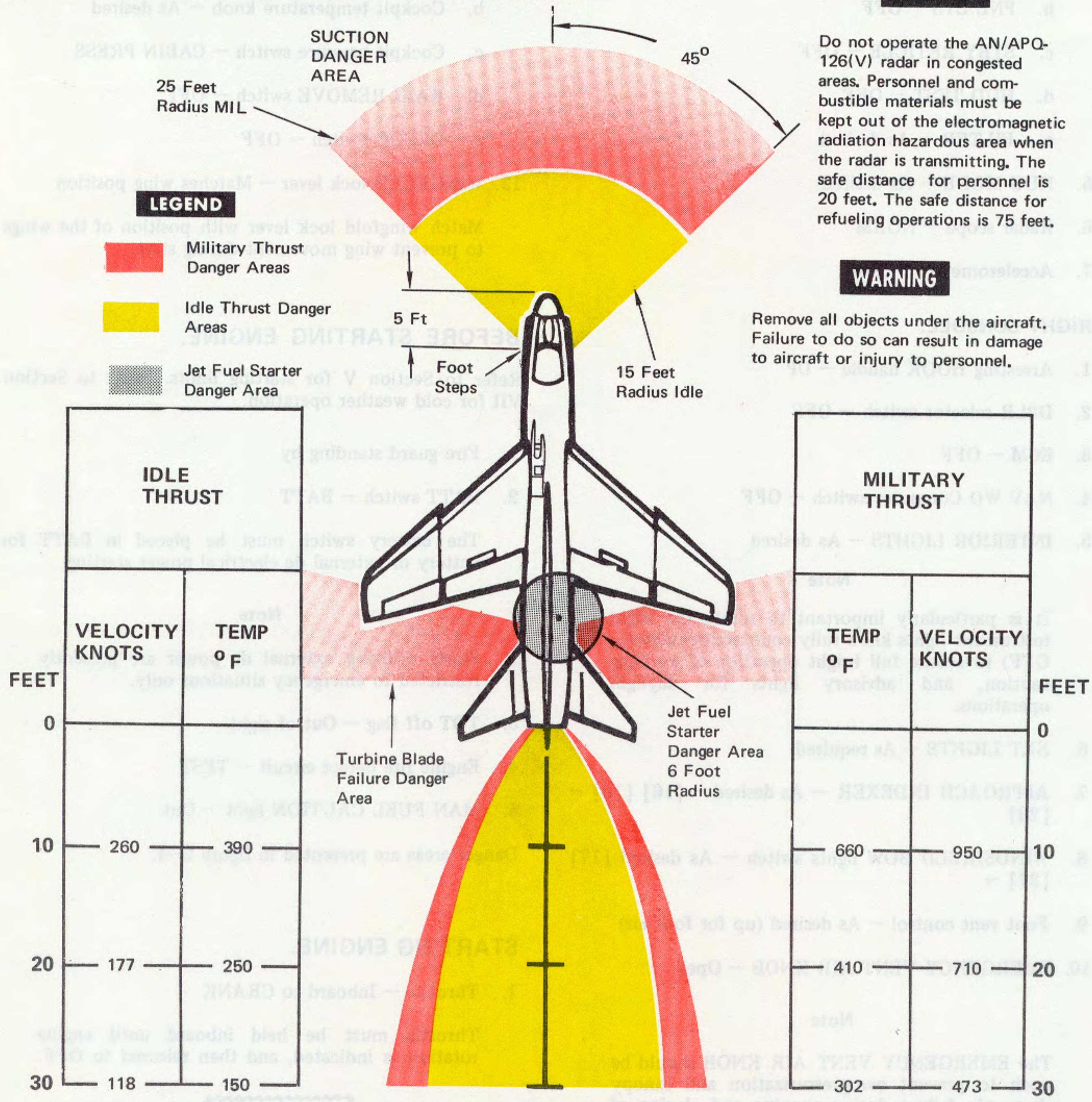
   Throttle must be held inboard until engine rotation is indicated, and then released to OFF.

CAUTION

If engine rotation is not indicated within 7 seconds, or the STARTER caution light illuminates, abort the start by placing the STARTER ABORT switch in ABORT to prevent damage to the jet fuel starter.

DANGER AREAS

EXHAUST, INLET AND TURBINE DANGER AREAS



WARNING

Do not operate the AN/APQ-126(V) radar in congested areas. Personnel and combustible materials must be kept out of the electromagnetic radiation hazardous area when the radar is transmitting. The safe distance for personnel is 20 feet. The safe distance for refueling operations is 75 feet.

WARNING

Remove all objects under the aircraft. Failure to do so can result in damage to aircraft or injury to personnel.

CAUTION

Make certain that suction danger area is clear of debris. Jet blast zone will vary according to prevailing wind.

WARNING

Stay clear of area within 100 feet directly behind the aircraft when the engine is operating at MIL power.

WARNING

Do not stand within 6 feet of the jet fuel starter exhaust during engine start. The following temperatures will be encountered within 6 feet of the starter exhaust

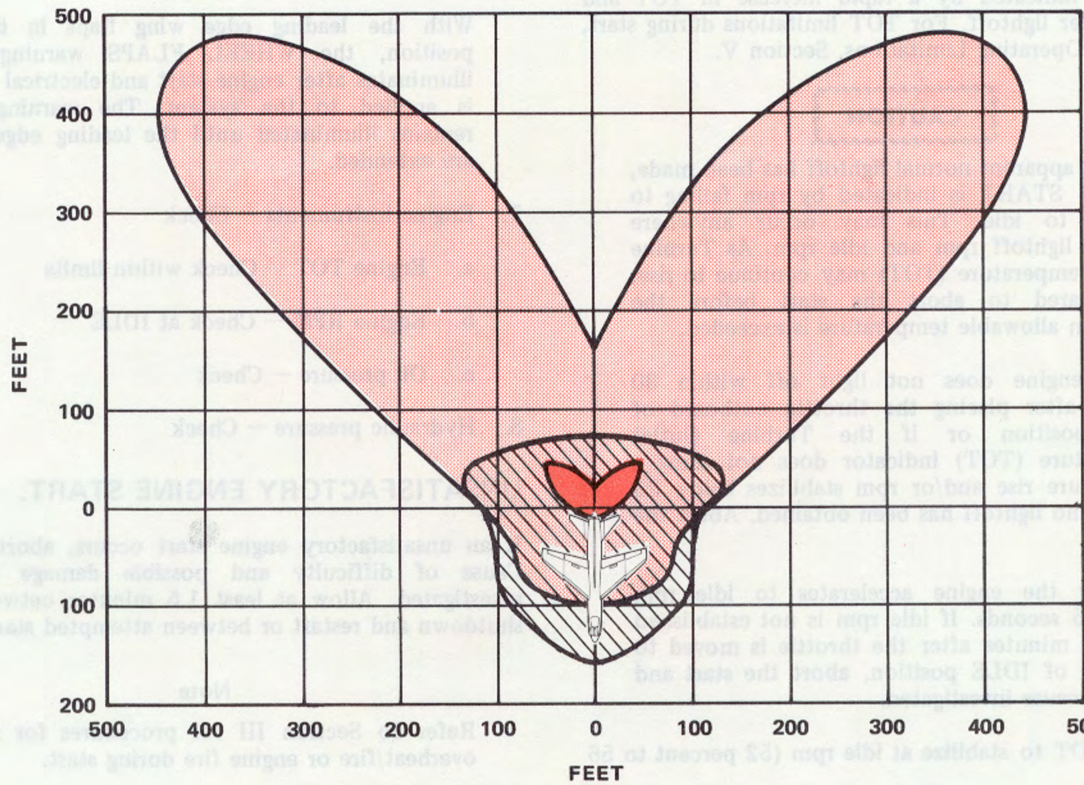
6 inches	. . . .	1,200°F
3 feet	. . . .	500°F
6 feet	. . . .	120°F

75DO30(1)–12–70

Figure 2–4 (Sheet 1)

DANGER AREAS

HAZARDOUS NOISE LEVEL AREAS
TF41-A-1



LEGEND

- Military Thrust — 140 db and above. Dangerous even with ear protection. Limit exposure to absolute minimum.
- Idle Thrust — 95 db and above. Ear protection required.
- Military Thrust — 120 db to 140 db. Ear protection required. Use caution in exposure time.

NOTE

Noise contours will be altered by the presence of nearby buildings or other obstructions.

75D030 (2)—10—69

Figure 2–4 (Sheet 2)

2. Throttle outboard at 5 percent rpm to IGNITE

Throttle must be maintained in the outboard position to initiate and maintain ignition throughout the starting cycle as there is no ignite relay.

3. At 15 percent rpm – Smoothly advance the throttle lever to outboard of IDLE position. Metered starting fuel is supplied to the engine as the throttle is advanced to outboard of IDLE position. A normal start is indicated by a rapid increase in TOT and RPM after lightoff. For TOT limitations during start, refer to Operating Limitations, Section V.

CAUTION

After an apparent normal lightoff has been made, a HUNG START is indicated by rpm failing to increase to idle. This may occur anywhere between lightoff rpm and idle rpm. As Turbine Outlet Temperature (TOT) may continue to rise, be prepared to abort the start before the maximum allowable temperature is exceeded.

If the engine does not light off within 30 seconds after placing the throttle outboard of IDLE position or if the Turbine Outlet Temperature (TOT) indicator does not show a temperature rise and/or rpm stabilizes below 25 percent, no lightoff has been obtained. Abort the start.

Normally the engine accelerates to idle rpm within 45 seconds. If idle rpm is not established within 2 minutes after the throttle is moved to outboard of IDLE position, abort the start and have the cause investigated.

Allow TOT to stabilize at idle rpm (52 percent to 56 percent).

During normal starting cycle, the starter shuts down at 41 percent to 44 percent engine rpm. Starter shutdown above 44 percent rpm indicates a malfunction in the automatic shutdown system.

CAUTION

Ground crew shall check that fuel starter has shut down after engine start. This can be accomplished by monitoring the starter exhaust area.

4. Throttle – Inboard to the IDLE position when idle rpm is established.

CAUTION

To prevent igniter damage due to prolonged activation, move the throttle inboard to IDLE position as soon as idle rpm is reached.

If starter shutdown has not occurred by 52 percent to 56 percent, manually shut it down using the STARTER ABORT switch. The switch must remain in the ABORT position for a minimum of 5 seconds to ensure starter shutdown.

5. STARTER ABORT switch – ABORT

6. MASTER GEN indicator – V showing

Note

With the leading edge wing flaps in the up position, the WHEEL FLAPS warning light illuminates after engine start and electrical power is applied to the system. The warning light remains illuminated until the leading edge flaps are extended.

7. Engine instruments – Check

   a. Engine TOT – Check within limits

   b. Engine RPM – Check at IDLE

   c. Oil pressure – Check

8. Hydraulic pressure – Check

UNSATISFACTORY ENGINE START.

If an unsatisfactory engine start occurs, abort the start. Cause of difficulty and possible damage should be investigated. Allow at least 1.5 minutes between engine shutdown and restart or between attempted starts.

Note

Refer to Section III for procedures for starter overheat/fire or engine fire during start.

1. Throttle – OFF

2. STARTER ABORT switch – ABORT

CAUTION

Moving the throttle to OFF does not shut down the starter, and placing the STARTER ABORT switch in the ABORT position does not shut down an engine that has started. Two separate actions are required to abort the start.

Allow a minimum of 5 seconds for starter to run down before returning starter switch to NORM. Moving the switch out of ABORT before 5 seconds has elapsed may result in starter relight and damage to the starter.

BEFORE TAXI.

1. Landing gear lights – 3 green

2. HUD – ON; STBY RETICLE – ON
   Set HUD intensity as desired.

Set STBY RETICLE to zero mil.

3. CAUTION and ADVISORY IND LTS TEST button — Press to test

4. Wingfold — SPREAD (if folded) on signal, handle latched down

    a. Place the wingfold control switch in SPREAD. When the wings are fully spread, close the wing hinge pin lock lever, right aft console. Check WINGFOLD light out. Ground crew shall check that wingfold warning flags are not visible.

    b. After wings are spread or if already in the spread position, place finger under forward outboard edge of lever and pull up to ensure that the lever is positively locked. If lock lever detent is properly engaged, the lever is flush with the console and the lever cannot be moved. Care must be taken not to press the detent release lever while performing this check. If the wing lock lever is inadvertently released, relock wings and recheck that they are locked.

WARNING

The aircraft is unsafe for flight if any of the conditions listed below exists. Any one of these conditions is indicative of the outer wing panels being improperly locked by the hinge pins or the lock latches failing to engage the hinge pins properly. Do not attempt to force lock the wings. The wings are not locked in the spread position if:

The wing hinge pin lock lever springs back after having been locked in the detent.

An excessive force is required to move the lock lever to the lock position.

The warning flag is visible.

The WINGFOLD light is on.

5. IMS MODE switch — GND ALIGN, lights check

Placing the MODE switch in GND ALIGN initiates alignment of IMS. Self-test is automatically obtained during initial stages of operation.

    a. MAG VAR — Enter local magnetic variation

    b. IMS caution light — Check on

    c. GND ALIGN advisory light — Check on

CAUTION

Do not place the NAV WD Computer switch in TEST position during or after IMS fine alignment or all fine alignment will be lost. Fine alignment will be reinitiated when the NAV WD Computer has completed the self test.

Do not transfer ac power while in GND ALIGN. Power interruption erases alignment accomplished, requiring reinitiation of ground align.

Note

IMS fine alignment is accomplished by the NAV WD computer. Therefore, proceed with subsequent procedure steps to assure that the computer turn-on and test has been accomplished before the IMS 2-minute coarse alignment has timed out. Any delay in computer turn-on will delay fine alignment.

Do not initiate IMS GND ALIGN with the wings folded because the ML-1 remote compass transmitter, located in the outer right wing panel, is in a vertical orientation and will not provide the IMS with a correct magnetic heading reference. Alignment of the ADI, HSI and HUD will be to this erroneous heading reference during the initial coarse alignment. After the wings are spread, the IMS will correct to the proper magnetic heading at the rate of 2.4 degrees per minute. The erroneous heading condition can also be corrected by cycling the IMS to OFF and back on again after the wings are spread. However this will reinitiate the coarse alignment and will require an additional 2 minutes before usable outputs are obtained.

The aircraft may be moved after 2 minutes of GND ALIGN has elapsed without affecting previous alignment provided the mode switch is moved from GND ALIGN to NORM or INERTIAL.

6. NAV WD Computer switch — PWR

    a. PRES POS — Check, enter (if necessary)

        (1) Rotary mode selector switch — PRES POS

        (2) Three-position toggle switch — LAT LONG

        (3) KEYBD pushbutton — Press

        (4) Latitude and longitude display windows — Verify coordinates

        (5) ENT pushbutton — Press

b. TEST (if time and conditions permit)

(1) Any attack mode selected

(2) Standby reticle on

(3) NAV WD Computer switch momentarily to TEST to initiate self-test

7. Anti-g suit hose — Connected, test

8. ADF/Auxiliary UHF receiver — As required

To place the ADF/Auxiliary UHF (ADF/UHF) AN/ARA-50 radio in operation:

a. AUX monitor/volume switch — Pull out

Adjust volume to Midrange.

b. Master VOL control — Midrange

c. Function switch — AUX REC-CMD

d. SENS and VOL controls — Midrange

e. AUX CHAN selector — Desired channel

An audible signal should be heard in the headset.

f. SENS knob — Fully clockwise

g. VOL control — ADJUST

For continuous guard channel reception:

h. Function selector — AUX REC-GRD

To place the set in operation for automatic direction finding:

i. HDG MODE switch — TACAN or MAN

j. Function selector — AUX REC-ADF

k. AUX CHAN selector — Desired channel

l. VOL control — Adjust

Note

When the receiver is operating in ADF, full sensitivity which cannot be adjusted with the SENS knob is automatically provided. To identify the ADF station, increase the ADF set volume and decrease the AN/ARC-51BX volume as necessary.

9. RHAW — As required

10. IFF MASTER control switch — STBY

To place the AN/APX-72 (IFF) system in operation, perform the following:

a. MASTER switch — STBY for 1 minute under standard temperature conditions (5 minutes under extreme ranges of operating temperatures) and then to NORM position

b. Code selectors — Set

c. IDENT-OUT-MIC switch — OUT

11. AFCS yaw STAB switch — STAB, light out within 30 seconds

12. RADAR power switch — STBY

13. RADAR ALTIMETER — ON, set pointer

14. HUD — TEST, verify displays and that flightpath marker overlays standby reticle pipper within 3 mil tolerance

15. PMDS — NORM

16. Fuel quantity — Test and check

Rotate FUEL TANK QTY monitor switch to check fuel quantity in wing and external tanks. Check that totalizer reflects total (main and transfer) fuel quantity. Press the indicator press-to-test switch. Pointers and counter move toward zero. When released, pointers and counter return to indicate actual fuel quantity.

17. LOX IND TEST button — Press to test

Press and hold the LOX IND TEST button. Check liter gage for oxygen quantity decrease. When the pointer reaches one liter, the oxygen low-level light should illuminate. Release button and check that the pointer returns to actual gage reading. OXYGEN low-level light should go out.

18. DPLR selector switch — STBY for 30 seconds, then TEST

19. ECM — As required

20. Emergency isolation valve — CLOSED, check caution light off

The EMERG HYD ISO caution light remains on until the isolation valve is closed. Signal ground crew to check accumulators for proper pressures and PC system reservoirs for proper fluid level. If indications are normal, ground crew shall close isolation valve.

21. IMS fine align — Check

After 2 minutes in GND ALIGN:

a. IMS NOT ALIGNED advisory light — Check on

b. ADI OFF flag — Retracted from view

c. IMS caution light — Check off

IMS caution light goes out to indicate completion of coarse alignment.

Note

After 5 minutes total in GND ALIGN position, gross error is eliminated and ground alignment is approximately 95 percent complete.

After 11 minutes total in GND ALIGN position, the ground alignment preflight check is completed. If the aircraft remains stationary for the full 11 minutes in GND ALIGN, the IMS NOT ALIGNED advisory light goes off to indicate completion of fine alignment. The IMS MODE switch may then be moved to NORM or INERTIAL which turns off the GND ALIGN advisory light and permits the aircraft to be taxied without disturbing alignment.

22. TACAN, ILS, VHF — As required

23. RADAR BEACON, Juliet 28 — As required

24. IFF/SIF — TEST

a. MASTER control switch — NORM

b. Place each mode switch to TEST, check TEST indicator light on and then place mode switch to OUT.

c. MASTER control switch — As required

d. Mode switches — Position determined by mission

25. Flaps — Check on signal, then set to 25 degrees for takeoff

Place flap handle in the DN position and check flap position indicators show leading edge DN and trailing edge 40 degrees. WHEELS FLAPS warning light should go off. Ground crew shall visually check for all flaps in the down position. Place flap handle UP and check indicators for leading edge UP and trailing edge 0 degrees, and warning light illuminated. Set trailing edge flaps at 25 degrees. WHEELS FLAPS warning light should go off. Ground crew shall visually check.

CAUTION

On aircraft → [16] [18] → [26] before T.O. 1A-7D-524, the trailing edge flaps must be down 20 degrees or more to ensure full nosewheel steering.

26. AFCS — Perform system self-test

a. Place yaw STAB engage switch in STAB.

Note that the YAW STAB advisory light goes off within 30 seconds.

b. Rotate rudder trim knob clockwise.

Note that the yaw indicator deflects counterclockwise and the rudder deflects in the trailing edge right direction.

c. Rotate rudder trim knob to align yaw indicator bars, use the stick trim switch to trim horizontal stabilizer 1.5 degree trailing edge up, then place AFCS engage switch in CONT AUG.

Note that the PITCH AFCS and ROLL AFCS advisory lights remain off.

d. Move the control stick full travel aft and to the right.

Note that the pitch indicator rotates clockwise, the roll indicator rotates counterclockwise, and the yaw indicator rotates counterclockwise. No AFCS advisory light should come on.

e. Place AFCS test selector switch in RATE, then press the AFCS test pushbutton.

Note that the yaw indicator deflects counterclockwise and returns to zero, the pitch and roll indicators deflect clockwise, and the advisory lights remain off.

f. Place AFCS test selector switch in ACCEL, then press the AFCS test pushbutton.

Note that the yaw indicator deflects counterclockwise in an initial step, then slowly continues to rotate in the same direction; the pitch indicator deflects counterclockwise, and the advisory lights remain off.

g. Place longitudinal mode engage switch in ALT, the AFCS test selector switch in ALT, and then press the AFCS test pushbutton.

Note that the pitch indicator deflects clockwise, the stick moves aft, and the advisory lights remain off.

h. Apply a pitch stick force greater than 4.0 pounds.

Note that longitudinal mode engage switch disconnects. No AFCS advisory lights should come on.

i. Place AFCS test selector switch in MON, then press the AFCS test pushbutton.

Note that the PITCH AFCS, ROLL AFCS, and YAW STAB advisory lights come on.

j. Place AFCS test selector switch in OFF, then cycle the yaw STAB switch to OFF, then back to STAB.

Note that the YAW STAB, PITCH AFCS and ROLL AFCS advisory lights go off.

k. Place AFCS engage switch in CONT AUG, then lateral mode engage switch in HDG, and longitudinal mode engage switch in ALT.

Note that the PITCH AFCS and ROLL AFCS advisory lights remain off.

l. Actuate the AFCS disconnect switch.

Note that all switches on the AFCS control panel unlatch and return to OFF except the yaw STAB engage switch which should remain in STAB.

27. Manual fuel — Check

a. Throttle — 60 percent to 66 percent rpm

b. FUEL CONTROL switch — MAN

Check MANUAL FUEL caution light on.

c. Throttle — Idle

After 15 seconds, RPM must be 54 percent to 64 percent.

CAUTION

If engine speed decreases below 48 percent rpm, shut down the engine immediately. Any attempt to accelerate the engine from below 48 percent may result in severe engine damage.

Note

A positive indication of switchover must be observed. The MANUAL FUEL caution light illuminates anytime the FUEL CONTROL switch is in MAN position and is not a positive indication that a switchover has occurred.

d. FUEL CONTROL switch — NORM

Check MANUAL FUEL caution light off.

28. Air refueling (AR) probe operation — Check, if required, on signal → [16] [18] → [26]

a. AR PROBE switch — EXTEND

Observe probe advisory light on until probe locks in extended position.

b. AR PROBE switch — RETRACT

Hold switch in RETRACT until probe is in and the probe advisory light is out.

29. AR DOOR handle operation — Check, if required, on signal [17] [27] →

a. AR DOOR handle — Pull up

Check refueling READY light on. Have ground crew verify door open.

b. AR DOOR handle — Push in

Ready light should go off. Have ground crew verify door closed.

30. Flight controls and viscous dampers — Check on signal

On signal from ground crew, check for correct, full, and free travel of flight controls and surfaces. Make sure controls contact all stops. Ground crew shall check that all controls move properly and check for aileron-rudder interconnect operation.

Correct aileron-rudder interconnect operation is indicated as follows: stick full forward and full right, rudder trailing edge left approximately 5 degrees; stick full forward and full left, rudder trailing edge right approximately 5 degrees; stick full aft and full left, rudder trailing edge left approximately 5 degrees; stick full aft and full right, rudder trailing edge right approximately 5 degrees. If desired, the yaw AFCS actuator indicator can be used for pilot monitoring of rudder surface position during the aileron-rudder interconnect check in lieu of ground crew observance. (Counterclockwise rotation indicates rudder trailing edge right; clockwise rotation indicates trailing edge left.)

Check viscous dampers by rapidly pushing the control stick full forward. When released, the stick should reposition smoothly to its original position.

31. Trim — Check, set pitch trim 5-degrees nose up for takeoff

a. Rudder — Rotate the rudder trim knob and check for proper movement, left, right, then center

b. Ailerons — Using trim button, check aileron trim left, right, then zero

c. Horizontal stabilizer — Check noseup and nosedown, then set at 5-degrees noseup

Ground crew shall visually check both sides of horizontal stabilizer for movement in the proper direction and for takeoff trim position.

32. Ram air turbine (RAT) — Check on signal

The RAT is extended by pulling out (approximately 2 inches) on the EMER POWER handle. To retract, raise the trigger on the emergency power handle and allow the handle to return to the stowed position.

Note

Pull the EMER POWER handle (RAT) to positive stop (approximately 2 inches) and hold for at least 2 seconds to ensure full extension.

33. Wheel brakes — Check on signal

34. Main landing gear downlocks (2) and nose gear safety pin (1) — Signal for ground crewman to remove. Verify removal

35. Radar altimeter — Check

An indication of 0 (+10, -5) feet is displayed when the control knob is pressed with weight on the gear.

36. DPLR — Check readouts, then as required

After one minute in TEST position, panel readout should be 534.5 (±3) knots groundspeed and 0 (±1) degrees drift.

37. NAV WD computer — Insert destination data

a. Rotary mode selector switch — Desired mode

b. Keyboard panel — Identify destination number

c. KEYBD pushbutton — Press

d. Keyboard panel — Enter required data

e. Latitude and longitude window — Verify data

f. ENT pushbutton — Press to enter data

38. IMS NOT ALIGNED advisory light — Check off

39. IMS MODE switch — As required, GND ALIGN light off

If taxi and takeoff are required before the ground alignment check is completed, select NORM/INERTIAL position after ADI erect is indicated (approximately 2 minutes) and before moving the aircraft. After takeoff, fine alignment is automatically performed when the DPLR becomes available at approximately 50 feet altitude.

CAUTION

If the IMS fails in flight, the IMS light on the caution panel comes on. The ADI power OFF flag also appears, indicating an unreliable ADI. The standby attitude indicator is available for flight reference.

INSTRUMENT CHECK.

1. Standby attitude indicator — Erected and set

2. Airspeed indicator — Check and set memory marker

3. Altimeter — Check barocounters then RESET

Slowly cycle (do not spin) the AAU-19/A barometric setting from 29.92 Hg through 30.00 Hg to ensure smoothness of operation at the rollover point on the barocounters.

Check the HUD altitude display. If within ±75 feet of field elevation, it may be used as an aid for instrument approaches. If the HUD altitude display error is over ±75 feet and less than 116 feet, the HUD is acceptable but will not be used for instrument approaches. A HUD altitude deviation over 115 feet will be entered in the Form 781.

4. Turbine outlet pressure (TOP) — Set index marker

The TOP setting is obtained from the Thrust Check Data charts, this section.

5. Vertical velocity indicator — Check

6. Angle-of-attack indicator — Check operation by moving the angle-of-attack transducer manually and observing indications and cockpit lights

TAXI AND TAKEOFF.

TAXI.

1. Ejection control safety handle — Up (arm)

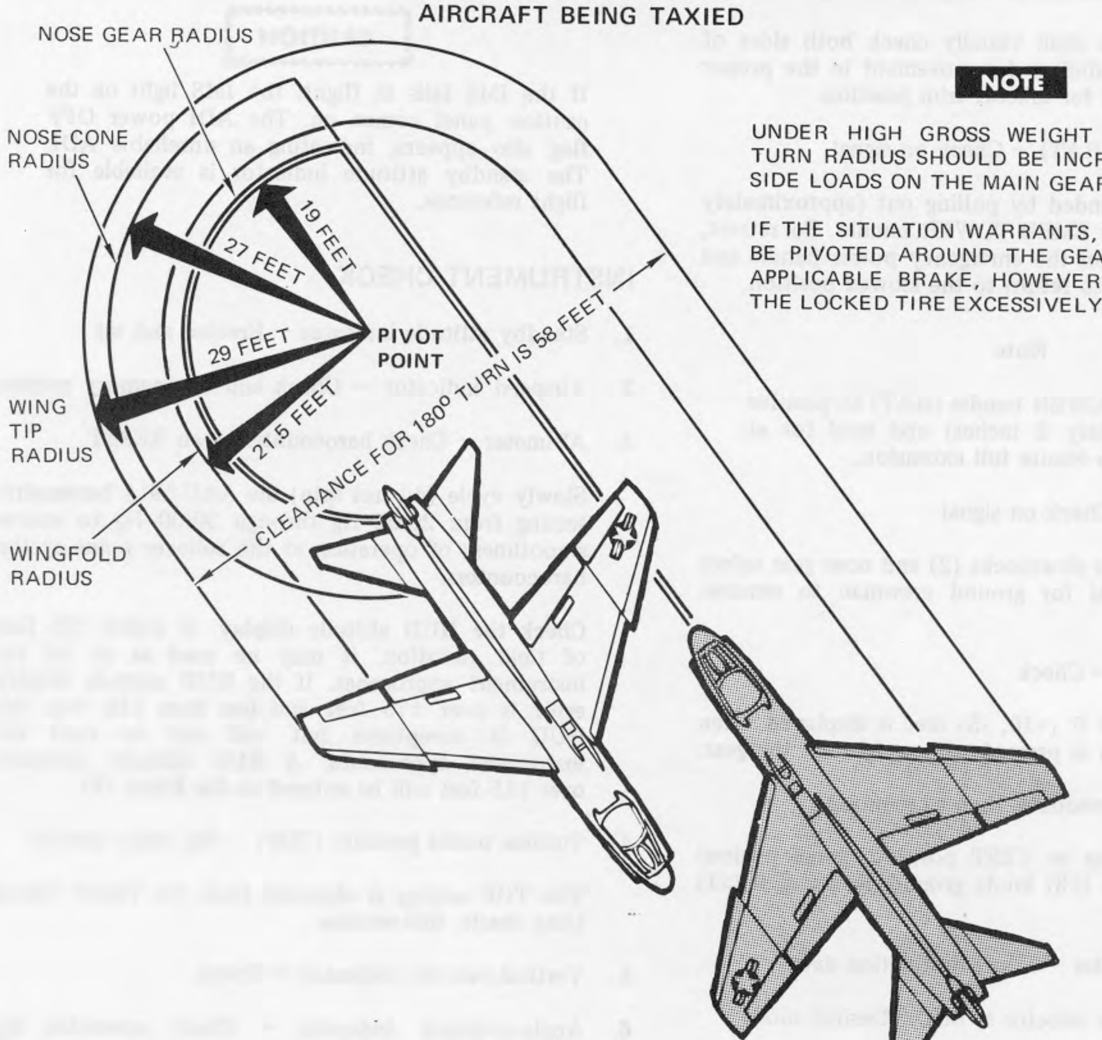
2. Wheel chocks and ground wire — Signal removal

Turning radius is presented in figure 2–5.

3. Nose gear steering and wheel brakes — Check

With aircraft moving, engage nose gear steering and check left and right. Disengage and check for positive release. Reengage steering for taxi.

TURNING RADIUS AND GROUND CLEARANCE



NOTE

UNDER HIGH GROSS WEIGHT CONDITIONS. THE TURN RADIUS SHOULD BE INCREASED TO RELIEVE SIDE LOADS ON THE MAIN GEAR TIRES.

IF THE SITUATION WARRANTS, THE AIRCRAFT CAN BE PIVOTED AROUND THE GEAR BY LOCKING THE APPLICABLE BRAKE, HOWEVER, DOING SO SCUFFS THE LOCKED TIRE EXCESSIVELY.

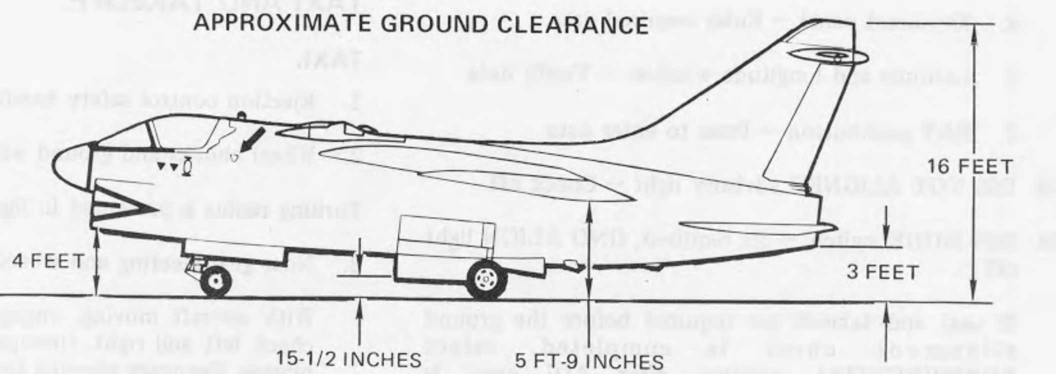


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Figure 2–5

As aircraft rolls forward, check action of wheel brakes. Do not ride brakes or use excessive differential braking during taxi.

CAUTION

On aircraft [17] [27] → [114] before T.O. 1A-7D-597, do not taxi the aircraft with the AR DOOR handle pulled out. With the handle pulled as little as 1/8 inch from full in, nose gear steering system remains in the position selected when the handle is pulled, i.e., if nose gear steering is engaged, depressing the steering button will not disengage nose gear steering. Likewise, if nose gear steering is disengaged, depressing the steering button will not engage nose gear steering. Refueling indicator lights going off is not a positive indication that the AR DOOR handle is full in. On [17] [27] → [114] after T.O. 1A-7D-597 and [115] →, nose gear steering is not affected by AR DOOR handle position.

4. Turn needle — Check

BEFORE TAKEOFF.

The cockpit mounted takeoff checklist is presented in figure 2–6.

1. IFF — As required
2. Canopy defog, cabin temp — As required
3. Anti-ice/pitot heat — As required
4. ANTICOLLISION light switch — BOTH
5. Flaps — Recheck position

   Check flap indicators for down indication, and WHEELS FLAPS warning light off.
6. AFCS — Yaw STAB engaged, CONT AUG if desired
7. Shoulder harness — LOCKED
8. Trim — Recheck 5-degree noseup
9. Canopy — Closed and locked, light out
10. EMERGENCY VENT AIR KNOB — Close
11. Fuel — Checked

    Check quantity indicators for proper fuel transfer.
12. Wingfold — Wings extended and checked

TAKEOFF CHECKLIST

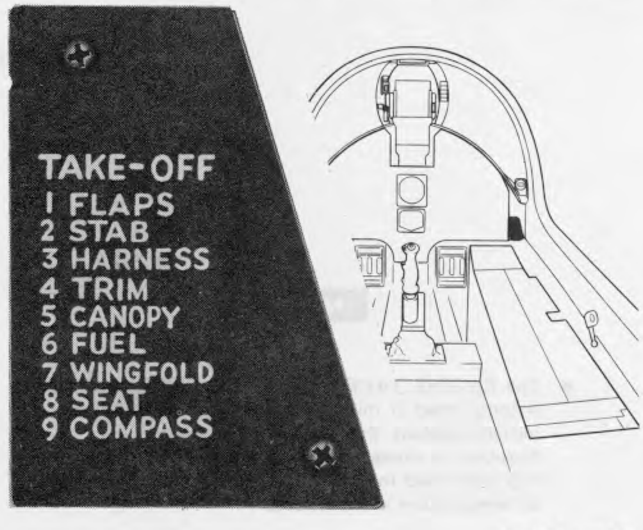

Figure 2–6

13. Seat — Recheck ARM

    Recheck ejection control safety handle armed.
14. Compass — Check
15. RADAR power switch — POWER

    Perform pretakeoff check if required.

    Engine thrust check data is presented in figure 2–7.

TAKEOFF.

1. Throttle — 90 percent rpm or 35 Hg TOP, whichever occurs first

   Note

   Wheel skid may occur when brakes are locked and military power is applied. Skid is possible under average runway and tire conditions when aircraft gross weight is less than 28,000 pounds. Skid may occur under adverse runway and tire conditions when gross weight is as high as 30,000 pounds.
2. Engine instruments, hydraulic pressure, and flight controls — Check

THRUST CHECK DATA — WITH DOUBLE DATUM AMPLIFIER

AIR-CONDITIONING — ON

NOTE

- The ENGINE TAKE-OFF POWER (TOP) check is accomplished at military power after the TOP has initially peaked, then reached maximum droop. Numbers in shaded area are minimum TOP readings permitted for takeoff under given conditions of temperature and pressure.
- For temperatures below 12°C (53.6°F), use 12°C TOP reading.
- If TOP reading is below range of TOP instrument (34°C ambient temperature or higher), turn off air-conditioning and TOP check values shall be 2.0 inches mercury higher than indicated in table below.

TEMPERATURE		PRESSURE ALTITUDE – FEET				
DEG C	DEG F	–800	–400	0	400	800
54	129.2	23.9	23.6	23.3	22.9	22.6
52	125.6	24.6	24.3	23.9	23.6	23.2
50	122.0	25.3	24.9	24.5	24.2	23.8
48	118.4	25.9	25.6	25.2	24.8	24.5
46	114.8	26.7	26.3	25.9	25.5	25.1
44	111.2	27.4	27.0	26.6	26.2	25.8
42	107.6	28.0	27.6	27.2	26.8	26.4
40	104.0	28.8	28.4	28.0	27.5	27.1
38	100.4	29.5	29.1	28.7	28.3	27.9
36	96.8	30.3	29.9	29.5	29.0	28.6
34	93.2	31.1	30.6	30.2	29.8	29.3
32	89.6	31.9	31.4	31.0	30.5	30.1
30	86.0	32.6	32.1	31.7	31.2	30.7
28	82.4	33.3	32.8	32.3	31.9	31.4
26	78.8	34.0	33.6	33.1	32.6	32.1
24	75.2	34.7	34.2	33.7	33.2	32.8
22	71.6	35.4	34.9	34.4	33.9	33.4
20	68.0	36.1	35.6	35.1	34.6	34.1
18	64.4	36.8	36.3	35.7	35.2	34.7
16	60.8	37.4	36.9	36.4	35.8	35.3
14	57.2	38.1	37.5	37.0	36.5	35.9
12	53.6	38.7	38.1	37.6	37.0	36.5

TEMPERATURE		PRESSURE ALTITUDE – FEET											
DEG C	DEG F	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000	4,400	4,800	5,200	5,600
54	129.2	22.2	21.9	21.6	21.3	21.0	20.6	20.3	20.0	19.7	19.4	19.1	18.9
52	125.6	22.9	22.5	22.2	21.9	21.6	21.2	20.9	20.6	20.3	20.0	19.7	19.4
50	122.0	23.5	23.1	22.8	22.5	22.1	21.8	21.5	21.1	20.8	20.5	20.2	19.9
48	118.4	24.1	23.8	23.4	23.1	22.7	22.4	22.0	21.7	21.4	21.1	20.8	20.4
46	114.8	24.8	24.4	24.0	23.7	23.3	23.0	22.6	22.3	22.0	21.6	21.3	21.0
44	111.2	25.4	25.1	24.7	24.3	24.0	23.6	23.3	22.9	22.6	22.2	21.9	21.6
42	107.6	26.1	25.7	25.3	24.9	24.6	24.2	23.8	23.5	23.1	22.8	22.4	22.1
40	104.0	26.7	26.4	26.0	25.6	25.2	24.8	24.5	24.1	23.7	23.4	23.0	22.7
38	100.4	27.5	27.1	26.7	26.3	25.9	25.5	25.1	24.7	24.4	24.0	23.6	23.3
36	96.8	28.2	27.8	27.4	27.0	26.6	26.2	25.8	25.4	25.0	24.7	24.3	23.9
34	93.2	28.9	28.5	28.1	27.6	27.2	26.8	26.4	26.0	25.6	25.3	24.9	24.5
32	89.6	29.6	29.2	28.8	28.4	27.9	27.5	27.1	26.7	26.3	25.9	25.5	25.1
30	86.0	30.3	29.9	29.4	29.0	28.6	28.1	27.7	27.3	26.9	26.5	26.1	25.7
28	82.4	31.0	30.5	30.1	29.6	29.2	28.7	28.3	27.9	27.5	27.1	26.7	26.3
26	78.8	31.6	31.2	30.7	30.3	29.8	29.4	28.9	28.5	28.1	27.7	27.2	26.8
24	75.2	32.3	31.8	31.3	30.9	30.4	30.0	29.5	29.1	28.6	28.2	27.8	27.4
22	71.6	32.9	32.5	32.0	31.5	31.0	30.6	30.1	29.7	29.2	28.8	28.4	27.9
20	68.0	33.6	33.1	32.6	32.1	31.6	31.2	30.7	30.2	29.8	29.3	28.9	28.5
18	64.4	34.2	33.7	33.2	32.7	32.2	31.7	31.3	30.8	30.4	29.9	29.4	29.0
16	60.8	34.8	34.3	33.8	33.3	32.8	32.3	31.8	31.4	30.9	30.4	30.0	29.5
14	57.2	35.4	34.9	34.4	33.9	33.4	32.9	32.4	31.9	31.4	30.9	30.5	30.0
12	53.6	36.0	35.4	34.9	34.4	33.9	33.4	32.9	32.4	31.9	31.5	31.0	30.5

75D031-03-71

Figure 2–7 (Sheet 1)

THRUST CHECK DATA – WITHOUT DOUBLE DATUM AMPLIFIER

AIR-CONDITIONING – ON

NOTE

- The ENGINE TAKE-OFF POWER (TOP) check is accomplished at military power after the TOP has initially peaked, then reached maximum droop. Numbers in shaded area are minimum TOP readings permitted for takeoff under given conditions of temperature and pressure.
- For temperatures below 4°C (39.2°F), use 4°C TOP reading.
- If TOP reading is below range of TOP instrument (28°C ambient temperature or higher), turn off air-conditioning and TOP check values shall be 2.0 inches mercury higher than indicated in table below.

TEMPERATURE		PRESSURE ALTITUDE – FEET				
DEG C	DEG F	–800	–400	0	400	800
54	129.2	21.9	21.6	21.2	20.9	20.6
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50	122.0	23.3	22.9	22.6	22.3	21.9
48	118.4	23.9	23.6	23.2	22.9	22.5
46	114.8	24.6	24.3	23.9	23.6	23.2
44	111.2	25.3	25.0	24.6	24.2	23.9
42	107.6	26.0	25.7	25.3	24.9	24.6
40	104.0	26.8	26.4	26.0	25.6	25.3
38	100.4	27.5	27.1	26.7	26.3	25.9
36	96.8	28.2	27.8	27.4	27.0	26.6
34	93.2	28.9	28.5	28.1	27.7	27.3
32	89.6	29.7	29.2	28.8	28.4	28.0
30	86.0	30.4	29.9	29.5	29.1	28.7
28	82.4	31.1	30.7	30.2	29.8	29.4
26	78.8	31.7	31.3	30.8	30.4	29.9
24	75.2	32.4	31.9	31.5	31.0	30.5
22	71.6	33.1	32.6	32.1	31.7	31.2
20	68.0	33.7	33.2	32.8	32.3	31.8
18	64.4	34.4	33.9	33.4	32.9	32.4
16	60.8	35.0	34.5	34.0	33.5	33.0
14	57.2	35.7	35.2	34.7	34.2	33.7
12	53.6	36.3	35.8	35.3	34.7	34.2
10	50.0	36.9	36.4	35.9	35.3	34.8
8	46.4	37.5	37.0	36.4	35.9	35.4
6	42.8	38.1	37.6	37.0	36.5	36.0
4	39.2	38.7	38.1	37.6	37.0	36.5

TEMPERATURE		PRESSURE ALTITUDE – FEET											
DEG C	DEG F	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000	4,400	4,800	5,200	5,600
54	129.2	20.3	20.0	19.7	19.4	19.2	18.9	18.6	18.3	18.0	17.8	17.5	17.2
52	125.6	21.0	20.7	20.4	20.1	19.8	19.5	19.2	18.9	18.6	18.4	18.1	17.8
50	122.0	21.6	21.3	21.0	20.7	20.4	20.1	19.8	19.5	19.2	18.9	18.6	18.3
48	118.4	22.2	21.9	21.6	21.2	20.9	20.6	20.3	20.0	19.7	19.4	19.1	18.8
46	114.8	22.9	22.6	22.2	21.9	21.6	21.3	20.9	20.6	20.3	20.0	19.7	19.4
44	111.2	23.5	23.2	22.8	22.5	22.2	21.8	21.5	21.2	20.9	20.6	20.3	20.0
42	107.6	24.2	23.8	23.5	23.1	22.8	22.5	22.1	21.8	21.5	21.1	20.8	20.5
40	104.0	24.9	24.5	24.2	23.8	23.4	23.1	22.8	22.4	22.1	21.7	21.4	21.1
38	100.4	25.5	25.1	24.8	24.4	24.0	23.7	23.3	23.0	22.6	22.3	22.0	21.6
36	96.8	26.2	25.8	25.4	25.1	24.7	24.3	24.0	23.6	23.2	22.9	22.6	22.2
34	93.2	26.9	26.5	26.1	25.7	25.3	25.0	24.6	24.2	23.9	23.5	23.1	22.8
32	89.6	27.6	27.2	26.8	26.4	26.0	25.6	25.2	24.8	24.5	24.1	23.7	23.4
30	86.0	28.2	27.8	27.4	27.0	26.6	26.2	25.8	25.4	25.1	24.7	24.3	23.9
28	82.4	28.9	28.5	28.1	27.7	27.3	26.9	26.5	26.1	25.7	25.3	24.9	24.5
26	78.8	29.5	29.1	28.6	28.2	27.8	27.4	27.0	26.6	26.2	25.8	25.4	25.0
24	75.2	30.1	29.7	29.2	28.8	28.4	27.9	27.5	27.1	26.7	26.3	25.9	25.5
22	71.6	30.8	30.3	29.9	29.4	29.0	28.6	28.1	27.7	27.3	26.9	26.5	26.1
20	68.0	31.4	30.9	30.4	30.0	29.6	29.1	28.7	28.3	27.8	27.4	27.0	26.6
18	64.4	31.9	31.5	31.0	30.5	30.1	29.6	29.2	28.8	28.3	27.9	27.5	27.1
16	60.8	32.5	32.1	31.6	31.1	30.7	30.2	29.8	29.3	28.9	28.4	28.0	27.6
14	57.2	33.2	32.7	32.2	31.7	31.3	30.8	30.3	29.9	29.4	29.0	28.6	28.1
12	53.6	33.7	33.2	32.8	32.3	31.8	31.3	30.9	30.4	29.9	29.5	29.1	28.6
10	50.0	34.3	33.8	33.3	32.8	32.3	31.9	31.4	30.9	30.5	30.0	29.5	29.1
8	46.4	34.9	34.4	33.9	33.4	32.9	32.4	31.9	31.4	31.0	30.5	30.0	29.6
6	42.8	35.4	34.9	34.4	33.9	33.4	32.9	32.4	31.9	31.4	31.0	30.5	30.1
4	39.2	35.9	35.4	34.9	34.4	33.9	33.4	32.9	32.4	31.9	31.4	31.0	30.5

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Figure 2–7 (Sheet 2)

3. SP BK switch – Check CLOSE

WARNING

Check for SP BR switch in CLOSE position to preclude possible speed brake extension when the landing gear is raised.

4. ANTI-SKID – ON

Note

The antiskid system may be used only for takeoff and landing.

5. MASTER CAUTION light and caution lights panel – Off

6. Brakes – Release, throttle military power

a. Nose gear steering may be used during the initial part of the takeoff roll to maintain directional control until the rudder becomes effective (about 50 KIAS). Press nose gear steering switch to release steering as rudder becomes effective. Differential braking may also be used if necessary to assist in maintaining directional control. At 6 knots below computed takeoff speed, apply aft control stick pressure and ease the nose gear smoothly from the runway to establish takeoff attitude (normally 5° nose high). If the nose gear is lifted off the runway 6 knots below the computed takeoff speed, a normal takeoff results. A takeoff (typical) is presented in figure 2–8.

7. Check TOP indicator equals or exceeds preset value.

With a double datum amplifier system installed, a TOT indication as low as 560°C may activate the system for a complete 2-minute cycle. If inadvertent activation occurs from engine accelerations or high inlet air temperature during ground operation, the double datum cycle may be timing out when the takeoff power check is made. If double datum has been activated, the engine should be operated for approximately 30 seconds below a TOT of 560°C after the 2-minute double datum cycle has timed out to ensure availability of the higher datum for the takeoff power check.

Note

The TOP check is accomplished at military power after the TOP has initially peaked, then reached maximum droop.

8. Check engine instruments within limits.

Note

Attitude hold should not be used for takeoff or landing.

CROSSWIND TAKEOFF.

Crosswind produces a tendency to weathervane (turn into the wind) and will tend to raise the upwind wing. Nose gear steering or differential braking should be used for directional control below 60 knots. Between 60 and 80 knots the nose gear steering should be disengaged and rudder should be used for directional control. Ailerons may be used to hold wings level and equalize weight distribution on the main landing gear. The ailerons are very effective and should be used to augment rudder for directional control if required. Right aileron (right stick) causes a right turn and left aileron (left stick) causes a left turn. The maximum allowable crosswind component for takeoff is 20 knots for symmetrically loaded aircraft and 15 knots for all asymmetrically loaded configurations not to exceed 13,000 pound-feet asymmetrical moment.

When asymmetrically loaded, the heavier wing drops slightly after brake release. Between 60 to 80 knots, depending on asymmetric load, the heavier wing may be raised by aileron while directional control is maintained by rudder. CONT AUG should be engaged to ensure sufficient aileron authority, and ailerons may be used to augment rudder for directional control if required. Improved aircraft control is noticeable during takeoff when the heavier wing is upwind. Refer to figure A1–7 in Appendix 1 for computation of crosswind components.

AFTER TAKEOFF.

1. Landing gear handle – WHLS UP, when definitely airborne

After definitely airborne and a positive climb is established, place the landing gear handle in the WHLS UP position. Observe that the warning light in the gear handle goes off.

CAUTION

Landing gear retraction above 220 KIAS increases gear retraction time due to increased drag and may result in damage to the gear doors.

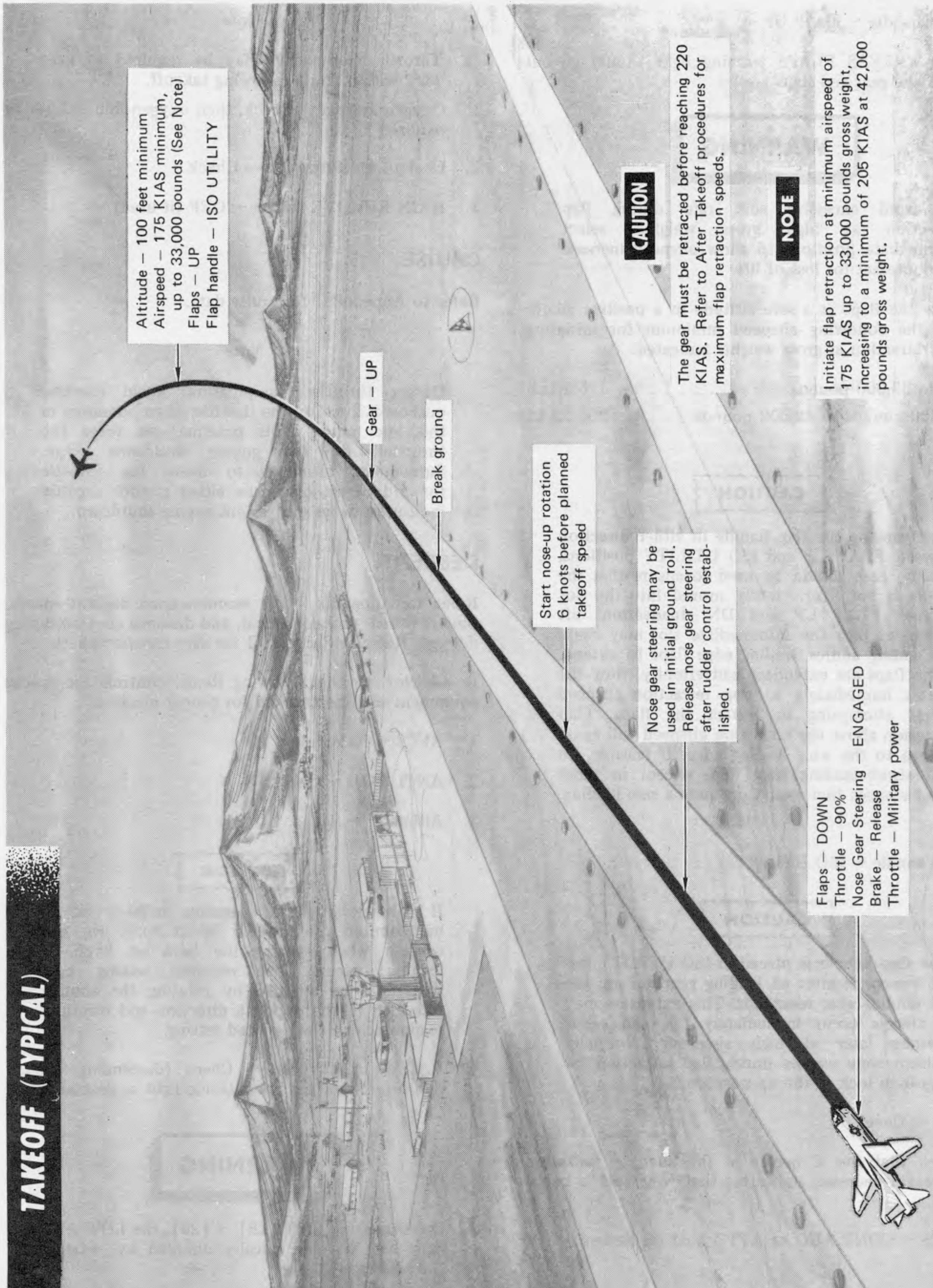
TAKEOFF (TYPICAL)
Altitude – 100 feet minimum
Airspeed – 175 KIAS minimum, up to 33,000 pounds (See Note)
Flaps – UP
Flap handle – ISO UTILITY
Gear – UP
Break ground
Start nose-up rotation 6 knots before planned takeoff speed
Nose gear steering may be used in initial ground roll. Release nose gear steering after rudder control established.
CAUTION
The gear must be retracted before reaching 220 KIAS. Refer to After Takeoff procedures for maximum flap retraction speeds.
NOTE
Initiate flap retraction at minimum airspeed of 175 KIAS up to 33,000 pounds gross weight, increasing to a minimum of 205 KIAS at 42,000 pounds gross weight.
Flaps – DOWN
Throttle – 90%
Nose Gear Steering – ENGAGED
Brake – Release
Throttle – Military power
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Figure 2–8

2. Flap handle — FLAP UP

The WHEELS FLAPS warning light should go out after the gear and flaps are up.

WARNING

To avoid excessive sink rate during flap retraction at high gross weights, select intermediate positions to allow airspeed increase to counteract for loss of lift.

Raise the flaps at a safe altitude in a positive climb. Use the following airspeed minimum for initiating flap retraction at gross weights indicated:

Up to 33,000 pounds . . . . 175 KIAS

33,000 pounds to 42,000 pounds . . . . . 205 KIAS

CAUTION

When moving the flap handle in either direction between FLAP UP and ISO UTILITY positions, extreme care should be used to ensure that the handle is not inadvertently moved into the slot between FLAP UP and DN. Inadvertent aft movement into the intermediate slot may cause the leading and/or trailing edge flaps to extend. If the flaps are extended inadvertently, slow the aircraft immediately to flap retraction airspeed before attempting to retract the flaps. Flap retraction above the retraction airspeed will cause damage to the wing leading edge. If feasible, do not retract leading edge flaps except in those circumstances that would preclude a safe landing.

3. Flap handle — ISO UTILITY

CAUTION

If the flap handle is placed in ISO UTILITY less than 8 seconds after all landing gear are up, the main landing gear reextends. This extension may not always occur immediately but can occur sometime later at high airspeeds. Normally sufficient time elapses during flap retraction for the gear to lock in the up position.

4. Fuel — Check

Check that the T needle of the quantity indicator reflects a decrease, indicating that wing fuel is being used.

5. AFCS — CONT AUG or ATTD hold (as desired)

CLIMB.

Refer to Appendix I for climb speed schedules, distances covered during climb, time to climb, and climb rates.

Note

Throttle modulation may be required to keep TOT within limits following takeoff.

1. Oxygen system — Check, then oxygen diluter lever as required
2. Cockpit pressurization — Check
3. RAIN REMOVE switch — OFF (if used)

CRUISE.

Refer to Appendix I for cruise data.

Note

During throttle manipulation, avoid exerting outboard force on the throttle when operating in the idle range. This practice can force the throttle into the engine shutdown range. Subsequent attempts to move the throttle forward or aft can cause either a stuck throttle indication or an inadvertent engine shutdown.

DESCENT.

Refer to Appendix I for recommended descent speeds, time required, fuel consumed, and distance covered during descent. Refer to Section VI for dive recovery charts.

In addition to the following items, controls for special equipment shall be checked for proper position.

1. AFCS — As required
2. ANTI SKID — Check ON
3. Altimeter — Set

CAUTION

If barometric setting requires rollover of all barocounters, i.e., 29.92 Hg to 30.00 Hg, use caution when turning the baro set knob. If locking occurs, the required setting may sometimes be attained by rotating the knob a full turn in the opposite direction and carefully reapproaching the required setting.

4. RADAR ALTITUDE — Check (descending through 5,000 feet) and set low altitude light as desired

WARNING

On aircraft → [16] [18] → [26], the LOW ALT light can be mechanically dimmed by rotating the lens cap.

5. Fuel — Quantity checked
6. ANTI-ICE PITOT ENG — As required

7. APPROACH INDEXER lights — As required

   On aircraft [17] [27] →, intensity of the APPROACH INDEXER lights is controlled by the WINDSHIELD BOW lights control switch.

8. DEFOG switch — As required

   To avoid cockpit fogging during rapid descent, the defog system shall be turned on at least 5 minutes prior to beginning descent.

9. ARMT switches — SAFE and OFF

10. Flap handle — ISO UTILITY to FLAP UP

BEFORE LANDING.

Refer to Section V for maximum recommended landing gross weights.

1. FUEL DUMP switch — Check OFF (cover down)

2. ALTERNATE FUEL FEED — NORMAL [17] [27] →

3. AR DOOR handle — Full in

   CAUTION

   Do not taxi the aircraft with the AR DOOR handle pulled out. With the handle pulled as little as 1/8 inch from full in, nose gear system will remain in the position selected when the handle is pulled, i.e., if nose gear steering is engaged, depressing the steering button will not disengage nose gear steering. Likewise, if nose gear steering is disengaged, depressing the steering button will not engage nose gear steering. Refueling indicator lights going off is not a positive indication that the AR DOOR handle is full in.

4. ARMT switches — Check

5. Shoulder harness — Locked

6. SP BK switch — CLOSE

   Check advisory light off.

   WARNING

   Check for speed brake switch in CLOSE position to preclude possible speed brake extension should the landing gear be raised during a go-around.

7. Landing gear handle — WHLS DOWN and checked

   Check indicator lights three green, and WHEELS FLAPS warning light off.

   Note

   The WHEELS FLAPS warning light remains flashing until flaps are down.

8. Flap handle — DN and checked

   Check leading and trailing edge flaps down, WHEELS FLAPS warning light off, and CAUTION and ADVISORY lights off.

9. LAND TAXI light — As required

A cockpit-mounted landing checklist is presented in figure 2–9.

LANDING CHECKLIST (TYPICAL)

Figure 2–9

LANDING.

Refer to figure 2–10 for typical landing and go-around pattern.

Set up a power-on rate of descent with the angle-of-attack indexer donut illuminated and aim for a touchdown point 500 to 700 feet beyond the runway threshold. Cross-check angle of attack and airspeed. If final approach

LANDING AND GO-AROUND (TYPICAL)

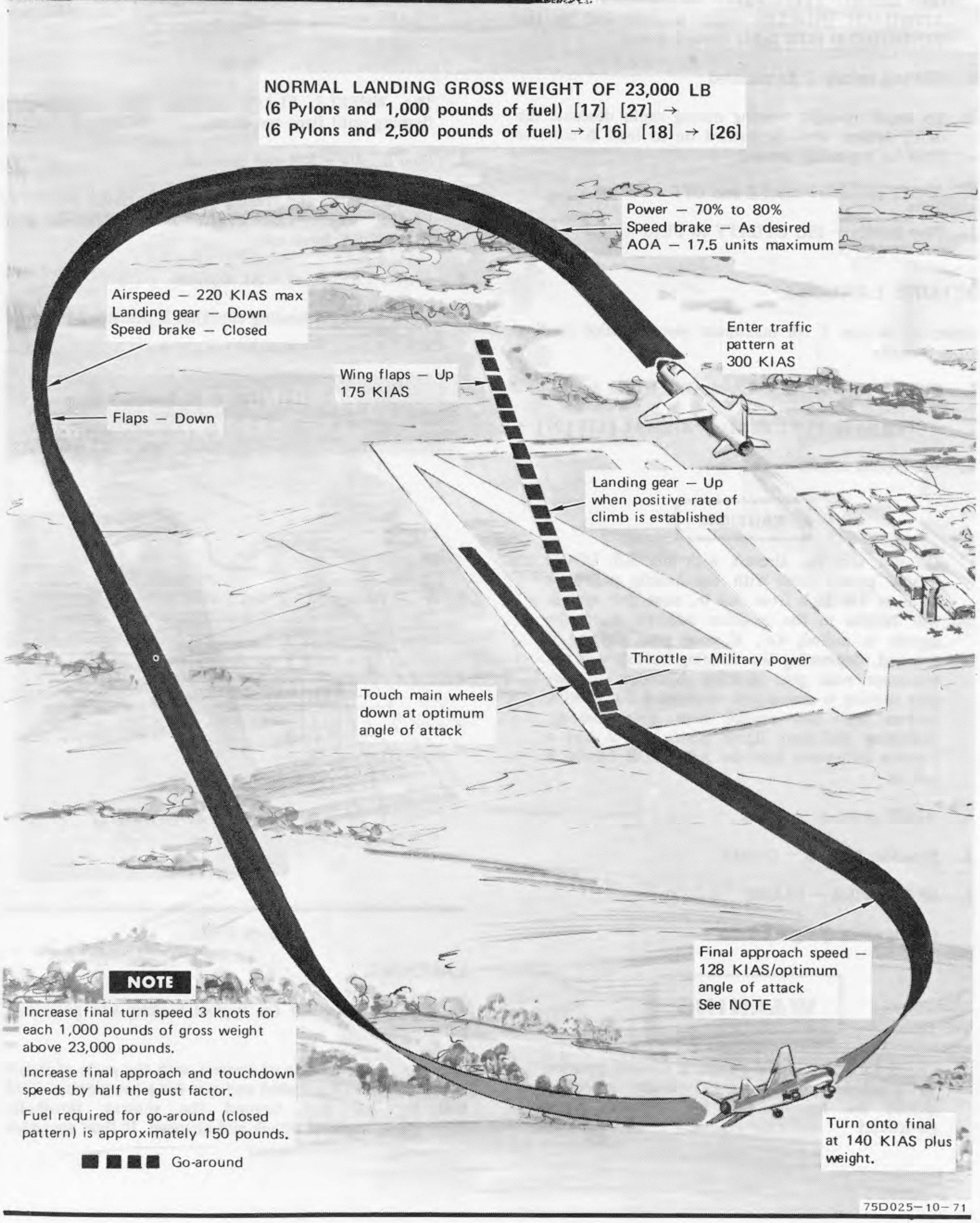


Figure 2–10

drops below computed and the sink rate becomes excessive, correct first by adding power and then adjusting attitude. Hold the donut to touchdown.

If wheel braking without the antiskid system is anticipated and control augmentation is not required for aircraft control, the CONT AUG switch should be placed in OFF before touchdown to remove lateral control stick inputs from the AFCS. Without control augmentation, it is easier to maintain equal weight distribution on the main gear and reduce the possibility of blown tires.

On touchdown with higher sink rates, the aircraft has a tendency to rock forward and, unless a small amount of back stick pressure is held, the nose gear contacts the runway. If the aircraft bounces, reestablish the proper landing attitude and adjust sink rate with throttle. If aircraft control becomes questionable, do not hesitate to execute a go-around.

On the rollout, gradually increase aft stick and hold the nose gear off as long as possible to obtain optimum aerodynamic braking. When the nose gear is on the runway, apply braking and continue to hold aft stick since the horizontal stabilizer remains effective in creating drag.

CAUTION

During aerodynamic braking, do not exceed 21 units angle of attack or damage to the tail cone may result.

Neutralize rudder pedals before engaging nose gear steering or the nose gear will be abruptly displaced in the direction of rudder deflection.

NORMAL ANTISKID BRAKING, DRY RUNWAY

During a normal landing, the use of maximum aerodynamic braking and the full length of the runway to stop the aircraft will conserve the aircraft wheel brakes. Normally light to moderate wheel braking will be all that is required. However, at any time stopping the aircraft in the shortest possible distance is required, the brake pedals should be fully depressed and held. The antiskid system will function to give maximum performance braking. Expect intermittent wheel skidding and brake releases by the antiskid system as this will indicate normal system operation. During maximum performance braking the pilot should hold aft stick. If the antiskid system is functioning properly, full aft stick can be held without raising the nose gear off of the runway (dry runway only; on a wet runway the nose of the aircraft can be held in the air for aerodynamic braking until 100 to 120 KIAS, depending on aircraft weight). Nose gear steering should be used to maintain directional control after the rudder becomes ineffective or when deemed necessary by the pilot.

Maximum performance braking at heavy gross weights and/or high speeds (especially high speed, no flaps) may result in fuzed brakes. Releasing the brakes before coming to a full stop and taxiing clear of the runway will minimize the chance of fuzing the brakes while on the runway.

CAUTION

Maximum performance braking will result in hot brakes. The aircraft should be parked in an isolated area with the wheel axis pointed in a safe direction. Warn other personnel to stay clear. Temperature buildup in the wheel generated during braking reaches its peak 20 to 30 minutes after the braking effort. The blowout plugs in the tires should prevent any violent explosion. They are designed to melt at a temperature of 392°F, releasing the air from the tire.

The aircraft speed at brake application should be noted during maximum performance braking for dry runway landings or refused takeoffs. An entry should be made in the aircraft Form 781 noting maximum performance braking and the ground speed at brake application. (Groundspeed will be IAS minus any headwind component or plus any tailwind component). This speed should be used to enter the Brake Energy Limit chart to determine the Kinetic energy absorbed by the brakes and any necessary action. Information on maximum performance braking from the Form 781 should be used to aid in determining when a brake change is necessary.

MANUAL BRAKING, DRY RUNWAY

To obtain optimum braking action without the antiskid system, apply brakes in a single, smooth application with constantly increasing pedal pressure. Use care when applying brakes above 90 KIAS after touchdown or at any time when there is considerable lift on the wings to prevent skidding and possible blown tires. For maximum performance manual braking, attempt to hold brake pressure just short of wheel skidding. Once locked, a wheel will remain locked as long as brake pressure is maintained. If skidding occurs, momentarily release all

brake pressure and reapply brakes. This procedure will provide the shortest stopping distance possible from wheel braking action without antiskid system.

Note

The reason for using braking without the antiskid system must be considered, i.e., PC 2 failure, antiskid failure, generator failure, etc. If PC 2 failure is the reason, there will be a limited number of accumulator brake applications available.

Nose gear steering should be engaged to maintain directional control after the rudder becomes ineffective or whenever deemed necessary by the pilot.

CROSSWIND LANDING.

The maximum allowable crosswind component for landing is 20 knots for a symmetrically loaded aircraft, and 15 knots for asymmetrically loaded configurations not to exceed 13,000 pound-feet asymmetric moment. The aircraft's ground track must be aligned with runway centerline prior to touchdown by use of a crab, or wing down sideslip or any desired combination of these techniques. Aerodynamic braking (not to exceed 21 units angle of attack) is effective from touchdown to approximately 90 knots, but care must be exercised to maintain a track down the runway centerline. After touchdown the crosswind produces a tendency to weathervane (turn into the wind) and will tend to raise the upwind wing. If the upwind wing is allowed to rise, it will be difficult to lower the wing. Ailerons should be used to hold wings level and equalize weight distribution on the main landing gear while rudder is used to maintain a centerline track. The ailerons are very effective, particularly with control augmentation engaged, and ailerons should be used to augment rudder for directional control if required. Differential braking or nose gear steering are adequate to maintain directional control after the rudder becomes ineffective below approximately 60 knots.

CAUTION

During approach and landing, be cautious of gusts and windshift near the ground. Add 1/2 gust factor in computing final approach and touchdown speed.

LANDING ON WET/ICE RUNWAY.

The technique for a wet or icy runway landing is essentially the same as for a normal landing. Particular attention shall be paid to maintaining final approach speed and touching down as close to the end of the runway as safety permits. As with the normal landing technique, reduce power to IDLE immediately upon touchdown, and gradually increase back stick (not to exceed 21 units angle of attack) for full effect of aerodynamic braking throughout the landing roll. Apply full brakes as the nose falls through.

CAUTION

If water is standing on the runway, the tires may hydroplane. Little or no braking will be available above 90 knots; therefore it is imperative that maximum aerodynamic braking be obtained.

The antiskid system protects against a locked wheel and can effectively and safely produce the maximum deceleration possible for the existing runway conditions. During the high speed portion of the landing roll, little braking deceleration results because the braking potential is very low. As braking potential increases with lowered speeds, the antiskid system increases deceleration accordingly. Nose gear steering will be required to maintain directional control due to aircraft fishtailing. Unless the pilot is familiar with the variables in braking potential of the aircraft, the low deceleration under high speed or adverse runway conditions, and the intermittent brake releases associated with full antiskid modulation, he may mistakenly interpret these as brake or antiskid failure. Use crosswind landing procedures if a crosswind exists. Refer to Appendix 1 for landing data.

CAUTION

If braking action is not apparent below 90 KIAS during antiskid operation, release the brakes, turn the ANTI-SKID switch to OFF, and reapply brakes.

Manual braking on a wet or icy runway will require more care. The most effective braking method is to apply the brakes intermittently. The brakes should be momentarily released and reapplied when a skid is felt. Once locked, a wheel will remain locked as long as brake pressure is maintained. This procedure will provide the shortest stopping distance possible from wheel braking action without the antiskid system.

Note

The reason for using braking without the antiskid system must be considered, i.e., PC 2 failure, antiskid failure, generator failure, etc. If PC 2 failure is the reason, there will be a limited number of accumulator brake applications available.

Manual braking will probably result in locked wheels. Nose gear steering will be required to maintain directional control if the aircraft begins skidding during manual braking. Brake Energy Limits will not be reached on a wet runway due to the lower braking coefficient. Therefore, it will not be necessary to make an aircraft Form 781 entry when making maximum performance braking on a wet runway.

GO-AROUND (TYPICAL).

The decision to go around shall be made as early as possible. When the decision to go around is made, smoothly advance the throttle to military power. Continue the approach maintaining landing attitude as touchdown may be necessary during a late go-around. As the aircraft accelerates, rotate to takeoff attitude (normally 5° nose high) and when a definite climb has been established, perform the normal after-takeoff check. Refer to figure 2–10 for go-around.

Note

If a touchdown is made, accelerate to takeoff airspeed; then establish takeoff attitude and allow the aircraft to fly off the runway.

1. Throttle – Military power
2. Landing gear handle – WHLS UP, when definitely airborne
3. Flap handle – FLAP UP

TOUCH-AND-GO LANDING.

When making a touch-and-go landing, perform a normal approach and landing to touchdown. After touchdown, advance the throttle to MIL and follow normal takeoff procedures.

WARNING

Check for speed brake switch in CLOSE position to preclude possible speed brake extension when the landing gear is raised.

Touch-and-go landings encompass all aspects of the landing and takeoff procedures in a short time span. Be alert for possible aircraft malfunctions during this critical phase of flight.

AFTER LANDING CHECK.

Perform the following steps before clearing the landing runway:

1. Nose gear steering – Engage (as necessary)

   Nose gear steering should be engaged as necessary when rudder control becomes ineffective, preferably at taxi speed.

2. ANTI-SKID switch – OFF

Perform the following check after clearing the landing runway:

3. EMERGENCY VENT AIR KNOB – Open

   Note

   The EMERGENCY VENT AIR KNOB should be open to prevent overpressurization and canopy sheer pin failure when opening the canopy.

4. Canopy – Open

   Hold the restraining handle on the canopy bow until the canopy is full open. Canopy opening should be restrained to prevent excessive opening speed and/or gusty wind conditions from shearing the canopy shearpins.

   CAUTION

   Be extremely careful when opening canopy in high gusty wind conditions. The throttle will be placed in IDLE before opening the canopy.

5. Ejection control safety handle – SAFE (down)
6. LAND TAXI light – As required
7. IFF, AFCS switches, Radar, and Radar altimeter – OFF
8. Trim – Neutral
9. ANTICOLLISION lights – OFF
10. ANTI-ICE PITOT ENG – OFF
11. RAIN REMOVE and DEFOG – OFF
12. RADAR BEACON – OFF

HOT REFUELING PROCEDURES.

Hot pit refueling is allowed with certain items of empty or inert ordnance aboard. Permitted ordnance is limited to the following items:

1. Practice bomblet dispensers (SUU-20), provided dispensers are electrically and mechanically safe
2. Practice rocket dispensers (SUU-20), provided tubes are empty
3. Empty rocket launchers
4. Flare dispensers (SUU-42), provided tubes are empty
5. All captive AIM/AGM missiles used for training purposes that contain inert motor and warhead sections

6. All internal gun systems, provided gun is electrically safe

WARNING

Live ordnance will not be permitted in the refueling area. Photoflash cartridges and flares, rockets/missiles with motor, and freefall ordnance, except inert freefall ordnance, are considered live ordnance and will be removed from the aircraft before entering the refueling area.

Note

Pylon ejector cartridges and cartridge actuated device items are not considered live ordnance.

Perform the following checks before entering the refueling pit:

1. After landing check — Completed
2. DPLR — OFF
3. Hydraulic pressure — Within limits

WARNING

Do not enter the refueling hydrant area when hung ordnance is aboard.

Do not enter the refueling hydrant area until pylon and stores safety pins are installed and internal gun is electrically safe.

Do not enter the refueling hydrant area if another aircraft is in the hydrant area, or a known hot brake condition exists (if notified of hot brakes, taxi clear of the refueling area).

Use minimum power while taxiing in the refueling area.

4. FORMATION lights — BRT (during night refueling)
5. Position lights — STEADY (during night refueling)

Note

Remain alert to all visual signals from the refueling supervisor.

6. Wheel chocks — Installed
7. Ejection control safety handle — Recheck SAFE (down)
8. Lap belt — Unfastened
9. Shoulder harness and survival kit connections — Disconnected
10. Boarding ladder — Checked, steps extended

Note

Do not refuel unless intercom contact is complete between pilot and refueling supervisor.

11. Ground control frequency — Monitored during refueling operation

WARNING

Do not transmit on UHF while refueling except in an emergency.

Terminate all refueling if a malfunction is suspected.

In the event of fire, advise tower of situation and taxi clear of area.

12. To refuel external tanks, perform the following when advised by the refueling supervisor:
    a. AR PROBE — EXTEND → [16] [18] → [26]
    b. AR DOOR handle — Pull up [17] [27] →
13. Refueling complete — AR PROBE switch in RETRACT → [16] [18] → [26], AR DOOR handle down [17] [27] →. Refasten lap belt, taxi to parking area, complete checklist

BEFORE ENGINE SHUTDOWN.

1. Wheels — Chocked
2. Main landing gear downlocks (2) and nose gear safety pin (1) — Verify installed
3. Flap handle — FLAP UP (WHEELS FLAPS caution light flashes)

CAUTION

On aircraft → [16] [18] → [26] before T.O. 1A-7D-524, the trailing edge flaps must be down 20° or more to ensure full nose gear steering.

4. START ABORT switch — Check ABORT

CAUTION

Failure to place the START ABORT switch in ABORT, coupled with inadvertent movement of the throttle to CRANK, will result in starter initiation. Starter damage may occur.

5. HUD — OFF
6. DPLR — OFF
7. NAV WD Computer — OFF
8. IMS MODE switch — OFF

CAUTION

Failure to turn off the inertial measurement set (IMS) before engine shutdown results in excessive drain on the IMS battery.

9. Communications and navigation switches — OFF
10. Wingfold — As required

ENGINE SHUTDOWN.

Stabilize TOT at IDLE before engine shutdown.

1. Throttle — OFF

   Check RPM indicator for free engine deceleration.

2. FUEL MASTER handle — OFF

   Place FUEL MASTER handle in OFF after engine stops rotating.

CAUTION

Do not shut down engine with the FUEL MASTER handle. Damage to the main fuel pump may result.

3. BATT switch — OFF

BEFORE LEAVING AIRCRAFT.

1. All electrical switches — OFF
2. EMERGENCY VENT AIR KNOB — Close
3. Ejection control safety handle — Recheck SAFE (down)

WARNING

Do not unbuckle parachute leg straps before exiting cockpit. Unbuckled straps may become entangled with the primary ejection handle and fire the seat.

4. After leaving cockpit — Ensure ejection seat initiator safety pin (1), canopy jettison initiator safety pin (1), and external fuel tank safety pins installed

Note

The pilot shall also make entries into Form 781 indicating when any flight limits have been exceeded.

SCRAMBLE TAKEOFF PROCEDURE.

Abbreviated scramble procedures may be used if the following actions have been completed prior to the aircraft being placed in alert status:

1. Park the aircraft in the alert area. Perform a complete preflight interior inspection, including an engine start, a complete before taxi check, and an instrument check.
2. Perform a complete IMS alignment with current present position, entry of destinations, offset data, target elevation and MSLP. The platform true heading will be recorded in AF Form 781 and on the pilot's knee pad; any time the aircraft is moved, it will be recorded in the AF Form 781 and a new alignment must be performed to obtain a new heading. Leave the computer in IMS-HUD, UPDATE, and PRES POS.
3. Cock the aircraft for scramble by placing all mission applicable fuel and electrical switches (except the battery switch) in the ON position. Turn the IMS off prior to engine shutdown; turn it on prior to securing the aircraft. (This prevents IMS battery decay.)

BEFORE TAXI (SCRAMBLES ONLY).

1. BATT switch — ON
2. Start engine.
3. Connect all personal equipment and strap in.
4. Wings spread — Check locked; light out
5. Altimeter — Check barocounters then RESET
6. Flight controls — Check

7. Perform IMS/HUD alignment.

   a. Keyboard — Press

   b. Keyboard panel — Type in platform heading recorded from pre-alert ground alignment. This data appears on the lower line of the display in seven digits.

   c. ENT pushbutton — Depress

   d. As soon as IMS NOT ALIGNED light comes on, switch IMS to NORM and designate.

   e. IMS NOT ALIGNED light — Check off

   f. IMS — GND ALIGN (25 seconds)

   g. IMS — NORM

   h. IMS NOT ALIGNED advisory light — Check on

8. Seat — Recheck ARM

9. Taxi

BEFORE TAKEOFF (SCRAMBLES ONLY).

1. Flaps — Recheck position
2. AFCS — Yaw STAB and CONT AUG engaged
3. Shoulder harness — LOCKED
4. Trim — Recheck 5 degrees noseup
5. Canopy — Closed and locked, light out
6. EMERGENCY VENT AIR KNOB — Close
7. Fuel — Checked
8. Wingfold — Check locked, light out
9. Seat — Recheck ARM
10. Compass — Check
11. ANTI SKID — ON

AVIONIC SELF-CHECKS.

NAV WD COMPUTER SELF-TEST.

The test is initiated by selecting any attack mode and momentarily placing the COMPUTER OFF-POWER-TEST switch in TEST. Approximately 17 seconds after the computer switch is placed in TEST, the digital data display windows must display all 8's for 4 seconds, and the CMPTR light must not illuminate. Information cannot be entered into the computer during the test.

CAUTION

Do not place the NAV WD Computer switch in TEST during or after IMS fine align has started or all fine align will be lost. Fine align will be reinstated when the NAV WD Computer is out of TEST.

During the test, the HUD presents the following displays:

1. Flightpath Marker — Positioned in the center of the HUD field of view
2. Aiming Symbol — Overlays the Flightpath Marker
3. Bombfall line — Positioned perpendicular to the horizontal reference, through the Flightpath Marker, and through standby reticle aiming dot.
4. Solution Cue No. 1 — Positioned at the bottom of the aiming symbol
5. Solution Cue No. 2 — Positioned at the top of the aiming symbol
6. Pullup Anticipation Cue — Positioned to intersect the Flightpath Marker

A malfunction in the HUD is indicated by displacement of one or more symbols. A malfunction within the computer is indicated by illumination of the CMPTR light on the caution panel.

RADAR CHECKS.

Pretakeoff Check.

Perform the following checks prior to takeoff to ensure that the radar system is functioning properly. When possible, point the aircraft toward a reflective target that is positioned at a distance of 1 to 10 miles.

Place the system controls and switches in the following positions:

Radar Set Control	*Position*
OFF-STBY-POWER switch	STBY
ANTENNA TILT	0 (Detent)
TER CLEAR	500 feet
MODE SELECT	GMS

Wait approximately 3 minutes and then place the OFF-STBY-POWER switch in the POWER position and perform the following:

1. TF mode switch — TF selected
2. FAIL light — Observe off

3. Ten-mile RANGE light — Observe on

4. Climb command on ADI — Observe indication

5. TF mode switch — TF deselected

Spoking may occur with receiver gain too high. The video level should be adequate on display before reaching this condition. (See figure 1–104, sheet 1.)

Proper display setup procedures:

1. Brilliance full down (CCW)

2. Set receiver gain full down (CCW)

3. Set video gain full down (CCW)

   Minimum receiver and video gain allows scope brilliance adjustment without the influence of video and provides a check on uniformity of intensity.

4. Adjust brilliance control CW for a light line paint at each side of display

5. Set storage full up (CW) then just slightly back CCW until storage remains for one cycle. Mode TA

6. Map mode (GMP or GMS). Adjust receiver gain 1/3 to 1/2 CW

Note

Increasing the receiver gain control beyond this point would tend to saturate the receiver video while raising the receiver noise level. The result would be poor target definition and a spoking paint of receiver noise that would have a greater tendency to mask targets than to enhance them.

7. Set video gain full up (CW)

8. Minor adjustment may be required with the storage control

Inflight Turnon Procedure.

If the radar system has been off prior to becoming airborne, place the OFF-STBY-PWR switch in the POWER position and allow at least 3 minutes for the system to time out. Select the desired mode and adjust the controls as necessary.

STRANGE FIELD TURNAROUND PROCEDURES.

The following procedures provide servicing instructions when ground crew personnel are not familiar with the aircraft. These procedures shall be used by the pilot only after a thorough briefing by home base maintenance personnel on all aspects of servicing the aircraft. Servicing fluid specifications are contained in the Servicing Diagram, figure 2–11.

When required to direct or accomplish servicing of the aircraft at a strange field, proceed as follows.

ENGINE OIL SERVICE.

Note

For accurate oil level determination, check engine oil during the time interval between 5 and 20 minutes after engine shutdown.

The oil sight gage is located behind access door 5222-3-3, on the left rear side of the fuselage.

1. If oil is not in the green band of the sight glass, open access door 5222-4 and remove oil filler cap.

2. Add the number of quarts (indicated by graduations) of MIL-L-7808 oil to restore level within green band. Do not overfill.

3. Reinstall and lock oil filler cap.

CONSTANT SPEED DRIVE (CSD) SERVICE.

Note

Checking CSD oil level with engine operating results in false indication.

Before each engine run, check CSD oil level as follows:

1. Open access door 6222-3.

2. If oil level is not within green band of sight glass, open access door 6222-1, remove overflow plug, and add MIL-L-7808 oil until level is within green band. Reinstall and lock plug.

CAUTION

To prevent inaccurate oil level checks, do not check CSD oil level until five minutes after engine shutdown.

JET FUEL STARTER OIL SERVICE.

Note

There are two separate oil reservoirs on the starter.

1. Open access door 6222-2-1.

2. Remove dipstick adjacent to starter exhaust, wipe dipstick, replace, and remove again. If oil does not show on the dipstick, add MIL-L-7808 oil to overflowing. Replace and lock dipstick.

3. Remove oil fill plug on accessory section of starter. Add MIL-L-7808 oil, if necessary, to bring level to overflowing. Replace and lock plug.

SERVICING DIAGRAM

WARNING

JP-5 fuel does not contain an anti-ice additive. To prevent fuel system icing and possible engine flameout, avoid flight at altitudes where the outside air temperature is 2°C (35°F) and below.

FLUID SPECIFICATION		
	USAF	NATO
Fuel	Normal: MIL-T-5624 (Grade JP-4) Emergency: MIL-T-5624 (Grade JP-5)	F-40
Engine Oil	MIL-L-7808	0-148
Hydraulic Fluid	MIL-H-5606B	H-515
Nitrogen	BB-N-411b	
Liquid Oxygen	MIL-O-27210 (Grade A, Type I or II)	None
Turbine Oil	MIL-L-6085	0-147

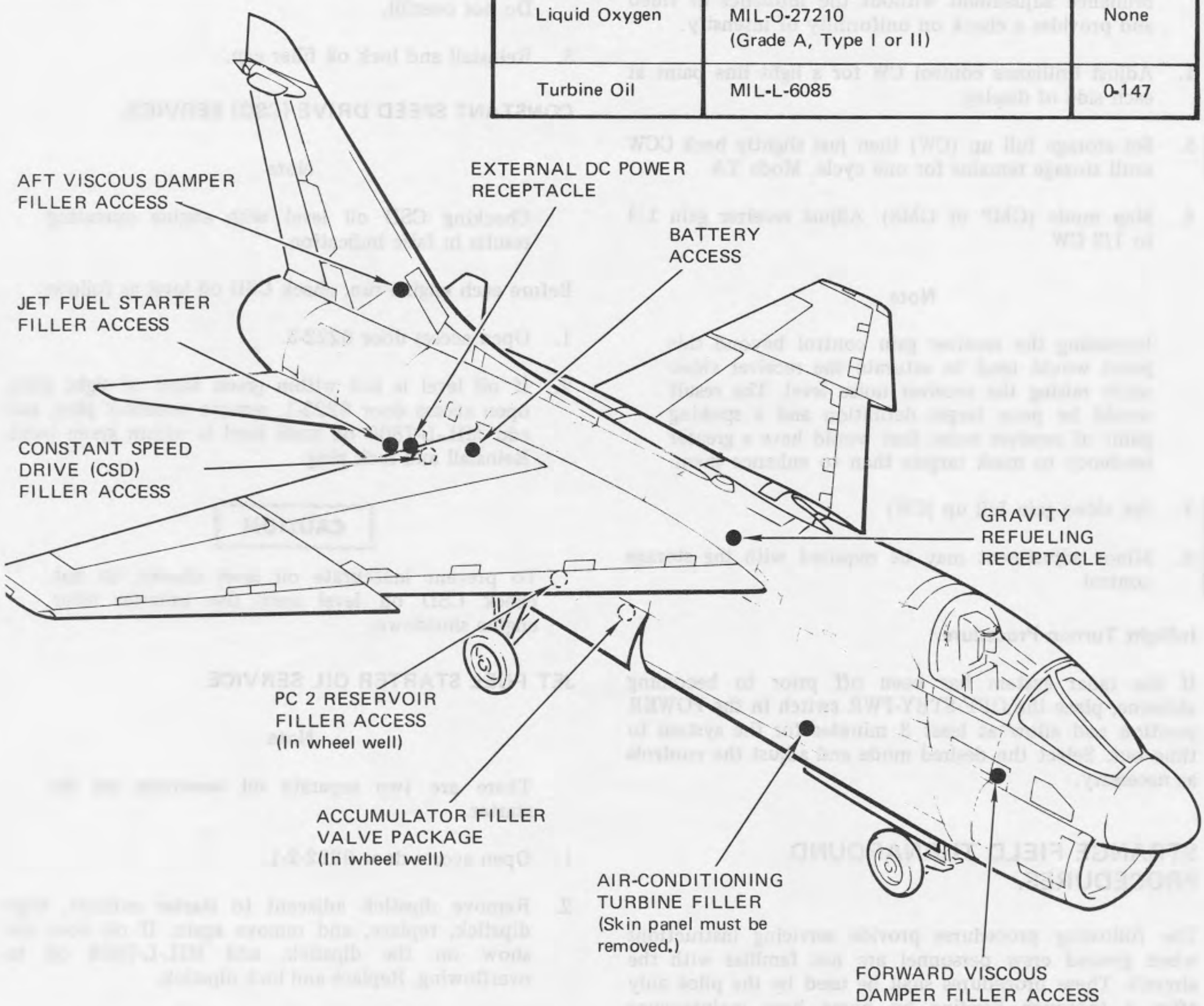


Figure 2–11 (Sheet 1)

SYSTEM SERVICING	
Engine Constant Speed Drive Jet Fuel Starter	Engine Oil
PC 1 PC 2 PC 3 Viscous Dampers	Hydraulic Fluid
Liquid Oxygen Converter	Liquid Oxygen
All External and Internal Fuel Tanks	Fuel
All Hydraulic Accumulators	Nitrogen
Air-Conditioning Turbine	Turbine Oil

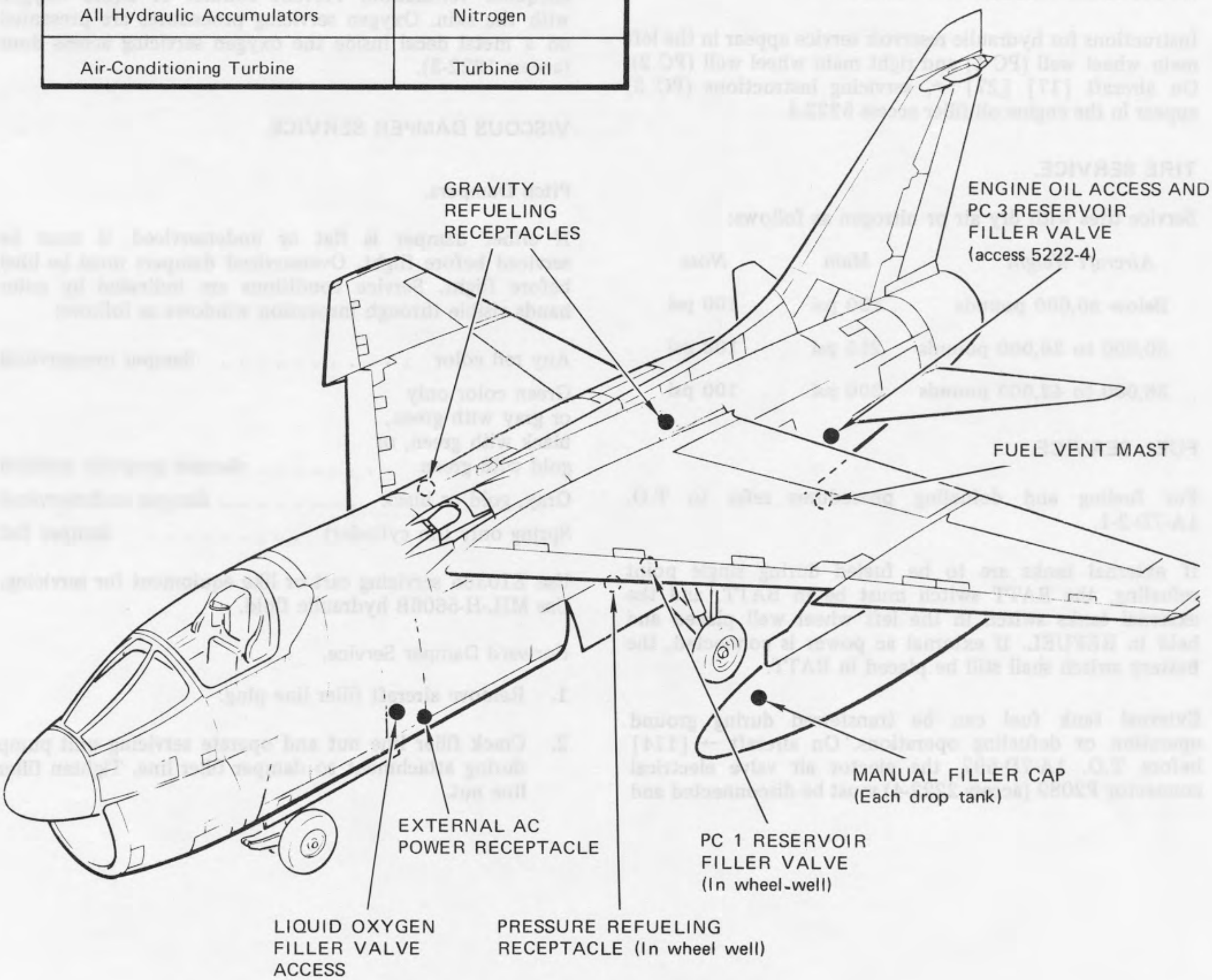


Figure 2–11 (Sheet 2)

SHOCK STRUT SERVICE.

For instructions for servicing shock struts, refer to T.O. 1A-7D-2-1.

ACCUMULATOR PRECHARGING.

Accumulator filler instructions appear on a decal attached to the right main gear door.

LANDING GEAR DOWNLOCK REMOVAL.

CAUTION

Advise ground personnel not to forcibly remove jammed main landing gear downlocks as the landing gear may collapse.

HYDRAULIC RESERVOIR SERVICE.

Instructions for hydraulic reservoir service appear in the left main wheel well (PC 1) and right main wheel well (PC 2). On aircraft [17] [27] →, servicing instructions (PC 3) appear in the engine oil filler access 5222-4.

TIRE SERVICE.

Service tires with dry air or nitrogen as follows:

Aircraft Weight	*Main*	*Nose*
Below 30,000 pounds	190 psi	100 psi
30,000 to 36,000 pounds	215 psi	100 psi
36,000 to 42,000 pounds	300 psi	100 psi

FUEL SERVICE.

For fueling and defueling procedures refer to T.O. 1A-7D-2-1.

If external tanks are to be fueled during single point refueling, the BATT switch must be in BATT, and the external tanks switch in the left wheel well placed and held in REFUEL. If external ac power is connected, the battery switch shall still be placed in BATT.

External tank fuel can be transferred during ground operation or defueling operations. On aircraft → [114] before T.O. 1A-7D-597, the ejector air valve electrical connector P2089 (access 2222-4) must be disconnected and then the right main gear up-and-locked switch manually actuated to remove electrical power from the pressurization valve. If the aircraft engine is not operating, an external air source must be connected.

CAUTION

On aircraft → [114] before T.O. 1A-7D-597, to prevent overheating of air-conditioning systems, do not hold right gear up-and-locked switch in the up-and-locked position with engine running unless ejector air valve electrical connector P2089 is disconnected.

OXYGEN SERVICE.

Service oxygen system with MIL-0-27210 (Grade A, Type I or Type II) liquid oxygen only. Keep oxygen away from oil, grease, or other combustible materials. Ensure adequate ventilation. Prevent contact of liquid oxygen with the skin. Oxygen servicing procedures are presented on a metal decal inside the oxygen servicing access door (access 1222-3).

VISCOUS DAMPER SERVICE.

Pitch Dampers.

If either damper is flat or underserviced, it must be serviced before flight. Overserviced dampers must be bled before flight. Service conditions are indicated by color bands visible through inspection windows as follows:

Any red color . . . . damper overserviced

Green color only
or gray with green,
black with green, or
gold with green . . . . damper properly serviced

Gray, gold or black . . . . damper underserviced

Spring only (no cylinder) . . . . damper flat

Use E10385 servicing cart or like equipment for servicing. Use MIL-H-5606B hydraulic fluid.

Forward Damper Service.

1. Remove aircraft filler line plug.

2. Crack filler line nut and operate servicing unit pump during attachment to damper filler line. Tighten filler line nut.

3. Operate servicing unit pump slowly, filling damper until only green color fills the inspection window.

WARNING

If ANY red color is visible in the inspection window, damper is overserviced and must be bled.

4. Disconnect servicing unit line and install damper filler line plug.

Aft Damper Service.

1. Remove filler access panel (access 9113-3).
2. Remove damper filler cap, crack servicing unit line nut, operate pump during attachment to damper filler valve. Tighten servicing unit line nut.
3. Operate servicing unit pump slowly, filling damper until only green color fills inspection window.

WARNING

If ANY red color is visible in the inspection window, damper is overserviced and must be bled.

4. Disconnect servicing unit filler line and install damper cap. Torque cap to 50 (±10) pound-inches. If cap comes loose in flight, it could jam the vertical fin control linkage.

Bleeding Damper After Overservice (Forward Or Aft).

1. Remove access panel for forward or aft damper, respectively.

Note

Do not move aircraft control stick during bleeding operation.

2. Carefully crack top bleed plug on damper and allow fluid to escape until green color is visible in the inspection window, and gray, black or gold color just appears at the edge of the inspection window. Tighten bleed plug.
3. Perform servicing procedure until only green color shows in inspection window.

Operational Check After Damper Service (Forward Or Aft).

1. Pressurize both PC systems to 3,000 psi.
2. Check control stick response by moving stick forward approximately 3 inches, and then releasing. A slow, steady return to neutral indicates normal damper action. Snapback of any kind indicates air in the damper and bleeding is required. (See air in damper bleed procedure.) Excessive play or sloppiness in the area of neutral stick position indicates underservicing. Perform normal or flat damper filling procedure if applicable.

Excessively slow return to neutral indicates that viscous dampers are possibly overserviced and excess fluid must be bled.

Bleeding Damper Of Air (Forward Or Aft).

Perform this operation if operational check indicates air in damper.

1. Remove applicable access panel.
2. Operate servicing unit pump while attaching filler line to damper valve. Tighten nut.
3. Pressurize both PC systems to 3,000 psi.

CAUTION

Excessive stick force while cycling fore and aft to bleed the system may break the forward damper rod end.

4. Crack damper top bleed plug and bleed air and fluid from damper as control stick is cycled fore and aft with quick, smooth strokes. MAINTAIN POSITIVE PRESSURE WITH SERVICING UNIT PUMP DURING BLEED OPERATION (maximum 50 psi). Continue bleeding until fluid is free of air and sponginess or snapback in control stick is eliminated.
5. Remove both PC system pressures; tighten bleed plug.
6. Reservice the damper as necessary.
7. Disconnect servicing unit line; install damper filler line plug/cap.

Filling Flat Damper (Forward Or Aft).

Damper is considered flat if internal spring only (no cylinder) is visible.

1. Repeat steps 1 and 2 of filling procedure for appropriate damper.

2. Operate servicing unit pump slowly, filling damper until red color first appears (50 psi maximum).

3. Bleed air from damper in accordance with air in damper bleed procedure.

4. If red color is still visible after bleeding air from damper, bleed fluid until only green color is visible.

WARNING

If ANY red color is visible in the inspection window, damper is overserviced and must be bled.

Lateral Damper.

If the lateral damper is underserviced or flat, servicing is not required until return to home station or to a base where maintenance personnel are familiar with the aircraft. If damper is overserviced (as evidenced by observing lower red, or green and upper red bands in the inspection window), it must be bled until lower red and green bands are visible.

EXTERNAL POWER.

For external electrical power (except starting) use AM32A60 (115/200-volt, 3-phase, 400-cycle) unit or like equipment. Plug into the ac electrical receptacle on the left forward side of the fuselage. Under no circumstances shall a generator power unit be connected to the dc electrical power receptacle for starting. For emergency, use a 28-volt dc aircraft battery or two 12-volt auto batteries in series and connect to dc electrical receptacle. Receptacle locations are referenced in figure 2–11.

CAUTION

If a generator power unit is connected to the external dc power receptacle as a power source for starting, damage to the aircraft battery and the engine starter will result.

External batteries may be connected to the external dc power receptacle for a maximum period of 5 minutes to provide dc power for starting. Damage to the aircraft battery may result if the external batteries remain connected beyond the 5-minute period.

EMERGENCY PROCEDURES

SECTION III

TABLE OF CONTENTS.

Note

Critical steps of an emergency procedure are printed in bold face capital letters. In an actual emergency, these steps must be performed immediately without reference to a written checklist.

LAND AS SOON AS POSSIBLE.

Land the aircraft without delay. Aircraft gross weight may be reduced by dumping wing fuel and/or jettisoning external load. A landing shall then be accomplished at the nearest suitable airfield.

LAND AS SOON AS PRACTICAL.

Aircraft gross weight may be reduced by dumping or burning out fuel. A landing can be accomplished any time after maximum landing gross weight is reached.

RAT.

This term shall be used throughout Section III when reference is made to the Emergency Power Package. For the EMER POWER handle (as labeled in the cockpit) the term EMER POWER handle (RAT) shall be used.

GROUND OPERATION EMERGENCIES

STARTER OVERHEAT/FIRE.

1. START ABORT SWITCH — ABORT

CAUTION

Allow a minimum of 5 seconds for starter to run down before returning starter switch to NORM. Moving the switch out of ABORT before 5 seconds has elapsed may result in starter relight and damage to the starter.

If STARTER caution light remains illuminated or if fire persists:

2. FUEL MASTER handle – OFF
3. Throttle – OFF
4. BATT – OFF
5. Abandon aircraft

STARTER OVERSPEED.

If starter shutoff has not occurred by idle rpm:

1. START ABORT switch – ABORT

ENGINE FIRE DURING START.

1. THROTTLE — OFF

2. FUEL MASTER handle – ON

CAUTION

The OFF position of the fuel master handle prevents engine cranking.

3. Throttle – CRANK

   Continue cranking until fire is out.

When fire is out, or if fire persists:

4. START ABORT switch – ABORT
5. FUEL MASTER handle – OFF
6. BATT – OFF
7. Abandon aircraft

BRAKE FAILURE.

To obtain accumulator braking after failure of PC 2 system:

1. ANTI-SKID switch – BRAKE ACCUM → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →

   ANTI-SKID switch – OFF → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685

After exhaustion of the utility brake accumulator:

2. EMERG BRAKE handle – Pull aft slowly

   Braking is not linearly proportional to brake handle movement.

CAUTION

Pull handle slowly to avoid locking the brakes as application is extremely sensitive in the effective braking range. Anticipate rapid stops, probable blown tires, and loss of directional control if the emergency braking system is used to stop the aircraft during landing rollout. Differential and antiskid braking are not available with emergency braking.

Note

Approximately five separate brake applications can be obtained with pressure supplied by the emergency brake accumulator.

3. Shut down the engine if necessary

HOT BRAKES.

Hot brakes result from aborted takeoff, excessive braking, or dragging brakes. If hot brakes are discovered, have the aircraft moved to an isolated area and park the aircraft with wheel axis pointed in a safe direction. Warn other personnel to stay clear. Temperature buildup in the wheel generated during braking reaches its peak 20 to 30 minutes after the braking effort.

ANTISKID FAILURE.

If wheel braking is lost with PC 2 system pressure normal and with the antiskid switch on, antiskid system failure probably has occurred. Disengage the antiskid system in the following manner:

1. Wheel brakes — Release

CAUTION

Release the brakes before turning the ANTI SKID switch OFF to prevent tire skidding and possible blown tires.

2. ANTI SKID switch — OFF
3. Wheel brakes — Reapply

If braking is not regained:

4. EMERG BRAKE handle — Pull aft slowly

   Refer to brake failure.

TAKEOFF EMERGENCIES

ABORT/BARRIER ENGAGEMENT.

1. THROTTLE — IDLE (OFF FOR FIRE)

WARNING

When the generator drops off the line, antiskid braking and nose gear steering are not available.

On aircraft → [16] [18] → [26] before T.O. 1A-7D-519, do not shut down engine unless on fire. Maintain idle rpm until fire equipment arrives and hook is cooled. Engine shutdown allows fuel to vent in the vicinity of a hot hook.

2. WHEEL BRAKES — APPLY

CAUTION

If the throttle has been placed OFF, the ANTI-SKID switch must be placed in BRAKE ACCUM on aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] → to obtain utility brake accumulator pressure for differential braking.

Heavy braking during a heavy gross weight abort will result in hot brakes.

Note

Maximum performance antiskid braking should be used if required to stop the aircraft in the remaining available runway.

When aborting on a wet runway, the tires may hydroplane. Little or no braking will be available above 90 KIAS; therefore, it is imperative that maximum aerodynamic braking be obtained.

3. ARRESTING HOOK — EXTEND (At least 2,000 feet prior to barrier)

See figure 3–10 for maximum engaging speeds.

4. Shoulder harness – Locked

5. Use ailerons and rudder to maintain directional control. When effectiveness of flight controls is lost, use nose gear steering and brakes as necessary.

6. Steer for center of barrier and make contact perpendicular to the barrier.

7. Engage barrier with brakes off and sufficient aft stick to fully extend the nose gear strut.

CAUTION

At nose low aircraft attitudes (nose strut compressed due to forward stick forces or applied brakes) the angle between the hook shank and the runway may be large enough to raise the nose of the hook point off the runway. To ensure optimum hook point attitude, engagements should be made as slow as possible. If it is necessary to engage the arresting gear at high speed, optimum hook point attitude can be attained by applying sufficient aft stick to ensure full extension of the nose gear strut with the nose wheel on the runway.

The canopy shall be retained during all emergencies that could result in structural damage or fire during landings, aborted takeoffs, and barrier arresting gear engagements. The protection the canopy affords the pilot during these emergencies far outweighs the isolated risk of entrapment due to a canopy malfunction or aircraft overturn. During aircraft abandonment, normal canopy opening procedures shall be considered first. These considerations do not preclude the pilot from exercising judgment in jettisoning the canopy when he deems it necessary. Refer to Emergency Ground Egress.

ENGINE FAILURE DURING TAKEOFF.

If decision is made to stop:

1. ABORT

Refer to Abort procedures this section.

If unable to abort:

1. EXTERNAL LOAD – JETTISON

Note

Stations 3 and 6 cannot be jettisoned unless the landing gear is up and locked.

2. ZOOM, IF POSSIBLE, AND EJECT

If airborne and unable to eject, land straight ahead and perform as many of the following procedures as possible:

3. Airspeed – 140 KIAS minimum
4. RAT – Extend
5. Throttle – OFF
6. Perform emergency landing gear extension

   Refer to Emergency Landing Gear Extension procedure.

7. Perform emergency flap extension

   Refer to Emergency Flap Extension procedure.

ENGINE FIRE DURING TAKEOFF.

If decision is made to stop:

1. ABORT

Refer to Abort procedure this section.

2. FUEL MASTER handle – OFF

If takeoff is continued:

1. THROTTLE — MILITARY POWER (To safe ejection altitude)

2. EXTERNAL LOAD — JETTISON (If necessary)

3. IF ON FIRE — EJECT

TIRE FAILURE DURING TAKEOFF.

If decision is made to stop:

1. ABORT

Refer to Abort procedure, this section.

2. ANTI SKID — OFF

Note

Nose gear steering shall be used for primary directional control. Do not engage nose gear steering with rudder pedals displaced from neutral.

If takeoff is continued:

1. EXTERNAL LOAD — JETTISON (If necessary)

2. DO NOT RETRACT GEAR

Refer to Landing with Blown Tire procedure.

ASYMMETRICAL FLAP CONDITION DURING TAKEOFF.

In the event an asymmetrical flap condition occurs, sufficient aileron exists to overcome the effects of the rolling moment induced. Use of roll and yaw trim increases available roll control.

If transitioning to climb configurations:

Control augmentation (CONT AUG) may be used to reduce pilot effort required to maintain aircraft control. If flaps become asymmetrical during transition, immediately reposition flap handle to previous position. If a symmetrical flap condition is obtained, do not reselect flaps. Perform a normal or flaps up landing as appropriate.

If flaps remain asymmetrical:

1. Select jettison stores from the up flap side only

CAUTION

Do not jettison external load to the extent that the asymmetrical load limit is exceeded.

2. Perform slow flight controllability check at a safe altitude

3. Land as soon as practical

INFLIGHT EMERGENCIES

EJECTION.

The ejection seat escape system provides safe escape during level flight conditions from zero altitude and from zero airspeed to 650 KIAS except for high rate of descent or steep bank conditions at low altitude. For effects of bank angle, dive angle, and rate of descent on ejection capability, refer to figures 3–1 and 3–2 (aircraft → [10]) and to figures 3–1 and 3–3 (aircraft [11] →).

The ground level capability of the ejection seat can be utilized in the event of overrun into a hazardous area or in other situations in which sufficient flying speed is not available. When ejecting at minimum altitudes, use of the primary ejection handle is recommended as the most expeditious means of abandoning the aircraft.

WARNING

Do not attempt to jettison a partially opened or raised canopy. Do not eject with the canopy in the partially or fully opened position.

The possibility of canopy/seat collision exists during ejection on the ground under deceleration forces greater than 1.2g at low speeds. Maximum normal or emergency braking causes forces less than 1.2g. The effect of deceleration g forces beyond that found in maximum normal or emergency braking can seriously degrade performance of the escape system. Experience has proven the airframe strong enough to withstand overrun into most hazardous areas without disintegration. These factors should be considered when making the decision to ride out a crash landing or eject.

If the aircraft is descending out of control, eject at an altitude not lower than 10,000 feet above the terrain. Below 10,000 feet, if uncontrolled flight is entered, don't hesitate; eject. If the aircraft is in controlled flight and you decide to eject, head the aircraft away from populated areas.

A human factor study and analysis of ejection seat escape criteria for all types of aircraft reveals that forces exerted on the body increase as airspeed increases.

WARNING

Wind blasts will exert medium forces on the body up to 450 KIAS. Severe forces cause flailing and skin injuries result between 450 and 600 KIAS. Excessive forces result above 600 KIAS.

PREPARATION FOR EJECTION.

If time and conditions permit:

1. At low altitude and with sufficient airspeed – Establish a climb

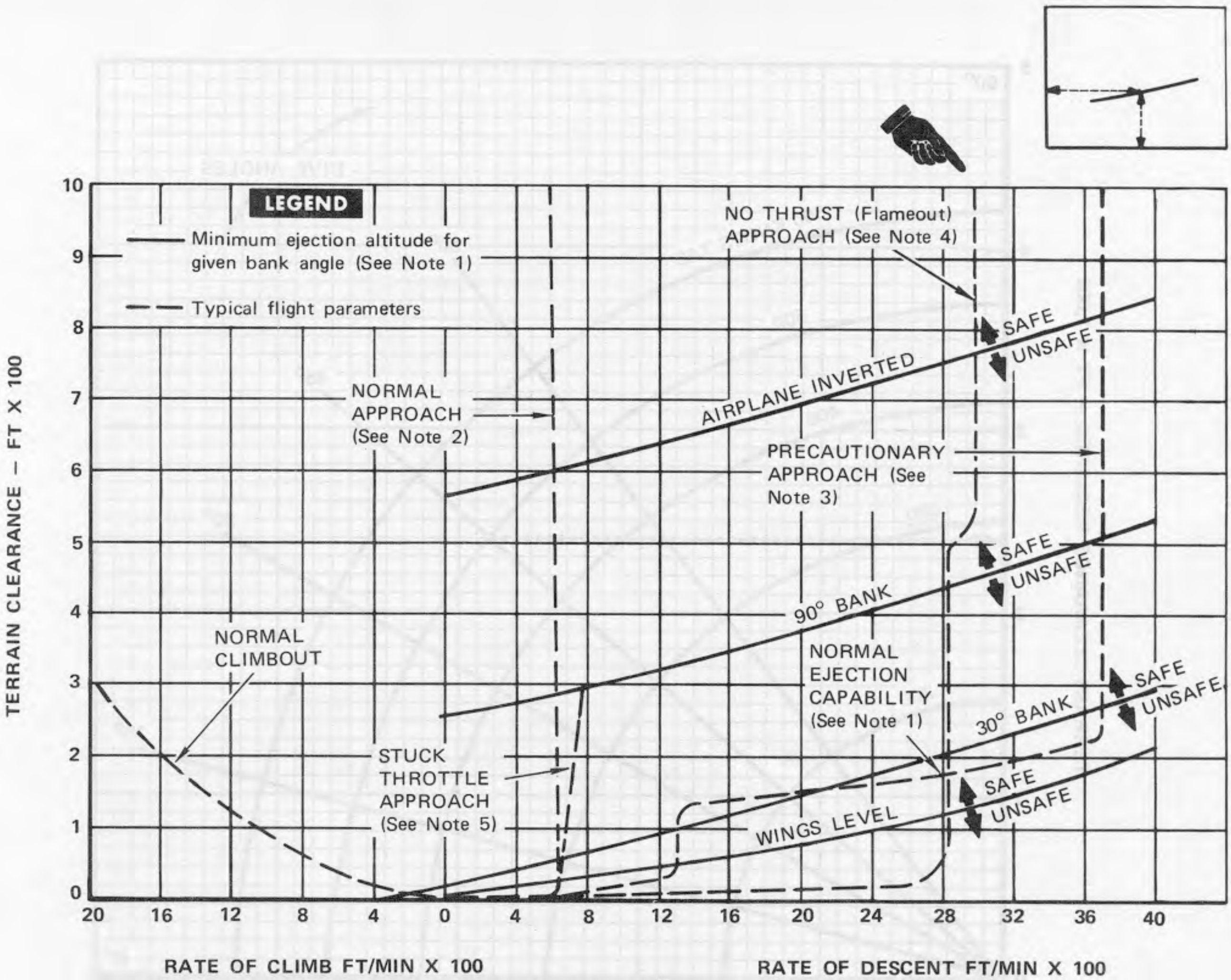
   To perform a power-off pullup, apply light to moderate aft stick force until a climb is established maintaining 20 units angle of attack.

2. Airspeed – Reduce below 250 KIAS, if possible
3. IFF – EMER
4. Transmit Mayday and give position
5. Turn aircraft toward uninhabited area
6. Stow loose gear
7. Manually lock shoulder harness
8. Lower helmet visor
9. Assume proper ejection position

EJECTION PROCEDURE.

Refer to figure 3–4 for ejection procedure.

EFFECT OF RATE OF DESCENT ON EJECTION CAPABILITY



NOTE

1. Ejection capability based on:
   a. Two-second pilot reaction time.
   b. 0° pitch attitude.
   c. Maximum operational ejected weight.
2. Normal approach based on 128 KIAS.
3. Precautionary approach based on 150 KIAS.
4. No thrust (flameout) approach based on 175 KIAS, TE flaps down 20°.
5. Stuck throttle approach based on:
   a. Hoop entry at 215 KIAS.
   b. 20 knot headwind.
6. Terrain clearance based on sea level terrain.

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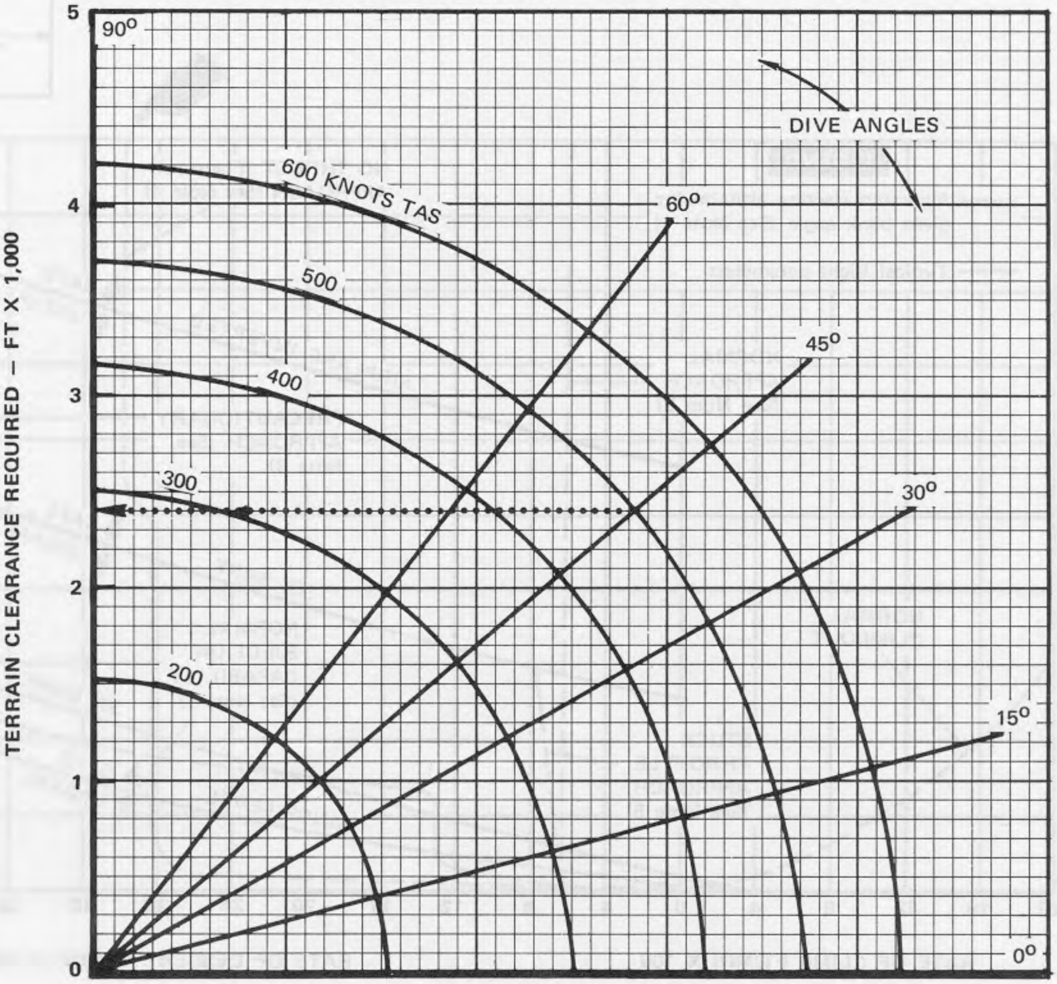
Figure 3–1

DIVE EJECTION CAPABILITY → [10]



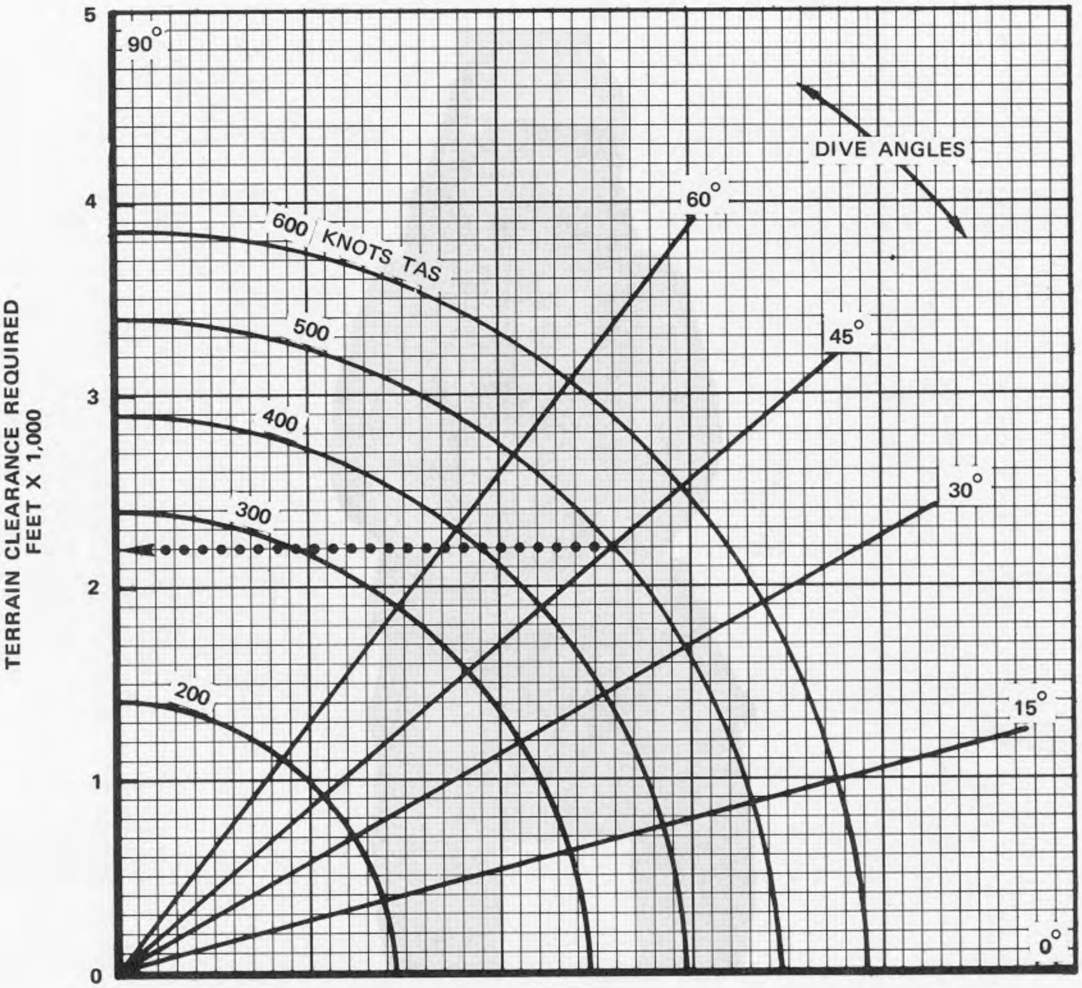
NOTES

1. Curves include 2-second pilot reaction time.
2. Curves are based on wings-level bank attitude and 0° angle of attack.
3. Terrain clearance required is based on sea level terrain.
4. Curves are based on maximum operational ejected weight.
5. Example: At 500 knots TAS in a 45° dive, terrain clearance required is 2,400 feet.

75D052–02–70

Figure 3–2

DIVE EJECTION CAPABILITY [11] →



NOTES

1. Curves include 2-second pilot reaction time
2. Curves are based on wings-level bank attitude and 0° angle of attack
3. Terrain clearance required is based on sea level terrain
4. Curves are based on maximum operational ejected weight
5. Example: At 500 knots TAS in a 45° dive, terrain clearance required for safe ejection is 2,112 ft

75D181−02−70

Figure 3–3

EJECTION PROCEDURE

UNDER CONDITIONS WHERE EJECTION MUST BE MADE WITHOUT HESITATION.

1. PRIMARY EJECTION HANDLE OR FACE CURTAIN – PULL

NOTE

- Grasp primary ejection handle with either hand. The other hand should grasp either the primary ejection handle or opposite wrist.
- If the face curtain is used, grasp the curtain ring with both hands, elbows in, and thumbs pointed outboard. Then pull down in one continuous motion until seat ejects.

75D125–10–71

Figure 3–4

EJECTION SEQUENCE OF EVENTS.

For sequence of events, refer to figure 3–5 for aircraft → [10] and to figure 3–6 for aircraft [11] →.

If time and conditions permit:

1. Prior to ejecting, correct inverted and severe yaw flight conditions and make every attempt to reduce speed below 250 KIAS.

2. Sit erect in seat, buttocks against backrest, head firmly against headrest, spine straight, thighs firmly against survival kit, legs extended forward with feet on rudder pedals, harness properly adjusted and tight, inertia reel locked.

   Eject by grasping the primary ejection handle and pull up (about 4 inches) in one firm continuous motion. In aircraft → [10], the seat rocket fires in 0.4 second. In aircraft [11] →, the seat rocket fires as soon as the canopy clears the aircraft. If the canopy does not jettison, the seat fires through the canopy in 0.4 second. In all aircraft, seat separation takes place 1.0 second after ejection and the parachute deploys after a time delay of 2 seconds when below the preset altitude of 14,000 feet.

Note

Emergency (bailout) oxygen is not available after ejection.

AFTER EJECTION.

If the automatic functions fail to actuate the harness release and separate the pilot from the seat 1.0 second after ejection, pull the emergency harness release handle, lunge forward, and push free from the seat. If below 14,000 feet, allow 2 seconds for the automatic altitude time delay parachute opener to function. If the automatic parachute opener fails to deploy the parachute when below 14,000 feet, pull the parachute D-ring. Disconnect one side of the oxygen mask and raise the helmet visor to provide better visibility for landing. If a landing in trees is evident, lower the visor and loosely reattach the oxygen mask for face protection.

If the automatic release feature of the survival kit has been selected and the survival kit does not deploy in 4 seconds after parachute line stretch, pull the manual kit release handle. The parachute container separates and falls free from the pilot and the survival bag and liferaft release from the survival kit. As the seat kit falls away, the valve on the CO_2 cylinder opens to automatically inflate the raft. The inflated raft and equipment are attached to the pilot by a 25-foot lanyard. The suspended equipment will gyrate during descent. Leg movements are necessary to avoid becoming tangled with the lanyard. Equipment gyrations dampen near the surface. After surface contact, release the shoulder fittings to release the parachute canopy and release the survival kit equipment by disconnecting the hip fittings.

OVERWATER EJECTION.

Inflate personal flotation gear prior to contact with water. Disconnect shoulder fittings immediately after water contact to free the parachute canopy. Rapid release of the canopy is desired to avoid becoming entangled in the shroud lines. Board raft and carry out survival procedures. Completely release survival equipment before entering a helicopter rescue sling.

EJECTION SEAT FAILURE.

If all attempts to eject have failed, ditching or rough field landing (conditions permitting) is considered the best course of action. Bailout shall be accomplished only as the last resort for personal survival. If the aircraft is out of control, acceleration forces shall generally dictate the manner in which the pilot evacuates the aircraft.

WARNING

Inverted attitudes are not advised for bailout. To maintain inverted flight, the tail must be placed several additional feet below the cockpit, creating the hazard of striking the tail of aircraft.

The following assumes that pilot control of the aircraft is available.

The recommended configuration for bailout is landing gear up, wing flaps down, and external stores jettisoned. If available, the AFCS (ATTD HOLD, HDG SEL, ALT HOLD) shall be engaged and airspeed maintained 20 to 30 knots above stall. If possible, the bailout shall be accomplished at 10,000 feet or above. Disconnect all personal leads, and dump cockpit pressure. Lower the seat full down and pull the emergency harness release handle to become free from the seat. Rotate body forward to dislodge forward hooks on the survival kit, and move into a crouching position on the seat. If the canopy is still on the aircraft, jettison the canopy with the canopy jettison handle or by actuating the canopy handle to unlock. If

EJECTION SEQUENCE → [10]

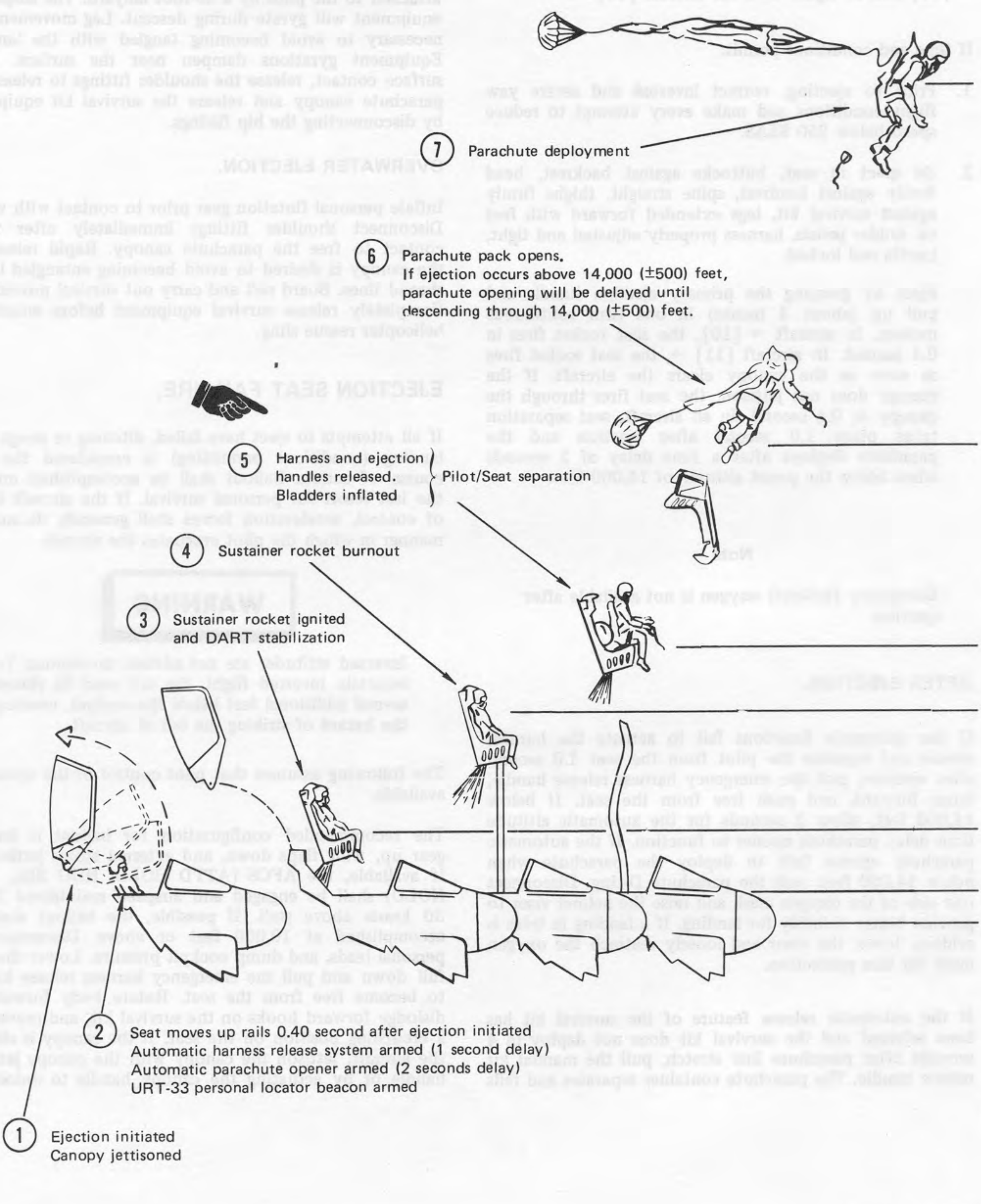
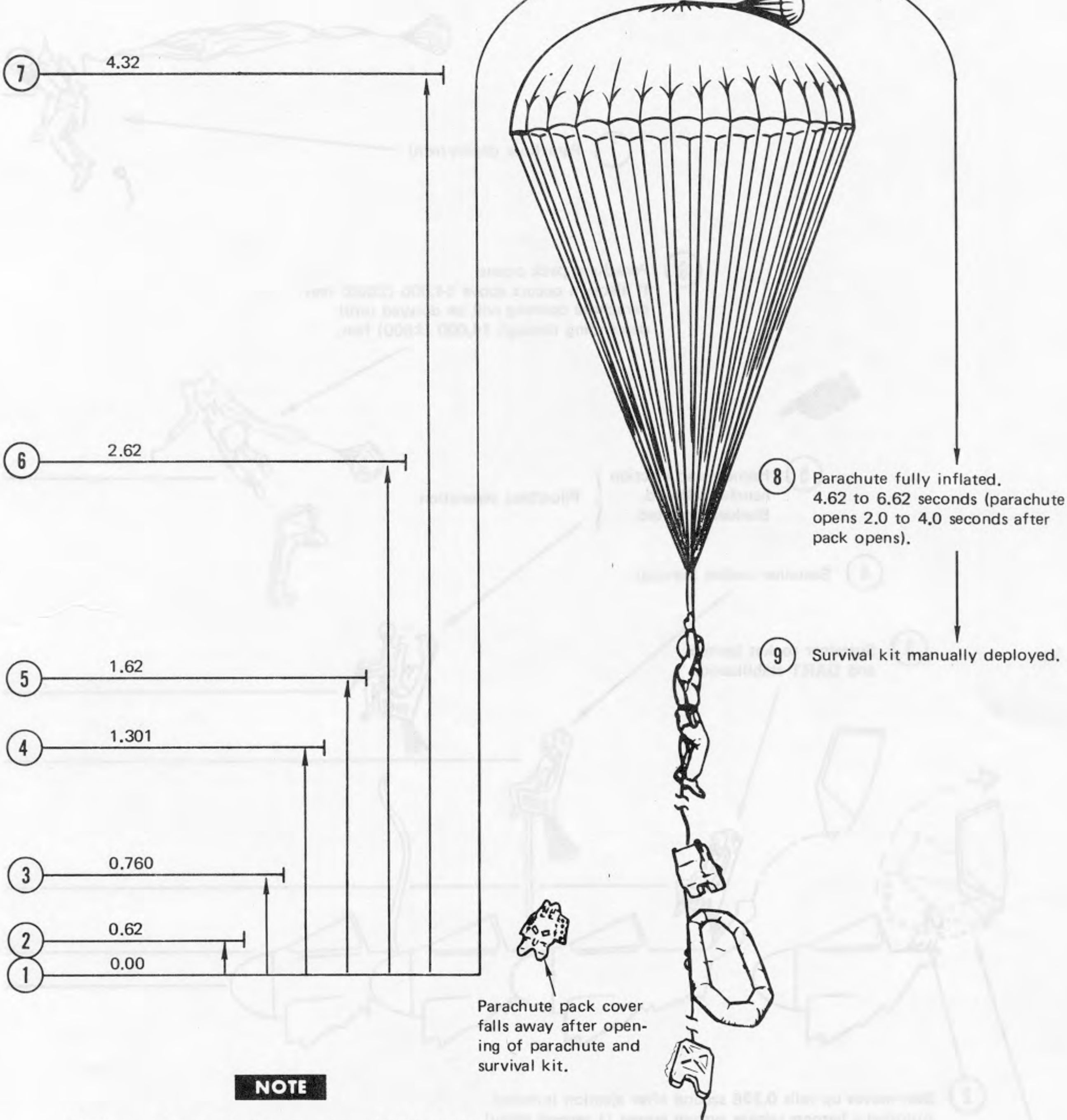


Figure 3–5 (Sheet 1)



NOTE

All times are at nominal temperature of 21°C (70°F)
300 Knots

Survival kit may be deployed by pulling the survival kit release handle.

The kit is shown deployed for reference only.

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Figure 3–5 (Sheet 2)

EJECTION SEQUENCE [11] →

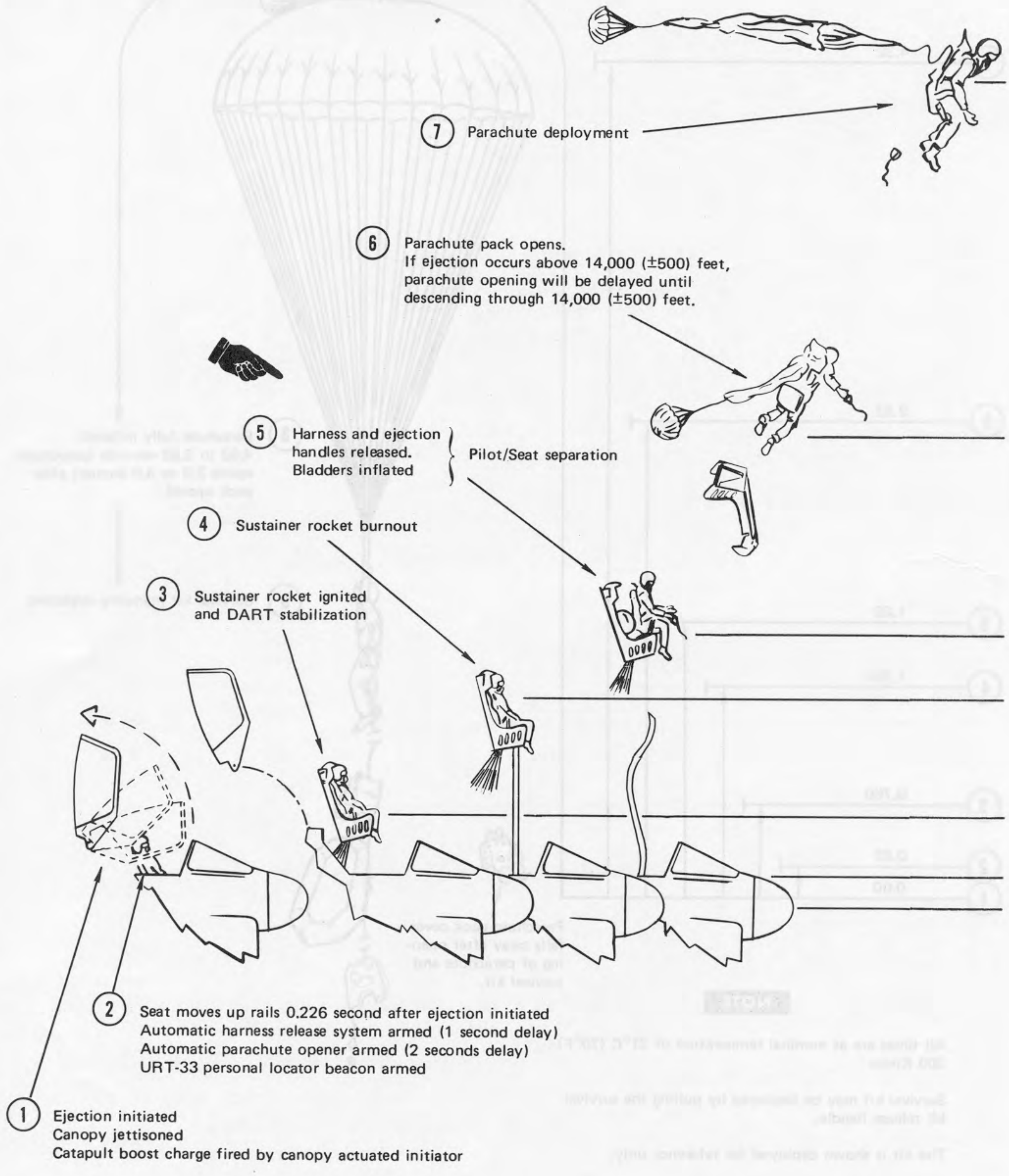
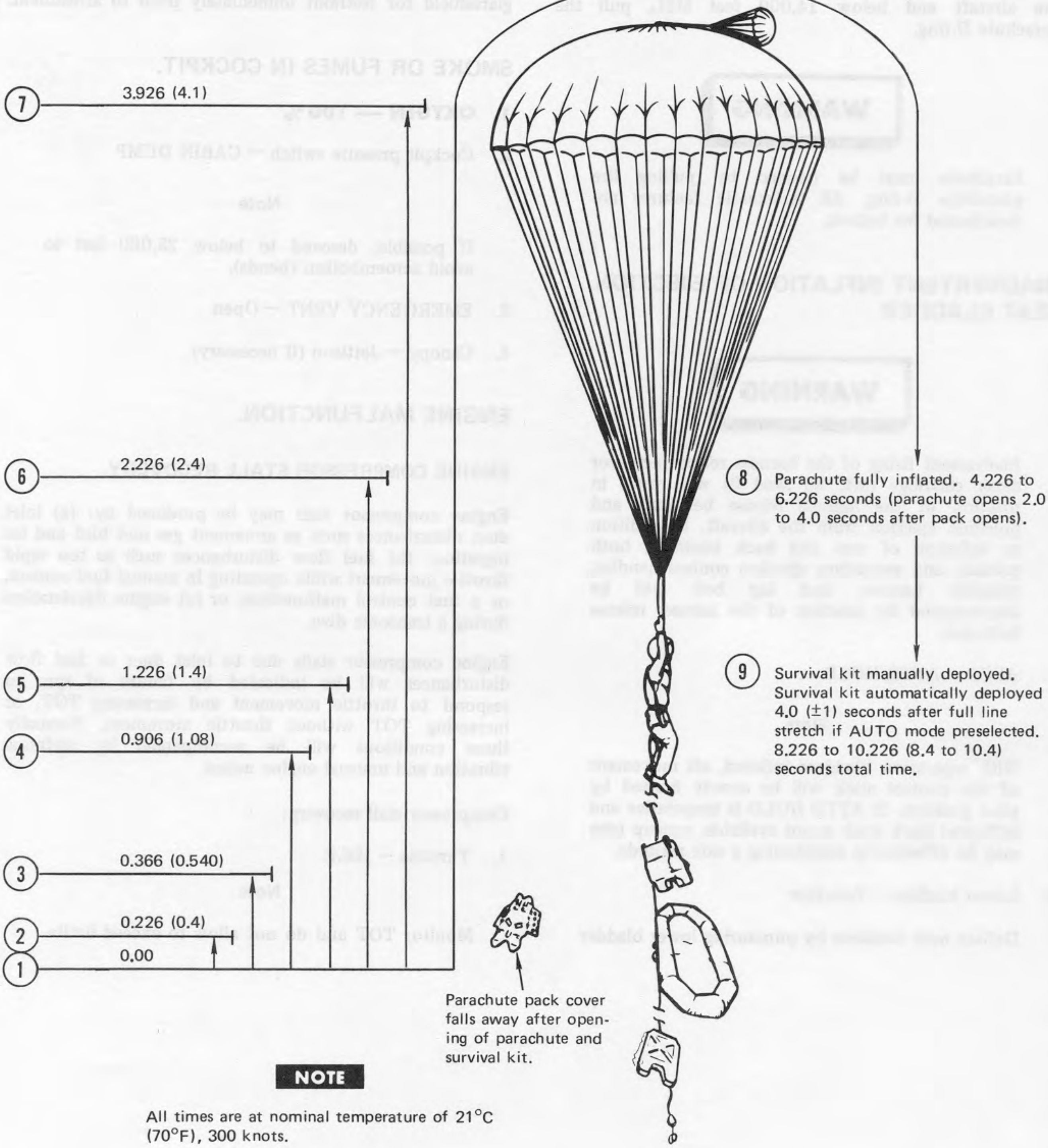


Figure 3–6 (Sheet 1)



NOTE

All times are at nominal temperature of 21°C (70°F), 300 knots.

In the event the canopy fails to jettison, the seat will eject through the canopy after a 0.4-second time delay. The differences in times are presented in parentheses.

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Figure 3–6 (Sheet 2)

aileron trim is available, apply full trim in one direction, disengage AFCS, and dive over the side opposite the low wing trim. If trim is not available, disengage AFCS, roll the aircraft, and dive under the high wing. When clear of the aircraft and below 14,000 feet MSL, pull the parachute D-ring.

WARNING

Parachute must be opened by pulling the parachute D-ring. All automatic features are deactivated for bailout.

INADVERTENT INFLATION OF EJECTION SEAT BLADDER

WARNING

Inadvertent firing of the harness release actuator delay cartridge (MK 86 Mod 0) will result in rotation of the harness release bellcrank and preclude ejection from the aircraft. In addition to inflation of seat and back bladders, both primary and secondary ejection control handles, shoulder harness, and lap belt will be disconnected by rotation of the harness release bellcrank.

1. AFCS — ATTD HOLD

Note

With separation bladders inflated, aft movement of the control stick will be severly limited by pilot position. If ATTD HOLD is inoperative and sufficient back stick is not available, noseup trim may be effective in establishing a safe attitude.

2. Lower bladder — Puncture

Deflate both bladders by puncturing lower bladder

3. Land as soon as practical

If barrier engagement is necessary, place both feet firmly on rudder pedals with knees flexed and both hands on glareshield for restraint immediately prior to arrestment.

SMOKE OR FUMES IN COCKPIT.

1. OXYGEN — 100%

2. Cockpit pressure switch — CABIN DUMP

Note

If possible, descend to below 25,000 feet to avoid aeroembolism (bends).

3. EMERGENCY VENT — Open

4. Canopy — Jettison (if necessary)

ENGINE MALFUNCTION.

ENGINE COMPRESSOR STALL RECOVERY.

Engine compressor stall may be produced by: (a) inlet duct disturbances such as armament gas and bird and ice ingestion: (b) fuel flow disturbances such as too rapid throttle movement while operating in manual fuel control, or a fuel control malfunction; or (c) engine deceleration during a transonic dive.

Engine compressor stalls due to inlet duct or fuel flow disturbances will be indicated by failure of rpm to respond to throttle movement and increasing TOT, or increasing TOT without throttle movement. Normally these conditions will be accompanied by airframe vibration and unusual engine noises.

Compressor stall recovery:

1. Throttle — IDLE

Note

Monitor TOT and do not allow to exceed limits.

2. Airspeed — Increase

Altitude permitting, increase airspeed by diving. Stall recovery will be indicated by return of normal control of rpm and TOT with throttle movement and termination of any unusual engine noises.

If compressor stall does not terminate:

3. FUEL CONTROL — MAN

If above 25,000 feet, continue dive to below 25,000 feet before switching to manual fuel control.

CAUTION

Throttle advancements should be made slowly to avoid compressor stalls and excessive TOT and rpm. If operating at high power settings in manual fuel control, monitor TOT for possible engine overtemperature. Manipulate the throttle as necessary to maintain engine temperature within limits. Use extreme caution between 6,000 feet and 18,000 feet pressure altitude.

If compressor stall still does not terminate and/or TOT exceeds limits:

4. Throttle — OFF

5. Air ignite switch — Press and hold

6. Throttle — IDLE

7. Air ignite switch — Release

Release air ignite switch when engine relights and rpm is above 50%.

Compressor stall occurring in a transonic dive during engine deceleration may be indicated by rpm stabilizing between 80% and 90% lack of response to throttle movement, and unusual engine noises and airframe vibration. Recovery technique is to pull out of the dive and match throttle position and engine rpm. If these actions do not result in normal engine response, accomplish steps 1 through 7.

FLAMEOUT.

The engine is equipped with a momentary automatic restart feature which actuates the ignition system when the rate of compressor discharge pressure drop exceeds a preset rate. If engine flameout is caused by something

other than a malfunctioning fuel control or fuel exhaustion, the relight is automatic. The automatic relight system relights the engine faster than the pilot can definitely ascertain that a flameout has occurred and initiate the airstart procedure.

CAUTION

Do not permit engine rpm to drop below 12 percent. Utilizing a 20 degree glide, approximately 3,000 feet of altitude is required to accelerate from best glide speed of 220 KIAS to the 270 KIAS required to obtain 12 percent engine rpm for airstart.

Note

If below 10,000 feet MSL, the jet fuel starter may be used to maintain engine rpm above 12 percent while maintaining best glide speed.

If flameout occurs at medium or high altitudes, expect loss of cockpit pressurization if an immediate airstart is not accomplished.

Should the engine fail to respond to automatic relight:

1. Throttle — OFF
2. FUEL MASTER handle — ON
3. WING TRANS switch — AUTO
4. RAT — Extend
5. EMER GEN switch — CRUISE (maintain airspeed above 175 KIAS)
6. Determine causes of flameout
   a. With the engine shut down and at less than 40 percent rpm, illumination of FUEL BOOST 1, FUEL BOOST 2, MAIN FUEL PUMP, and/or ENG OIL caution light after the RAT is extended should not be interpreted as failure of these components unless their illumination was present before flameout or is present after restart.
   b. Pump failure may cause unstable engine operation above 20,000 feet at high power settings and could lead to a flameout under these conditions. The probability of restart increases as altitude decreases.
   c. Main sump fuel exhaustion may have the same indications as a boost pump failure, but the FUEL LOW and SUMP LOW caution lights are also on. A restart under this condition is highly improbable.
   d. Failure of both elements of the main engine-driven fuel pump results in engine flameout. A restart is impossible.
   e. Failure of the normal fuel control is normally indicated by unstable engine operation or failure of engine rpm to respond to throttle movements. Restarts are highly probable using manual fuel control. If manual fuel control is selected, advance the throttle slowly to avoid compressor stall or excessive TOT.
   f. Engine oil system failure with subsequent bearing failure is normally indicated by noticeable vibration, high TOT, and loss of oil pressure. Restart improbable.
7. Perform airstart (if practical)

AIRSTART.

A minimum of 12 percent engine rpm is required for airstart. Tests on the TF-41 engine have demonstrated that 270 KIAS provides more than the minimum 12 percent engine rpm required for a successful airstart. For a 270 KIAS glide, best gliding range is degraded by 10 percent. See figure 3–12.

1. Airspeed — 270 KIAS (minimum)
2. RPM — 12 percent (minimum)

   Do not permit rpm to drop below 12 percent or excessive airspeed and altitude are required to regain engine speed.

   Note

   If below 10,000 feet MSL, the jet fuel starter may be used to maintain engine rpm above 12 percent while maintaining best glide speed.

3. RAT — Extend
4. EMER GEN switch — CRUISE
5. FUEL CONTROL switch — MAN

   CAUTION

   Throttle advancements should be made slowly to avoid compressor stalls and excessive TOT and rpm. If operating at high power settings in manual fuel control, monitor TOT for possible engine overtemperature. Manipulate the throttle as necessary to maintain engine temperature within limits. Use extreme caution between 6,000 feet and 18,000 feet pressure altitude.

6. AIR IGNITE switch — Press and hold
7. Throttle — IDLE
8. Optimum fuel flow — 500 to 1,200 pph

   Advance throttle. Monitor fuel flow and attempt to meter 500 to 1,500 pph fuel flow for best results.

9. Engine instruments — Check indication of start, within limits

   Monitor tachometer and TOT gages for first indication of a start. Check oil pressure gage for normal indication as RPM approaches idle.

10. Throttle — As required

11. Air ignite switch — Release

12. MASTER GEN switch — OFF RESET, then ON

    Check for V indication.

13. Hydraulic pressures — Check

14. YAW STAB advisory light — OFF

15. RAT — Retract

16. RAT accumulator — Recharge

    Recharge accumulator by placing flap handle in UP for 3 seconds minimum, then back to ISO UTILITY.

IMMEDIATE AIRSTART.

1. RAT — EXTEND

RAT must be extended to assure electrical power is available to position FUEL CONTROL switch to MAN and to allow fuel flow indications to be checked. If RAT is not extended, when rpm has decreased below approximately 45%, main generator will drop off line and these actions will not be possible.

2. THROTTLE — IDLE (time permitting)

3. FUEL CONTROL SWITCH — MAN

CAUTION

Throttle advancements should be made slowly to avoid compressor stalls and excessive TOT and rpm. If operating at high power settings in manual fuel control, monitor TOT for possible engine overtemperature. Manipulate the throttle as necessary to maintain engine temperature within limits. Use extreme caution between 6,000 feet and 18,000 feet pressure altitude.

4. AIR IGNITE SWITCH — PRESS AND HOLD

5. Check for start TOT, fuel flow, and RPM

6. Throttle — As required

7. AIR IGNITE switch — Release

Note

The abbreviated airstart procedure is to be used when minimum time is available.

ENGINE INSTABILITY OR FUEL CONTROL MALFUNCTION.

Engine instability may be indicated by erratic fuel flow, erratic TOT, sudden reduction or fluctuating rpm, no increase in rpm when throttle advanced, TOT not responding to throttle movement, or compressor stall. If no physical sensation, verify by at least two engine instrument readings.

Fuel control unit malfunction or impending failure may be indicated by erratic TOT or rpm at a constant throttle setting. Other indications may be unusual or no engine response to throttle movement, or excessive decrease in TOT with gain in altitude.

Note

If at military power, retard throttle at least 2% to allow fuel control amplifier to stabilize engine.

1. Throttle — IDLE (time permitting)

2. FUEL CONTROL switch — MAN

CAUTION

Throttle advancements should be made slowly to avoid compressor stalls and excessive TOT and rpm. If operating at high power settings in manual fuel control, monitor TOT for possible engine overtemperature. Manipulate the throttle as necessary to maintain engine temperature within limits. Use extreme caution between 6,000 feet and 18,000 feet pressure altitude.

3. Throttle — As required

4. Land as soon as possible (precautionary approach recommended)

Note

If switching to MAN fuel control clears up the problem, land as soon as practical. If engine instability continues, land as soon as possible.

OIL PRESSURE FLUCTUATION.

If oil pressure fluctuations occur with low oil quantity during other than level flight, level the aircraft within 15 seconds. If fluctuations do not clear within 15 seconds after leveling, land the aircraft as soon as possible.

OIL PRESSURE FAILURE.

Failure of the engine oil pressure system is indicated by the oil pressure indicator and illumination of the ENG OIL caution light and MASTER CAUTION light. The two lights illuminate as oil pressure decreases to approximately 11(±1) psi.

Allowable tolerance of the oil pressure indicator is ±3 psi. Idle oil pressure may be as low as 15 psi. Low oil pressure during zero or negative g operation does not necessarily indicate a failure. If a low oil pressure is indicated, attempt to forestall probable engine failure as follows:

1. Throttle — Minimum power to maintain flight

   This will minimize bearing thrust loading and prolong bearing life under oil starvation conditions.

2. RAT — Extend

Note

> In the event of engine failure, the extended RAT will immediately supply hydraulic pressure for flight control.

Bearing failure caused by oil starvation is generally characterized by vibration that rapidly increases in magnitude and usually results in an engine seizure. Avoid power changes and flight accelerations to keep acceleration forces on the engine to a minimum. If speed brake is required, extend in small increments as airspeed is reduced. Land as soon as possible; a flameout pattern is recommended. After landing, shut down the engine as soon as practical to prevent possible engine damage.

OIL QUANTITY LOW.

If the engine oil quantity gage drops below 3/16 full, the ENG OIL caution light illuminates.

1. Monitor oil quantity and oil pressure and land as soon as possible

Note

> The ENG OIL caution light illuminates when either the oil pressure or oil quantity is low. Individual gages must be checked to determine which condition caused the light to illuminate. If the ENG OIL caution light comes on as a result of low oil quantity, subsequent loss of oil pressure will not activate the master caution light.

ENGINE ICING.

Indications of ice accumulation are:

Increasing TOT

Compressor stalls

The aircraft should not be flown in icing conditions. If icing is inadvertently encountered, leave the area of icing conditions as soon as possible. Maintain engine TOT within limits by reducing power as necessary.

If TOT limits exceeded with throttle in IDLE and altitude permits:

1. RAT — Extend
2. EMER GEN switch — CRUISE

   Maintain airspeed above 175 KIAS

3. Throttle — OFF

   Maintain airspeed required to provide RAT hydraulic pressure to flight controls.

4. When out of icing conditions, perform airstart procedure.

SUSPECTED ENGINE FOD IN FLIGHT.

If any foreign object is ingested or appears to have been ingested into the engine, monitor engine instruments and noises for impending engine malfunctions. Land as soon as possible, using Oil Pressure Failure procedures.

FUEL SYSTEM MALFUNCTIONS.

ENGINE MAIN FUEL PUMP FAILURE.

1. Land as soon as possible

Failure of either element of the main fuel pump causes illumination of the MAIN FUEL PUMP caution light. Maximum engine performance may be degraded slightly at high power settings at low altitude. Failure of both elements result in engine flameout. With both elements of the fuel pump failed, no fuel flow is indicated during the airstart cycle and a restart is impossible.

CAUTION

> The MAIN FUEL PUMP caution light may stay on after engine start and during acceleration without an actual pump failure as a result of flow imbalance between the two pump elements. The pump is acceptable provided the caution light goes out during any throttle manipulation, acceleration or deceleration, at any percent rpm and at any altitude in either main or manual fuel control. If the caution light stays on continually during throttle manipulations, treat as a fuel pump element failure.

SINGLE FUEL BOOST PUMP FAILURE.

Illumination of FUEL BOOST 1 or FUEL BOOST 2 caution light indicates failure of boost pump 1 or 2 respectively.

Loss of either fuel boost pump does not result in a noticeable decrease in engine performance at low or medium altitude. The possibility of engine flameout increases with one boost pump failed as altitude is increased above 20,000 feet. If failure occurs above 20,000 feet, maintain 80% rpm or greater. Avoid nosedown attitudes greater than -5° to maintain optimum system flow and pressure which prevents high-pressure fuel pump cavitation. Below 20,000 feet, avoid excessive nosedown attitudes.

WARNING

With a failure of FUEL BOOST 1 or FUEL BOOST 2, do not place the ALTERNATE FUEL FEED handle in COMBAT as fuel pressure may not be sufficient and engine flameout may result.

Note

If failure of fuel boost 2 occurs, the transfer system may not keep up with sustained engine operation above 4,000 pounds per hour fuel flow; therefore, monitor engine fuel flow and quantity.

LOSS OF FUEL BOOST 1 AND 2.

To reduce the possibility of flameout following loss of both fuel boost pumps:

1. Throttle — IDLE and descend to lowest possible altitude
2. Use minimum possible power settings
3. Land as soon as possible

EXTERNAL FUEL TANK TRANSFER FAILURE.

The indication that external fuel tanks are not feeding is main or wing fuel quantity decreasing with fuel remaining in the external tanks.

If external tank(s) are not empty:

1. AR probe → [16] [18] → [26] — Cycle to extend; then retract to ensure that probe is fully stowed. Make sure the switch is returned to OFF

   AR DOOR [17] [27] → — Cycle AR DOOR handle. Ensure that the handle is returned to the full in position and that the READY light goes out.

If external tank(s) still do not transfer:

2. RAT — Extend to provide electrical power after the main generator is turned off
3. EMER GEN switch — CRUISE

   Maintain airspeed above 175 KIAS.

4. MASTER GEN switch — OFF

   Turning the MASTER GEN switch off deenergizes the secondary bus and opens the external tank pressurization valve. Fuel transfer occurs if difficulty is a defective landing gear uplock switch.

If external tank(s) transfer remains inoperative, or after external tank fuel is depleted:

5. MASTER GEN switch — ON
6. RAT — Retract
7. Flap handle — FLAP UP (minimum of 3 seconds)

   Place the flap handle in FLAP UP for 3 seconds to recharge the RAT accumulator.

8. Flap handle — ISO UTILITY
9. Jettison external fuel tanks if necessary

   External fuel may be dumped only when transferred to the wing tank, then through the wing tank dump valves.

WING FUEL TRANSFER FAILURE.

Wing fuel transfer failure is indicated by a reduction of main system fuel with little or no reduction in wing fuel quantity.

If wing tank fails to transfer with WING TRANS switch in AUTO:

1. WING TRANS switch — EMERG

When wing fuel transfer is complete or if transfer is inoperative:

2. WING TRANS switch — AUTO

If EMERG transfer fails to restore wing fuel transfer:

3. Land as soon as practical (anticipate loss of main generator)

Note

If placing WING TRANS switch in EMERG fails to restore wing fuel transfer, complete loss of motive flow fuel is the most probable cause. Anticipate loss of main generator because motive flow fuel will not be available to the CSD oil cooler and thermal disconnect of the CSD is probable.

FUSELAGE FUEL TRANSFER FAILURE → [16] [18] → [26].

If the FUEL LOW caution light comes on with the main fuel indicator M pointer showing more than 1,000 (±200) pounds of fuel remaining and the WING TRANS switch is in AUTO, an aft tank fuel transfer malfunction is probable. In this condition, at least 800 pounds of usable fuselage fuel is available.

1. WING TRANS switch — Check AUTO
2. External stores — Jettison (if necessary)

Note

In some external stores configurations, improper fuel transfer sequencing may cause aircraft cg to approach the aft cg limit, degrading longitudinal stability. If longitudinal stability is not improved by ensuring CONT AUG is engaged and reducing airspeed, it may be necessary to jettison external stores. Refer to Section VI for a description of the flying characteristics of an aircraft approaching the aft cg limit.

3. Land as soon as possible (precautionary approach recommended)

FUSELAGE FUEL TRANSFER FAILURE [17] [27] →

Failure of the aft and right mid tanks to transfer with wing transfer switch in AUTO will be indicated by illumination of the FUEL LOW caution light at a fuel quantity above 1,000 (±200) pounds, and as much as 3,600 pounds indicated on the main fuel indicator M pointer. If no corrective action is taken, at least 800 pounds of fuselage fuel is available.

1. WING TRANS switch — Check AUTO
2. Throttle — IDLE (conditions permitting)
3. ALTERNATE FUEL FEED handle — ALT FEED

WARNING

Placing the ALTERNATE FUEL FEED handle in ALT FEED restricts the aircraft to nosedown attitudes not exceeding those of a standard jet penetration, positive g loads and operating altitudes below 30,000 feet.

4. Throttle — Advance slowly

If FUEL BOOST caution lights flash continuously any time *BEFORE* the SUMP LOW caution light comes on:

5. ALTERNATE FUEL FEED handle — Return to NORMAL

Note

If FUEL BOOST caution lights flash immediately upon selecting ALT FEED, as much as 1,000 pounds of fuel may be trapped. Maximum fuel availability will occur at normal cruise power settings. In all other failure conditions, trapped fuel will not exceed 200 pounds at normal flight attitudes.

6. External stores — Jettison (if necessary)

Note

In some external stores configurations, improper fuel transfer sequencing may cause aircraft cg to approach the aft cg limit, degrading longitudinal stability. If longitudinal stability is not improved by ensuring CONT AUG is engaged and reducing airspeed, it may be necessary to jettison external stores. Refer to Section VI for a description of the flying characteristics of an aircraft approaching the aft cg limit.

7. Land as soon as possible (precautionary approach recommended)

Maximum fuel availability occurs at positive pitch attitudes. Once the SUMP LOW caution light has illuminated, FUEL BOOST caution lights are an indication of limited gravity feed capability, not of fuel/air mixture in the transfer lines.

WARNING

If FUEL BOOST caution lights come on after the SUMP LOW caution light comes on, remain in ALT FEED and reduce engine fuel demands by retarding the throttle until the FUEL BOOST caution lights go off.

SUMP LOW CAUTION LIGHT OR DAMAGE TO MAIN FUEL TANKS [17] [27] →

A fuel level monitoring thermistor in the sump tank causes the SUMP LOW caution light to come on when sump tank fuel falls below 360 (±40) pounds. With fuel

remaining in any other tank(s) a SUMP LOW caution light is an indication of a severe leak in the sump tank, main fuel feed line, motive flow line, or trapped fuel.

If SUMP LOW caution light comes on with fuel remaining in other tanks

OR

If damage is suspected to main fuel tanks:

1. Throttle — IDLE (conditions permitting)
2. ALTERNATE FUEL FEED handle — ALT FEED

WARNING

Placing the ALTERNATE FUEL FEED handle in ALT FEED restricts the aircraft to nosedown attitudes not exceeding those of a standard jet penetration, positive g loads and operating altitudes below 30,000 feet.

3. Throttle — Advance slowly
4. External stores — SALVO JETT

   External stores should be jettisoned to ensure aircraft cg remains within limits, and to reduce drag for improved specific fuel consumption.

If wing tank contains fuel:

5. WING TRANS switch — EMERG

WARNING

With ALT FEED selected and WING TRANS switch in EMERG, aircraft is restricted to positive pitch attitudes. WING TRANS switch should be placed in AUTO when descending for landing to allow nosedown attitudes not exceeding those of a standard jet penetration.

When wing tank fuel is depleted, or FUEL BOOST caution lights come on with WING TRANS in EMERG, or when descending for landing:

6. WING TRANS switch — AUTO

Note

If engine operation cannot be sustained at required power setting in ALT FEED, the ALTERNATE FUEL FEED handle may be placed in NORMAL or COMBAT as a last resort in an attempt to use fuel that may be available in the forward, left midfuselage, or sump tanks.

7. Land as soon as possible (precautionary approach recommended)

POWER CONTROL (PC) SYSTEM FAILURES ALL AIRCRAFT.

Note

Flight operating limitations imposed by failure of PC systems in aircraft [17] [27] → are based on contractor flight test.

On aircraft [17] [27] →, figure 1–34 indicates availability of flight controls under all conditions of PC system failures. Refer to figure 3–7 for flight restrictions which apply under all conditions of PC system failures.

Note

A PC system pressure below 2,950 psi or above 3,250 psi constitutes a PC system failure.

The MASTER CAUTION light flashes and the HYD PRESS caution light illuminates when hydraulic pressure in any PC system falls below 1,500 psi. Determine which PC system has failed by referring to the individual system

POWER CONTROL (PC) SYSTEM FAILURE RESTRICTIONS

AIRCRAFT [17] [27] →

RESTRICTIONS / SYSTEM FAILED	MAXIMUM AIRSPEED	MAXIMUM AOA UNITS	MAXIMUM ACCELERATION	MAXIMUM 90° CROSSWIND COMPONENT FOR LANDING
PC-1	Limits of Basic Aircraft	22	Limits of Basic Aircraft	Limits of Basic Aircraft
PC-2	Limits of Basic Aircraft	22	Limits of Basic Aircraft	Limits of Basic Aircraft
PC-3	Limits of Basic Aircraft	22	Limits of Basic Aircraft	Limits of Basic Aircraft
PC-1 AND PC-2	200 KIAS	20.5	−1.0g to +5.0g	15 kts.
PC-1 AND PC-3	200 KIAS	20.5	−1.0g to +5.0g	15 kts.
PC-2 AND PC-3	200 KIAS	20.5	−1.0g to +5.0g	10 kts.
PC-1 PC-2 AND †PC-3	200 KIAS	20.5	−1.0g to +5.0g	10 kts.

†Operating on RAT hydraulic pressure only

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Figure 3–7

pressure gages. The MASTER CAUTION light may be extinguished by pressing on the cover of the light.

CAUTION

A subsequent failure of the remaining PC system will not make the MASTER CAUTION light flash.

On aircraft → [16] [18] → [26] if PC 1 failure occurs, the yaw stab is inoperative.

ANY SINGLE PC FAILURE.

Take appropriate actions as outlined in the following procedures:

1. FLAP HANDLE — ISO UTILITY

Opening of the isolation valve may compromise the remaining flight control system(s) should a leak occur in one or more of the hydraulically powered utilities.

2. Monitor good PC system(s) pressure and extend RAT only if necessary

3. ANTI-SKID switch – OFF (PC 2 failure)

WARNING

On aircraft → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685, if the PC 2 system fails, turn off the antiskid system before using wheel brakes. If the ANTI-SKID switch is left on and brakes are applied, all utility brake accumulator pressure will bypass through the antiskid control valve in less than 20 seconds. Leakage occurs even if brakes are applied moderately enough to prevent antiskid system cycling. Even with the antiskid system off, the utility brake accumulator cannot be relied on 45 minutes after flap handle is placed in ISO UTILITY. Power brake cylinder leakage may deplete the accumulator in this time span.

On aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →, if the PC 2 system fails, hydraulic pressure trapped in the utility brake accumulator system is available for backup braking only with the ANTI-SKID switch in the BRAKE ACCUM position. Antiskid protection is bypassed and will not be available. This system prevents bleed off leakage and bypass pressure loss, provided the ANTI-SKID switch remains in the OFF or ANTI-SKID position until just prior to landing.

4. Land as soon as possible

When preparing to land:

5. Slow to under 180 KIAS

6. Perform emergency landing gear extension

   Refer to Emergency Landing Gear Extension procedure.

7. Perform emergency flap extension

   Refer to Emergency Flap Extension procedure.

8. ANTI-SKID switch – BRAKE ACCUM (PC 2 failure) → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →

Note

With PC 2 failure consider approach end engagement since nose gear steering is not available and braking is from accumulator pressure only.

If approach end gear is not used, use whatever pressure exists in the utility wheel brake accumulator through normal brake applications before reverting to the emergency brake system.

After landing touchdown:

9. Flap handle – Out of ISO UTILITY

10. Tow required (PC 2 failure)

If In Landing Configuration when PC 2 System Fails.

1. ANTI-SKID switch – BRAKE ACCUM → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →

   ANTI-SKID switch – OFF → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685

Consider approach end engagement since nose gear steering is not available and braking is from accumulator pressure only.

Note

If approach end gear is not used, use whatever pressure exists in the utility wheel brake accumulator through normal brake applications before reverting to the emergency brake system.

FAILURE OF ALL PC SYSTEMS.

WARNING

Complete loss of all PC system hydraulic pressure may result in an uncontrollable nose down pitch and high negative g forces. If the RAT will not restore PC 3 pressure, abandon the aircraft before all pressure is lost. Check valves installed at the horizontal stabilizer actuators reduce the violence of the pitchover and provide more time to eject. After all pressure is lost, g forces resulting from the nose down pitch may exceed pilot capability to successfully eject.

1. RAT — EXTEND

2. EMER GEN SWITCH — OFF

With the EMER GEN switch in off, the RAT furnishes maximum PC hydraulic pressure to the flight controls.

Note

Minimum RAT airspeed requirements for hydraulic pressure are as follows:

	→ [16] [18] → [26]	[17] [27] →
OFF	125	135 KIAS
T.O. LAND	130	140 KIAS
CRUISE	175	175 KIAS

If emergency hydraulic power fails to restore aircraft control:

3. Eject

If aircraft control is restored:

4. Land as soon as possible

A no-flap approach is recommended. Refer to Flaps Up Landing.

A no-flap approach requires additional airspeed which provides adequate RAT hydraulic pressure output.

5. Make approach end engagement, if possible. If circumstances permit, do not land with more than a 10-knot crosswind component.

FAILURE OF TWO PC SYSTEMS [17] [27] →

Adequate control is available to return to base and land with only one PC system operating. Certain flight restrictions are imposed by different combinations of double PC failures due to the control configurations which result from dual system loss. If a double PC failure is the result of battle damage, other airframe or system damage may produce additional flight control system malfunctions and a slow flight stability check should be performed prior to landing. Refer to Flight Control System Malfunctions, this section.

PC 2 and PC 3 Failure.

PC 2 and PC 3 system failure results in the loss of fuel boost pump No. 1, yaw stabilization, pitch AFCS, rudder, roll feel isolation actuator (manual lateral control), nose gear steering, antiskid (normal braking), speed brake, air refueling receptacle (normal), hook retract, M61A1 gun, wing fold, landing gear extension/retraction (normal), and flap extension (normal).

The left and right horizontal stabilizer actuators, and the left and right ailerons and spoilers are powered by the PC 1 system to provide flight control.

If both PC 2 and PC 3 systems fail and the PC 1 system is operating, proceed as follows:

1. FLAP HANDLE — ISO UTILITY

2. AFCS — CONT AUG

Check ROLL AFCS advisory light off.

WARNING

Landings should not be attempted with only the PC 1 system operating unless roll AFCS is engaged and operating.

Note

Lateral control is available only through the use of roll trim if CONT AUG is not engaged or if roll AFCS is out. Roll trim only is marginal for cruising in normal flight and is inadequate for landing.

3. EXTERNAL LOAD — JETTISON (If Necessary)

WARNING

If control is lost due to asymmetric condition after PC 2 and PC 3 failure, SALVO JETT may be the only means of regaining aircraft control. However, if roll control is maintained through use of trim, SALVO JETT malfunction could result in an uncontrollable asymmetric condition; therefore depending on number, type and location of stores, AUX JETT or SEL JETT may be the most desirable.

4. AIRSPEED — 200 KIAS MAXIMUM

Reduce power and climb to reduce airspeed as quickly as possible. Do not exceed 20.5 units angle of attack.

WARNING

If all hydraulic fluid is drained from the rudder actuator, destructive flutter of the rudder occurs at speeds above 200 KIAS. Destructive flutter causes catastrophic failure of the rudder and vertical stabilizer.

5. ANTI-SKID switch — OFF

6. Land as soon as possible

Fly a straight-in approach and make arresting gear engagement, if available. Refer to figure 3–7 for maximum crosswind component if arresting gear engagement not available.

When preparing to land:

7. Slow to under 180 KIAS

8. Perform emergency landing gear extension

Refer to Emergency Landing Gear Extension procedure.

9. Perform emergency flap extension

Refer to Emergency Flap Extension procedure.

10. ANTI-SKID switch — BRAKE ACCUM → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →

11. RAT — Extend on final approach

    If RAT restores PC 3 pressure, normal flight control will be restored for landing.

CAUTION

Premature extension of the RAT may result in loss of RAT pressure before landing.

After landing:

12. Tow required

PC 1 and PC 2/PC 1 and PC 3 Failure [17] [27] →

PC 1 and PC 2 system failure results in loss of pitch and roll AFCS and the right aileron, spoiler, and horizontal stabilizer and all PC 2 utility systems.

Yaw AFCS, the left aileron, left horizontal stabilizer, left spoiler, the roll feel isolation actuator and rudder are powered by the PC 3 system to provide flight control.

PC 1 and PC 3 failure results in the loss of yaw stabilization, fuel boost pump No. 1, roll AFCS, left aileron, left spoiler, and left horizontal stabilizer actuator. The right aileron, right spoiler, right horizontal stabilizer (drives left horizontal stabilizer through crossover yoke), rudder, and pitch AFCS are powered by the PC 2 system to provide flight control. Additionally, the air refueling receptacle (normal), speed brake, and M61A1 gun are powered by the PC 2 system with the flap handle in ISO UTILITY. After landing, nose gear steering, antiskid (normal braking), hook retract, and wingfold are powered by the PC 2 system and are available when the flap handle is placed in the DN position.

1. FLAP HANDLE — ISO UTILITY

2. External load — SALVO JETT

3. Airspeed — 200 KIAS maximum

   Airspeeds above 200 KIAS will cause aileron flutter.

   Do not exceed 20.5 units angle of attack. Do not exceed -1.0g to +5.0g.

4. ANTI-SKID switch — OFF (PC 2 failure)

5. Land as soon as possible

   Fly a straight-in approach and make an approach end engagement, if available. Refer to figure A1—7 for maximum crosswind component if arresting gear engagement not available.

When preparing to land:

6. Slow to under 180 KIAS

7. Perform emergency landing gear extension

   Refer to Emergency Landing Gear Extension procedure.

8. Perform emergency flap extension

   Refer to Emergency Flap Extension procedure.

9. ANTI-SKID switch — BRAKE ACCUM (PC 2 failure) → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →

After landing:

10. Flap handle — Out of ISO UTILITY (PC 1, PC 3 failure)

Provides normal brakes, nose gear steering, and hook retract.

11. Tow required (PC 2 failure)

EMERGENCY LANDING GEAR EXTENSION.

If normal system fails to extend the landing gear to a down and locked position, check flap handle in other than ISO UTILITY.

CAUTION

When utilizing the emergency extension systems, the landing gear should always be extended prior to extending the flaps. If the single check valve in the landing gear accumulator charging line has failed open, extending the flaps first will cause loss of landing gear accumulator pressure through the flap extension system and preclude subsequent extension of the landing gear. The only exception to this sequence is emergency extension of flaps and gear in the flameout approach and landing procedure when the engine is seized.

With loss of PC 2, the landing gear is extended by the landing gear emergency accumulator.

1. Airspeed — 180 KIAS or less

2. Flap handle — ISO UTILITY

3. Landing gear handle — WHLS DOWN

4. Landing gear handle — Push in, turn 90°, and pull out

   Push in, turn clockwise approximately 90°, pull all the way out (approximately 2 inches), and hold until the landing gear handle warning light goes out.

5. Landing gear position indicators — Check

Note

If nose gear indicates unsafe, slow aircraft to 145 KIAS to allow nose gear spring tension to fully extend and lock the nose gear. If the main gear indicates unsafe, increase airspeed (do not exceed 244 KIAS) to increase ram air pressure and force the main gear aft.

EMERGENCY FLAP EXTENSION.

With loss of PC 2, the leading edge and trailing edge flaps are lowered by the emergency flap accumulator.

CAUTION

When utilizing the emergency extension systems, the landing gear should always be extended prior to extending the flaps. If the single check valve in the landing gear accumulator charging line has failed open, extending the flaps first will cause loss of landing gear accumulator pressure through the flap extension system, and preclude subsequent extension of the landing gear. The only exception to this sequence is emergency extension of flaps and gear in the flameout approach and landing procedure when the engine is seized.

1. Airspeed – 220 KIAS or less

Note

Emergency flap extension can be initiated at any speed up to the emergency flap extension maximum airspeed. Since emergency extension of the flaps is normally performed only after emergency landing gear extension, speeds encountered will not normally exceed 180 KIAS. However, full extension of the trailing edge flaps probably will not be achieved until aircraft speed decreases to approximately 160 KIAS.

2. Flap handle – ISO UTILITY
3. Emergency flap switch – EMER DN
4. TE FLAPS AND LE FLAPS indicators – Check

CAUTION

Unless a specific procedure dictates otherwise, do not return the emergency flap switch to NORM while airborne. If leaks exist in the flap extension system, any or all of the flaps may retract.

FAILURE OF RAM AIR TURBINE (RAT) TO EXTEND.

Failure of the ram air turbine to extend is indicated by failure to regain electrical power after an electrical failure and lack of RAT spinup noise.

This procedure is to be utilized to provide emergency *electrical* power only.

Note

Do not take the flap handle out of ISO UTILITY if a PC system failure is indicated. If failure of the RAT to extend is caused by hydraulic failure in the RAT external system, opening the flap isolation valve may result in loss of the PC 2 system.

1. RAT – Extend
2. Flap handle – FLAP UP for 3 seconds

   Move the flap handle out of ISO UTILITY to FLAP UP to recharge the RAT accumulator.

3. Flap handle – ISO UTILITY

If this procedure fails to extend the RAT:

4. Land as soon as possible

ELECTRICAL SYSTEM MALFUNCTIONS.

MASTER GENERATOR FAILURE.

Master generator failure is indicated by a barberpole in the master generator indicator.

1. RAT – Extend

   With the RAT extended, range is reduced by 5%. If the RAT fails to extend, refer to Failure of Ram Air Turbine to Extend.

WARNING

IMS alignment and all attitude indications are lost 30 seconds after generator failure if the RAT is not extended or generator operation is not regained. Under IFR conditions, do not attempt to reset the generator until after extending the RAT.

Note

If the IMS shuts off due to power interruption to the set during flight, a complete realignment is required to regain IMS operation. During realignment, maintain level flight attitude for the first 2 minutes to ensure reliable ADI presentation.

It is possible to extend and retract the RAT repeatedly. Actuate the flap handle out of ISO UTILITY to FLAP UP position for 3 seconds to recharge RAT accumulator. Return the flap handle to ISO UTILITY after recharging.

2. MASTER GEN switch – OFF RESET, then back to ON

   Switch may be recycled as many times as deemed necessary. If generator does not reset, leave RAT extended.

3. EMER GEN switch – As required

   With the emergency generator switch in CRUISE, the minimum airspeed required to supply adequate electrical power is 175 KIAS.

With the switch in T.O. LAND, the minimum airspeed to meet electrical power needs is 120 KIAS.

WARNING

When using the RAT for electrical power only, the emergency generator may drop off the line in a narrow speed band (2 to 10 knots) while decelerating at speeds below 200 KIAS. Continuing deceleration, or accelerating 5 to 10 knots will normally restore electrical power.

CAUTION

With the RAT extended and the EMER GEN switch in T.O. LAND, the temperature/rpm limiter amplifier is inoperative. Throttle advancement must be made cautiously to avoid engine overtemp/overspeed, and the fuel control should be left in the normal position. Engine overtemperature during operation at high power settings can be minimized by operating on the normal fuel control. The normal fuel control offers better engine protection even without the electrical limiters than does the manual fuel control.

Note

With the EMER GEN switch in T.O. LAND, the trailing edge flaps can only be extended by the emergency flap switch.

4. CABIN PRESS switch – CABIN DUMP

Select CABIN DUMP prior to selecting T.O. LAND on the emergency generator.

CAUTION

When the emergency generator switch is placed in T.O. LAND, the air-conditioning system goes to full cold.

Note

If the RAT is not extended until some time after the electrical failure, it may be necessary to recharge the RAT accumulator to accomplish RAT extension. The requirement for recharging exists because with no electrical power, the RAT accumulator heater blanket is inoperative. Heat is not required if the accumulator can be recharged.

With the landing gear handle in the down position, the EMER GEN caution light is on with the selector switch in CRUISE and off with the selector switch in T.O. LAND.

Note

Antiskid and nose gear steering are inoperative with a master generator failure.

If the RAT fails, perform Complete Electrical Failure procedure.

TRANSFORMER-RECTIFIER FAILURE.

Transformer-Rectifier failure is indicated by loss of nonbattery dc powered systems. The primary systems lost are:

AFCS
Angle-of-attack
HUD
Speed brake
Cockpit and suit temperature controls

COMPLETE ELECTRICAL FAILURE.

If both master and emergency generators fail: Land as soon as possible. Only pressure operated flight instruments, the tachometer, and the battery powered items operate.

Note

A fully charged battery will provide power for normal operation of all equipment on the battery bus for approximately 1 hour.

If master generator, emergency generator, and battery fail, trailing edge flaps will not be available. Consider approach end/barrier engagement. Nose gear steering and antiskid braking will not be available.

TRIM MALFUNCTIONS OR FAILURE.

Indications of trim malfunctions are runaway trim and no trim response.

RUNAWAY PITCH TRIM.

Maximum pitch trim deflection is limited and can be controlled with a maximum of 20-pound stick force.

1. PITCH TRIM disconnect switch – OFF
2. Land as soon as practical

Should prolonged flight be required and pilot fatigue become a factor, the stick force may be reduced by engaging AFCS control augmentation. Landing in this mode is not recommended because if the AFCS should disengage, a pitch transient can be expected.

INOPERATIVE PITCH TRIM.

1. PITCH TRIM disconnect switch — OFF, then ON
2. Attempt to trim with stick trim switch
3. AFCS engage switch — ATTD

   The pitch trim actuator may adjust to flight conditions.

4. Land as soon as practical

   Should AFCS (attitude hold) trimming of the trim actuator be available, trim the aircraft for optimum angle of attack in landing configuration prior to landing and turn the pitch trim switch off. Should AFCS (attitude hold) trimming of the trim actuator be inoperative, follow runaway trim procedure.

RUNAWAY OR INOPERATIVE ROLL TRIM.

Maximum roll trim deflection is limited and may be controlled with a maximum of 10-pound stick force.

1. ROLL TRIM disconnect switch — OFF
2. AFCS engage switch — CONT AUG

   This mode reduces stick force requirements and is recommended for maneuvering flight.

3. Land as soon as practical

   Should prolonged flight be required and pilot fatigue become a factor, the stick force may be reduced by engaging AFCS control augmentation. Landing in this mode is not recommended because if the AFCS should disengage, a roll transient can be expected.

AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS) MALFUNCTIONS.

For pitch or roll AFCS oscillation or uncalled for inputs:

1. Stick AFCS switch — Press
2. AFCS mode(s) — Checked OFF
3. Trim aircraft normally

For yaw oscillations or uncalled for inputs:

1. Yaw STAB switch — Off

   Rudder trim is lost.

FLIGHT CONTROL SYSTEM MALFUNCTIONS.

In the event of control surface or stick binding, rolling tendency, or suspected malfunction due to airframe or system damage, perform the following:

1. AFCS — CONT AUG

   If the control stick is immovable, the AFCS sensors provide limited control surface movement.

2. Establish a safe altitude of at least 15,000 feet
3. Landing gear handle — WHLS DOWN
4. Flap handle — DN
5. Perform a slow flight stability check to determine minimum safe airspeed to be used during landing approach

   If sufficient pitch control is not available to perform a flaps down landing, retract the flaps and make a flaps up landing. Refer to Flaps Up Landing procedure. If roll problems exist, consider jettisoning stores from the heavy wing.

   CAUTION

   Do not jettison external load to the extent that the asymmetrical load limit is exceeded.

6. Land as soon as practical

EXTERNAL LOAD JETTISON.

The launchers on stations 4 and 5 cannot be jettisoned. However, missiles can be fired unarmed by select jettison only with weight off the landing gear.

To salvo jettison external stores:

1. SALVO JETT button — Press

   Note

   On aircraft → [16] [18] → [26], external stores cannot be jettisoned from wing stations with aircraft weight on the landing gear. Aircraft [17] [27] →, stations 1, 2, 7, and 8 can be jettisoned with aircraft weight on the landing gear. On all aircraft, the main gear must be up and locked for stations 3 and 6 to be jettisoned.

OXYGEN SYSTEM FAILURE.

If symptoms of hypoxia or difficulty in breathing occur:

1. EMERGENCY lever — EMERGENCY

If positive pressure oxygen is not immediately obtained:

2. Emergency oxygen bottle — Activate
3. Descend immediately to an altitude at which oxygen is no longer required

PITOT-STATIC SYSTEM FAILURE.

If the airspeed indicator is lost or suspected to be erroneous, use angle-of-attack indicator for approximate airspeed indications as shown in figure 3–8. Placing the engine anti-ice switch in PITOT or in PITOT ENG normally restores operation if the malfunction is due to pitot tube icing. If it is apparent that pitot icing is not the cause, descend below 25,000 feet. When the cockpit pressure altimeter stabilizes at 8,000 feet, aircraft altitude is about 23,000 feet. Open the emergency vent and place the cockpit pressure switch in CABIN DUMP. Use the cockpit pressure altimeter as a cross-check with the aircraft altimeter above 5,000 feet, and use the radar altimeter as a cross-check below 5,000 feet. A substitute for airspeed indication is the Doppler radar. The Doppler may also be used to determine groundspeed. If it is suspected that the static ports or static lines have become iced, descend to a lower altitude to allow warm air to permit melting. If static pressure is lost, the altimeter, vertical velocity indicator, cockpit pressure regulator, pressure safety regulator, Mach and airspeed indicator, and the air data computer are inoperative.

SPEED BRAKE FAILS TO RETRACT.

If the speed brake fails to retract, the speed brake ADVISORY light remains illuminated, SPEED BRAKE position indicator indicates down, excessive power is required to maintain flight, and airframe buffet may be noticeable.

1. SP BR switch — Cycle to CLOSE
2. Airspeed — 220 KIAS or less
3. Flap handle — ISO UTILITY

Note

Move the flap handle to ISO UTILITY to isolate the landing gear actuators from the PC 2 system.

4. Landing gear handle — WHLS DOWN

   The speed brake will retract if failure was due to a defective speed brake switch. The landing gear will not extend.

After using this procedure, the gear handle cannot be moved from the WHLS DOWN position without actuating the landing gear EMER DOWN LOCK REL button or moving the flap handle out of ISO UTILITY and allowing the gear to extend.

CAUTION

Do not move the flap handle out of ISO UTILITY position until below 220 KIAS.

UNSAFE FLAP INDICATION.

The leading edge flap indicator shows a barberpole and/or the trailing edge flap indicator shows partial extension. An unsafe flap condition is indicated by illumination of the WHEELS FLAPS warning light only when the left leading edge flap is not down with the landing gear down and locked or one or more leading edge flaps not locked up with the nose gear up and locked.

Note

On aircraft [1] → [10], maximum airspeed for flap operation is 220 KIAS.

If the flaps fail to indicate up, do not exceed 260 KIAS; cycle flaps and then position flap handle to FLAP UP.

Note

After cycling flaps, if the leading edge flaps do not indicate up, select ISO UTILITY.

If flaps still do not indicate up, place the flap handle to FLAP UP; this allows hydraulic pressure to hold the flaps up. Do not exceed 260 KIAS, avoid g, and make a normal landing.

If the flaps fail to indicate down, do not exceed 220 KIAS with landing gear extended or 260 KIAS with landing gear up; cycle flaps and then position flap handle to DN. After cycling flaps, if the leading edge flaps do not indicate down, make a normal landing.

If the trailing edge flaps still do not indicate full-down, position flap handle to FLAP UP and perform Flaps Up landing procedure.

LOSS OF AIRSPEED INDICATOR

If the airspeed indicator fails, the angle-of-attack indicator is sufficient to perform the following. The values are accurate only in lg flight.

FLIGHT CONDITION	ANGLE OF ATTACK – UNITS
AFTER TAKEOFF	
Start flaps up	13.8 (33,000 lb) 11.6 (38,000 lb)
MILITARY POWER CLIMB	
0 to 10,000 feet	9.6
10,000 to 20,000 feet	9.7
20,000 to 30,000 feet	9.8 to 10.4
30,000 to 40,000 feet	10.4 to 11.0
MAXIMUM ENDURANCE	
Any altitude	13.4
MAXIMUM RANGE	10.7
PENETRATION	
Speed brake down, 80% RPM, 4,000 to 6,000 FPM rate of descent	10.8
LANDING	
Gear extension	13.0
Flap extension	13.0
GCA pattern (clean)	11.9
GCA pattern (landing configuration	12.2
GCA pattern (final)	17.5
STALL WARNING	
Clean (power on)	20.5
Clean (power off)	20.5
Landing configuration	20.5

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Figure 3–8

LOSS OF CONTROL.

For departure from controlled flight, stalls, and spin characteristics, refer to Section VI, Flight Characteristics.

RECOVERY FROM DEPARTURE OR ERECT SPIN.

If the aircraft departs or enters an erect spin:

1. AFCS — DISCONNECT SWITCH — ACTUATE

2. CONTROLS — RELEASE

Flight tests show that inadvertent pro-spin aileron inputs occur if the pilot continues holding the stick, even if conscious efforts are made to hold the stick centered.

3. AOA — MONITOR

When below 22 units AOA, and as rotation slows, recover from the dive by smoothly attaining and holding 20 units AOA.

CAUTION

Do not exceed 22 units AOA or loss of control may recur.

If rotation continues beyond 2 turns and the AOA stays pegged at 30 units, the aircraft is spinning. If compressor stalls occur the throttle should be retarded to maintain TOT within limits.

WARNING

Do not apply antispin ailerons before a spin is confirmed. A spin in the opposite direction may result. The ailerons are the primary control for both spin entry and recovery. Confirm that the aircraft is spinning and determine spin direction before applying antispin ailerons (in the direction of the turn needle).

Note

If the aircraft is configured with asymmetrically loaded stores, it is more prone to enter a sustained spin; therefore, antispin controls should be applied as soon as spin direction is confirmed.

If the aircraft is spinning (erect spin) and AOA is pegged at 30 units:

4. AILERON — FULL WITH SPIN (same direction as turn needle)

RUDDER — FULL AGAINST SPIN (opposite turn needle)

LONGITUDINAL STICK — NEUTRAL

As rotation approaches zero:

5. CONTROLS — NEUTRAL WITH SLIGHT FORWARD STICK

CAUTION

Maintaining full antispin controls below 22 units AOA will result in a steep diving aileron roll which can be easily confused with a spin. Neutralize controls below 22 units AOA during spin recovery.

Note

With asymmetrically loaded stores, recovery may not occur for several turns. Should normal recovery procedures not prove effective, an alternate is to jettison external stores to aid in recovery. However, there is a possibility that the jettisoned stores may strike the aircraft.

When rotation stops:

6. Speed brake — Check closed

7. Pullout — Smoothly pull to and hold 20 units AOA

CAUTION

Do not exceed 22 units AOA or loss of control may recur.

8. Add power to increase airspeed

9. If spin continues through 10,000 feet above terrain — Eject

WARNING

If a confirmed spin occurs below 10,000 feet AGL, EJECT. Recovery from a fully developed spin below 10,000 feet is doubtful since 6,000 to 8,000 feet are required to obtain level flight after rotation is stopped.

RECOVERY FROM INVERTED SPIN.

If the aircraft enters an inverted spin:

1. AFCS — DISCONNECT SWITCH — ACTUATE

2. CONTROLS — RELEASE

An inverted spin may be recognized by negative g, negative AOA, and rotation. Flight tests show that an inverted spin will be of short duration and rapid recovery should be effected by releasing the controls.

3. AOA — MONITOR

As rotation slows, check speed brake closed and recover from the dive by smoothly attaining and holding 20 units AOA.

CAUTION

Do not exceed 22 units AOA or loss of control may recur.

4. Add power to increase airspeed

5. If inverted spin continues through 10,000 feet above terrain — Eject

WARNING

If a confirmed spin occurs below 10,000 feet AGL, EJECT. Recovery from an inverted spin below 10,000 feet is doubtful since 6,000 to 8,000 feet are required to obtain level flight after rotation is stopped.

LANDING EMERGENCIES

ALL LANDING EMERGENCIES.

If time and conditions permit and the nature of emergency dictates, jettison all external loads except empty external tanks and racks. Refer to External Load Jettison procedure.

Note

Landing emergency information is summarized for ready reference in figure 3–9.

The maximum permissible arresting hook load is 116,000 pounds and the maximum permissible longitudinal deceleration for barrier engagement is 6.0g. The ultimate arresting hook load is 174,000 pounds and the ultimate strength longitudinal deceleration for arresting hook engagement is 9.0g. Refer to figure 3–10.

Before entering the traffic pattern, reduce gross weight by dumping and/or burning fuel to the lowest practicable amount. Prior to landing, place FUEL DUMP switch in OFF even if fuel dumping has not been completed to ensure availability of electrical power for closing dump valves. Place helmet visor down. After landing abandon aircraft as necessary. Refer to Emergency Ground Egress procedures.

CAUTION

The canopy shall be retained during all emergencies that could result in structural damage or fire during landings, aborted takeoffs, and barrier arresting gear engagements. The protection the canopy affords the pilot during these emergencies far outweighs the isolated risk of entrapment due to a canopy malfunction or aircraft overturn. During aircraft abandonment, normal canopy opening procedures shall be considered first. These considerations do not preclude the pilot from exercising judgment in jettisoning the canopy when he deems it necessary. Refer to Emergency Ground Egress.

BARRIER/APPROACH END ENGAGEMENT.

BARRIER ENGAGEMENT.

Refer to ABORT/BARRIER ENGAGEMENT, Takeoff Emergencies.

APPROACH END ENGAGEMENT.

Arresting gear engagements are considered practical when a malfunction presents a threat to directional control and there are approximately 1,000 feet or more of runway overrun in front of the barrier on which to land. Consideration should also be given to the engaging speed limits to prevent structural failure of the arresting barrier or the aircraft.

There should be little concern if the touchdown point is close to a BAK-12 arresting system or the nose gear is not on the runway. The deceleration force of the BAK-12 arresting system is applied in a smooth increasing manner, which will cause the nose of the aircraft to lower to the runway in much the same way as during a normal landing. The motion is not violent. With BAK-13 type engagements, the deceleration force is applied more rapidly. For engagements less than 35 feet off-center, aircraft yaw and roll are minimal to nonexistent. Rudder, aileron, and nose gear steering may be required to maintain aircraft control on engagements over 35 feet off-center.

The yaw is abrupt for the BAK-13, whereas the onset is more gradual for the BAK-12. The magnitude is approximately the same. The aircraft tends to skid in the opposite direction to the yaw (i.e., yaw right, skid left). The arresting cable itself tends to straighten the path of the aircraft after the initial yaw; however, use of aircraft controls and nose gear steering will help the pilot maintain directional control of the aircraft path.

1. Arresting HOOK – Extend

2. Shoulder harness – Locked

LANDING EMERGENCIES

Refer to, "Landing emergencies," this section, for additional information.

DESCRIPTION OF FAILURE	RECOMMENDED ACTION
All landing gear up	Normal landing or controlled ejection. * † ‡
Nose gear up or not fully extended	Normal landing. No barrier engagement. Fly nose onto runway before losing pitch control. †
Both main gear up or not fully extended	Approach end engagement*
One main gear up or not fully extended	Approach end engagement*
One main gear and nose gear up or not fully extended	Approach end engagement*
Nose gear canted	Normal landing. Turn generator switch off just prior to touchdown.
Gear down indicator lights off	Treat as corresponding gear up unless determined to be down.**
Blown tires	Approach end engagement if possible
PC 2 hydraulic failure	Approach end engagement when adverse runway conditions exist.

*Runway should be foamed if time permits.
**Once the aircraft is stopped on the runway, do not taxi until maintenance personnel have inserted the landing gear downlocks and nose gear pin.
†Remove runway arresting cables in landing roll-out area to prevent engagement of aircraft by cables.
‡High sink rates on landing must be avoided.

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Figure 3-9

3. Touch down 300 to 500 feet short of arresting gear

Note

If touchdown occurs less than approximately 200 feet from the arresting gear, the possibility of a missed engagement (hook skip) is increased. The initial rocking forward motion of the aircraft tends to raise the nose of the hook point off the runway surface. If touchdown occurs more than 300 feet from the arresting gear, ample time is available to establish optimum aircraft arrestment attitude.

4. Throttle – IDLE

5. Use ailerons and rudder to maintain directional control. When effectiveness of flight controls is lost, use nose gear steering and brakes as necessary

Note

It is desirable to steer for center of arresting gear and make contact perpendicular to the barrier if this can be done without any danger of losing aircraft control.

6. Engage arresting gear with wheel brakes off and sufficient aft stick to fully extend nose gear strut

CAUTION

At nose low aircraft attitudes (nose strut compressed due to forward stick forces or applied brakes), the angle between the hook shank and the runway may be large enough to raise the nose of the hook point off the runway. To ensure optimum hook point attitude, engagements should be made as slow as possible. If it is necessary to engage the arresting gear at high speed, optimum hook point attitude can be attained by applying sufficient aft stick to ensure full extension of the nose gear strut with the nose wheel on the runway.

Note

The throttle may be inadvertently advanced due to deceleration forces on the pilot's body from engagements at higher speeds (over 130 knots).

ARRESTING HOOK/BARRIER MAXIMUM ENGAGEMENT SPEEDS

Aircraft Weight	MA-1A (Modified for Tailhook) See Note 1	BAK-9		BAK-12		BAK-13 See Note 2		M-21
	Max Engage Speed-KTS	Max Engage Speed-KTS	Aircraft G Load	Max Engage Speed-KTS	Aircraft G Load	Max Engage Speed-KTS	Aircraft G Load	Max Engage Speed-KTS
20,000	110	190	3.4	190	3.7	160	3.2	167
22,000	106	190	3.2	190	3.5	160	3.0	162
24,000	102	190	3.0	190	3.3	160	2.8	157
26,000	98	190	2.9	190	3.1	160	2.7	153
28,000	94	189	2.7	190	2.9	160	2.6	148
30,000	90	188	2.5	190	2.8	160	2.5	144
32,000	88	186	2.4	190	2.7	160	2.4	140
34,000	86	184	2.2	190	2.6	160	2.3	136
36,000	84	182	2.1	190	2.5	160	2.2	131
38,000	82	180	2.0	190	2.4	160	2.1	128
40,000	80	177	1.9	190	2.3	160	2.1	124
42,000	78	175	1.8	190	2.3	160	2.0	120

NOTE

1. MA-1A not suitable for approach end engagements.
2. BAK-13 engaging speed is temporarily restricted to 160 KTS pending additional barrier tests.
3. High energy engagements may result in aircraft rollback. If brakes are operating, rollback can be controlled by light braking at the end of the arrestment.

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Figure 3–10

LANDING WITH LANDING GEAR OUT OF POSITION.

ALL LANDING GEAR UP.

1. Have runway foamed if time permits
2. Have barrier cables removed in landing rollout area to prevent engagement of aircraft duct by cables.
3. Execute minimum sink rate landing.

At touchdown:

4. Shut down engine.

NOSE GEAR UP OR NOT FULLY EXTENDED.

1. Have barrier cables removed in landing rollout area to prevent engagement of aircraft duct by wires
2. Execute normal landing without approach-end engagement

After touchdown:

3. Throttle – OFF
4. ANTI-SKID switch – BRAKE ACCUM → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →
5. Fly nose onto runway before losing pitch control
6. Use brakes only if necessary to avoid obstacles or maintain directional control if rudder is ineffective

ALL OTHER GEAR COMBINATIONS.

1. Have runway foamed if time permits.
2. Perform approach-end engagement if possible.

Following engagement:

3. Shut down engine.

FAILURE OF ARRESTING HOOK TO EXTEND.

If arresting hook fails to extend:

1. Landing gear handle – WHLS DOWN
2. Flap handle – ISO UTILITY

   Placing the flap handle to ISO UTILITY removes PC 2 hydraulic pressure from the hook retract actuator, permitting the hook to extend.

3. Arresting HOOK – Extend

If hook lowers:

4. Flap switch – EMER DN

   Note

   Flap handle must remain in ISO UTILITY position to prevent PC 2 hydraulic pressure from retracting arresting hook.

5. For ground taxi – Place the flap handle out of ISO UTILITY to obtain normal braking, nose gear steering, and hook retraction

NOSE GEAR STEERING MALFUNCTIONING OR CANTED.

Ground Operation:

If directional control problems develop during taxiing or the takeoff/landing roll with the nose gear steering engaged, disengage and use differential braking. If directional control problems continue, place the MASTER GEN switch to OFF to deenergize the secondary bus.

1. MASTER GEN switch – OFF

CAUTION

Antiskid is inoperative with the MASTER GEN switch in the off position.

Do not take off with a known or suspected nose gear steering failure. If committed to takeoff and failure occurs, do not retract landing gear. Failed nose gear steering linkage can cause binding of nose gear upon retraction or subsequent extension.

Airborne Operation:

If a malfunction of the nose gear steering system is suspected, remove electrical power from the steering system as follows:

1. EMER GEN switch – CRUISE
2. RAT – Extend
3. MASTER GEN switch – OFF

Prior to landing:

4. EMER GEN switch — T.O. LAND to reduce electrical load on the generator

CAUTION

With the RAT extended and the EMER GEN switch in T.O. LAND, the temperature/rpm limiter amplifier is inoperative. Throttle advancement must be made cautiously to avoid engine overtemp/overspeed.

Make an approach end engagement, if possible.

BLOWN TIRES.

LANDING WITH A KNOWN BLOWN MAIN GEAR TIRE.

Landing with a blown main gear tire is easily controlled with rudder and aileron immediately after touchdown. Use aileron to hold the weight off the blown tire, and rudder to maintain directional control. Engage nose gear steering as the aircraft slows.

1. ANTI-SKID switch — BRAKE ACCUM → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →

   ANTI-SKID switch — OFF → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685

   Turn the ANTI-SKID switch OFF to prevent loss of braking on the good tire resulting from skid applications from the blown tire.

2. Arresting HOOK — Extend

3. Make an approach end engagement, if possible

If an approach end engagement is not feasible:

4. Land on the side of the runway opposite blown tire

5. Use nose gear steering if necessary to maintain directional control

CAUTION

Neutralize rudder before engaging nose gear steering, or an abrupt swerve will result with possible damage to the nose gear.

6. Use light opposite braking to slow aircraft. As speed decreases, if vibration or shimmy increases, lock the brake on the wheel with the blown tire, but release before crossing barrier cable.

BLOWN MAIN GEAR TIRE DURING LANDING ROLLOUT.

1. **ANTI-SKID SWITCH — BRAKE ACCUM** → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →

   ANTI-SKID SWITCH — OFF → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685

   Turn the ANTI-SKID switch OFF to prevent loss of braking on the good tire resulting from skid applications from the blown tire.

2. Arresting HOOK — Extend

3. Use nose gear steering if necessary to maintain directional control

CAUTION

Neutralize rudder before engaging nose gear steering, or an abrupt swerve will result with possible damage to the nose gear.

4. Use light opposite braking to slow aircraft. As speed decreases, if vibration or shimmy increases, lock the brake on the wheel with the blown tire, but release before crossing barrier cable.

NOSE GEAR TIRE.

1. Make an approach end engagement, if possible

If approach end engagement is not feasible:

2. Make normal landing

FLAPS UP LANDING.

Flaps up landing is basically the same as a normal landing. Use the normal landing procedures and expand the pattern to avoid steep bank turns, and allow a longer final approach, or fly a straight-in approach.

1. Fly a wide pattern or straight-in approach

2. Based on an aircraft gross weight of 23,000 pounds, fly the base turn to final approach at 16 units AOA (approximately 175 KIAS). When on final approach, maintain 17.5 units AOA (approximately 158 KIAS) to touchdown. For each 1,000 pounds increase in gross weight, increase speed by 3 knots.

CAUTION

With the flaps up, the engine will be operating in a relatively low rpm range during the approach. Corrections for low and/or slow situations will take significantly longer than normally encountered in a flaps down approach. Corrections for high and/or fast situations may require the throttle to be retarded to the idle stop. If the aircraft is high and/or fast on final approach, it may not be possible to decelerate sufficiently to land on speed. Should a go-around be required during final approach, maintain aircraft attitude until the engine is fully accelerated and speed increase is assured.

With the flaps up and the engine operating at low rpm, caution must be exercised when maneuvering at high angles of attack to avoid departures. Due to indicator lag, abrupt movements of flight controls may cause the aircraft to depart at indicated angles-of-attack which are less than actual aircraft angle of attack.

On aircraft → [16] [18] → [26] after T.O. 1A-7D-524 and [17] [27] →, in a landing gear down condition, 24° of rudder authority is available. Under this condition, with the flaps up, the aircraft can be departed through use of rudder alone at high angles of attack.

ASYMMETRICAL FLAP CONDITION DURING LANDING.

In the event an asymmetrical flap condition occurs, sufficient aileron exists to overcome the effects of the rolling moment induced. Use of roll and yaw trim increases available roll control.

If transitioning to landing configurations:

Control augmentation (CONT AUG) may be used to reduce pilot effort required to maintain aircraft control. If flaps become asymmetrical during transition, immediately reposition flap handle to previous position. If a symmetrical flap condition is obtained, do not reselect flaps. Perform a normal or flaps up landing as appropriate.

If flaps remain asymmetrical:

1. Select jettison stores from the up flap side only.

CAUTION

Do not jettison external load to the extent that the asymmetrical load limit is exceeded.

2. Perform slow flight controllability check at a safe altitude
3. Land as soon as practical using the Flaps Up Landing procedure
4. Perform approach end engagement, if required

CAUTION

On aircraft → [16] [18] → [26] before T.O. 1A-7D-524, with the left wing flap up, the rudder clean condition stops are inserted, restricting rudder travel and nose gear steering during landing rollout and taxi.

FLAMEOUT APPROACH AND LANDING.

If necessary, a flameout approach and landing can be made using the techniques and procedures shown in figure 3–11.

Normally, ejection is the best course of action, but the decision to eject or to make a flameout landing must be left to the pilot. It is impossible to make a set of rules and instructions to provide a ready made decision for the pilot. The basic conditions listed below, combined with the pilot's analysis of the situation, should exist before a flameout landing is made:

1. Flameout landings shall be attempted only by pilots who have satisfactorily completed simulated flameout approaches in this aircraft.
2. Flameout landings shall be attempted only on a prepared or designated suitable surface.
3. Approaches to the runway shall be clear.

Note

No attempt shall be made to land a flamed-out aircraft at any field where approaches are over heavily populated areas.

4. Weather and terrain conditions must be favorable. Cloud cover, ceiling, visibility, turbulence, surface wind, etc must not impede in any manner the establishment of a proper flameout landing pattern.

Note

Night flameout landings, or flameout landings under poor lighting conditions, such as at dusk or dawn, shall not be contemplated regardless of weather or field lighting.

5. Flameout landings shall only be attempted when a satisfactory High Key or Low Key position can be achieved.
6. If at any time during the flameout approach, conditions do not appear ideal for successful completion of the landing, eject.
7. The minimum runway length for flameout landings should be 10,000 feet or 8,000 feet if arresting gear is available.

AIRSTART ATTEMPTS DURING FLAMEOUT LANDING PATTERN.

It is suspected that a contributing factor in some recent unsuccessful flameout landings may have been that the pilot did not devote his full attention to the maintenance of the required flameout pattern once high key was reached. The distracting influence in these instances was airstart attempts. The solution to this problem is not simply to prohibit airstart attempts once high key is reached. Past experience has shown that flameout landings are dangerous and should be attempted only under ideal conditions. Accordingly, it would be dangerously misleading to create the impression that airstarts should be abandoned at any specific time and all concentration be directed towards a flameout landing. If several airstarts have already been attempted or if the nature of the flameout indicates that any further airstart attempts will be futile, then obviously no further attempts should be made even long before the high key point is reached. But if flameout has occurred near high key point, the pilot would be well advised to attempt an airstart below high key provided he is not dangerously distracted. Regaining power must be afforded a high priority since flameout landings shall be avoided to the extent that ejection is normally considered the best course of action.

FLAMEOUT LANDING (TYPICAL)

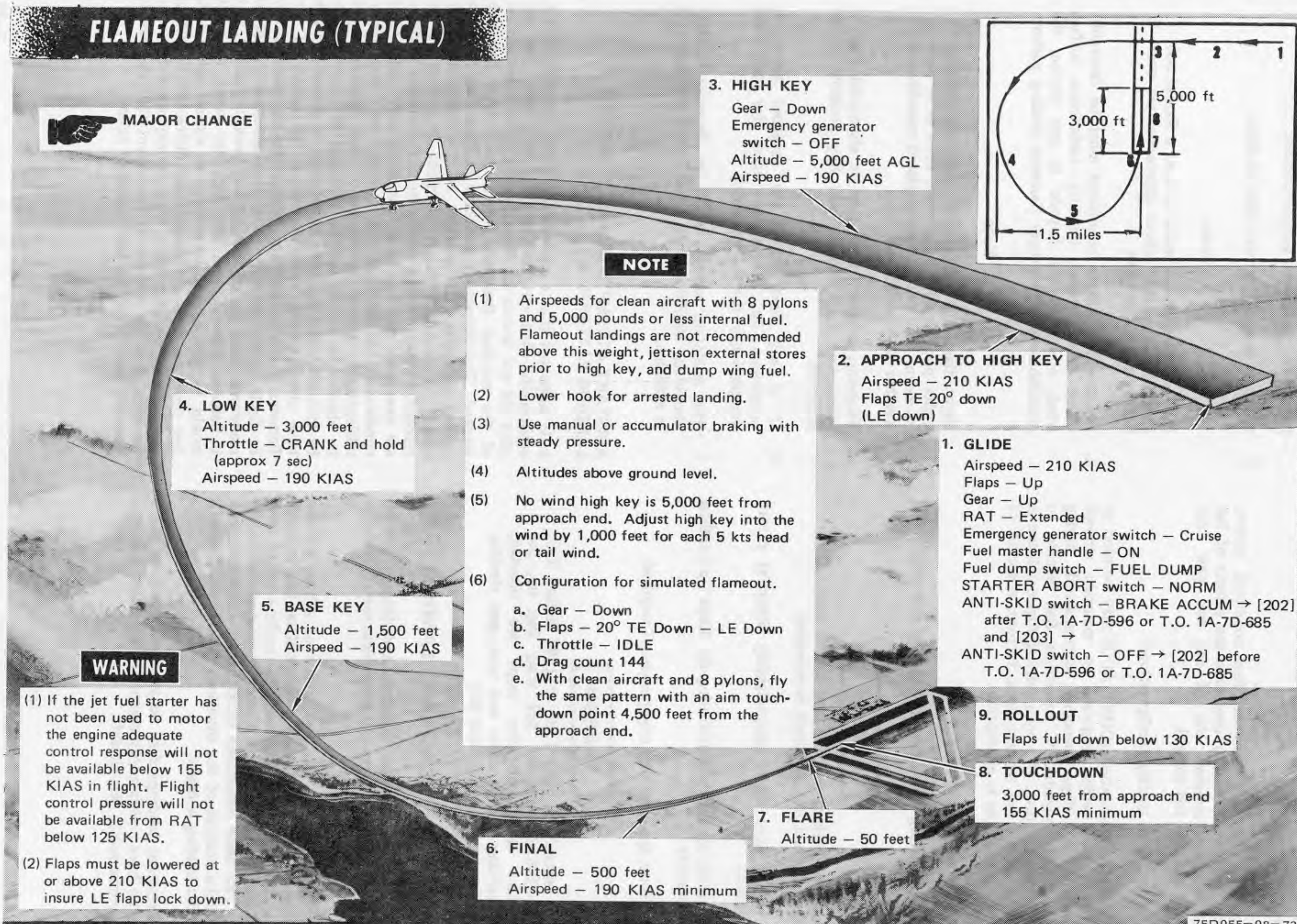


Figure 3–11

If flameout landing attempt is continued:

Attempt to complete all air start efforts before high key is reached so that full attention may be devoted to accomplishing a successful flameout landing.

If the circumstances of flameout have precluded conclusive airstart attempts prior to high key, further airstarts may be attempted but primary attention should be devoted to proper execution of the flameout landing.

Do not attempt airstarts after low key is reached.

PROCEDURES.

A flameout pattern (typical) is illustrated in figure 3–11. Maximum power-off glide distances (no wind) are illustrated in figure 3–12.

Glide.

The flameout pattern is entered gear and flaps up, antiskid OFF, with the RAT extended, and the EMER GEN switch in CRUISE. Before entry, all external load, racks, and wing fuel should be jettisoned to reduce drag and gross weight. While approaching the high key, excessive altitude can be dissipated in decrements of 5,000 feet by performing 360-degree turns using a bank angle of 30 degrees while maintaining 210 KIAS (4,500 feet can be lost if a 45 degrees bank is used). Smaller altitude decrements of 1,000 to 2,000 feet can be lost by using speed brake and/or gentle S-turns.

Note

To anticipate use of the jet fuel starter for engine motoring, the STARTER ABORT switch should be placed to NORM before reaching high key.

Approach To High Key (Windmilling Engine).

Prior to reaching high key, while still at an airspeed of 210 KIAS, the flaps should be lowered by the normal system to 20° trailing edge down and the indicators checked to ensure that the leading edge flaps indicate down. If flap extension is initiated below 210 KIAS, leading edge flaps may not lock in the fully extended position by the time the trailing edge flaps have reached 20°. Subsequent maneuvers could cause one or both leading edge flaps to retract.

Approach To High Key (Seized Engine).

With the engine seized, PC 2 system pressure will not be available to extend the flaps by the normal system. Prior to reaching high key, while at an airspeed of 210 KIAS, check flap handle in ISO UTILITY and extend the flaps by placing the emergency flap switch in EMER DN. The trailing edge flaps can be stopped at 20° (or any intermediate position) by returning the emergency flap switch to NORM. Once extended, the flaps cannot be retracted by the emergency extension system. If flap extension is initiated below 210 KIAS, leading edge flaps may not lock in the fully extended position by the time the trailing edge flaps have reached 20°. Subsequent maneuvers could cause one or both leading edge flaps to retract.

Note

Lowering the leading edge flaps and trailing edge flaps 20 degrees permits a lower high key, better aircraft control, and reduced ground roll after landing. Sufficient airspeed is available for RAT operation and flare for landing.

High Key.

The high key altitude is 5,000 feet above ground level (AGL). The optimum high key position is 5,000 feet from the approach end of the runway, with the aircraft headed 90 degrees to the landing runway. At high key, the landing gear is extended using the normal system. The shoulder harness shall be locked.

Note

With a seized engine or insufficient PC 2 pressure, reduce airspeed to 180 KIAS and extend landing gear using the emergency system. Extending the landing gear may be delayed if the high key is intercepted below the optimum altitude.

At high key, a 20-degree bank turn is established and held until approaching the low key position. Approaching low key, bank angle may be varied as necessary to arrive at the optimum low key position. Airspeed throughout the pattern is 190 KIAS. (Average angle of attack is 10.5 units.)

Low Key.

The low key is directly abeam of the approach-end of the runway with the aircraft headed opposite to the direction of landing. The optimum position is 1 1/4 to 1 1/2 miles abeam the approach-end of the runway at 3,000 feet altitude. Maintain 190 KIAS. The turn to final approach shall continue throughout the low key. To compensate for an altitude below low key, bank angle is increased up to 60 degrees if necessary. Excess altitude may be lost by using a bank angle slightly less than 30 degrees. In no case shall airspeed be allowed to vary from 190 KIAS (10.5 units angle of attack). If the engine is not seized, the throttle should be placed in CRANK (approximately 7 seconds) until the engine indicates an increase in rpm. This will permit the jet fuel starter to motor the engine at approximately 26 percent rpm and provide nearly normal hydraulic pressure for landing, ground rollout, and braking.

Base Key.

The base key is approximately 1 mile downwind from the approach-end of the runway at 1,500 feet altitude. Maintain 190 KIAS. From this position, bank angle may be varied as necessary to line up with the runway.

MAXIMUM RANGE DESCENT – WINDMILLING ENGINE

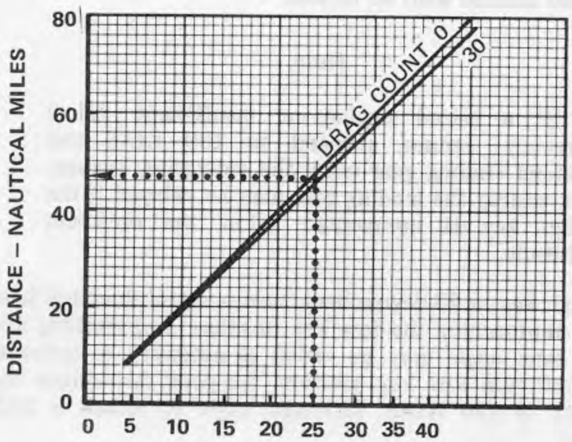
Standard Day – No Wind

DISTANCE TO DESCEND FROM SELECTED ALTITUDE TO SEA LEVEL GROSS WEIGHTS 18,000 TO 26,000 POUNDS

Example: Gross Weight	–	23,000 Pounds
Altitude	–	25,000 Feet
Drag Count	–	Zero
Glide Distance	–	47 NM

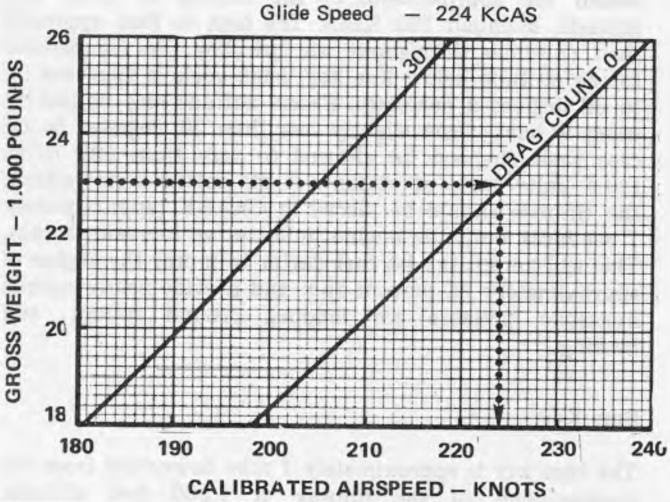
NOTE

For a 270 knot glide, reduce computed distance for best airspeed by 10%



DESCENT SPEEDS

Example: Gross Weight	–	23,000 Pounds
Drag Count	–	Zero
Glide Speed	–	224 KCAS



TIME REQUIRED TO DESCEND FROM SELECTED ALTITUDE TO SEA LEVEL

Example: Gross Weight	–	23,000 Pounds
Pressure Altitude	–	25,000 Feet
Drag Count	–	Zero
Time	–	11 Minutes

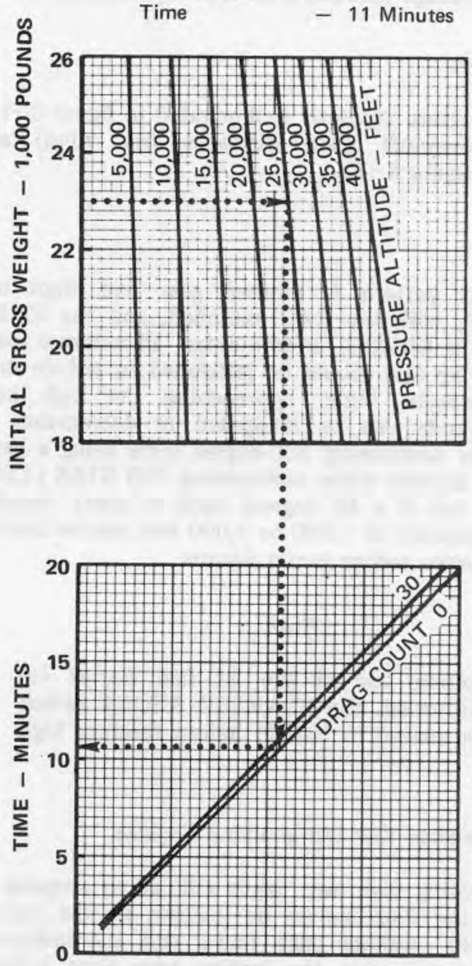


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Figure 3–12

Final.

Optimum conditions are 500 feet altitude, 190 KIAS (10.5 units angle of attack) and 1,000 feet from the approach end of the runway.

Flare.

The flare is begun at 50 feet above the ground with 190 KIAS (175 KIAS minimum), directly over the approach-end of the runway. Due to the high approach speed and excellent longitudinal control power available, the flare is an easy maneuver to perform. Aft stick is used as necessary to decrease airspeed and rate of descent to effect a touchdown at 155 KIAS. The touchdown point is approximately 3,000 feet down the runway.

WARNING

If the jet fuel starter has not been used to motor the engine, adequate control response will not be available below 155 KIAS in flight. Flight control pressure will not be available from RAT below 125 KIAS.

Landing.

Optimum touchdown speed is 155 KIAS. After touchdown and below 140 KIAS, aerodynamic braking is accomplished by very slowly and gently increasing pitch attitude to a point just before main gear liftoff. Care should be exercised to avoid becoming airborne. As airspeed decreases, aerodynamic braking may be increased. Braking may be started immediately with one smooth, ever-increasing application of brake pedal force. Up to four complete brake applications (brakes on to brakes off) may be available from the utility brake accumulator. The emergency brake should only be used as a last resort. Approximately four complete brake applications are available from the emergency brake accumulator. Utilize arresting gear or overrun gear if necessary. Below 130 KIAS, the trailing edge flaps may be lowered to full down using the emergency extension switch. After the aircraft comes to a stop, shut down the jet fuel starter, if used, by placing the STARTER ABORT switch to ABORT.

STUCK THROTTLE APPROACH.

A stuck throttle approach may be required when the throttle cannot be moved, when RPM response to throttle movement is erratic, or when engine RPM does not change when the throttle is moved.

Note

If engine rpm is in the IDLE range and throttle cannot be moved forward, check that throttle may have inadvertently been placed outboard of IDLE.

The optimum stuck-throttle/no-throttle response approach is started from a hoop position 5,000 feet from the end of the runway, 250 feet above field elevation, and at 215 KIAS. The hoop position is achieved flying level at 250 feet AGL to intercept a point 5,000 feet from the approach end of the runway. With the aircraft level, the HUD horizon line essentially overlays the real world horizon with the FPM on the horizon line. During approach to the hoop, the aircraft should be flown level until the touchdown point (750 feet down the runway) is 2.5° below the horizon line. This is the hoop position. Immediately fly the aircraft to position the FPM over the touchdown point. This automatically establishes the aircraft on a 2.5° glide slope. The FPM should be utilized as long as possible. At some point in the approach, the engine is shut down with eventual loss of the main generator. When this occurs, the HUD display is lost. When the display is lost, the pilot should maintain the 2.5° glide path as during a normal approach. The ON glide path indication of VASI may be utilized for hoop and glide path indications if installed. Refer to figure 3–13 for illustrations of the stuck throttle approach.

Approach conditions are based on a standard day temperature, 20-knot headwind, 23,000-pound gross weight, a 2.5° glide slope, and a touchdown airspeed of 135 KIAS.

Note

Add 3 knots of airspeed for each 1,000 pounds gross weight above 23,000 at each key point of airspeed. Do not decrease airspeed at key points if gross weight is less than 23,000 pounds.

Three contingencies must be considered in arriving at the procedure to be used:

1. RPM at or above 85% which permits level flight with gear and flaps down.
2. RPM between 75% and 85% which permits level flight in clean condition.
3. RPM below 75% which will not permit level flight in any condition.

Note

Listed rpm is for gross weight up to 23,000 pounds. Higher gross weights will require higher rpm.

CAUTION

RPMs listed in the above contingencies are estimated and should be used with caution. This data will be verified by flight test at a later date.

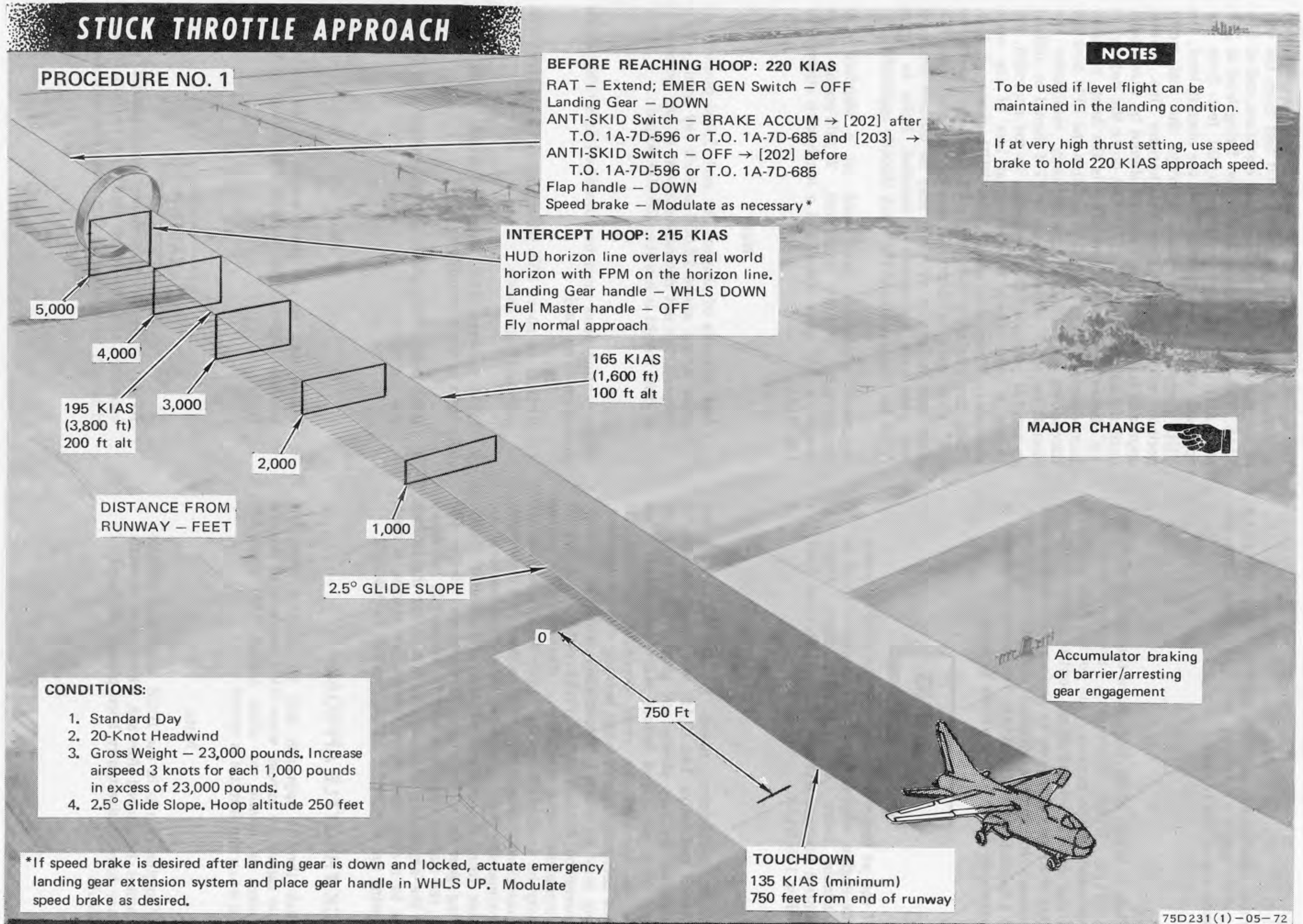

Figure 3–13 (Sheet 1)

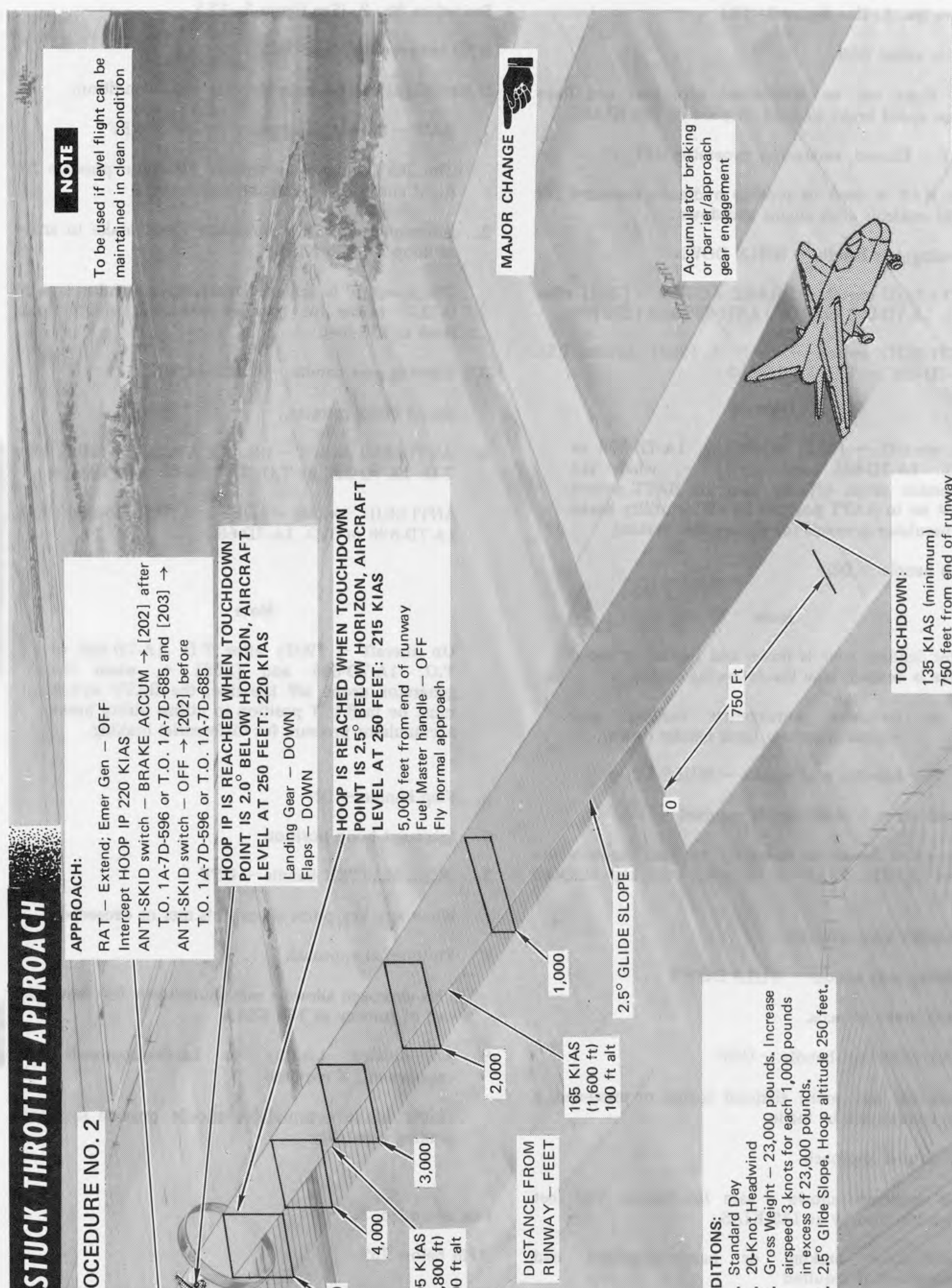

Figure 3–13 (Sheet 2)

Procedure No. 1. (See figure 3–13.)

RPM at or above 85%

If level flight can be maintained with gear and flaps down, use speed brake to hold airspeed at 220 KIAS.

1. RAT – Extend, emergency generator OFF

   The RAT is used to provide hydraulic pressures for flight controls after engine shutdown.

2. Landing gear handle – WHLS DOWN

3. ANTI-SKID switch – BRAKE ACCUM → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →

   ANTI-SKID switch – OFF → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685

   Note

   On aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →, when the generator drops off the line, the BATT switch must be in BATT position to utilize utility brake accumulator pressure for differential braking.

4. Flap handle – DN

   Note

   After landing gear is down and locked, if speed brake is desired, take the following action:

   a. Actuate emergency landing gear extension system (gear handle down)

   b. Landing gear handle – WHLS UP

5. Speed brake – Modulate as required

   Use speed brake as necessary to pass through the hoop at 215 KIAS or to reach any key airspeed point.

6. Intercept hoop position

7. Landing gear handle – WHLS DOWN

   Speed brake retracts.

8. FUEL MASTER handle – OFF

   When any key point airspeed is met or exceeded, a safe landing can be made.

9. Fly normal approach

   This approach allows a safe touchdown 750 feet down the runway at 135 KIAS.

10. Accumulator braking or barrier/approach end engagement, if required

    Utility brake accumulator should provide sufficient braking capability.

Procedure No. 2. (See figure 3–13.)

RPM between 75% and 85%

If level flight can be maintained in clean condition:

1. RAT – Extend, emergency generator OFF

   The RAT is used to provide hydraulic pressure for flight controls after engine shutdown.

2. Intercept hoop IP – Modulate speed brake to arrive at hoop IP, 220 KIAS

   The hoop IP is achieved when the touchdown point is 2.0° below the horizon with the aircraft flying level at 250 feet.

3. Landing gear handle – WHLS DOWN

   Speed brake retracts.

4. ANTI-SKID switch – BRAKE ACCUM → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →

   ANTI-SKID switch – OFF → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685

   Note

   On aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →, when the generator drops off the line, the BATT switch must be in BATT position to utilize utility brake accumulator pressure for differential braking.

5. Flap handle – DN

6. Intercept hoop position

7. FUEL MASTER handle – OFF

   When any key point airspeed is met or exceeded

8. Fly normal approach

   This approach allows a safe touchdown 750 feet from end of runway at 135 KIAS.

9. Accumulator braking or barrier/approach end engagement, if required

   Utility brake accumulator should provide sufficient braking capability.

Procedure No. 3.

RPM below 75%

If level flight cannot be maintained in clean condition:

1. Consider a Flameout Approach; or EJECT

PRECAUTIONARY APPROACH.

The precautionary landing pattern is slightly larger than the normal landing pattern, and can be intercepted on the downwind, base or final leg. The prime objective in using the precautionary landing pattern is to get the aircraft on the runway on the first attempt using available engine thrust as required. Because of the many variables involved, pilot evaluation of all factors and his judgment will determine the type of precautionary landing pattern most suitable. Such factors as pattern intercept points, aircraft configuration, altitude and airspeed will have to be evaluated. However, there are some general procedures which are applicable regardless of the type approach selected:

When on final:

1. The landing gear should be down, the flaps down, and the RAT extended (EMER GEN switch in OFF).
2. A normal glide path should be flown maintaining recommended computed final approach speed.
3. The throttle should be used as necessary to transition to a normal flared landing. Be careful not to overrotate. Avoid landing nose gear first.

If engine related problems are anticipated:

4. Computed approach speed plus 20 knots should be flown.

Note

If the engine fails or it becomes apparent that the runway cannot be made with available power, the 20 knots extra airspeed will permit a smooth wings level rotation to break the descent and permit ejection in level flight.

5. Plan on making a barrier engagement.

The pilot should strive for the normal touchdown airspeed with only minor variations from the normal touchdown point during precautionary landings.

DITCHING.

If possible, abandon the aircraft. Ditching is the last resort.

WARNING

In any ditching situation, pull the emergency canopy jettison handle before contact.

1. Perform distress procedure — Radio, IFF
2. Landing gear handle — WHLS UP
3. Speed brake — CLOSE
4. External load — SALVO JETT
5. Oxygen lever — 100%
6. Visor — Down
7. Shoulder harness — Locked
8. Seat — Lower
9. Glide speed — As required

   If the RAT is extended, the minimum airspeed for adequate flight control hydraulic pressure is as follows:

	MINIMUM AIRSPEED	
EMER GEN SWITCH	*→ [16] [18] → [26]*	*[17] [27] →*
CRUISE	175 KIAS	175 KIAS
T.O. LAND	130 KIAS	140 KIAS
OFF	125 KIAS	135 KIAS

10. Flap handle — DN
11. Canopy — Jettison

    Jettison canopy prior to making contact with the water.

12. Flare the aircraft just before contact and touch down nose high.

    Immediately after the forward motion stops, abandon the aircraft.

ROUGH FIELD LANDING.

If possible, eject.

If the aircraft must be landed on an unprepared surface, perform as many of the following as possible:

1. Distress procedure — Radio, IFF
2. Landing gear handle — WHLS DOWN
3. Flap handle — DN

4. Shoulder harness — Locked

5. RAT — Extend

   Extend the RAT to supply hydraulic power to the flight controls after engine shutdown.

6. EMER GEN — OFF

   Turn off the emergency generator to reduce the load on the RAT for flight control operation.

7. Seat — Lower

8. Canopy — Jettison

Just before touchdown:

9. Throttle — OFF

10. FUEL MASTER handle — OFF

11. MASTER GEN switch — OFF

12. BATT switch — OFF

EMERGENCY ENTRANCE.

Refer to figure 3—14 for the procedure to be followed for emergency entrance to the cockpit.

EMERGENCY GROUND EGRESS.

Refer to figure 3—15 for procedure to be followed for emergency ground egress.

EMERGENCY ENTRANCE

TO OPEN THE CANOPY AND REMOVE PILOT:

1. Push to release exterior canopy release handle. Rotate handle to unlock canopy. Raise canopy manually.
2. Pull the ejection controls safety handle down to safety the seat.
3. Pull the survival kit operation handle to release survival kit from pilot's harness.
4. Pull the emergency harness release handle upward, about 6 inches, to stop. This releases the two seat harness connections, lap belt and parachute arming cable.

WARNING

Do not actuate either ejection seat firing handle.

CAUTION

If the seat pan is raised 3/4 of an inch prior to the left seat harness connector disconnecting from the seat pan, the mode sensor will sense seat pan/seat separation, even though the survival kit handle has been properly activated, and the emergency equipment lanyard will be deployed. A 25-foot lanyard, with all survival gear and raft secured to it, connects the pilot to the survival kit. The raft will inflate when the lanyard is pulled taut. The lower portion of the survival kit will not separate from the seat unless it is rotated forward to release the retaining hooks. The lanyard must be cut to separate the pilot from the survival equipment, raft and the lower portion of the survival container remaining in the aircraft.

ALTERNATE PROCEDURES FOR CANOPY REMOVAL

IF CANOPY CANNOT BE OPENED MANUALLY –

Open rescue handle access door (on left or right side). Grasp handle and pull away from aircraft to full length of lanyard (approximately 66 inches). Pull handle sharply to fire canopy actuator cartridge. If canopy does not separate from aircraft, it may fall to a closed position but will not lock.

WARNING

If fuel is in the cockpit area, do not use the emergency rescue handle. Use fire axe or similar instrument to break canopy.

IF CANOPY CANNOT BE OPENED WITH RELEASE HANDLE OR RESCUE HANDLE –

Break canopy with fire axe or similar instrument. Be careful not to injure pilot.

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Figure 3–14

EMERGENCY GROUND EGRESS

EVACUATION WITHOUT PARACHUTE AND WITHOUT SURVIVAL CONTAINER

Begin egress immediately after aircraft comes to rest.

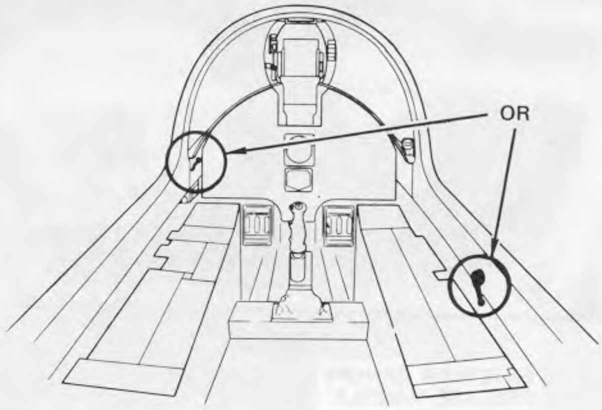
1. CANOPY – OPEN, JETTISON IF REQUIRED

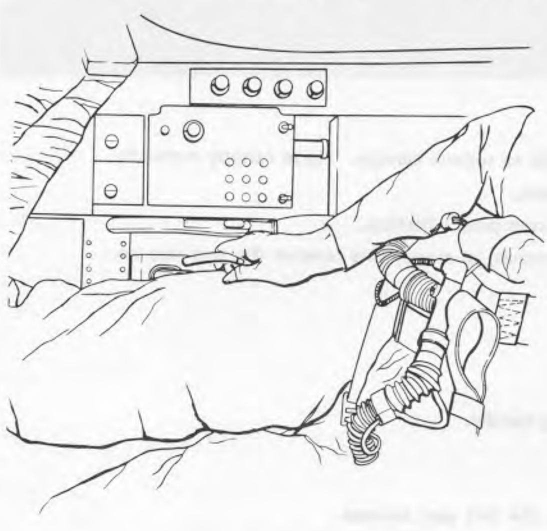
WARNING

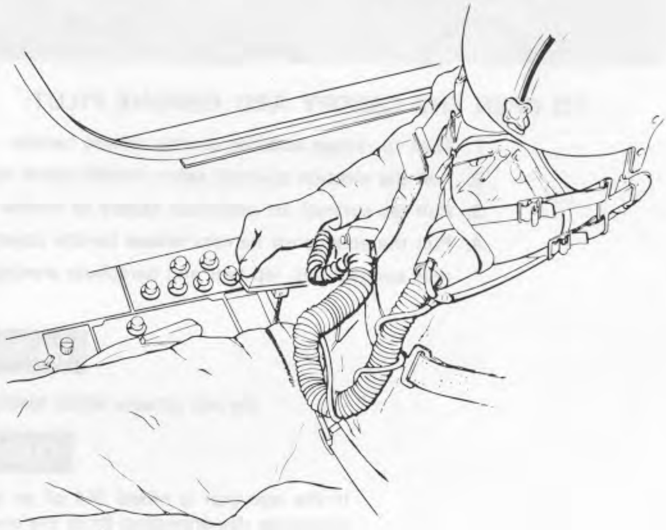
Do not attempt to jettison a partly or fully opened canopy.

NOTE

On aircraft → [114] after T.O. 1A-7D-619 and [115] →, a canopy breaker tool, located on the left canopy rail, is provided to break away the canopy for emergency egress should all other methods of opening the canopy fail.







2. EJECTION SAFETY HANDLE – DOWN

3. EMERGENCY KIT RELEASE HANDLE – PULL

(Completely away from survival kit)

Pulling this handle releases the survival container from pilot's harness.

WARNING

Failure to follow procedure in the correct sequence could result in the pilot standing up prior to pulling the emergency kit release handle. If the survival kit is raised 3/4 inch prior to the left seat connector disconnecting from the survival kit, the mode sensor will sense survival kit/seat separation even though the emergency kit release handle is pulled. A 25-foot emergency equipment lanyard will be deployed, connecting the pilot to survival kit. This lanyard restricts pilot movement to a 25-foot radius of the cockpit until manually released or severed.

4. EMERGENCY HARNESS RELEASE HANDLE – PULL

1. Squeeze trigger to free handle from seat.
2. Pull upward (about 6 inches) to stop. This releases the two seat-harness connections (lap belt and parachute arming cable).

5. SHOULDER HARNESS ATTACHMENTS – RELEASE

6. ABANDON AIRCRAFT

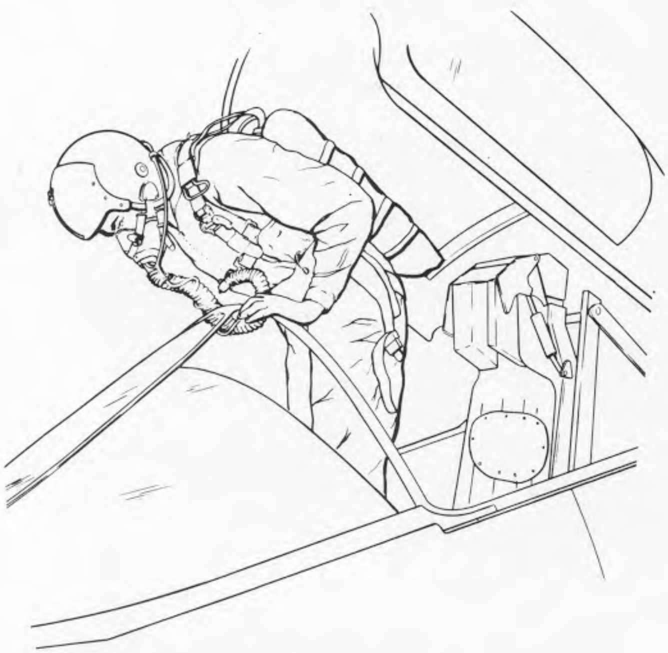
1. Stand up in cockpit. This disconnects pilot services (exposure suit vent air, oxygen, communications leads, and anti-g lead).
2. Rotate body using windshield as pivot point.
3. Slide down aircraft side.

75D 121 (1)–03–72

Figure 3–15 (Sheet 1)

EMERGENCY GROUND EGRESS

EVACUATION WITH PARACHUTE AND WITHOUT SURVIVAL CONTAINER



1. Canopy – Open, jettison if required

WARNING

Do not attempt to jettison a partly or fully opened canopy.

2. Ejection safety handle – DOWN

3. Emergency kit release handle – Pull completely away from survival kit

Pulling this handle releases the survival container from pilot's harness.

4. Emergency harness release handle – Pull

   1. Squeeze trigger to free handle from seat.
   2. Pull upward (about 6 inches) to stop. This releases the two seat-harness connections (lap belt and parachute arming cable).

5. Abandon aircraft

   1. Stand up in cockpit. This disconnects pilot services (exposure suit vent air, oxygen, communications leads, and anti-g lead).
   2. Rotate body using windshield as pivot point.
   3. Slide down aircraft side.

EVACUATION WITH PARACHUTE AND SURVIVAL CONTAINER

After aircraft comes to rest, place ejection safety handle in the DOWN position and begin egress by squeezing and then pulling up on the Emergency Harness Release handle. Abandon the aircraft.

75D121(2)–03–72

Figure 3–15 (Sheet 2)

CREW DUTIES

SECTION IV

(This section not applicable.)

OPERATING LIMITATIONS

SECTION V

TABLE OF CONTENTS.

Note

Refer to other sections of the Flight Manual for operating limitations that are characteristic of a specific phase of operation and are not covered in this section.

INTRODUCTION.

This section specifies limitations to be observed during normal operation of the aircraft. They are derived from actual flight tests and demonstrations. Since the most restrictive limitation applies to any given flight condition, read all the limitations in this section. Limitations which are merely associated with a certain technique or specialized phase of operation are discussed appropriately in other sections of the manual.

The operating limits indicated by flight and engine instruments are illustrated in figure 5–1. These limits are not necessarily repeated in the text. Should engine overtemperature or overspeed occur in excess of limitations listed, the engine should be shut down as soon as practical and the required maintenance inspection performed before further operation.

DEFINITIONS.

BASIC AIRCRAFT – An aircraft with four or more wing pylons with or without stores.

CRUISE CONDITION – Landing gear and flaps up, speed brake retracted.

TAKEOFF AND LANDING CONDITIONS – Landing gear and flaps down, speed brake retracted.

LIKE STORES CONFIGURATION – An approved configuration which consists of identical store types.

MIXED STORES CONFIGURATION – An approved configuration which consists of two or more different store types. Mixed stores are never loaded on the same aircraft store station.

PARTIAL CONFIGURATION – A configuration obtained by deleting stores in the normal release sequence from existing approved configurations.

L B A – Limits of Basic Aircraft.

N E – Not Established.

ENGINE OPERATING LIMITATIONS.
(See figure 5–2.)

INSTRUMENT MARKINGS

AIRSPEED

220 KIAS MAXIMUM FOR FLAP AND LANDING GEAR OPERATION

NOTE

On aircraft [11] → maximum airspeed for flap operation is 260 KIAS.

645 KIAS MAXIMUM ALLOWABLE

OIL PRESSURE

15 PSI MINIMUM (BELOW 80% RPM)

27 TO 53 PSI NORMAL OPERATING RANGE

53 PSI MAXIMUM

NOTE

During engine operation following initial start, oil pressure may peg at 60 psi but shall return to 27–53 psi range within 5 minutes.

ENGINE SPEED

80% TO 96% RPM BEST CRUISE

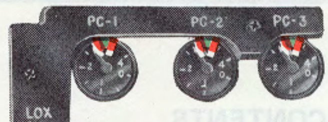
101% MAXIMUM AT MILITARY THRUST

ACCELEROMETER

7.0G AND –3.0G MAXIMUM AT DESIGN GROSS WEIGHT

NOTE

A counting accelerometer is located in the left wheel well. The instrument senses and records the number of times each of four preset positive g-loads is equaled or exceeded.



AIRCRAFT [17] [27] →

AIRCRAFT → [16] [18] → [26]

HYDRAULIC PRESSURE

2,950 PSI MINIMUM

2,950 TO 3,250 PSI NORMAL RANGE

3,250 PSI MAXIMUM

NOTE

On aircraft → [125] for PC 2 systems, hydraulic pressure instrument markings apply to throttle settings of 60% rpm or greater. A minimum pressure of 2,800 psi is permitted at idle to 60% rpm.

TURBINE OUTLET TEMPERATURE

175° C MINIMUM

350° C TO 553° C CONTINUOUS OPERATION

583° C MAXIMUM AT MIL THRUST

NOTE

Based on JP-4 fuel

75D208–10–71

Figure 5–1

ENGINE OPERATING LIMITATIONS

CONDITION	TOT °C	RPM %	FUEL FLOW LB/HR	OIL PRESS	DURATION MINUTES
GROUND STEADY STATE					
START	620 (See note 1)	---	500 – 1,000	INDICATION	---
IDLE	175 min	54 (±2) (See note 2)		15 psi min (See note 5)	---
MILITARY	583 (For transient or take-off conditions, see note 3)	101 (See note 4)		27 – 53	30
FLIGHT					
START	620	---		INDICATION	---
IDLE	175 min	---		15 psi min	---
MAX CONTINUOUS	553	96.8		27 – 53	---
MILITARY	583 (For transient conditions, see note 6)	101.0 (See note 4)		27 – 53	30
FLUCTUATION LIMITS					
IDLE (GROUND)	±3	±0.2 (See note 7)		±2	---
GROUND AND FLIGHT MIL	±3	±0.2		±2	---

NOTE

1. Start – Five seconds is allowable between 620°C and 700°C if rpm is rising. If rpm stagnates and temperature climbs above 620°C, abort start.
2. Low idle rpm – After prolonged shutdown at ambient temperatures below approximately 10°C (50°F), idle rpm after engine start may be below normal range. The amount of reduction varies between engines but expect rpm to indicate lower as temperature decreases. Minimum acceptable is 48% rpm. Modulate throttle to obtain 52% to 56% rpm.
3. Engine acceleration (without double datum) – 640°C provided temperature returns to 583°C or below within 3 seconds.

   Engine acceleration (with double datum activated) – 620°C to 640°C permitted for 3 seconds, 606°C to 620°C permitted for 10 seconds, 589°C to 606°C permitted for 2 minutes, and 583°C to 589°C permitted for 5 minutes.
4. Engine overspeed – 104% maximum provided rpm returns to or below 101% within 6 seconds.
5. Oil – Maximum allowable oil consumption is 0.12 gallon per hour. The engine is restricted to MIL-L-7808 oil. Oil pressure shall be 27 – 53 psi at 80% rpm and above. (Minimum oil pressure is 15 psi from idle to 80% rpm). During engine operation following initial start, oil pressure may peg 60 psi but shall return to 27 – 53 psi range within 5 minutes.
6. Engine acceleration (with or without double datum) – 640°C provided temperature returns to 583°C or below within 3 seconds.
7. Increase in engine rpm during brake application is acceptable provided it does not exceed 6% and rpm returns to normal upon brake release.

75D209-02-71

Figure 5-2

STARTER GROUND OPERATING LIMITATIONS.

1. Hold throttle in CRANK position until engine rpm is indicated. Abort if no indication in 7 seconds.
2. Starter operating limits are 2 minutes accumulated within 30 minutes followed by a 30-minute cooling period. (One start or start attempt counts as 30-second operation).
3. Minimum time between consecutive starts is 1.5 minutes.
4. Abort immediately if a starter overtemp indication occurs. Confirm that battery is not discharged. Reject starter if overtemp indication reoccurs.
5. To abort, hold switch for a minimum of 5 seconds.
6. Do not use external ground power for starting. For emergency starts use a 28-volt dc aircraft battery or two 12-volt auto batteries in series.

STARTER INFLIGHT OPERATING LIMITATIONS.

1. Do not operate starter in flight at altitudes above 10,000 feet MSL.

WEIGHT LIMITS.

Maximum operating weight . . . . 42,000 pounds
Maximum landing weight . . . . 37,088 pounds
(at maximum sink speed of 558 fpm)

CAUTION

If operational necessity dictates landing in excess of the maximum landing weight, touch down at minimum sink rate to preclude possible aircraft structural damage.

AIRSPEED LIMITATIONS.

For systems operations limitations, see figure 5–3. For basic aircraft limitations, see figure 5–4.

MANEUVERING LIMITATIONS.

ROLL RESTRICTIONS.

For roll restrictions, see Prohibited Maneuvers, this section.

PROHIBITED MANEUVERS.

1. Intentional spins.
2. Rolls in excess of 360°.
3. Aileron rolls initiated at less than 0.5g with a symmetrical store load or 1.0g with an asymmetrical store load. This limitation is imposed to prevent excessive yaw buildup. During all rolls, the stick shall not be moved forward of the level flight longitudinal stick position for the entry airspeed.
4. Rolls in excess of 180° of bank angle change in rolling pullout maneuver.
5. Rolls in excess of 180° of bank angle change in landing configuration.
6. Bank angle changes in excess of 120° in diving flight at low altitudes and high indicated airspeeds. Rate of roll decreases rapidly at speeds greater than 0.92 IMN.
7. Roll control into an asymmetrical store load is restricted to a maximum of approximately 1/2 lateral stick throw and bank angle changes in either direction of 180° or less.
8. Intentional control augmentation disengagements above +6.0g.
9. Do not use heading hold, heading select, attitude hold, or altitude hold modes below 500 feet AGL.

BRAKE LIMITATIONS.

Brake energy limits for all configurations, using either antiskid or manual braking, are presented in figure 5–4A. Energy absorbed by the brakes is a function of gross weight, airspeed when brakes are applied, temperature pressure altitude, and runway wind. The legend beside the chart explains actions to be taken when a stop in the DANGER, CAUTION, or NORMAL zones is performed.

Use.

Enter the chart at gross weight and proceed vertically upward to airspeed, then horizontally right to the baseline. From this point contour a guideline left and right of the baseline. Enter the lower right part of the chart at runway temperature and proceed horizontally left to pressure altitude; then proceed vertically upward to the intersection of the contoured guideline. At this intersection proceed horizontally right and read energy absorbed.

AIRSPEED AND G LIMITATIONS FOR INDIVIDUAL SYSTEMS

<table>
<tr><th colspan="2">CONDITION</th><th>AIRSPEED</th><th>LOAD FACTOR</th></tr>
<tr><td colspan="2">Landing Gear Extension and Retraction
Landing Gear Extended (Not in transit)</td><td>220 KIAS (Normal)
180 (KIAS (Emergency)
244 KIAS</td><td rowspan="2">Symmetrical Flight
+2.0g to 0.0g

Unsymmetrical Flight
+2.0g to +1.0g</td></tr>
<tr><td colspan="2">Flap Extension and Retraction

Flaps Extended (Not in transit)
(or with TE flaps fixed at intermediate position)</td><td>220 KIAS (Normal)*
260 KIAS (Normal)†
220 KIAS (Emergency)

244 KIAS*
260 KIAS†</td></tr>
<tr><td colspan="2">Speed Brake Extension, Retraction, and Extended</td><td colspan="2">Limits of Basic Aircraft</td></tr>
<tr><td rowspan="2">Air Refueling Probe</td><td>Extension and Retraction</td><td>300 KIAS</td><td>Limits of Basic Aircraft</td></tr>
<tr><td>Extended</td><td>440 KIAS</td><td>Limits of Basic Aircraft</td></tr>
<tr><td colspan="2">Air Refueling Receptacle</td><td colspan="2" rowspan="3">Limits of Basic Aircraft</td></tr>
<tr><td colspan="2">Arresting Hook</td></tr>
<tr><td colspan="2">Ram Air Turbine Extension, Retraction, and Operation</td></tr>
<tr><td colspan="2">Canopy Open, Ground Operation</td><td>60 KIAS</td><td>Not Applicable</td></tr>
</table>

*On aircraft → [10]

†On aircraft [11] →

5D216-10-71

Figure 5–3

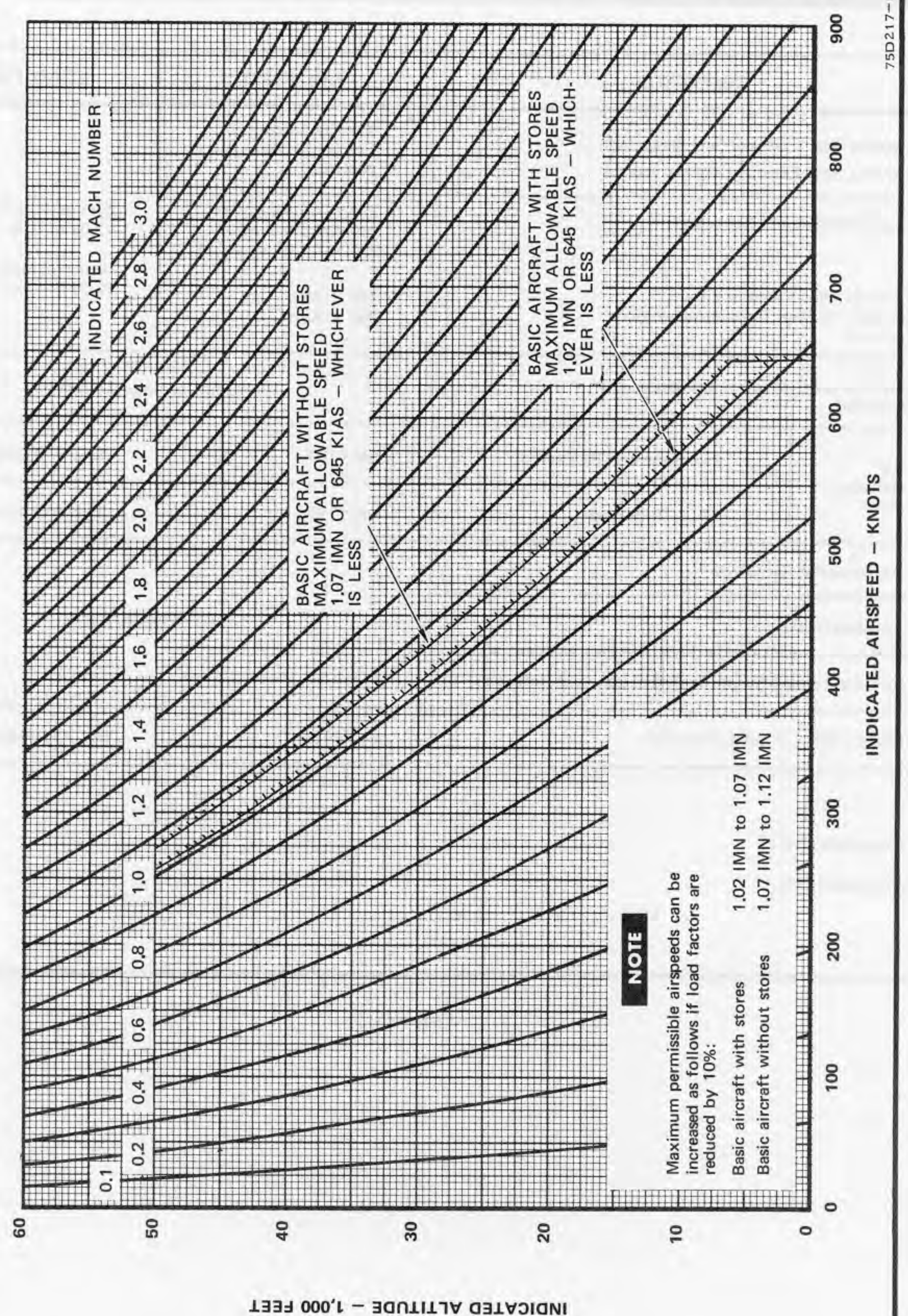


Figure 5–4

AIRSPEED LIMITATIONS

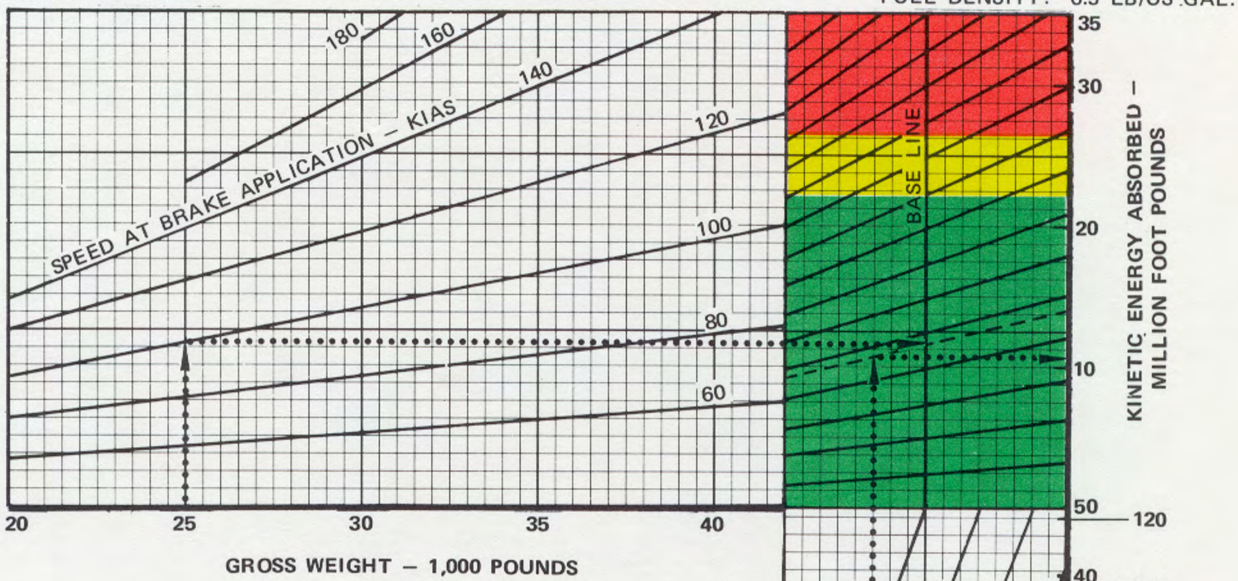
BRAKE ENERGY LIMITS

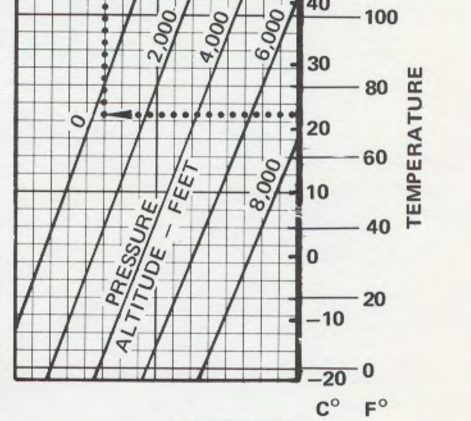
The following information explains action to be taken when a stop in the DANGER, CAUTION, or NORMAL ZONES is performed:

MODEL: A-7D
DATE: APRIL 1972
DATA BASIS: **FLIGHT TEST**

DRY RUNWAY, CG = 26% MAC
25° AND 40° FLAPS
ANTI-SKID AND MANUAL BRAKING

ENGINE: TF41-A-1
FUEL GRADE: JP4
FUEL DENSITY: 6.5 LB/US GAL.





DANGER ZONE

1. Use moderate braking below 25 knots until taxi speed of 5–10 knots is obtained. Release brakes, if possible, and maintain forward motion.

CAUTION

Applying maximum brake pressure below 25 knots may cause brake rotors and stators to fuse together.

2. Proceed to the nearest parking area clear of other aircraft and personnel without stopping and as quickly as possible. Park aircraft with the wheel axis pointed in a safe direction.
3. Request fire fighting equipment. Hydraulic fluid fire is possible. Approach main landing gear wheel and tire from front or rear for fire fighting purposes only.
4. Extinguishing agents shall be applied as a fog or foam on the tires and directly to the brakes. Do not spray liquid directly on the wheels.
5. Evacuate aircraft immediately. Leave immediate vicinity keeping forward of the aircraft.

CAUTION ZONE

1. The area in the vicinity of the main landing gear within 50 feet of any brake should be regarded as unsafe during the first hour after the stop, unless the thermal release (fuse) plugs have blown allowing the tires to be deflated.
2. Request fire fighting equipment. Hydraulic fluid fire is possible.
3. Do not attempt takeoff until the tires are cool to the bare hand and the brake housings have cooled to where a bare hand can be held against them. This is to prevent possible tire failure during takeoff or in flight.

NORMAL ZONE

1. If stop does not exceed 16 million foot pounds (8 million per brake), subsequent takeoff may be performed immediately. However, brake application is restricted to speeds and gross weights in the Normal Zone or below in the event a subsequent takeoff is aborted.
2. If stop does not exceed 22 million foot pounds (11 million per brake), subsequent takeoff may be performed after a one hour waiting period.
3. Unrestricted subsequent takeoff may be performed only after brake housings and tires are cool to the bare hand.

NOTE

1. Brake energy uses is 20% higher with flaps up.
2. Speed at brake application is IAS minus any headwind or plus any tailwind component.
3. If it becomes necessary to stop the aircraft in a minimum distance, maximum anti-skid braking should be used no matter what the aircraft energy is at brake application.

LEGEND

DANGER ZONE
26 To 35 Million Foot-Pounds

CAUTION ZONE
22 To 26 Million Foot-Pounds

NORMAL ZONE
0 To 22 Million Foot-Pounds

75D272–06–72

Figure 5–4A

STRUCTURAL LIMITATIONS.

CRUISE CONDITION. (See figure 5–5.)

TAKEOFF AND LANDING CONDITION.

Symmetrical flight . . . . +2.0g to 0.0g
Rolling pullouts . . . . +2.0g to +1.0g

FUEL SYSTEM RESTRICTIONS.

The engine is restricted to JP-4 fuel for normal use. Emergency fuel is JP-5.

WARNING

JP-5 fuel does not contain an anti-ice additive. To prevent fuel system icing and possible engine flameout, avoid flight at altitudes where the outside air temperature is 2°C (35°F) and below.

THROTTLE AND FUEL CONTROL SELECTION RESTRICTIONS.

1. Throttle movement while in MAN fuel control must take 10 seconds minimum from idle to military or military to idle.

CAUTION

Rapid throttle movement at high altitude or in near-sonic dive maneuvers may cause engine compressor stalls. All throttle movements at or above 40,000 feet altitude, or in near-sonic dive maneuvers, should be made smoothly and slowly (idle to military, 10 seconds minimum; military to idle, 10 seconds minimum).

2. There are no restrictions in moving the FUEL CONTROL selection switch from NORM to MAN. Transferring from MAN to NORM must be done below 80% rpm.

Note

If a malfunction causes throttle position and engine speed to become mismatched, it is desirable that the throttle be retarded to IDLE before transfer from NORM to MAN or back, unless an emergency situation dictates otherwise.

AIR REFUELING RESTRICTIONS → [16] [18] → [26]

Air refueling is limited to the total aircraft capacity, including external tanks, minus 1,000 pounds.

AIR REFUELING RESTRICTIONS [17] [27] →

1. After filling aircraft internal fuel to shutoff, the tanker boom must not be reengaged until at least 200 pounds internal fuel has been used or jettisoned.
2. Except for a low fuel emergency, air refueling with nozzle latches retracted to the unlocked position (tanker boom forcefully maintaining contact to transfer fuel) is prohibited.

ALTERNATE FUEL FEED RESTRICTIONS [17] [27] →

COMBAT Position.

When the ALT FUEL FEED handle is in the COMBAT position, the following restrictions apply.

1. There are no maneuvering restrictions below 15,000 feet pressure altitude. Above 15,000 feet, the aircraft is restricted to the attitude envelope shown in figure 5–6.
2. Use of the COMBAT position above 30,000 feet pressure altitude is prohibited.
3. Do not select or operate in COMBAT position with failure of either fuel boost pump 1 or fuel boost pump 2.

ALT FEED Position.

When the ALT FUEL FEED handle is in the ALT FEED position, the following restrictions apply.

1. Limit flight maneuvers to positive g load factors.
2. Use of the ALT FEED position above 30,000 feet pressure altitude is prohibited.
3. To achieve maximum fuel availability, the aircraft is restricted to nosedown attitudes not exceeding those of a standard jet penetration while on ALT FEED, AUTO transfer, and to positive pitch attitudes while in EMERG transfer. The WING TRANS switch should be placed in AUTO when descending for landing.

ACCELERATION LIMITATIONS

NOTE

If less than four wing pylons are installed, the aircraft weight for design limit load factors reduces from 29,575 lb to 27,100 lb as indicated in chart by dashed lines.

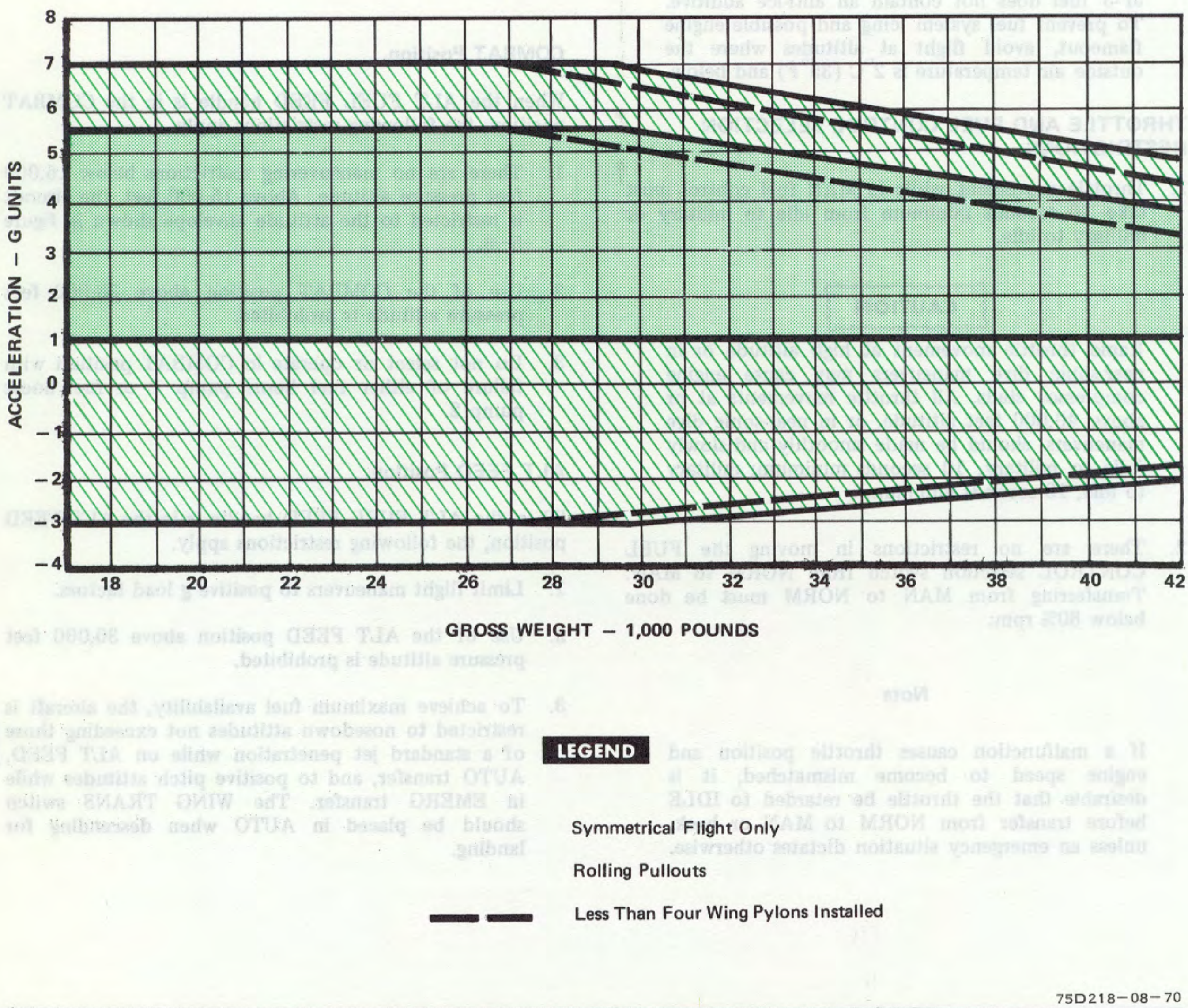


Figure 5–5

ALTERNATE FUEL FEED WITH COMBAT SELECTED

AIRCRAFT PITCH ATTITUDE VS ALTITUDE

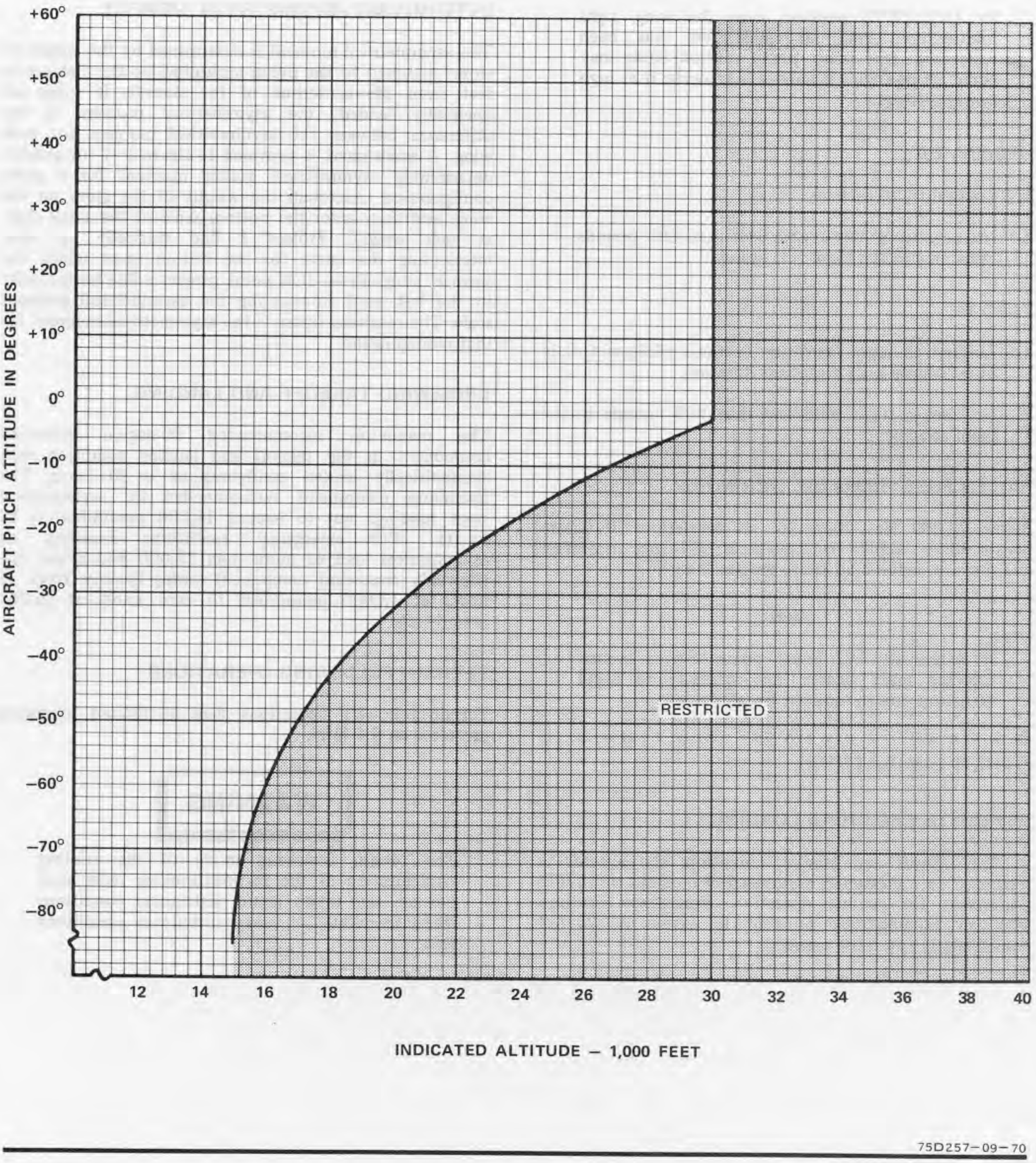


Figure 5–6

4. Except during fuel transfer malfunctions, do not select ALT FEED below main indicator readings of 2,100 pounds because the aft tank is empty.

WARNING

In ALT FEED position, once the wing, right midfuselage, and aft tank fuel has been exhausted, fuel boost pump caution lights may come on or engine flameout may occur if at high power settings.

NEGATIVE G.

1. Limited to 10 seconds.
2. No negative g flight with less than 600 pounds remaining in the main fuel system.

ZERO G.

1. Limited to rapid transition between +0.3g and -0.3g of no longer than 5 seconds duration.
2. No zero g flight with less than 600 pounds in the main system.

FAILED FUEL PUMPS NO. 1 OR NO. 2

Below 20,000 feet, there are no restrictions. If failure occurs above 20,000 feet, maintain 80% rpm or greater and avoid nosedown attitudes greater than -5°.

Note

If failure of fuel boost pump No. 2 occurs, monitor main system fuel quantity to avoid depletion due to reduced transfer rate.

OTHER LIMITATIONS.

ASYMMETRICAL STORE LOADINGS.

In the takeoff and landing condition, the aircraft is restricted to a maximum asymmetrical moment of 13,000 pound-feet for normal operation. Emergency landings with an asymmetrical moment in excess of 25,000 pound-feet is not recommended.

Note

Maximum asymmetrical moment during cruise condition flight shall not exceed one full pylon. Sufficient airspeed should be maintained with asymmetrical moment to provide adequate lateral trimming.

DETERMINING ASYMMETRICAL MOMENT.

The asymmetrical moment is determined by the weight of stores attached to the pylon multiplied by the distance in feet from the centerline of the aircraft. If wings are unequally loaded, the asymmetrical moment is the difference between the asymmetrical moment for each wing. A small chart is provided in figure 5–7 for quickly determining asymmetrical rolling moment for a given configuration. Ascertain the weight of the store on the wing, and then enter the bottom scale of the small chart at that weight. Project a line vertically up until intersecting the curve for the station upon which the store is hung. From that point project a line horizontally to the left until intersecting the asymmetrical moment scale. The resultant figure is the asymmetrical moment for that configuration.

CROSSWIND TAKEOFF AND LANDING.

The maximum recommended 90-degree crosswind component in the takeoff and landing condition with symmetrically loaded configurations is 20 knots. The maximum component recommended for asymmetrical store loadings not to exceed 13,000 pound-feet is 15 knots. For emergency conditions requiring an asymmetrical load of more than 13,000 pound-feet, the allowable crosswind component varies linearly from 15 knots at 13,000 pound-feet to zero knots at 25,000 pound-feet.

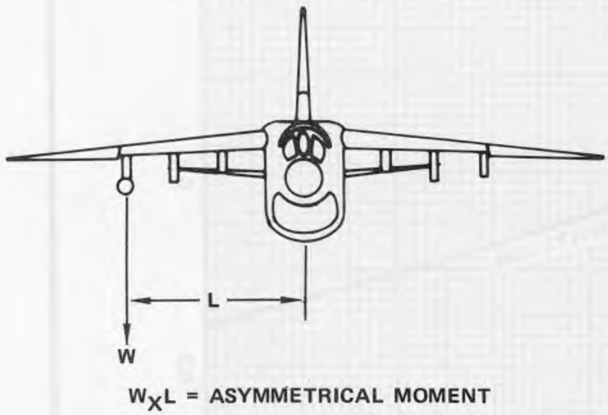
TERRAIN FOLLOWING OPERATIONS.

Terrain following operations shall be limited to speeds greater than 0.4 IMN.

WARNING

The terrain following mode of the existing configuration of the forward looking radar shall not be used under actual instrument conditions when moderate or heavy turbulence conditions exist.

ASYMMETRICAL STORE MOMENT CALCULATION



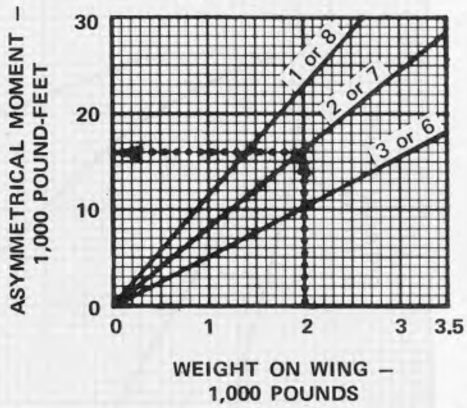


Figure 5–7

M61A1 GUNFIRING LIMITATIONS.

Gunfiring is restricted to +6.3g to -1.0g. Otherwise gunfiring is unrestricted except for the idle power gun firing limitations depicted in figure 5–8. Figure 5–8 shows the gunfiring envelope when flight conditions at idle power do not provide enough bleed air pressure to open the purge valve. The valve has a minimum allowable opening pressure tolerance and the envelope represents the upper limit of that tolerance. Therefore, the gun may fire slightly inside the envelope at idle power. The gun fires anywhere within the envelope at power settings of 70 percent or greater. The fuselage gun may be fired at any time before, during, or after store release, employment, or jettison.

Burst length is limited only by the amount of ammunition loaded. However, it is recommended that burst length not exceed 5.0 seconds to minimize gun barrel erosion and to increase barrel life.

EXTERNAL STORES LIMITATIONS.

INTRODUCTION.

Figure 5–9 depicts the symbols used to indicate the type of suspension and the rack stations for configurations shown in figure 5–12. These symbols are also used in the example configurations shown in figures 5–10 and 5–11.

Figure 5–12 covers carriage of like and mixed stores. Each configuration is illustrated to show the wing station on which the store is cleared, the approved rack loading, and the carriage, release, and jettison limits pertinent to each store making up the configuration. Unless otherwise noted, all six wing pylons with basic parent racks are installed on the configurations listed in figure 5–12.

WARNING

Only the configurations shown in figure 5–12, or partial or combined configurations properly obtained from those shown, may be carried, released, or jettisoned. Unauthorized loads may result in flutter, overstress, cg travel aft of the approved limit during carriage, and unpredictable ordnance separation characteristics during release or jettison. Mixed ordnance loads on any one aircraft station are not authorized.

For AIM-9 and TDU-11 limitations, refer to (Confidential) T.O. 1A-7D-1A. All of the configurations shown in figure 5–12 may be carried with or without fuselage stores unless otherwise noted.

M61A1 IDLE POWER GUNFIRING ENVELOPE

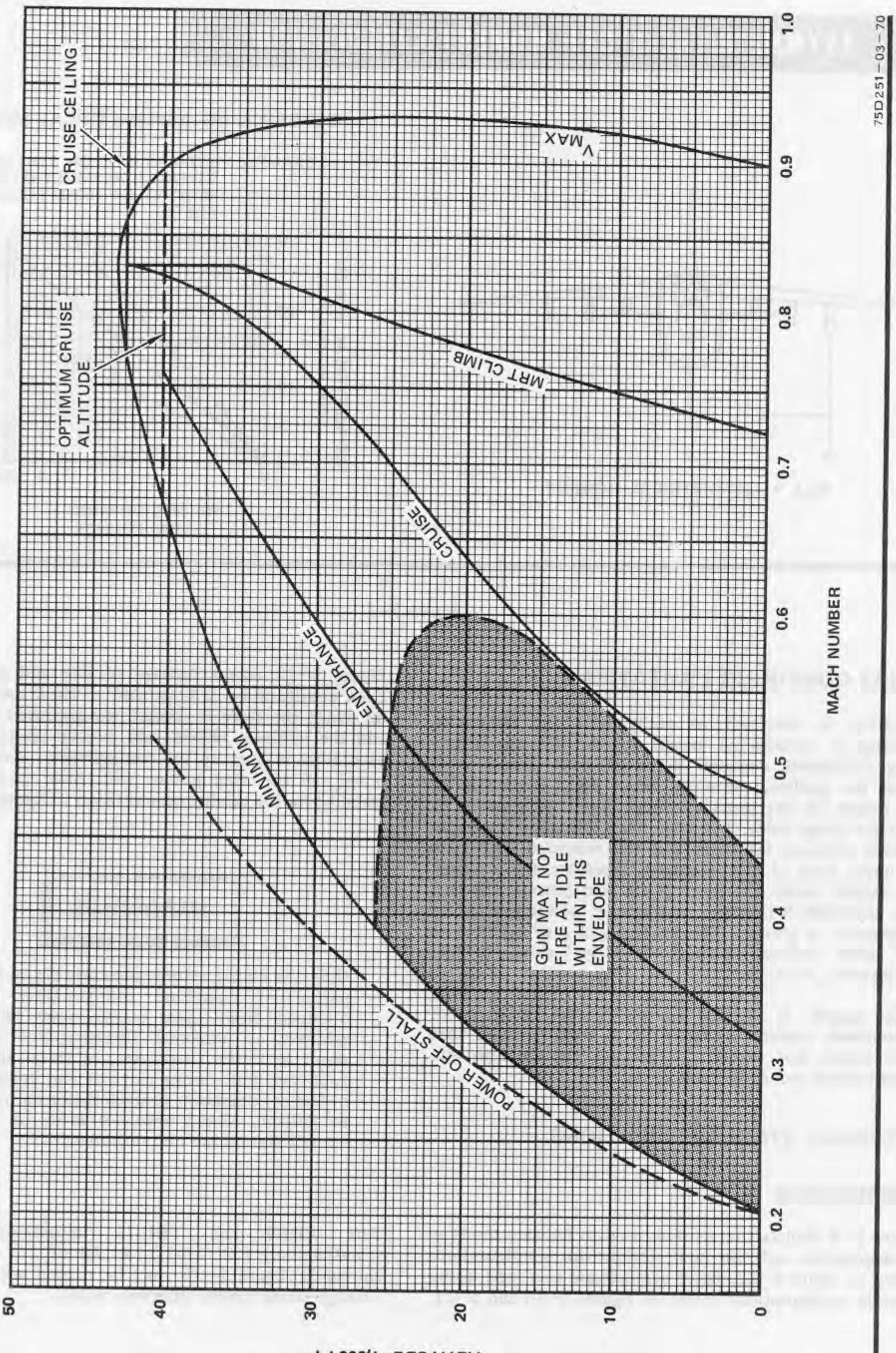


Figure 5–8

SYMBOLS USED IN EXTERNAL STORES LIMITATIONS CHARTS

NOTE

The external stores limitations charts depict the authorized types of suspension and store loadings. The symbols shown below are used to indicate the type of suspension and the rack stations upon which stores are authorized for carriage and release. Sequence of rack release is shown in rack symbols below.

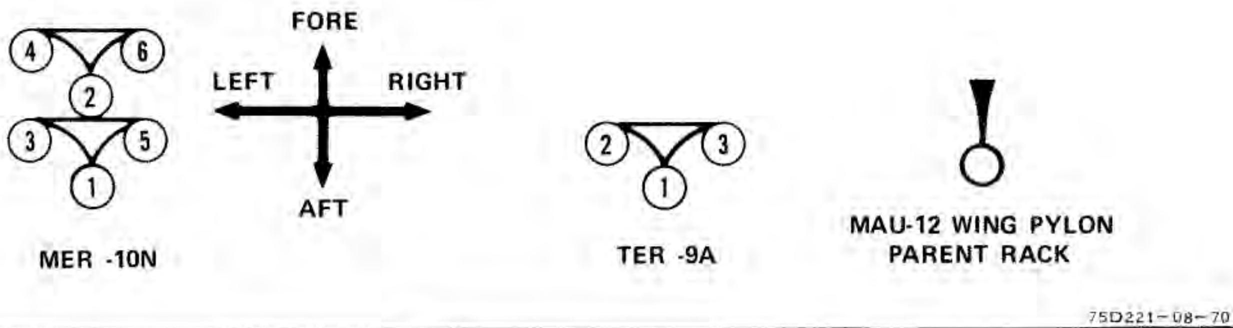


Figure 5-9

GENERAL RESTRICTIONS AND DEFINITIONS.

The following paragraphs present restrictions applying to carriage, employment, release, and jettison of the configurations shown in figure 5–12 and to their partial or combined configurations. Definitions are included for all the terms used in the columns of figure 5–12.

1. For mixed type store configurations, the carriage, release, and jettison limits are given in figure 5–12 for each store type. The limits of the most restricted store apply as long as that store is retained.

2. The limits shown in figure 5–12 represent maximum safe performance limits for the specific aircraft/store combinations depicted. T.O. 1A-7D-34-1-1 presents data to allow computation of optimum delivery envelopes, and as such, occasionally presents numbers which conflict with the limits presented in figure 5–12. In such cases the limits in figure 5–12 are authoritative and override the data presented in T.O. 1A-7D-34-1-1.

STORES CARRIAGE.

1. The symbols used in figure 5–12 for the station loading and suspension columns define the specific rack locations for the carriage of the stores. These locations must be adhered to in each particular configuration.

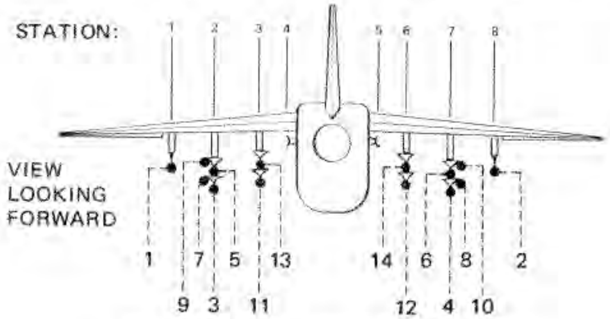
2. Carriage airspeed limits for each configuration are listed in KIAS and IMN. Carriage is restricted to whichever of the two airspeed values is less.

3. Empty MER and TER acceleration limits are to the limits of the basic aircraft. Airspeed limits are the same as the basic aircraft with stores.

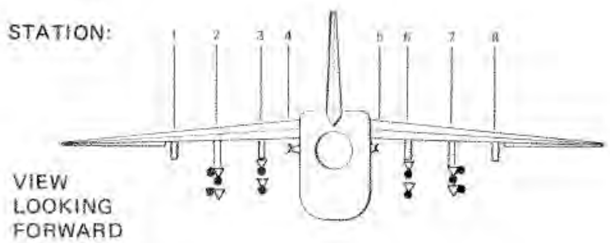
4. The carriage acceleration limits listed in figure 5–12 are applicable only to symmetrical flight maneuvers. The corresponding rolling pullout acceleration limits vary from a minimum of +1.0g to a value equal to 0.80 times the upper symmetrical flight limit unless noted otherwise.

5. Figure 5–5 presents acceleration limits as a function of aircraft gross weight and whether the pullout/pushover is symmetrical or rolling. Acceleration limits in figure 5–12 cover essentially typical conditions of symmetrical pullouts and do not consider gross weight variations. For any set of conditions both figures should be consulted and the more restrictive g limit observed.

LIKE STORE PARTIAL CONFIGURATIONS



NORMAL PYLON RELEASE SEQUENCE



FOUR LIKE STORES DELETED IN NORMAL RELEASE SEQUENCE

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Figure 5-10

Partial Configurations.

Partial configurations are obtained from the configurations presented in figure 5-12 by deleting stores from the existing approved configurations. Ground rules for partial loads are presented in the following paragraphs.

Note

Flight restrictions and limitations for all partial configurations are the same as the restrictions or limitations applying to the original configuration.

1. Like stores: Partial configurations of like stores must be obtained by deleting stores in the normal release sequence. This rule is necessary to assure that only configurations that have been analyzed and flight tested are flown. Figure 5-10 illustrates the normal release sequence for a typical load of like stores. Any configuration shown in figure 5-12 can be down loaded in accordance with these rules.

2. Mixed stores: Mixed store partial configurations are derived as follows:

   a. Any store type can be deleted independently of the other store type.

   b. Deletion of the selected store type must be in the normal release sequence for those stations on which the store to be deleted is carried.

Note

Like store configurations that can be obtained by deletion of all of the other type of store from a mixed store configuration are not depicted separately in the External Stores Limitations Charts. For example, many Mk 82 LDGP configurations can be obtained by deleting ECM pods or SUU-42 dispensers from the mixed store configurations of those stores and the Mk 82 LDGP.

Figure 5-11 illustrates the application of the mixed store rules. In the first case, the illustration depicts how a like store configuration can be obtained from a mixed store configuration by deleting all of one type of store. In the second case, the illustration depicts how a partial mixed store configuration can be obtained by deleting stores in the normal release sequence.

Combined Configurations.

A depicted or partial configuration for the left wing may be combined with a depicted or partial configuration for the right wing provided:

1. Applicable carriage, launch, release, and remarks limitations listed in figure 5-12 for the two depicted configurations are applied to the resulting configuration.

2. If the two depicted configurations used in the combination are symmetrical, the forward and aft center of gravity limits for the resulting configuration is obtained by averaging the applicable limits for the two depicted configurations.

3. If either of the depicted configurations used in the combination is asymmetrical, the more restrictive forward and aft center of gravity limits of the two configurations, i.e., the more aft forward limit and more forward aft limit, must be used for the resulting configuration.

4. All combined configurations shall comply with aircraft asymmetry and weight limits listed in Section V for takeoff, flight, and landing.

Note

Combining two depicted configurations may result in asymmetrical drag requiring rudder trim.

WARNING

When employing, releasing, or jettisoning stores (except when employing forward firing munitions), the speed brake must be closed and yaw maintained as close to zero as possible to prevent collision of stores with airframe. The speed brake may be extended during employment of forward firing munitions.

EMPLOYMENT.

Airspeed or acceleration (g's) limits quoted under the Employment column of figure 5–12 are applicable to the launching limitations of rockets and missiles and the dispensing limitations of flares and practice bombs.

STORES RELEASE.

Airspeeds or acceleration (g's) limits quoted in the Release column of figure 5–12 are applicable to releasing stores from suspension equipment, either MER/TER's or MAU-12 bomb racks. These limits are also applicable to select or salvo jettisoning of single stores from MAU-12 bomb racks and to auxiliary jettisoning of stores from MER/TER's.

WARNING

Stores should be jettisoned above the maximum fragmentation clearance altitude when possible, even though jettisoned in a safe condition.

Do not auxiliary jettison from stations 2 and 7 with the landing gear down.

1. When carrying stores of mixed types, any one store type may be selected for release in its normal release sequence on any given bomb run Rule 3 is applicable.
2. The single type of store selected must be released from the most outboard pylon first.
3. All configurations shown in figure 5–12 are assumed to consist of like store types when the station loading and suspension columns do not explicitly define the authorized store types. In mixed store configurations, when a general type such as BLU, CBU, etc. is listed, the same assumption applies for the stations so designated. Therefore mixing of various specific types such as BLU-1C/B, BLU-27/B or BLU-27B/B fire bombs in either a like or mixed store configuration is only authorized when these specific models are considered as a single store type in determining authorized release sequence. (This means if a BLU-27/B is loaded on station 1, it must be released before a BLU-1C/B loaded on station 2.)
4. Store release or selective jettisoning from one side of the aircraft must be followed by release or jettison from the opposite side. Do not exceed one pylon asymmetry in any release situation.

JETTISONING.

Airspeeds or acceleration (g's) limits quoted in the jettison column of figure 5–12 are applicable to jettisoning the combined suspension equipment (MER's or TER's) with or without stores(s) below the MAU-12 bomb rack.

WARNING

Stores should be jettisoned above the maximum fragmentation clearance altitude when possible, even though jettisoned in a safe condition.

1. Airspeeds for emergency level flight jettisoning of MER/TERs (with or without stores) are presented in Note 1 of figure 5–12.

MIXED STORE PARTIAL CONFIGURATIONS

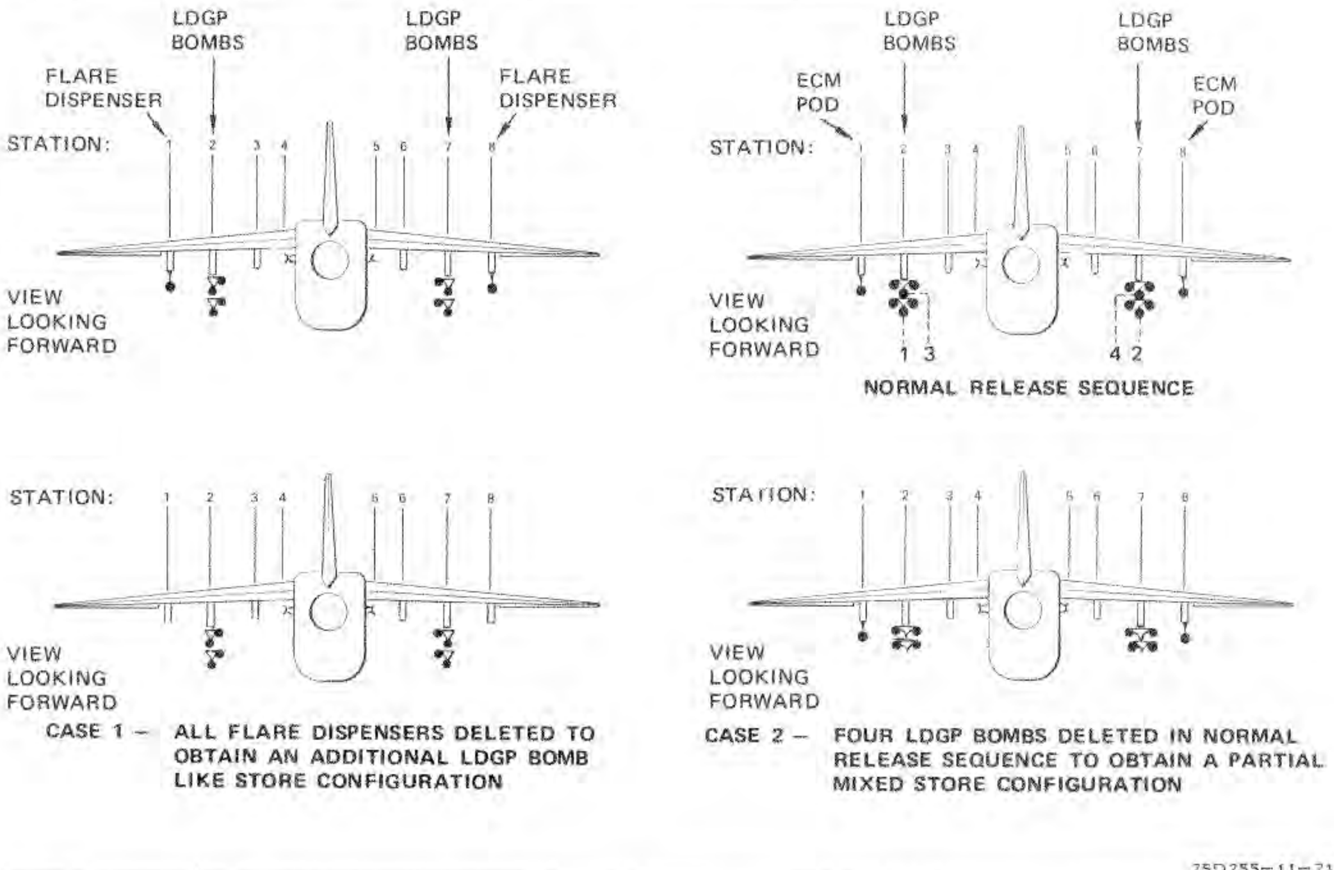

Figure 5–11

2. Do not jettison a loaded MER/TER unless the adjacent outboard MER/TER is empty of stores.

3. MER/TER jettison conditions apply to basic configurations and to partial or combined configurations.

4. Selective jettisoning of a MER/TER from one side of the aircraft must be followed by jettisoning or releasing from the opposite side. Do not exceed one pylon asymmetry in any jettison situation.

MAXIMUM DIVE FOR DELIVERY.

The dive angle listed in this column is the maximum dive angle currently certified from flight test results for tactical delivery on a target of a particular store or configuration. This maximum dive angle may in some cases be lower than delivery envelopes or ballistic tables contained in T.O. 1A-7D-34-1-1 or T.O. 1A-7D-34-1-2 since these T.O.'s do not take into consideration flight certification results. Maximum dive angles listed opposite dispensers, such as the SUU-20 or SUU-42, are dive angles for delivery of the submunition loaded within the dispensers.

CENTER OF GRAVITY LIMITS.

Center of gravity limits are presented as Chart C Arm Limits. Chart C Arm is the fuselage station location of the cg for the aircraft Basic Weight and Balance from Chart C in T.O. 1-1B-40, Handbook of Weight and Balance Data. The center of gravity limits for ordnance configured aircraft are shown in the External Stores Limitations Charts, figure 5–12. The cg limits for clean (no wing pylons) and six empty wing pylons configured aircraft are shown in figure 5–11A.

1. To determine if a specific aircraft has an acceptable cg to carry a specified configuration or a partial configuration obtained from it, compare the current Chart C Arm (moment divided by weight) from the T.O. 1-1B-40 handbook for the specific aircraft with the limits for the configuration.

2. If the Arm is within the limits, aircraft cg clearance with the specified (or partial) configuration is approved.

3. If the Arm is forward of the Fwd Limit, the Arm must be moved within the limits or the Fwd Limit must be moved forward of the Arm.

   a. The Arm may be moved by one or both of the following:

      (1) Removing equipment (located forward of the Arm) from the Basic Weight configuration

      (2) Adding ballast (aft of the Arm) to the Basic Weight configuration.

   b. The Fwd Limit may be moved forward by one or both of the following:

      (1) Loading less than a full load (1,000 rounds) of ammunition for take off. Figure 5–11B, sheet 1, shows the forward shift of the Fwd Limit associated with varying quantities of loaded ammunition. Example:

      A Fwd Limit of 456.0 will become 453.0 if zero ammunition is loaded for take off

      (2) Not loading the fuselage mounted missiles. This will move the Fwd Limit 1.3 inches. Example:

      A Fwd Limit of 453.3 will become 452.0 if fuselage mounted missiles are not loaded.

4. If the Arm is aft of the Aft Limit, the Arm must be moved within the limits or the Aft Limit must be moved aft of the Arm.

   a. The Arm may be moved by one or both of the following:

      (1) Installing missing equipment (located forward of the Arm) in the Basic Weight configuration

      (2) Adding Ballast (forward of the Arm) to the Basic Weight configuration.

   b. The Aft Limit is based on an aircraft with no ammunition or empty cases in the ammunition handling system. Therefore, the Aft Limit may be improved (shifted aft) if the weight of ammunition or empty cases is considered.

      (1) Figure 5–11B, sheet 2, shows the aft shift of the Aft Limit associated with varying quantities of retained ammunition. Example:

      An Aft Limit of 467.6 will become 471.0 if 1,000 rounds of ammunition are retained (not expended).

      (2) Figure 5–11B, sheet 3, shows the aft shift of the Aft Limit associated with varying quantities of empty cases. Example:

      An Aft Limit of 467.6 will become 469.2 if 1,000 rounds of expendable ammunition (empty cases) are in the ammunition handling system.

TOTAL DRAG INDEX.

The numbers listed in this column are the total drag indexes computed for a particular configuration, using basic store drag plus interference and trim drag, if any. These basic drag numbers are computed for 0.6, 0.7, 0.8, and 0.9 MN and are valid only for the specific store configuration listed. The numbers are listed vertically starting with 0.6 MN. Basic drag indexes at Mach numbers between 0.6 and 0.9 are provided in the Stores Computations Table, Appendix 1, for every store listed in the External Stores Limitations Charts. The total drag index for a configuration must be recomputed using this table to obtain performance data for partial configurations.

The total drag index for a configuration resulting from combining two depicted symmetrical configurations can be obtained by averaging the drag indexes of the two configurations. The drag index for a combined configuration when one or both of the configurations involved is asymmetrical must be computed using the Stores Computation Table, Appendix I.

Note

Drag indexes shown do not include drag for fuselage stations 4 and 5. If missiles are installed, add 15 to the total drag count shown. If missiles are not installed, add 5 to the total drag count for the pylon/launchers.

CHART C ARM CG LIMITS

CONFIGURATION	CHART C ARM LIMIT			
	WITH FUSELAGE MOUNTED STORES		WITHOUT FUSELAGE MOUNTED STORES	
	FWD	AFT	FWD	AFT
	1000 Rounds Ammunition Loaded*			
Clean (No Wing Pylons)	456.4	473.2	455.1	471.9
Six Empty Wing Pylons	455.5	470.5	454.2	469.3
	500 Rounds Ammunition Loaded*			
Clean (No Wing Pylons)	454.9	473.2	453.6	471.9
Six Empty Wing Pylons	454.0	470.5	452.7	469.3
	Zero Ammunition Loaded*			
Clean (No Wing Pylons)	453.4	473.2	452.1	471.9
Six Empty Wing Pylons	452.5	470.5	451.1	469.3

*Rounds of Ammunition Loaded for Takeoff

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Figure 5–11A

STORE CONFIGURATION WEIGHT.

Weights appearing under the store configuration weight column in figure 5–12 represent the combined weight of all stores and suspension equipment below the MAU-12 for the specified configuration. For certain configurations the total weight will vary because of differences in weight of types or models of stores (i.e., ECM pods, SUU-20 dispenser) or because of the type or quantity of submunitions carried. In these configurations only the heaviest weight possible will be listed. The store configuration weight can be added to the aircraft operating weight with wing pylons plus fuel and fuselage pylons/stores to obtain aircraft gross takeoff weight.

WARNING

If the computed takeoff weight exceeds the maximum operating weight restriction, fuel should be offloaded.

AIRCRAFT/BOMB COLLISION.

When making single or multiple bomb releases, care must be taken to avoid pushover at release. Since the effective g is less than 1 when in dive, any further reduction by pushover can cause aircraft/bomb collision. Various weapons have minimum g restrictions even for ejected releases. Refer to the External Stores Limitations, figure 5–12, for release g limitations.

TAKEOFF AND LANDING.

Refer to Other Limitations for takeoff and landing restrictions with asymmetrical store loadings.

BARRIER ENGAGEMENT.

Barrier engagements for all configurations listed in figure 5–12 are unrestricted. Also see figure 3–10, Arresting Hook/Barrier Maximum Engagement Speeds.

CHART C ARM LIMIT

CHART C ARM FWD LIMIT SHIFT VS AMMUNITION LOADED

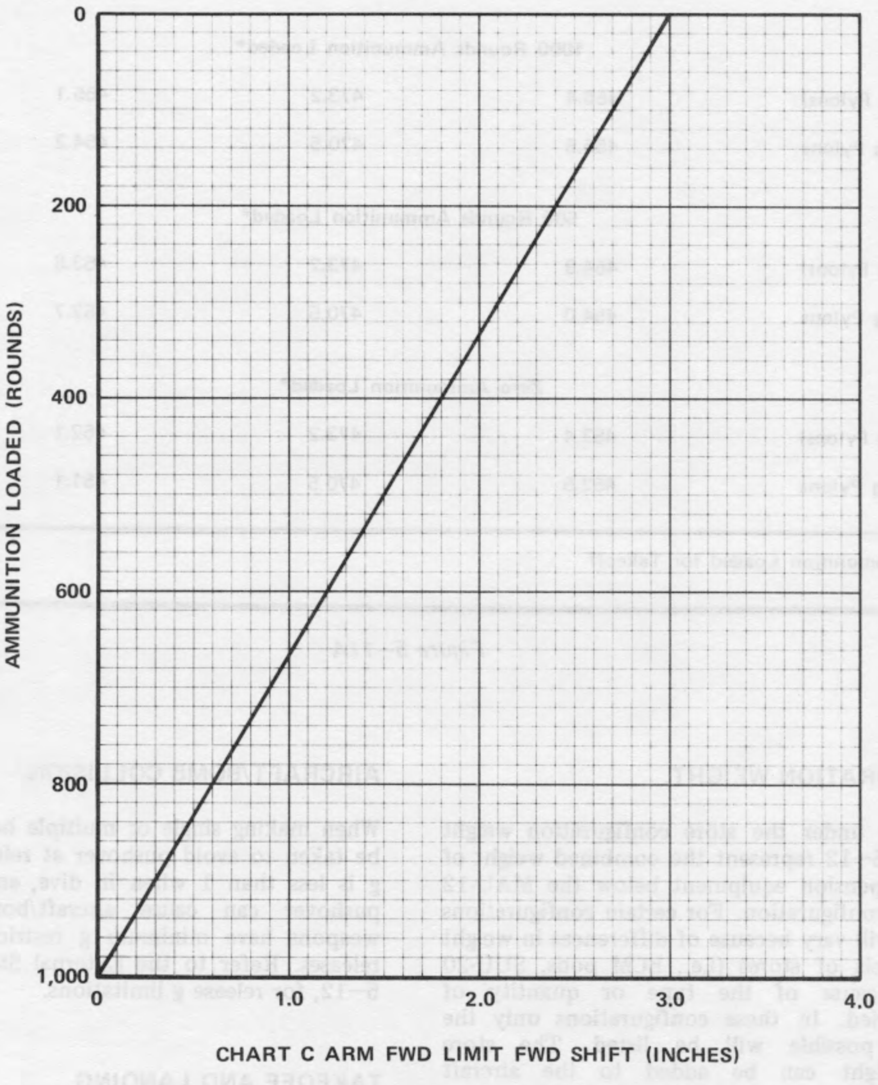
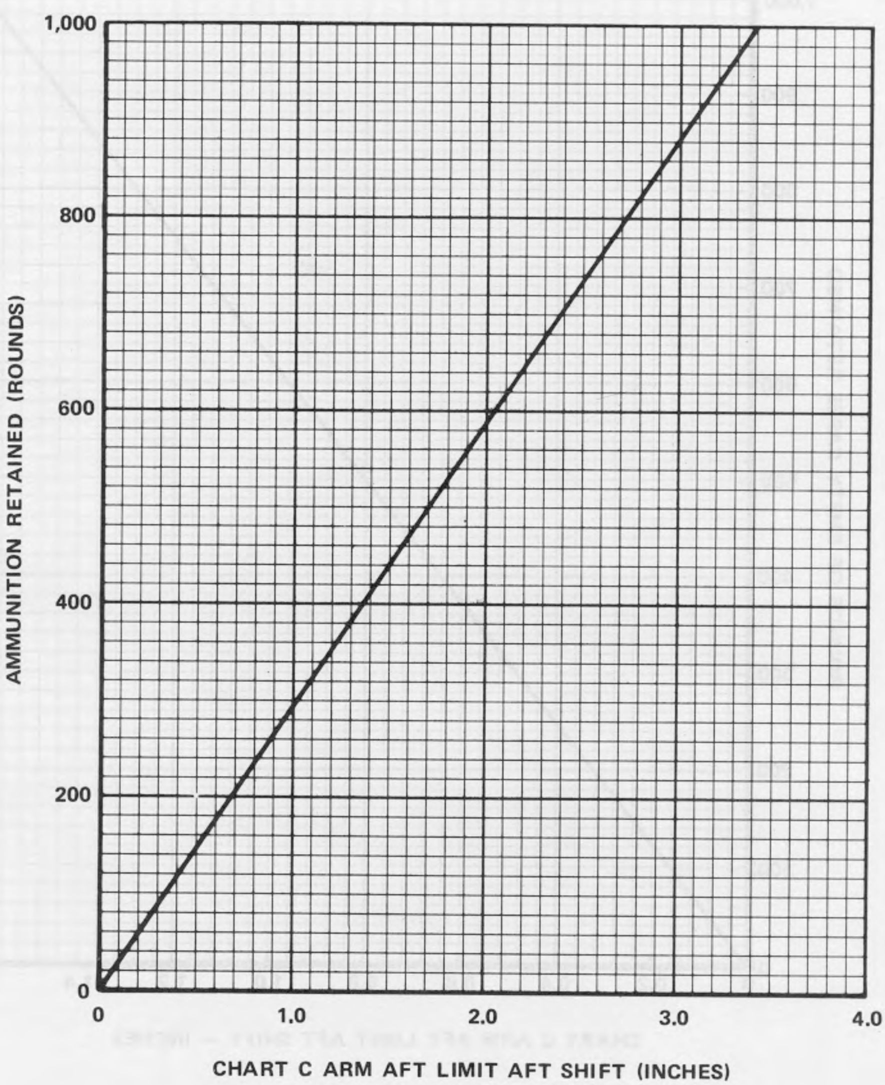


Figure 5–11B (Sheet 1)

CHART C ARM LIMIT

CHART C ARM AFT LIMIT SHIFT VS AMMUNITION RETAINED



NOTE

Retaining ammunition to move the Aft Limit aft means loading and not expending a quantity of ammunition as determined by the above chart.

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Figure 5–11B (Sheet 2)

CHART C ARM LIMIT

CHART C ARM AFT LIMIT AFT SHIFT VS EMPTY CASES RETAINED

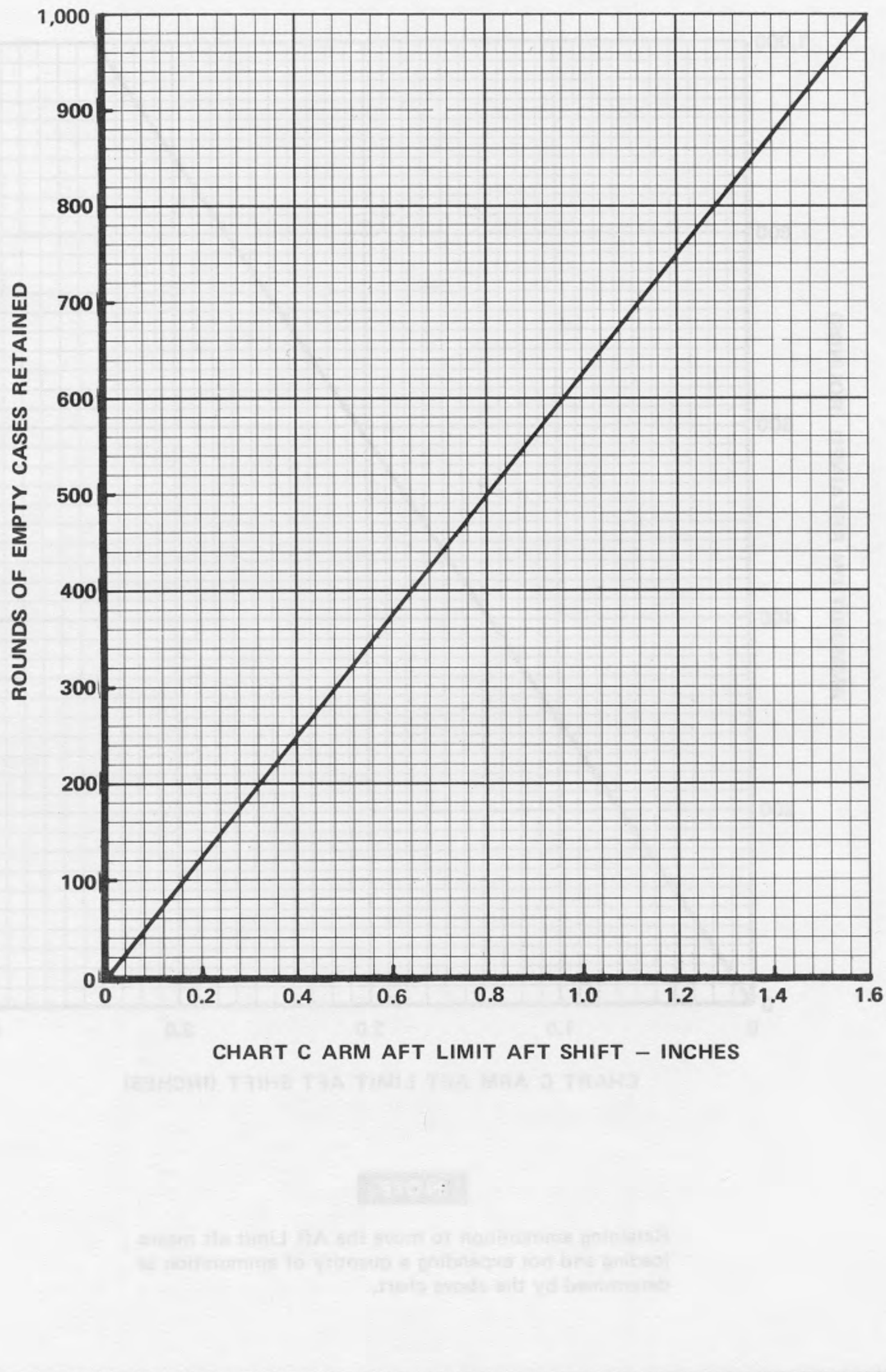


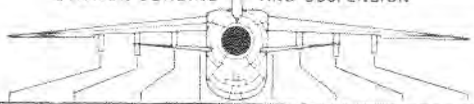
Figure 5–11B (Sheet 3)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

MAJOR CHANGE



	LINE NUMBER	STATION LOADING AND SUSPENSION								MAXIMUM KIAS OR IMN WHICHEVER IS LESS				ACCELERATION "g"				MAX DIVE FOR DEL	CHART C ARM LIMIT		TOTAL DRAG INDEX	STORE CONFIGURATION WEIGHT – LBS	REMARKS
		1	2	3	4	5	6	7	8	CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	CARRIAGE	EMPLOYMENT	RELEASE	JETTISON		FWD	AFT			
AER. NO. 45-9534 FUEL TANK	1	●		●			●		●	600 1.02	NA	See Remarks	NA	-3.0 to +7.0	NA	+1.0 Level Flight	NA	NA	455.3	462.4 Note 7	92 96 122 252	8764	Release full tanks up to 500 KIAS, 0.90 IMN.
	2	●							●										455.5	466.7	64 69 91 168	4382	Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
FLARE SERIES (SEE NOTE 13)	3	●							●	600 1.02	NA	4.50 0.80	Note 1	3.0 to +7.0	NA	+1.0 Level Flight	+1.0 Level Flight	0°	455.6	468.4	96 101 137 192	672	May be substituted on stations 1 and 8 on all configurations. See Note 17.
MK 82 LDGP	4	●	●					●	●	600 1.02	NA	550 0.95 See Remarks	Note 1	-3.0 to +7.0	NA	+0.5 to +7.0 Note 3 See Remarks	-1.0 Level Flight	60°	459.2	465.9	180 202 260 376	13,528 Note 2	Only one pylon per side may be selected for release in any given bomb run.
	5	●	●					●	●										459.2	468.0	160 184 255 387	10,118 Note 2	
	6	●	●					●	●										456.0	467.5	140 166 250 398	6708	
	7	●	●					●	●			550 0.95				+0.5 to +7.0 Note 3			459.2	467.7	152 160 194 277	11,420 Note 2	
	8	●	●					●	●										459.2	468.0	132 142 188 283	9064	
	9	●	●					●	●										456.0	467.5	112 124 183 294	5654	

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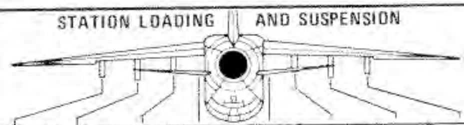
Figure 5–12 (Sheet 1)

EXTERNAL STORES LIMITATIONS

MAJOR CHANGE

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.



	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g" CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
MK 82 LDGP	1	●	●●●●●●					●●●●●●	●	600 1.02	NA	550 0.95	Note 1	−3.0 to +7.0	NA	+0.5 to +7.0 Note 3 See Remarks	+1.0 Level Flight	60°	459.2	468.5	103 110 137 203	7818	Minimum release acceleration for release from MAU-12 rack is +0.3 "g"
	2	●	●●●					●●●	●										456.0	468.0	83 92 132 214	4408	
	3	●	●	●			●	●	●								NA		456.3	469.3	48 54 72 126	3162	
	4		●					●											455.7	469.3	40 46 64 98	1054	
MK 20 MOD 2 AND MOD 3 CLUSTER BOMB	5	●●●		●●			●●		●●●	600 1.02	NA	500 0.90	Note 1	−3.0 to +7.0	NA	+0.5 to +6.0	+1.0 Level Flight	60°	456.7	466.0	177 195 272 434	5300	For multiple releases, release accelerations must be less than +3.0 and greater than +0.7 "g" and release interval must be set at greater than 300 feet.
	6																						
MK 84 LDGP	7	●	●	●			●	●	●	600 1.02	NA	550 0.95	NA	−3.0 to +7.0	NA	+0.3 to +5.0 Note 3	NA	60°	458.4	469.3	66 69 90 144	11,820 Note 2	
	8	●	●					●	●										456.1	468.6	56 60 80 124	7880	
	9																						

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Figure 5–12 (Sheet 2)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

Store	Line Number	Station Loading and Suspension 1	2	3	4	5	6	7	8	Max KIAS or IMN (whichever is less) Carriage	Employment	Release	Jettison	Acceleration "g" Carriage	Employment	Release	Jettison	Max Dive for DEL	Chart C Arm Limit FWD	AFT	Total Drag Index	Store Configuration Weight – LBS	Remarks
MK 82 SNAKEYE OR MK 36 DESTRUCTOR (SEE NOTES 8 AND 11)	1		●					●		600 1.02	NA	550 0.95 (Unrtd) 450 0.90 (Rtd) See Remarks	NA	-3.0 to +7.0	NA	+0.5 to +7.0 See Remarks Note 3	NA	60° (Unrtd) 30° (Rtd) Note 6	455.6	469.3	46 51 70 104	1120	Minimum release acceleration for unretarded release from MAU-12 rack is +0.3 "g". Maximum release speed retarded is 500 KIAS when using the MK 15 Mod 3, Mod 3A and Mod 4 fins.
	2	●							●										455.5	468.3	46 51 70 104	1120	
	3	●		●			●		●										456.1	469.2	56 60 80 124	2240	
	4	●	●	●			●	●	●										456.1	469.3	66 69 90 144	3360	
	5	●		●●			●●		●				Note 1				+1.0 Level Flight		456.7	468.9	93 100 134 207	3552	
	6	●		●●●●			●●●●		●										460.3	468.2	120 126 152 215	6040	
	7		●●●					●●●											455.7	468.0	100 108 143 213	3552	
	8	●●●							●●●										455.5	466.5	100 108 143 213	3552	
	9	●●●		●●			●●		●●●										456.7	467.2	147 157 207 316	5984	

Figure 5–12 (Sheet 3)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
MK 82 SNAKEYE OR MK 36 DESTRUCTOR (SEE NOTES 8 AND 11)	1									600 1.02	NA	550 0.95 (Unrtd) 450 0.90 (Rtd) See Remarks	Note 1	-3.0 to +7.0	NA	+0.5 to +7.0 Note 3	+1.0 Level Flight	60° (Unrtd) 30° (Rtd) Note 6	460.3	467.7	174 183 226 324	8472	Maximum release speed retarded is 500 KIAS when using the Mk 15 Mod 3, Mod 3A and Mod 4 fins.
	2																		460.3	462.5 Note 7	204 213 246 335	12,080 Note 2	
	3																						
M117A1 GP (WITH M131A1 FIN)	4									500 0.90	NA	500 0.90	Note 1	-2.5 to +6.0	NA	+0.5 to +6.0 Note 3	+1.0 Level Flight	60°	462.9	467.3	244 265 329 522	12,402 Note 2	
	5																		461.5	468.5	197 215 269 427	10,316 Note 2	
	6																		460.5	468.5	136 146 182 290	7024	
	7																		457.0	468.0	146 168 227 386	6776	
	8												NA				NA		456.7	469.3	96 99 120 186	4938	
	9																						

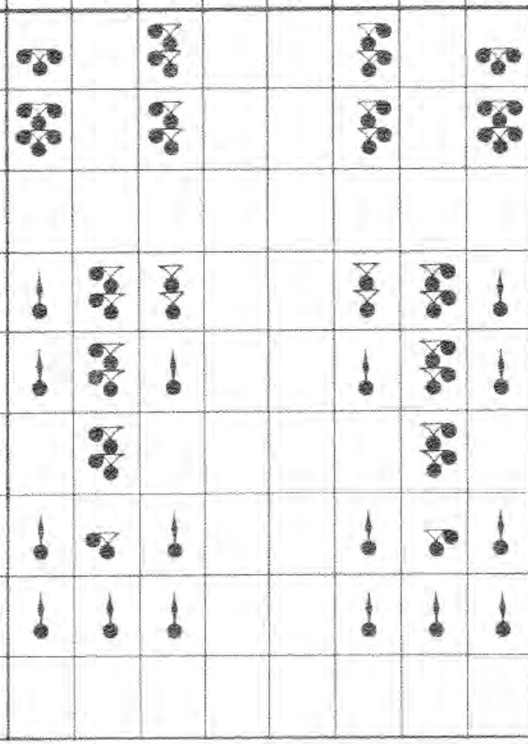


Figure 5–12 (Sheet 4)

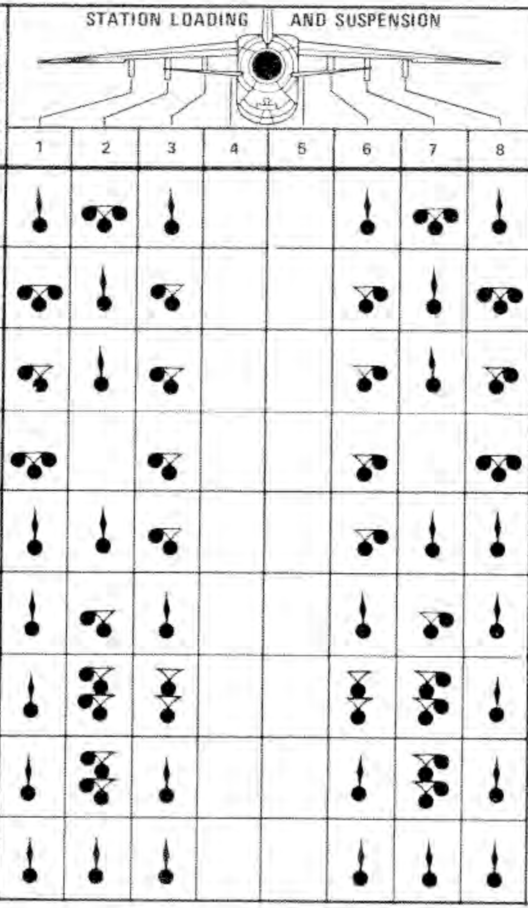
EXTERNAL STORES LIMITATIONS

MAJOR CHANGE

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

STATION LOADING AND SUSPENSION (stations 1–8, lines 1–9)



Store	Line Number	Max KIAS or IMN (whichever is less): Carriage	Employment	Release	Jettison	Acceleration "g": Carriage	Employment	Release	Jettison	Max Dive for Del	Chart C Arm Limit FWD	AFT	Total Drag Index	Store Configuration Weight – LBS	Remarks
M117A1GP (WITH MAU-103A/B FIN)	1	600 1.02	NA	550 0.95 See Remarks	Note 1	-2.5 to +6.0	NA	+0.5 to +6.0 See Remarks Note 3	+1.0 Level Flight	60°	457.2	468.0	190 255 306 518	8422	Only one pylon per side may be selected for release in any given bomb run.
	2										457.8	465.7	219 263 366 649	10,260 Note 2	
	3			550 0.95				+0.5 to +6.0 Note 3			457.8	467.1	181 212 293 523	8614	
	4										457.6	467.2	151 176 246 471	8614	
	5										457.8	468.7	152 174 233 392	6776	
	6										457.0	468.0	146 168 227 386	6776	
	7										462.9	467.3	244 265 329 522	12,402 Note 2	
	8										461.5	468.5	197 215 269 427	10,316 Note 2	
	9				NA				NA		456.7	469.3	96 99 120 186	4983	

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Figure 5–12 (Sheet 5)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
M117A1 GP (WITH MAU-103A/B FIN)	1	●	●●●					●●●	●	600 1.02	NA	550 0.95	Note 1	-2.5 to +6.0	NA	+0.5 to +6.0 Note 3	+1.0 Level Flight	60	460.5	468.5	177 196 249 393	8670	
	2		●●●●●●					●●●●●●											461.3	468.5	169 181 224 366	10,316 Note 2	Maximum allowable bank angle change is 180°.
CBU-24B/B CBU-49B/B CBU-52/B CBU-52A/B DISPENSER BOMBS	3	●	●	●			●	●	●	600 1.02	NA	550 0.95	Note 1	-2.0 to +7.0	NA	+0.5 to +7.0 Note 3	NA	60°	456.9	469.3	102 108 126 201	4992	See Note 18
	4	●	●●●					●●●	●								+1.0 Level Flight		460.8	468.5	194 217 266 377	8760	
BLU-1C/B, BLU-27 SERIES FIRE BOMBS (FINNED) (SEE NOTE 9)	5	●	●	●			●	●	●	600 1.02 (BLU-1) 600 0.95 (BLU-27)	NA	450 0.90	NA	-2.5 to +6.0 (BLU-1) -2.0 to +6.0 (BLU-27)	NA	+0.5 to +6.0 Note 3	NA	45° Note 12	456.6	466.0	68 76 102 163	4272 (BLU-1) 4932 (BLU-27)	For configuration shown in line 7 rolling pullouts limited to +4.0 "g" and only one pylon per side may be selected for release in any given bomb run.
	6																						
	7	●	●●●	●			●	●●●	●	450 0.95			Note 1				+1.0 Level Flight		461.3	466.2	177 203 257 375	7560 (BLU-1) 8660 (BLU-27)	
BLU-1C/B BLU-27 SERIES FIRE BOMBS (UNFINNED) (SEE NOTE 9)	8	●	●	●			●	●	●	600 1.02 (BLU-1) 600 0.95 (BLU-27)	NA	450 0.90	NA	-2.5 to +6.0 (BLU-1) -2.0 to +6.0 (BLU-27)	NA	+0.5 to +6.0 Note 3	NA	30	456.6	466.0	68 76 102 163	4182 (BLU-1) 4842 (BLU-27)	
	9																						

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Figure 5–12 (Sheet 6)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION								MAXIMUM KIAS OR IMN WHICHEVER IS LESS				ACCELERATION "g"				MAX DIVE FOR DEL	CHART C ARM LIMIT		TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
		1	2	3	4	5	6	7	8	CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON		FWD	AFT			
MK-82 LDGP WITH BLU-1C/B AND BLU-27 SERIES FIREBOMBS (FINNED) (SEE NOTE 9)	1	BLU	MK 82	BLU			BLU	MK 82	BLU	600 1.02 BLU-1 MK 82 600 0.95 BLU-27	NA	450 0.90 BLU MK 82	Note 1 MK 82 NA BLU	-2.6 to +6.0 BLU-1 -3.0 to +7.0 MK 82 -2.0 to +6.0 BLU-27	NA	+0.5 to +6.0 BLU +0.5 to +7.0 MK 82 See Remarks Note 3	+1.0 Level Flight MK 82 NA BLU	45° BLU MK 82	460.2	466.4	167 192 275 461	9612 BLU-1 10052 BLU-27 Note 2	Minimum release acceleration for Mk 82 from MAU-12 rack is +0.3 "g".
	2																						
	3	BLU	MK 82	BLU			BLU	MK 82	BLU			550 0.95 MK 82 450 0.90 BLU						45° BLU 60° MK 82	459.7	466.4	185 150 215 374	7504 BLU-1 7944 BLU-27	
	4	BLU	MK 82	BLU			BLU	MK 82	BLU										457.0	465.9	147 174 270 472	6202 BLU-1 6642 BLU-27	
	5	BLU	MK 82	BLU			BLU	MK 82	BLU				NA				NA		456.7	467.2	74 78 120 240	3902 BLU-1 4342 BLU-27	
	6																						
	7																						
	8																						
	9																						

Figure 5–12 (Sheet 6A)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

Store	Line Number	Station Loading and Suspension 1	2	3	4	5	6	7	8	Maximum KIAS or IMN Whichever Is Less: Carriage	Employment	Release	Jettison	Acceleration "g": Carriage	Employment	Release	Jettison	Max Dive for Del	Chart C Arm Limit FWD	AFT	Total Drag Index	Store Configuration Weight – LBS	Remarks
MK 82 LDGP WITH BLU-1C/B AND BLU-27 SERIES FIREBOMBS (UNFINNED) (SEE NOTE 9)	1	BLU	MK 82	BLU			BLU	MK 82	BLU	600 1.02 BLU-1 MK 82 600 0.95 BLU 27	NA	450 0.90 BLU MK 82	Note 1 MK 82 NA BLU	–2.5 to +6.0 BLU-1 –3.0 to +7.0 MK 82 –2.0 to +6.0 BLU 27	NA	+0.5 to +6.0 BLU +0.5 to +7.0 MK 82 See Remarks Note 3	+1.0 Level Flight MK 82 NA BLU	45° MK 82 30° BLU Note 12	460.3	466.7	167 192 275 461	9552 BLU-1 9992 BLU-27 Note 2	For configuration shown in line 4, release of BLU in ripple pairs mode not authorized Minimum release acceleration for Mk 82 from MAU-12 rack is +0.3 "g".
	2																						
	3	BLU	MK 82	BLU			BLU	MK 82	BLU			550 0.95 MK 82 450 0.90 BLU						60° MK 82 30° BLU Note 12	459.8	466.7	135 150 215 374	7444 BLU-1 7884 BLU-27	
	4	BLU	MK 82	BLU			BLU	MK 82	BLU										457.0	466.1	147 174 270 472	6142 BLU-1 6582 BLU-27	
	5	BLU	MK 82	BLU			BLU	MK 82	BLU				NA				NA		456.7	467.4	74 78 120 240	6142 BLU-1 6582 BLU-27	
	6																						
	7																						
	8																						
	9																						

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Figure 5–12 (Sheet 6B)

EXTERNAL STORES LIMITATIONS

MAJOR CHANGE

NOTE

Only the configurations shown in the following charts or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CONFIGURATION WEIGHT – LBS	REMARKS
MK 82 LDGP WITH AER NO. 45-9534 FUEL TANK	1	MK 82	MK 82	TANK			TANK	MK 82	MK 82	600 1.02	NA	500 0.90 MK 82 See Remarks TANK	Note 1 MK 82 NA TANK	−3.0 to +7.0	NA	+0.5 to +7.0 See Remarks Note 3 MK 82 +1.0 Level Flight TANK	+1.0 Level Flight MK 82 NA TANK	60°	458.3	463.5 Note 7	121 127 156 270	10,092 Note 2	Release full tanks up to 500 KIAS 0.90 IMN.
	2																						Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
	3																						Minimum release acceleration for release of Mk 82 from MAU-12 rack is +0.3 "g".
MK 82 LDGP WITH ECM PODS (SEE NOTE 10)	4	ECM	MK 82	MK 82			MK 82	MK 82	ECM	600 1.02 MK 82 ALQ-71 ALQ-101 600 0.90 ALQ-87	NA	550 0.95 See Remarks MK 82 500 0.90 ECM	Note 1 MK 82 NA ECM	−3.0 to +7.0 MK 82 −3.0 to +6.0 ECM	NA	+0.5 to +7.0 See Remarks Note 3 MK 82 +1.0 Level Flight ECM	+1.0 Level Flight MK 82 NA ECM	60°	462.3	466.2	186 208 255 384	12,020 Note 2	For configurations shown in lines 4, 5, and 6, only one pylon per side may be selected for release in any given bomb run.
	5	ECM	MK 82	MK 82			MK 82	MK 82	ECM										459.1	465.7	166 190 260 394	8610	
	6	ECM	MK 82	MK 82			MK 82	MK 82	ECM										457.3	466.5	146 172 254 400	6254	
	7	ECM	MK 82	MK 82			MK 82	MK 82	ECM			550 0.95 MK 82 500 0.90 ECM				+0.5 to +7.0 Note 3 MK 82 +1.0 Level Flight ECM			461.8	466.2	154 162 195 280	9912 Note 2	**WARNING** See Note 1, Figure 5-1, T.O. 1A-7D-1A for additional limitation on these configurations.
	8	ECM	MK 82	MK 82			MK 82	MK 82	ECM										460.3	465.7	134 144 189 286	7556	
	9	ECM	MK 82	MK 82			MK 82	MK 82	ECM										457.2	466.5	114 126 183 292	5200	

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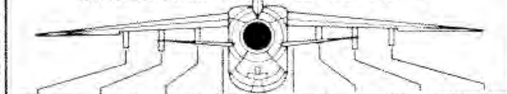
Figure 5–12 (Sheet 7)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

MAJOR CHANGE



	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
MK 82 LDGP WITH ECM PODS (SEE NOTE 10)	1	ECM	MK 82					MK 82	ECM	600 1.02 MK 82 ALQ-101 ALQ-71 600 0.90 ALQ-87	NA	550 0.95 MK 82 500 0.90 ECM	Note 1 MK 82 NA ECM	-3.0 to +7.0 MK 82 -3.0 to +6.0 ECM	NA	+0.5 to +7.0 See Remarks Note 3 MK 82 +1.0 Level Flight ECM	+1.0 Level Flight MK 82 NA ECM	60°	459.2	467.5	111 118 146 209	7364	Minimum release acceleration for release of Mk 82 from MAU-12 rack is +0.3 "g". **WARNING** See Note 1, Figure 5-1, T.O. 1A-7D-1A for additional limitation on these configurations.
	2	ECM	MK 82					MK 82	ECM										458.7	467.5	101 108 124 192	5256	
	3	ECM	MK 82	MK 82			MK 82	MK 82	ECM										460.3	467.1	115 132 174 264	6310	
MK 82 LDGP WITH SUU-42 SERIES FLARE DISPENSER (SEE NOTE 4)	4	SUU-42	MK 82	MK 82			MK 82	MK 82	SUU-42	600 1.02	500 0.90 SUU-42 NA MK 82	550 0.95 MK 82 See Remarks SUU-42	Note 1 MK 82 NA SUU-42	-3.0 to +7.0 MK 82 -2.0 to +6.0 SUU-42	+0.9 to +1.0 SUU-42 NA MK 82	+0.5 to +7.0 See Remarks Note 3 MK 82 +1.0 Level Flight SUU-42	+1.0 Level Flight MK 82 NA SUU-42	60° MK 82 20° SUU-42	456.3	466.8	58 64 84 154	3770	Minimum release acceleraton for release of Mk 82 from MAU-12 rack is +0.3 "g". Release full SUU-42 up to 500 KIAS, 0.90 IMN. Release empty and partially full SUU-42 up to 500 KIAS, 0.85 IMN
	5	SUU-42	MK 82	MK 82			MK 82	MK 82	SUU-42										457.0	466.4	97 116 171 292	5016	
	6	SUU-42	MK 82	MK 82			MK 82	MK 82	SUU-42										460.3	465.6	117 134 177 286	7372	
	7	SUU-42	MK 82					MK 82	SUU-42										455.8	465.4	83 94 131 220	3962	
	8	SUU-42	MK 82					MK 82	SUU-42										458.7	465.9	103 110 137 214	6318	
	9																						

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Figure 5–12 (Sheet 8)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

MAJOR CHANGE

	LINE NUMBER	STATION LOADING AND SUSPENSION								MAXIMUM KIAS OR IMN WHICHEVER IS LESS				ACCELERATION "g"				MAX DIVE FOR DEL	CHART C ARM LIMIT		TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT — LBS	REMARKS
		1	2	3	4	5	6	7	8	CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON		FWD	AFT			
MK 82 LDGP WITH SUU-42 SERIES FLARE DISPENSER (SEE NOTE 4)	1	SUU-42	MK 82	MK 82			MK 82	MK 82	SUU-42	600 1.02	500 0.90 SUU-42 NA MK 82	500 0.95 See Remarks MK 82 See Remarks SUU-42 500 0.90 See Remarks MK 82 See Remarks SUU-42	Note 1 MK 82 NA SUU-42	−3.0 to +7.0 MK 82 −2.0 to +6.0 SUU-42	+0.9 to +1.0 SUU-42 NA MK 82	+0.5 to +7.0 See Remarks Note 3 MK 82 +1.0 Level Flight SUU-42	+1.0 Level Flight MK 82 NA SUU-42	60° MK 82 20° SUU-42	460.3	464.1	158 182 250 394	8618	Only one pylon per side may be selected for release of Mk 82 in any given bomb run. Release full SUU-42 up to 500 KIAS, 0.90 IMN. Release empty and partially full SUU-42 up to 500 KIAS, 0.85 IMN.
	2																						
	3	SUU-42	MK 82	MK 82			MK 82	MK 82	SUU-42										461.8	464.6	178 200 256 388	10,974 NOTE 2	
MK 84 LDGP WITH ECM PODS (SEE NOTE 10)	4	ECM	MK 84	MK 84			MK 84	MK 84	ECM	600 1.02 MK 84 ALQ-101 ALQ-71 600 0.90 ALQ-87	NA	500 0.95 MK 84 500 0.90 ECM	NA	−3.0 to +7.0 MK 84 −3.0 to +6.0 ECM	NA	+0.3 to +5.0 Note 3 MK 84 +1.0 Level Flight ECM	NA	60°	458.4	468.3	68 72 93 144	8480	**WARNING** See Note 1, Figure 5-1, T.O. 1A-7D-1A for additional limitation on this configuration.
	5																						
	6																						
MK 84 LDGP WITH AER. NO. 45-9534 FUEL TANK AND ECM PODS (SEE NOTE 10)	7	ECM	MK 84	TANK			TANK	MK 84	ECM	600 1.02 TANK MK 84 ALQ-101 ALQ-71 600 0.90 ALQ-87	NA	550 0.95 MK 84 500 0.90 ECM See Remarks TANK	NA	−3.0 to +7.0 TANK MK 84 −3.0 to +6.0 ECM	NA	+0.3 to +5.0 Note 3 MK 84 +1.0 Level Flight ECM TANK	NA	60°	455.9	463.7 Note 7	111 117 149 259	8922	Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN. **WARNING** See Note 1, Figure 5-1, T.O. 1A-7D-1A for additional limitation on this configuration.
	8																						
	9																						

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Figure 5–12 (Sheet 9)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

STATION LOADING AND SUSPENSION

Store	Line Number	1	2	3	4	5	6	7	8	Max KIAS or IMN (whichever is less): Carriage	Max KIAS or IMN: Employment	Max KIAS or IMN: Release	Max KIAS or IMN: Jettison	Acceleration "g": Carriage	Acceleration "g": Employment	Acceleration "g": Release	Acceleration "g": Jettison	Max Dive for Del	Chart C Arm Limit: FWD	Chart C Arm Limit: AFT	Total Drag Index	Store Configuration Weight – LBS	Remarks
MK 82 SNAKEYE OR MK 36 DESTRUCTOR WITH BLU-1C/B AND BLU-27 SERIES FIREBOMBS (FINNED) (SEE NOTES 8, 9 AND 11)	1	BLU	MK 82	BLU			BLU	MK 82	BLU	600 1.02 MK 82 BLU-1 600 0.95 BLU-27	NA	450 0.90 (Unrtd) (Rtd) MK 82 BLU See Remarks	Note 1 MK 82 NA BLU	−2.5 to +6.0 BLU-1 −2.0 to +6.0 BLU-27 −3.0 to +7.0 MK 82	NA	+0.5 to +6.0 BLU +0.5 to +7.0 MK 82 Note 3	+1.0 Level Flight MK 82 NA BLU	45° (Unrtd) MK 82 BLU 30° (Rtd) MK 82 Note 6	459.9	466.4	178 224 306 496	10,008 BLU-1 10,448 BLU-27 Note 2	Minimum release acceleration for unretarded release of Mk 82 from MAU-12 rack is +0.3 "g". Maximum release speed retarded is 500 KIAS when using the Mk 15 Mod 3, Mod 3A and Mod 4 fins.
	2																						
	3																						
	4	BLU	MK 82	BLU			BLU	MK 82	BLU			550 0.95 (Unrtd) MK 82 450 0.90 (Rtd) MK 82 BLU See Remarks						45° BLU 60° (Unrtd) MK 82 30° (Rtd) MK 82 Note 6	459.6	466.9	156 171 238 397	7748 BLU-1 8208 BLU-27	
	5	BLU	MK 82	BLU			BLU	MK 82	BLU										456.7	465.9	168 194 285 485	6400 BLU-1 6840 BLU-27	
	6	BLU	MK 82	BLU			BLU	MK 82	BLU				NA				NA		456.6	467.0	80 83 126 246	3968 BLU-1 4408 BLU-27	
	7																						
	8																						
	9																						

Figure 5–12 (Sheet 9A)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

Store	Line Number	Station Loading and Suspension 1	2	3	4	5	6	7	8	Max KIAS or IMN (whichever is less) Carriage	Employment	Release	Jettison	Acceleration "g" Carriage	Employment	Release	Jettison	Max Dive for Del	Chart C Arm Limit FWD	AFT	Total Drag Index	Store Configuration Weight – LBS	Remarks
MK 82 SNAKEYE OR MK 36 DESTRUCTOR WITH BLU-1C/B AND BLU-27 SERIES FIREBOMBS (UNFINNED) (SEE NOTES 8, 9, AND 11)	1	BLU	MK 82	BLU			BLU	MK 82	BLU	600 1.02 MK 82 BLU-1 600 0.95 BLU-27	NA	450 0.90 (Unrtd) (Rtd) MK 82 BLU	Note 1 MK 82 NA BLU	−2.5 to +6.0 BLU-1 −3.0 to +7.0 MK 82 −2.0 to +6.0 BLU-27	NA	+0.5 to +6.0 BLU +0.5 to +7.0 MK 82 See Remarks Note 3	+1.0 Level Flight MK 82 NA BLU	45° (Unrtd) MK 82 30° (Rtd) MK 82 BLU Note 12	459.9	466.7	198 224 306 496	9948 BLU-1 10388 BLU-27 Note 2	For configuration shown in line 4, release of BLU in ripple pairs mode not authorized. Maximum release speed retarded is 500 KIAS when using the MK 15 Mod 3, Mod 3A and Mod 4 fins. Minimum release acceleration for unretarded release of MK 82 from MAU-12 rack is +0.3 "g".
	2																						
	3	BLU	MK 82	BLU			BLU	MK 82	BLU			550 0.95 (Unrtd) MK 82 450 0.90 (Rtd) MK 82 BLU See Remarks						60° (Unrtd) MK 82 30° (Rtd) MK 82 BLU Note 12	459.6	466.7	156 171 238 397	7708 BLU-1 8148 BLU-27	
	4	BLU	MK 82	BLU			BLU	MK 82	BLU										456.7	466.1	168 194 285 485	6340 BLU-1 6780 BLU-27	
	5	BLU	MK 82	BLU			BLU	MK 82	BLU				NA				NA		456.6	467.2	80 83 126 246	3908 BLU-1 4348 BLU-27	
	6																						
	7																						
	8																						
	9																						

Figure 5–12 (Sheet 9B)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

MAJOR CHANGE

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT FWD	AFT	TOTAL DRAG INDEX	STORE CONFIGURATION WEIGHT – LBS	REMARKS
MK 82 SNAKEYE OR MK 36 DESTRUCTOR WITH ECM PODS (SEE NOTES 8, 10 AND 11)	1	ECM	MK 82	MK 82			MK 82	MK 82	ECM	600 1.02 MK 82 ALQ-101 ALQ-71 600 0.90 ALQ-87	NA	550 0.95 (Unrtd) 450 0.90 (Rtd) MK 82 500 0.90 ECM See Remarks	Note 1 MK 82 NA ECM	-3.0 to +7.0 MK 82 -3.0 to +6.0 ECM	NA	+0.5 to +7.0 See Remarks Note 3 MK 82 +1.0 Level Flight ECM	+1.0 Level Flight MK 82 NA ECM	60° (Unrtd) 30° (Rtd) Note 6 MK 82	461.4	466.2	196 204 237 326	10,440 Note 2	Minimum release acceleration for unretarded release of MK 82 from MAU-12 rack is +0.3 "g".
	2	ECM	MK 82	MK 82			MK 82	MK 82	ECM										460.3	465.7	169 178 219 318	7952	**WARNING** See Note 1, Figure 5-1, T.O. 1A-7D-1A for additional limitation on configurations shown in lines 1 through 6.
	3	ECM	MK 82	MK 82			MK 82	MK 82	ECM										460.3	467.1	142 158 201 293	6840	
	4	ECM	MK 82	MK 82			MK 82	MK 82	ECM										456.8	466.5	142 152 201 310	5464	Maximum release speed retarded is 500 KIAS when using the Mk 15 Mod 3, Mod 3A and Mod 4 fins.
	5	ECM	MK 82					MK 82	ECM										458.9	467.5	142 150 177 244	7760	Release full tanks up to 500 KIAS, 0.90 IMN.
	6	ECM	MK 82					MK 82	ECM										458.6	467.5	122 129 155 215	6520	Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
MK 82 SNAKEYE OR MK 36 DESTRUCTOR WITH AER NO. 45-9534 FUEL TANK (SEE NOTES 8 AND 11)	7	MK 82	MK 82	TANK			TANK	MK 82	MK 82	600 1.02	NA	550 0.95 (Unrtd) MK 82 450 0.90 (Rtd) MK 82 See Remarks MK 82 TANK	Note 1 MK 82 NA TANK	-3.0 to +7.0	NA	+0.5 to +7.0 Note 3 MK 82 +1.0 Level Flight TANK	+1.0 Level Flight MK 82 NA TANK	60° (Unrtd) 30° (Rtd) Note 6 MK 82	458.7	462.8	148 153 183 299	10,422 Note 2	
	8																						
	9																						

Figure 5–12 (Sheet 10)

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

Store	Line Number	Station Loading and Suspension 1	2	3	4	5	6	7	8	Maximum KIAS or IMN Whichever Is Less: Carriage	Employment	Release	Jettison	Acceleration "g": Carriage	Employment	Release	Jettison	Max Dive for Del	Chart C Arm Limit: FWD	AFT	Total Drag Index	Store Configuration Weight – LBS	Remarks
MK 82 SNAKEYE OR MK 36 DESTRUCTOR WITH SUU-42 SERIES FLARE DISPENSER (SEE NOTES 4, 8 AND 11)	1	SUU-42	MK 82					MK 82	SUU-42										455.6	465.4	97 105 140 229	4094	With SUU-42 loaded on aircraft, Mk 82 bombs may be released in the unretarded (UNRTD) mode only.
	2	SUU-42	MK 82					MK 82	SUU-42										458.6	465.9	124 131 158 237	6582	Minimum release acceleration for unretarded release of Mk 82 from MAU-12 rack is +0.3 "g".
	3	SUU-42	MK 82	MK 82			MK 82	MK 82	SUU-42			550 0.95 (Unrtd) 450 0.90 (Rtd) See Remarks MK 82 SUU-42							456.1	466.8	70 74 96 166	3902	Maximum release speed retarded is 500 KIAS when using the Mk 15 Mod 3, Mod 3A and Mod 4 fins.
	4	SUU-42	MK 82	MK 82			MK 82	MK 82	SUU-42	600 1.02	500 0.90 SUU-42 NA MK 82		Note 1 MK 82 NA SUU-42	−3.0 to +7.0 MK 82 −2.0 to +6.0 SUU-42	+0.9 to +1.0 SUU-42 NA MK 82	+0.5 to +7.0 See Remarks Note 3 MK 82 +1.0 Level Flight SUU-42	+1.0 Level Flight MK 82 NA SUU-42	60° (Unrtd) 30° (Rtd) Note 6 MK 82 20° SUU-42	456.8	466.4	117 134 186 307	5214	Release full SUU-42 up to 500 KIAS, 0.90 IMN.
	5	SUU-42	MK 82	MK 82			MK 82	MK 82	SUU-42										460.3	465.6	144 160 204 315	7702	Release empty and partially full SUU-42 up to 500 KIAS, 0.85 IMN.
	6	SUU-42	MK 82	MK 82			MK 82	MK 82	SUU-42										458.5	464.1	193 216 280 426	9014	For configurations shown in lines 6 and 7, only one pylon per side may be selected for release in any given bomb run.
	7	SUU-42	MK 82	MK 82			MK 82	MK 82	SUU-42			500 0.95 (Unrtd) 450 0.90 (Rtd) See Remarks MK 82 SUU-42							461.4	464.6	220 242 298 434	11,502 Note 2	
	8																						
	9																						

Figure 5–12 (Sheet 11)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

MAJOR CHANGE

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g" CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
M117A1 GP (WITH M131A1 FIN) WITH AER NO. 45-9534 FUEL TANK	1	M117	M117	TANK			TANK	M117	M117	500 0.90 M117 600 1.02 TANK	NA	500 0.90 M117 See Remarks TANK	Note 1 M117 NA TANK	−2.5 to +6.0 M117 −3.0 to +7.0 TANK	NA	+0.5 to +6.0 Note 3 M117 +1.0 Level Flight TANK	+1.0 Level Flight M117 NA TANK	60°	455.8	462.2 Note 7	168 200 278 498	9512 Note 2	Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
	2																						
	3																						
M117A1 GP (WITH MAU-103A/B FIN) WITH AER NO. 45-9534 FUEL TANK	4	M117	M117	TANK			TANK	M117	M117	600 1.02	NA	550 0.95 M117 See Remarks TANK	Note 1 M117 NA TANK	−2.5 to +6.0 M117 −3.0 to +7.0 TANK	NA	+0.5 to +6.0 Note 3 M117 +1.0 Level Flight TANK	+1.0 Level Flight M117 NA TANK	60°	455.8	462.2 Note 7	168 200 278 498	9512 Note 2	Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
	5																						
M117A1 GP (WITH MAU-103A/B FIN) WITH ECM PODS (SEE NOTE 10)	6	ECM	M117					M117	ECM	600 1.02 M117 ALQ-101 ALQ-71 600 0.90 ALQ-87	NA	550 0.95 M117 500 0.90 ECM	Note 1 M117 NA ECM	2.5 to +6.0 M117 −3.0 to +6.0 ECM	NA	+0.5 to +6.0 Note 3 M117 +1.0 Level Flight ECM	+1.0 Level Flight M117 NA ECM	60°	456.0	466.9	109 133 191 329	4084	For configuration shown in line 9 only one pylon per side may be selected to release in any given bomb run. **WARNING** See Note 1, Figure 5-1, T.O. 1A-7D-1A for additional limitation on these configurations.
	7	ECM	M117					M117	ECM										456.2	466.9	127 153 217 386	5730	
	8	ECM	M117	M117			M117	M117	ECM										457.0	466.9	129 152 211 363	5730	
	9	ECM	M117	M117			M117	M117	ECM										457.2	466.9	173 209 290 495	7376	

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Figure 5–12 (Sheet 12)

NOTE

Only the configurations shown in the following charts or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
M117A1 GP (WITH MAU-103A/B FIN) WITH ECM PODS (SEE NOTE 10)	1	ECM	M117	M117			M117	M117	ECM	600 1.02 M117 ALQ-101 ALQ-71 600 0.90 ALQ-87	NA	550 0.95 M117 500 0.90 ECM	Note 1 M117 NA ECM	−2.5 to +6.0 M117 −3.0 to +6.0 ECM	NA	+0.5 to +6.0 Note 3 M117 +1.0 Level Flight ECM	+1.0 Level Flight M117 NA ECM	60°	462.9	466.2	235 261 333 525	11,356 Note 2	For configuration shown in line 1, only one pylon per side may be selected for release in any given bomb run.
	2	ECM	M117					M117	ECM										461.3	467.5	194 216 276 447	7624	For configuration shown in line 2, maximum allowable bank angle change is 180°. WARNING See Note 1, Figure 5-1, T.O. 1A-7D-1A for additional limitation on these configurations.
	3																						
M117A1 GP (WITH MAU-103A/B FIN) WITH BLU-1C/B, BLU-27 SERIES FIRE BOMBS (FINNED) (SEE NOTE 9)	4	BLU	M117	BLU			BLU	M117	BLU	600 1.02 M117 BLU-1 600 0.95 BLU-27	NA	550 0.95 M117 450 0.90 BLU	Note 1	−2.5 to +6.0 M117 BLU-1 −2.0 to +6.0 BLU-27	NA	+0.5 to +6.0 Note 3	+1.0 Level Flight	60° M117 45° BLU	458.4	466.4	185 205 257 401	9872 BLU-1 10,312 Note 2 BLU-27	
	5	BLU	M117	BLU			BLU	M117	BLU										456.9	465.9	129 153 210 355	6332 BLU-1 6772 BLU-27	
	6	BLU	M117	BLU			BLU	M117	BLU				NA				NA		456.6	467.4	76 81 100 152	4494 BLU-1 4934 BLU-27	
M-117A1 GP (WITH MAU-103A/B FIN) WITH BLU-1C/B AND BLU-27 SERIES FIRE BOMBS (UNFINNED) (SEE NOTE 9)	7	BLU	M117	BLU			BLU	M117	BLU	600 1.02 M117 BLU-1 600 0.95 BLU-27	NA	550 0.95 M117 450 0.90 BLU	Note 1 M117 NA BLU	−2.5 to +6.0 M117 BLU-1 −2.0 to +6.0 BLU-27	NA	+0.5 to +6.0 M117 BLU Note 3	+1.0 Level Flight M117 NA BLU	60° M117 30° BLU Note 12	461.6	466.7	194 212 288 504	9720 BLU-1 10,160 BLU-27 Note 2	
	8	BLU	M117	BLU			BLU	M117	BLU										457.1	466.1	143 165 246 463	6084 BLU-1 6524 BLU-27	Release of BLU in ripple pairs mode not authorized.
	9	BLU	M117	BLU			BLU	M117	BLU				NA				NA		456.8	467.6	90 93 136 260	4436 BLU-1 4876 BLU-27	

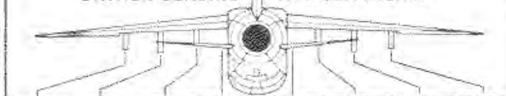
Figure 5–12 (Sheet 13)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

MAJOR CHANGE



	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT FWD	AFT	TOTAL DRAG INDEX	STORE CONFIGURATION WEIGHT – LBS	REMARKS
M117A1 GP (WITH MAU 103A/B FIN) WITH SUU-42 SERIES FLARE DISPENSER (SEE NOTE 4)	1	SUU-42	M117	M117			M117	M117	SUU-42	600 1.02	500 0.90 SUU-42 NA M117	550 0.95 M117 See Remarks SUU-42	NA	-2.5 to +6.0 M117 -2.0 to +6.0 SUU-42	+0.9 to +1.0 SUU-42 NA M117	+0.5 to +6.0 Note 3 M117 +1.0 Level Flight SUU-42	NA	60° M117 20° SUU-42	456.7	466.8	90 94 116 194	4954	Release full SUU-42 up to 500 KIAS, 0.90 IMN.
	2	SUU-42	M117					M117	SUU-42				Note 1				+1.0 Level Flight		455.7	465.4	99 113 156 291	6146	Release empty and partially full SUU-42 up to 500 KIAS, 0.85 IMN.
	3	SUU-42	M117					M117	SUU-42										460.5	465.9	150 160 198 166	8686	For configurations shown in lines 4 and 5 only one pylon per side may be selected for release of M117 in any given bomb run.
	4	SUU-42	M117	M117			M117	M117	SUU-42										457.0	465.4	146 169 229 400	6792	
	5	SUU-42	M117	M117			M117	M117	SUU-42										461.5	465.9	197 216 271 441	10,332 Note 2	
	6																						
BLU-1C/B BLU-27 SERIES FIRE BOMBS (FINNED) WITH SUU-42 SERIES FLARE DISPENSER (SEE NOTES 4 AND 9)	7	SUU-42	BLU	BLU			BLU	BLU	SUU-42	600 1.02 SUU-42 BLU-1 600 0.95 BLU-27	500 0.90 SUU-42 NA BLU	450 0.90 BLU See Remarks SUU-42	NA	-2.5 to +6.0 BLU-1 -2.0 to +6.0 SUU-42 BLU-27	+0.9 to +1.0 SUU-42 NA BLU	+0.5 to +6.0 BLU +1.0 Level Flight SUU-42	NA	45° BLU 20° SUU-42	456.6	465.3	70 76 96 160	4510 BLU-1 4950 BLU-27	Release full SUU-42 up to 500 KIAS, 0.90 IMN. Release empty and partially full SUU-42 up to 500 KIAS, 0.85 IMN.
	8																						
	9																						

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Figure 5–12 (Sheet 14)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

MAJOR CHANGE

Store	Line Number	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Max KIAS or IMN (whichever is less): Carriage	Employment	Release	Jettison	Acceleration "g": Carriage	Employment	Release	Jettison	Max Dive for Del	Chart C Arm Limit: FWD	AFT	Total Drag Index	Store Configuration Weight – LBS	Remarks
BLU-1C/B AND BLU-27 SERIES FIRE BOMBS (UNFINNED) WITH SUU-42 SERIES FLARE DISPENSER (SEE NOTES 4 AND 9)	1	SUU-42	BLU	BLU			BLU	BLU	SUU-42	600 1.02 SUU-42 BLU-1 600 0.95 BLU-27	500 0.90 SUU-42 NA BLU	450 0.90 BLU See Remarks SUU-42	NA	-2.5 to +6.0 BLU-1 -2.0 to +6.0 BLU-27 SUU-42	+0.9 to +1.0 SUU-42 NA BLU	+0.5 to +6.0 BLU +1.0 Level Flight SUU-42 Note 3	NA	30° BLU Note 12 20° SUU	456.8	465.4	86 92 144 296		Release full SUU-42 up to 500 KIAS, 0.90 IMN.
	2																					4450 BLU-1 4890 BLU-27	Release empty and partially full SUU-42 up to 500 KIAS, 0.85 IMN.
	3																						
BLU-1C/B, BLU-27 SERIES FIRE BOMBS (FINNED) WITH AERO NO. 45-9534 FUEL TANK	4	BLU	BLU	TANK			TANK	BLU	BLU	450 0.95 BLU 600 1.02 TANK	NA	450 0.90 BLU See Remarks TANK	Note 1 BLU NA TANK	-2.5 to +6.0 BLU-1 -2.0 to +6.0 BLU-27 -3.0 to +7.0 TANK	NA	+0.5 to +6.0 Note 3 BLU +1.0 Level Flight TANK	+1.0 Level Flight BLU NA TANK	45° BLU Note 12 NA TANK	458.3	463.0	203 225 319 584	9097 BLU-1 9760 BLU-27 Note 2	Rolling pullouts limited to +4.0 g. Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN. Fuselage store installation not authorized.
	5																						
	6																						
	7																						
	8																						
	9																						

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Figure 5–12 (Sheet 14A)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
MK 82 LASER GUIDED BOMB (LOW SPEED AND HIGH SPEED)	1	●	●	●			●	●	●	520 0.90	NA	500 0.90	NA	−1.0 to +5.0	NA	+0.5 to +4.5 See Note 3	NA	60°	456.9	466.9		4092	Minimum separation between bombs released from the same wing is 150 feet.
	2																						
MK 82 LASER GUIDED BOMB (HIGH SPEED ONLY) WITH AER. NO. 45-9534 FUEL TANK	3	● TANK	● MK 82	● MK 82			● MK 82	● MK 82	● TANK	520 0.90 MK 82 600 1.02 TANK	NA	500 0.90 See Remarks MK 82 TANK	NA	−1.0 to +5.0 MK 82 −3.0 to +7.0 TANK	NA	+0.5 to +4.5 See Note 3 MK 82 +1.0 Level Flight TANK	NA	60° MK 82 NA TANK	456.8	466.7		6802	Minimum separation between bombs released from the same wing is 150 feet. For configuration in line 4, maximum release airspeed is 450 KIAS/0.68 IMN when fuel tanks are carried on stations 3 and 6. Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
	4	● MK 82	● MK 82	● TANK			● TANK	● MK 82	● MK 82										455.9	461.9		6802	
	5																						
	6																						
	7																						
	8																						
	9																						

Figure 5–12 (Sheet 14B)

EXTERNAL STORES LIMITATIONS

MAJOR CHANGE

NOTE

Only the configurations shown in the following charts or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT FWD	AFT	TOTAL DRAG INDEX	STORE CONFIGURATION WEIGHT – LBS	REMARKS
CBU-24B/B CBU-49B/B CBU-52/B CBU-52A/B WITH MK 84 LDGP	1	CBU	CBU	MK 84			MK 84	CBU	CBU	600 1.02	NA	550 0.95	NA	-2.0 to +7.0 CBU -3.0 to +7.0 MK 84	NA	+0.3 to +5.0 Note 3 MK 84 +0.5 to +7.0 Note 3 CBU	NA	60°	458.2	469.0	90 95 114 182	7268	See Note 18
	2																						
	3																						
CBU-24B/B CBU-49B/B CBU-52/B CBU-52A/B WITH ECM PODS (SEE NOTE 10)	4	ECM	CBU					CBU	ECM	600 1.02 CBU ALQ-101 ALQ-71 600 0.90 ALQ-87	NA	550 0.95 CBU 500 0.90 ECM	Note 1 CBU NA ECM	-2.0 to +7.0 CBU -3.0 to +6.0 ECM	NA	+0.5 to +7.0 Note 3 CBU +1.0 Level Flight ECM	+1.0 Level Flight CBU NA ECM	60°	456.5	466.9	158 192 257 392	5784	For configuration shown on line 6 maximum allowable bank angle change is 180°. **WARNING** See Note 1, Figure 5-1, T.O. 1A-7D-1A for additional limitation on these configurations. See Note 18
	5	ECM	CBU					CBU	ECM										460.8	467.5	175 198 248 349	7696	
	6	ECM	CBU					CBU	ECM					-2.0 to +6.0 CBU -3.0 to +6.0 ECM		+0.5 to +6.0 Note 3 CBU +1.0 Level Flight ECM			461.8	467.5	216 242 297 414	11,024 Note 2	
	7																						
	8																						
	9																						

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Figure 5–12 (Sheet 15)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
CBU–24B/B, CBU–49B/B, CBU–52/B, CBU–52A/B WITH AER NO.45–9534 FUEL TANK	1	CBU	CBU	TANK			TANK	CBU	CBU	600 1.02 TANK CBU ALQ–101 ALQ–71 600 0.90 ALQ–87	NA	500 0.90 CBU ECM See Remarks TANK	NA TANK ECM Note 1 CBU	–3.0 to +7.0 TANK –2.0 to +7.0 CBU 3.0 to +6.0 ECM	NA	1.0 Level Flight TANK ECM +0.5 to +7.0 Note 3 CBU	NA TANK ECM +1.0 Level Flight CBU	NA TANK ECM 60° CBU	460.9	463.5	236 268 337 523	13,142 Note 2	Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN. See Note 18
	2																						
	3																						
CBU–24B/B, CBU–49B/B, CBU–52/B, CBU–52A/B WITH AER NO.45–9534 FUEL TANKS AND ECM PODS (SEE NOTE 10)	4	ECM	CBU	TANK			TANK	CBU	ECM										456.3	462.2	172 210 289 479	8842	**WARNING** See Note 1, Figure 5–1 T.O 1A-7D-1A for additional limitation on these configurations. See Note 18. Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN
	5	ECM	CBU	TANK			TANK	CBU	ECM										460.9	462.7	217 249 319 495	12,418 Note 2	
	6																						
	7																						
	8																						
	9																						

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Figure 5–12 (Sheet 16)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
CBU–52B/B, CBU–58/B,	1	●	●	●			●	●	●	600 1.02	NA	550 0.95	Note 1	–2.0 to +7.0	NA	+0.5 to +7.0 Note 3	NA	60°	457.2	469.3	156 156 180 300	4710 CBU-52 4860 CBU-58	See Note 18
	2	●	●●●					●●●	●								+1.0 Level Flight		461.1	468.5	291 303 345 560	8290 CBU-52 8540 CBU-58	
CBU–52B/B, CBU–58/B WITH MK 84 LDGP	3	● CBU	● CBU	● MK 84			● MK 84	● CBU	● CBU				NA	–2.0 to +7.0 CBU –3.0 to +7.0 MK 84		+0.5 to +7.0 Note 3 CBU +0.3 to +5.0 Note 3 MK 84	NA		458.4	469.0	126 127 150 248	7080 CBU-52 7180 CBU-58	
	4																						
	5																						
CBU–52B/B CBU–58/B WITH ECM PODS (SEE NOTE 10)	6	● ECM	●●● CBU					●●● CBU	● ECM	600 1.02 CBU ALQ–101 ALQ–71 600 0.90 ALQ–87	NA	550 0.95 CBU 500 0.90 ECM	Note 1 CBU NA ECM	–2.0 to +7.0 CBU –3.0 to +6.0 ECM	NA	+0.5 to +7.0 Note 3 CBU +1.0 Level Flight ECM	+1.0 Level Flight CBU NA ECM	60	456.9	466.7	194 208 259 450	5842 CBU-52 5992 CBU-58	**WARNING** See Note 1, Figure 5–1, T.O. 1A-7D-1A for additional limitation on these configurations.
	7	● ECM	●●●● CBU					●●●● CBU	● ECM										461.1	467.2	254 268 309 505	7662 CBU-52 7862 CBU-58	
	8	● ECM	●●●●●● CBU					●●●●●● CBU	● ECM					–2.0 to +6.0 CBU –3.0 to +6.0 ECM		+0.5 to +6.0 Note 3 CBU +1.0 Level Flight ECM			462.3	467.2	334 348 389 649	10,802 CBU-52 11,102 CBU-58 NOTE 2	For configuration shown on line 8 maximum allowable bank angle change is 180°.
	9																						See Note 18

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Figure 5–12 (Sheet 17)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

STATION LOADING AND SUSPENSION

	LINE NUMBER	1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CONFIGURATION WEIGHT – LBS	REMARKS
CBU-52B/B, CBU-58/B WITH AER NO.45-9534 FUEL TANK	1	CBU	CBU	TANK			TANK	CBU	CBU	600 1.02 TANK CBU ALQ-101 ALQ-71 600 0.90 ALQ-87	NA	500 0.90 ECM 550 0.95 CBU See Remarks TANK	NA TANK ECM Note 1 CBU	-3.0 to +7.0 TANK -2.0 to +7.0 CBU -3.0 to +6.0 ECM	NA	+1.0 Level Flight TANK ECM +0.5 to +7.0 Note 3 CBU	NA TANK ECM +1.0 Level Flight CBU	NA TANK ECM 60° CBU	461.1	463.1	333 354 416 612	12,672 CBU-52 12,922 CBU-58 NOTE 2	Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN. See Note 18
	2																						
CBU-52B/B, CBU-58/B WITH AER NO.45-9534 FUEL TANK AND ECM PODS (SEE NOTE 10)	3	ECM	CBU	TANK			TANK	CBU	ECM										456.5	462.3	196 219 290 522	8654 CBU-52 8754 CBU-58	**WARNING** See Note 1, Figure 5-1, T.O. 1A-7D-1A for additional limitation on these configurations. See Note 18 Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
	4	ECM	CBU	TANK			TANK	CBU	ECM										461.1	462.7	296 319 380 651	12,042 CBU-52 12,292 CBU-58 NOTE 2	
	5																						
	6																						
	7																						
	8																						
	9																						

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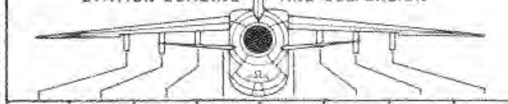
Figure 5–12 (Sheet 18)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.



	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
SUU-20 SERIES DISPENSER AND AER NO. 45-9534 FUEL TANK AND SUU-42 SERIES DISPENSER (SEE NOTES 4 AND 5)	1		SUU-20	TANK			TANK	SUU-20		550 1.02 SUU-20 600 1.02 TANK SUU-42 See Remarks	500 0.90 SUU-20 SUU-42 NA TANK	400 0.80 SUU-20 See Remarks TANK SUU-42	NA	-2.0 to +5.0 SUU-20 -3.0 to +7.0 TANK -2.0 to +6.0 SUU-42	+0.3 to +5.0 BDU-33 FFAR +0.5 to +5.0 MK 106 +0.9 to +1.0 SUU-42 NA TANK	+1.0 Level Flight	NA	60° BDU-33 FFAR 45° MK 106 20° SUU-42 NA TANK	455.6	462.7 Note 7	103 110 144 249	5426	Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN. Release full SUU-42 up to 500 KIAS, 0.90 IMN. Release empty and partially full SUU-42 up to 500 KIAS, 0.85 IMN. Configuration shown in line 6 is limited to 520 KIAS or 0.91 IMN carriage speed, whichever is less, when tanks are carried.
	2	SUU-42		TANK			TANK		SUU-42										455.5	462.3 Note 7	78 83 107 210	6044	
	3	SUU-42	SUU-20					SUU-20	SUU-42										455.6	465.8	60 66 90 152	2706	
	4		SUU-20	TANK			TANK		SUU-42										455.6	462.5 Note 7	90 96 125 230	5735	
	5	SUU-42		TANK			TANK	SUU-20											455.6	462.5 Note 7	90 96 125 230	5735	
	6	TANK	SUU-20					SUU-20	TANK										455.6	465.7	85 92 126 231	5426	
BDU-33A/B, BDU-33B/B PRACTICE BOMBS	7	BDU	BDU					BDU	BDU	600 1.02	NA	550 0.95 BDU See Remarks TANK	Note 1	-3.0 to +7.0	NA	+0.5 to +7.0 BDU +1.0 Level Flight TANK	+1.0 Level Flight	60° BDU	455.8	467.7	124 134 154 224	1456	TER-9A may be substituted for MER-10N where shown. Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
	8	BDU	BDU					BDU	BDU										455.8	468.0	100 110 139 211	1064	
BDU-33A/B, BDU-33B/B PRACTICE BOMBS WITH AER NO. 45-9534 FUEL TANK	9	BDU		TANK			TANK		BDU										455.5	463.5 Note 7	108 115 138 238	5110	

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Figure 5–12 (Sheet 19)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
FLARE SERIES WITH SUU-20 SERIES DISPENSER (SEE NOTES 5 AND 13)	1	FLARE	SUU-20					SUU-20	FLARE										455.7	467.2	119 123 171 246	1832	
	2																						
FLARE SERIES WITH AER NO.45-9534 FUEL TANKS (SEE NOTE 13)	3	FLARE		TANK			TANK		FLARE										455.6	463.3	137 140 188 304	5170	TER-9A may be substituted for MER-10N for BDU carriage. Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
	4									600 1.02 FLARE BDU TANK 550 1.02 SUU	500 0.90 SUU NA TANK FLARE BDU	450 0.80 FLARE 550 0.95 BDU 400 0.80 SUU See Remarks TANK	Note 1 FLARE BDU NA TANK SUU	-3.0 to +7.0 FLARE BDU TANK -2.0 to +5.0 SUU	+0.3 to +5.0 BDU FFAR FROM SUU +0.5 to +5.0 MK 106 NA TANK FLARE	+1.0 Level Flight FLARE SUU TANK +0.5 to +7.0 BDU	+1.0 Level Flight FLARE BDU NA SUU TANK	0° FLARE TANK 60° BDU FFAR 45° MK 106					
FLARE SERIES WITH BDU-33A/B, BDU-33B/B PRACTICE BOMBS AND AER NO.45-9534 FUEL TANKS (SEE NOTE 13)	5	FLARE		TANK			TANK		BDU										455.6	463.4	123 128 163 271	5134	
	6																						
	7																						
FLARE SERIES WITH BDU-33A/B, BDU-33B/B PRACTICE BOMBS (SEE NOTE 13)	8	FLARE	BDU					BDU	FLARE										455.9	467.6	153 159 204 289	1504	TER-9A may be substituted for MER-10N for BDU carriage.
	9																						

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Figure 5–12 (Sheet 20)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CONFIGURATION WEIGHT – LBS	REMARKS
BDU-33A/B, BDU-33B/B PRACTICE BOMBS WITH LAU SERIES AND AER NO.45-9534 FUEL TANKS (SEE NOTE 14)	1	BDU	LAU	TANK			TANK	LAU	BDU										455.7	462.0	133 149 188 317	6534 LAU-68 6048 LAU-3/95	TER-9A may be substituted for MER-10N for BDU carriage Release full tanks up to 500 KIAS, 0.90 IMN Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
	2																						
LAU SERIES WITH BDU-33A/B, BDU-33B/B PRACTICE BOMBS (SEE NOTE 14)	3		LAU					BDU		600 1.02 BDU 520 0.91 LAU	520 0.91 LAU NA BDU	550 0.95 BDU 250 to 350 0.80 LAU See Remarks TANK	Note 1 BDU NA LAU	-3.0 to +7.0 BDU LAU	+0.3 to +7.0 LAU	+1.0 Level Flight LAU +0.5 to +7.0 BDU	+1.0 Level Flight BDU NA LAU	60° BDU LAU	455.8	468.4	64 70 89 128	576 LAU-68 833 LAU-3/95	
	4																						
LAU SERIES (SEE NOTE 14)	5	●	●	●			●	●	●										456.3	466.3	69 72 90 136	1308 LAU-68 2850 LAU-3/95	
	6	●	●					●	●										455.7	467.5	58 62 80 120	872 LAU-68 1900 LAU-3/95	
	7	●							●										455.6	468.6	47 52 70 102	436 LAU-68 950 LAU-3/95	
	8																						
	9																						

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Figure 5–12 (Sheet 21)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CONFIGURATION WEIGHT – LBS	REMARKS
CBU–30/A	1	●	●	●			●	●	●	600 1.02	550 0.95	475 0.80 Full 450 0.80 Empty Or Partially Full	NA	-3.0 to +5.0	+0.9 to +1.0	+1.0 Level Flight	NA	20°	456.1	465.7	120 138 168 228	2310	See Notes 7 and 18 Fuselage store installation not authorized. Aft Limit, line 3: 461.7 Note 16 463.3 Note 15 Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN
CBU–38/A	2	●	●	●			●	●	●										456.6	465.7	120 138 168 228	4224	
CBU–12A/A WITH LAU SERIES AND AER NO. 45–9534 FUEL TANKS (SEE NOTE 14)	3	● CBU	● LAU	● TANK			● TANK	● LAU	● CBU	600 1.02 TANK 520 0.91 LAU CBU	520 0.91 LAU 400 to 520 0.91 CBU NA TANK	250 to 350 0.80 LAU See Remarks TANK 200 to 425 0.80 CBU	300 0.90 LAU NA TANK CBU	-3.0 to +7.0 TANK LAU -2.0 to +5.0 CBU	+0.3 to +7.0 LAU +0.9 to +1.0 CBU NA TANK	+1.0 Level Flight	+1.0 Level Flight LAU NA TANK CBU	60° LAU 20° CBU NA TANK	454.5	See Remarks	164 199 252 418	8246	
	4																						
CBU–12A/A WITH LAU SERIES AND AER NO. 45–9534 FUEL TANKS (SEE NOTE 14)	5	● CBU	● LAU	● TANK			● TANK	● LAU	● CBU				NA				NA		454.3	462.7 See Remarks	114 122 159 282	7104	
	6																						
	7																						
	8																						
	9																						

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Figure 5–12 (Sheet 22)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
CBU-12A/A WITH LAU SERIES AND AER NO. 45-9534 FUEL TANKS (SEE NOTE 14)	1	CBU	LAU	TANK			LAU	LAU	TANK										454.8	See Re-marks	137 154 208 364	8246	See Notes 7 and 18. Fuselage store installation not authorized. Aft limit, line 1: 461.1 462.1 Note 16 463.7 Note 15 Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN
	2																						
CBU-12A/A WITH LAU SERIES AND AER NO. 45-9534 FUEL TANKS (SEE NOTE 14)	3	CBU	LAU	TANK			LAU	LAU	TANK										454.5	462.8 See Re-marks	106 113 148 270	7675	
	4									500 0.90 CBU12 30/38 LAU 600 1.02 TANK	500 0.90 LAU CBU 30/38 400 TO 500 0.90 CBU12 NA TANK	See Remarks TANK 475 0.80 FULL 450 0.80 Empty Or Partially Full CBU 30/38 250 to 350 0.80 LAU 250 to 425 0.80 FULL 400 to 425 Empty Or Partially Full CBU12	300 0.80 CBU12 300 0.90 LAU NA TANK CBU 30/38	-3.0 to +7.0 TANK LAU -3.0 to +5.0 CBU 30/38 -2.0 to +5.0 CBU12	+0.3 to +7.0 LAU +0.9 to +1.0 CBU 30/38 12 NA TANK	+1.0 Level Flight	+1.0 Level Flight CBU 12 LAU NA TANK CBU 30/38	60° LAU 20° CBU12 30/38 NA TANK					
CBU-12A/A WITH CBU-30/A, -38/A, LAU SERIES AND AER NO. 45-9534 FUEL TANKS (SEE NOTE 14)	5	CBU12	CBU 30/38	TANK			LAU	CBU 30/38	TANK										454.6	462.6 See Re-marks	130 143 186 319	8133	
	6																						
CBU-12A/A WITH CBU-30/A, -38/A, LAU SERIES AND AER NO. 45-9534 FUEL TANKS (SEE NOTE 14)	7	CBU12	LAU	TANK			CBU 30/38	LAU	TANK										454.7	462.7 See Re-marks	115 124 161 285	7904	
	8																						
	9																						

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Figure 5–12 (Sheet 23)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION								MAXIMUM KIAS OR IMN WHICHEVER IS LESS				ACCELERATION "g"				MAX DIVE FOR DEL	CHART C ARM LIMIT		TOTAL DRAG INDEX	STORE CONFIGURATION WEIGHT – LBS	REMARKS
		1	2	3	4	5	6	7	8	CARRIAGE	EMPLOYMENT	RELEASE	JETTISON	CARRIAGE	EMPLOYMENT	RELEASE	JETTISON		FWD	AFT			
CBU 12A/A WITH CBU-30/A, -38/A AND AER NO. 45-9534 FUEL TANKS	1	CBU12	CBU 30/38	TANK			TANK	CBU 30/38	CBU12	450 0.90 CBU 12 30/38 600 1.02 TANK	400 to 500 0.90 CBU12 500 0.90 CBU 30/38 520 0.91 LAU	475 0.80 Full 450 0.80 Empty Or Partially Full CBU 30/38 250 to 350 0.80 LAU See Remarks TANK 250 to 425 0.80 Full 400 to 425 0.80 Empty Or Partially Full CBU12	300 0.80 CBU12 300 0.90 LAU NA CBU 30/38 TANK	-3.0 to +7.0 TANK LAU -3.0 to +5.0 CBU 30/38 -2.0 to +5.0 CBU12	+0.3 to +7.0 LAU +0.9 to +1.0 CBU12 30/38 NA TANK	+1.0 Level Flight	+1.0 Level Flight CBU12 LAU NA TANK CBU 30/38	60° LAU 20° CBU NA TANK	454.3	See Remarks	153 179 247 421	9526	See Notes 7 and 18 Fuselage store installation not authorized Aft Limits Line 1: 460.8 Note 16 483.9 Note 15 Line 5: 461.7 462.0 Note 16 464.2 Note 15 Line 7: 461.6 Note 16 464.2 Note 15 Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
	2																						
CBU 12A/A WITH LAU-3/A AND 95/A AND AER NO. 45-9534 FUEL TANKS (SEE NOTE 14)	3	CBU12	LAU 3/95	TANK			TANK	LAU 3/95	LAU 3/95	500 0.90 CBU LAU 600 1.02 TANK									454.3	462.0 See Remarks	144 157 211 373	8246	
	4																						
CBU-12A/A WITH CBU-30/A, -38/A, LAU-3/A AND 95/A, AND AER NO.45-9534 FUEL TANKS (SEE NOTE 14)	5	CBU12	CBU 30/38	TANK			TANK	CBU 30/38	LAU 3/95										454.3	See Remarks	151 177 243 414	8704	
	6																						
CBU 12A/A WITH LAU SERIES AND AER NO. 45-9534 FUEL TANKS (SEE NOTE 14)	7	CBU12	LAU	TANK			TANK	LAU	CBU12	450 0.90 CBU 520 0.91 LAU 600 1.02 TANK									454.3	See Remarks	146 159 215 380	9068	
	8																						
CBU 12A/A WITH AER NO. 45-9534 FUEL TANKS	9	CBU12		TANK			TANK		CBU12										454.2	462.7 See Remarks	115 127 175 315	6118	

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Figure 5–12 (Sheet 24)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

Configuration	Line Number	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6	Sta 7	Sta 8	Max KIAS or IMN (whichever is less): Carriage	Employment	Release	Jettison	Acceleration "g": Carriage	Employment	Release	Jettison	Max Dive for Del	Chart C Arm Limit: FWD	AFT	Total Drag Index	Store Configuration Weight – LBS	Remarks
CBU 30/A, –38/A WITH AER NO. 45–9534 FUEL TANKS	1	CBU	CBU	TANK			TANK	CBU	CBU	520 0.91 LAU CBU 600 1.02 MK 82 TANK	520 0.91 CBU LAU NA MK 82 TANK	250 to 350 0.80 LAU See Remarks TANK 475 0.80 Full 450 0.80 Empty Or Partial ly Full CBU 520 0.90 LDGP (Unrtd) MK 82 450 0.90 (Rtd) MK 82 See Remarks	Note 1 MK 82 NA CBU LAU TANK	–3.0 to +7.0 TANK LAU MK 82 –3.0 to +5.0 CBU	+0.3 to +7.0 LAU +0.9 to +1.0 CBU NA TANK MK 82	+1.0 Level Flight CBU TANK LAU +0.5 to +7.0 Note 3 MK 82	+1.0 Level Flight MK 82 NA TANK LAU CBU	60° LAU MK 82 LDGP SE (Unrtd) 30° Note 6 SE (Rtd) 20° CBU NA TANK	454.3	463.1 See Re- marks	120 133 163 264	7198	See Note 7 See Note 18 for lines 1 and 5 Fusetage store installation not authorized for lines 1, 3 or 5. Aft limit, line 7: 464.9 if fuselage stores not installed. Maximum release speed retarded is 500 KIAS when using the Mk 15 Mod 3, Mod 3A and Mod 4 fins. Release full tanks up to 500 KIAS, 0.90 IMN. Release empty and partially full tanks between 250 and 300 KIAS, 0.80 IMN.
	2																						
LAU SERIES WITH AER NO.45–9534 FUEL TANKS (SEE NOTE 14)	3	TANK	LAU	TANK			TANK	LAU	TANK										454.3	462.6 See Re marks	123 128 162 317	9714	
	4																						
LAU SERIES WITH CBU 30/A, 38/A AND AER NO.45–9534 FUEL TANKS (SEE NOTE 14)	5	TANK	LAU	TANK			TANK	CBU	TANK										454.3	462.5 See Re marks	119 125 157 306	9943 Note 2	
	6																						
MK 82 LDGP, MK 82 SNAKEYE, OR MK 36 DESTRUCTOR WITH LAU SERIES AND AER NO. 45–9534 FUEL TANKS (SEE NOTES 11 AND 14)	7	LAU	MK 82	TANK			TANK	MK 82	LAU										458.8	462.7 See Re- marks	166 181 226 363	10252 Note 2	
	8																						
	9																						

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Figure 5–12 (Sheet 25)

EXTERNAL STORES LIMITATIONS

NOTE

Only the configurations shown in the following charts, or partial configurations properly obtained from those shown, may be carried, released, or jettisoned.

	LINE NUMBER	STATION LOADING AND SUSPENSION 1	2	3	4	5	6	7	8	MAXIMUM KIAS OR IMN WHICHEVER IS LESS: CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	ACCELERATION "g": CARRIAGE	EMPLOY-MENT	RELEASE	JETTISON	MAX DIVE FOR DEL	CHART C ARM LIMIT: FWD	AFT	TOTAL DRAG INDEX	STORE CON-FIGURATION WEIGHT – LBS	REMARKS
LAU SERIES WITH AER NO.45–9534 FUEL TANKS (SEE NOTE 14)	1	LAU	LAU	TANK			TANK	LAU	LAU	520 0.91 LAU CBU 600 1.02 TANK	520 0.91 LAU CBU 30/38 400 to 520 0.91 CBU12 NA TANK	250 to 350 0.80 LAU See Remarks TANK 475 0.80 Full 450 0.80 Empty Or Partially Full CBU 30/38 250 to 425 0.80 Full 400 to 425 0.80 Empty Or Partially Full CBU12	300 0.90 LAU 300 0.80 CBU12 NA TANK CBU 30/38	−3.0 to +7.0 LAU TANK 3.0 to +5.0 CBU 30/38 −2.0 to +5.0 CBU12	+0.3 to +7.0 LAU NA TANK +0.9 to +1.0 CBU	+1.0 Level Flight LAU TANK CBU	+1.0 Level Flight LAU NA TANK CBU	60° LAU NA TANK 20° CBU	454.3	462.1 See Remarks	178 204 278 472	8374	See Note 7. See Note 18 for lines 5 and 7. Fuselage store installation not authorized on lines 1, 5 or 7. Aft Limit, line 3: 463.9 if fuselage stores not installed
	2																						
LAU SERIES WITH AER NO.45–9534 FUEL TANKS (SEE NOTE 14)	3	LAU		TANK			TANK		LAU										455.6	461.7 See Remarks	143 158 208 355	7424	
	4																						
LAU SERIES WITH CBU–30/A, –38/A, AND AER NO.45–9534 FUEL TANKS (SEE NOTE 14)	5	LAU	CBU	TANK			TANK	CBU	LAU										454.3	462.8 See Remarks	153 172 228 387	7904	
	6																						
LAU SERIES WITH CBU-12A/A AND AER NO. 45–9534 FUEL TANKS (SEE NOTE 14)	7	CBU	LAU	TANK			TANK	LAU	CBU										454.3	462.9 See Remarks	128 138 187 332	7296	
	8																						
	9																						

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Figure 5–12 (Sheet 26)

EXTERNAL STORES LIMITATIONS

NOTE

1. Emergency level flight jettison airspeed envelope for TER with or without stores is limited to 350 KIAS/ 0.90 IMN or less. Emergency level flight jettison airspeed envelope for empty MER, MER with more stores aft than forward, and MER with both forward and aft stores having no more than one store forward asymmetry is limited to 400 KIAS or less not to exceed 0.90 IMN. Safe jettison airspeed for MER with stores on forward stations only or MER with more than one store forward asymmetry is between 180 and 200 KIAS but not exceeding 17.5 units angle of attack.

2. Configuration may exceed maximum operating gross weight restriction of 42,000 pounds. Offload fuel to fall within weight limit.

3. Dive toss ripple release of stores will result in a dynamic response (g jump) and possible exceeding of the aircraft and/or store design g limit. To preclude exceeding g limits when a dive toss ripple release is contemplated, the release should be initiated at not more than 4.5 g.

   Exceptions to the above:

   (a) For configurations involving SUU-42/A, SUU-42A/A, ECM Pods, M117A1, BLU-1C/B, BLU-27/B, BLU-27A/B, and BLU-27B/B, release should be initiated at not more than 4.0 g.

   (b) For configurations involving Mk 84:
   2 or 3 Mk 84 releases-initiate at not more than 3.5 g.
   4 or more Mk 84 releases-initiate at not more than 3.0 g.

4. The authorized models of the SUU-42 Series Flare Dispenser are SUU-42/A and SUU-42A/A. The authorized submunition for the dispenser is the Mk 24 Mod 4 flare.

5. The authorized models of the SUU-20 Series Dispenser are SUU-20/A, SUU-20/A (M), SUU-20A/A, and SUU-20B/A. The authorized submunitions for the dispenser are the BDU-33A/B, BDU-33B/B, and Mk 106 practice bombs and all models of 2.75-inch folding fin aircraft rockets (FFAR).

6. Minimum allowable release interval for retarded release of Mk 82 Snakeye bombs or the Mk 36 Destructor from the same MER/TER or adjacent MAU-12 bomb racks is 300 ms. Do not select release intervals in feet less than the appropriate values listed (or linear interpolated values for other dive angles):

Dive Angle	0°	15°	30°
Interval	500 ft	375 ft	250 ft

7. This configuration will cause the aircraft CG to approach the aft limit. Refer to Section VI for a description of the flying characteristics of an aircraft approaching the aft CG limit.

8. The authorized fins for use with the Mk 82 SNAKEYE or Mk 36 Destructor are the Mk 15 Mod 1 w/T.O. 11A1-1-27S-20 or T.O. 11A1-1-27S-32 incorporated, Mk 15 Mod 2, Mk 15 Mod 3, Mk 15 Mod 3A and Mk 15 Mod 4.

9. The authorized models of the BLU-27 Series fire bombs are BLU-27/B, BLU-27A/B and BLU-27B/B.

10. The authorized ECM pods are the AN/ALQ-87, AN/ALQ-71(V)-1, AN/ALQ-71(V)-3, AN/ALQ-71(V)-4, AN/ALQ-101(V)-1, AN/ALQ-101(V)-3, and AN/ALQ-101(V)-4 pods.

11. The Mk 36 Destructor may be substituted for the Mk 82 SNAKEYE I bomb in all configurations involving the Mk 82 SNAKEYE I. However, mixed loads of Mk 36 Destructors and Mk 82 SNAKEYE bombs on the same station is not authorized.

12. Minimum release intervals (MRI) for BLU-1C/B and BLU-27 Series unfinned firebombs shall be 250 milliseconds in ripple pairs mode and 125 milliseconds in ripple singles mode. MRI for finned firebombs released from a MER shall be 150 milliseconds in the ripple pairs mode. Representative minimum release intervals in feet to satisfy these requirements are listed below.

Weapon	Release Mode	Dive Angle	Interval-Ft Setting
Unfinned firebomb	Ripple pairs	10°	450
Unfinned firebomb	Ripple pairs	30°	320
Unfinned firebomb	Ripple singles	10°	230
Unfinned firebomb	Ripple singles	30°	160
Finned firebombs	Ripple pairs (MER)	10°	450
Finned firebombs	Ripple pairs (MER)	30°	280

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Figure 5–12 (Sheet 27)

EXTERNAL STORES LIMITATIONS

NOTES

13. The authorized models of the FLARE series are LUU-1/B, LUU-2/B, LUU-5/B, Mk 24 Mod 4, and MJU-3/B.

14. The authorized models of the LAU series are the LAU-3/A, LAU-68A/A, LAU-68B/A, and LAU-95/A. The authorized rocket warheads are the Mk 1, M 151, WDU-4A/A, and M 156. Authorized rocket motor is the Mk 4.

    The authorized nose and tail fairings for the LAU-3/A and LAU-95/A are: FFAR FAIRING SET P/N 7027240-50 and 7027240-70.

15. The aft center of gravity limit listed requires that the internal gun ammunition handling system must contain 1,000 rounds and that the ammunition not be expended until the CBU-12A/A munition is empty. Chart C Arm Aft Limit aft shift obtained either by retention of empty ammunition cases or ammunition is not applicable to this limit.

16. The aft center of gravity limit listed required that the CBU-12A/A be empty prior to release and/or employment of other external stores.

17. This configuration may be mixed with any other configuration depicted in figure 5-12 provided the AFT CHART C ARM LIMIT of the original configuration is adjusted forward 0.5 inches for each MER added.

18. Until ballistic information is included in a future OFP, computed delivery is not possible for the CBU-12A/A, CBU-30/A, CBU-38/A, CBU-52/B, CBU-52A/B, CBU-52B/B, and CBU-58/B and release must be in the manual mode.

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Figure 5—12 (Sheet 28)

FLIGHT CHARACTERISTICS

SECTION VI

TABLE OF CONTENTS.

DEFINITIONS.

ANGLE OF ATTACK – Defined as the angle formed by the aircraft fuselage centerline and the aircraft flightpath (relative wind). All references to angle of attack are for indicated AOA.

ANTI-SPIN CONTROL – Neutral longitudinal stick, full rudder against direction of rotation, and full lateral stick in direction of rotation.

DEPARTURE FROM CONTROLLED FLIGHT – An uncontrollable, large-amplitude yaw usually followed by poststall gyrations. With flaps down, roll may be coincident with yaw. The departure is terminated either by recovery or spin entry.

ERECT SPIN – Sustained yaw rotation with angle of attack above stall. Antispin controls may be required for recovery.

INVERTED SPIN – Yaw rotation with negative normal accelerations and negative angle of attack. Recovery is effected by neutralizing controls.

PRO-SPIN CONTROL – Full aft longitudinal stick, full rudder in direction of rotation, and full lateral stick opposite to direction of rotation.

STALL – Defined as angle of attack of maximum usable lift. Limited by the point at which directional divergence begins. Normally occurs at approximately 24 to 25 units angle of attack.

STALL SPEED – Minimum speed at which equilibrium flight can be maintained if the limit of available thrust has not been reached.

FLIGHT CONTROLS.

PRIMARY CONTROL EFFECTIVENESS.

Horizontal Stabilizer.

At normal landing weights, horizontal stabilizer effectiveness provides sufficient pitch control to hold the nosewheel off the runway above 90 knots during landing. Refer to Maneuvering Flight, this section, for additional information. At cg near the aft limit, horizontal stabilizer effectiveness is increased to the point that rotation to an aerodynamic braking attitude should be executed with care to avoid tail cone damage.

Ailerons And Spoiler-Deflectors.

Lateral control is very effective and may even be noticeably effective during high speed taxi. In flight, the ailerons induce some adverse yaw; however, this yaw decreases as airspeed increases and becomes slightly favorable at higher Mach numbers. As an aileron moves upward to create roll, a spoiler-deflector is operated in conjunction with the aileron to provide increased roll rate and counteract yaw. The spoiler extends up into the airstream, disrupting the airflow, and decreases lift on the wing. The deflector extends down into the airstream and acts as a scoop to direct airflow over the wing surface behind the spoiler, which prevents flow separation.

Rudder.

The rudder is effective at all speeds above 40 to 50 knots. With heavy wing stores, the minimum effective speed is somewhat higher.

SECONDARY CONTROLS.

Flaps.

The aircraft accelerates smoothly as the flaps are retracted. As the flaps retract, pitch attitude must be increased to offset a slight settling effect. Pitch trim and trim rate are sufficient to reduce stick force to zero during flap retraction. If trim is not used, a pull force of approximately 10 to 15 pounds is required to overcome the pitch change if full flaps are used. Pull force is significantly less when using partial flaps for takeoff. Flap extension requires nosedown trim of equal magnitude.

Speed Brake.

The speed brake can be extended at any speed and is very effective. A mild noseup pitch tendency is apparent as the brake extends. Three or four pounds of stick force is required to overcome full extension pitch change at lower airspeeds while about 10 pounds of push force is required at high subsonic speeds. A directional trim change may occur when more than 40° of speed brake is extended. Airframe buffet accompanies 60° of brake extension. Buffet due to the extended brake varies from light at the lower airspeeds to moderate at high subsonic speeds. Buffet does not interfere significantly with target tracking.

When the speed brake is extended at airspeeds over approximately 450 KIAS, full extension of the brakes is not available until airspeed is reduced.

Trim.

For normal operation, particularly below 15,000 feet, the aircraft should be flown as near "in trim" as possible. At high airspeeds where horizontal stabilizer effectiveness is high, the control system is least sensitive when operated near trim.

FLIGHT CHARACTERISTICS WITH FAILED PC SYSTEMS.

AIRCRAFT → [16] [18] → [26]

Loss of either PC system reduces power to the flight controls by one-half and results in a slight reduction in control effectiveness at high airspeeds.

AIRCRAFT [17] [27] →

Flying qualities with a single PC system failure are unchanged except for a slight reduction in aileron effectiveness at high speed/low altitude. No additional flight restrictions are imposed on the aircraft by loss of a single PC system failure.

PC 2 and PC 3 System Failure.

With loss of both PC 2 and PC 3 systems, aileron deflection available through the roll trim system is ±13° at a 1° per second rate. Manual lateral control is lost, but with the AFCS CONT AUG or ATTD engaged and roll AFCS operating, adequate lateral control is available to the limits of AFCS authority (±10° of aileron deflection about the trim position and 24° of spoiler deflection). Approximately one-half lateral stick movement provides the ±10° aileron deflection. Further lateral stick displacement has no effect. If roll AFCS is not available, or if CONT AUG is not engaged, roll trim is the only available lateral control. Roll trim provides adequate lateral control for cruise in normal flight attitudes, but only affords marginal control at low speeds.

WARNING

A landing should not be attempted with only the PC 1 system operating unless roll AFCS is engaged and operating.

Note

Lateral control is available only through the use of roll trim if CONT AUG is not engaged or if roll AFCS is out. Roll trim only is marginal for cruising in normal flight and is inadequate for landing.

Since the rudder is powered by PC 2 and PC 3, neither yaw control nor yaw trim is available. A slight steady sideslip may exist, and a shallow bank angle may be required to maintain heading. Yaw damping is essentially the same as that of the normal aircraft with yaw stab OFF. Longitudinal stability and pitch control are essentially unchanged.

Control is adequate in the landing configuration with CONT AUG ON; however, a 1-cycle per second pilot induced lateral oscillation may develop if the pilot attempts late line up corrections or if the wind is gusty. Fly a straight-in approach at normal approach angle of attack. Precise line up should be accomplished as early as possible. If a go-around is required, climb straight ahead. The ailerons are effective for directional control immediately after touchdown to approximately 80 knots and aerodynamic braking should be used. The ailerons can be used to remain on the runway centerline during rollout. Right aileron (right stick) causes a right turn and left aileron (left stick) causes a left turn. In crosswind conditions, the aircraft will tend to weather-vane (crab into the wind) and the downwind wing will drop slightly. During rollout, a crab into the wind must be maintained to counteract the force of the crosswind which tends to push the aircraft toward the downwind side of the runway. A downwind wing low attitude must be maintained to counteract further weathervaning. Excessive weathervaning tends to overcome the force of the crosswind and make the aircraft veer to the upwind side of the runway. Ailerons and the utility brake accumulator pressure are the only directional control available. The attitude of the aircraft is uncomfortable and can best be described as a sideways, wing down skid along the runway. Differential braking from the utility brake accumulator must be used for directional control after the ailerons lose effectiveness.

CAUTION

On aircraft → [202] before T.O. 1A-7D-596 or T.O. 1A-7D-685, following PC 2 failure, utility wheel brake accumulator pressure may be depleted within 45 minutes due to normal leakage of the brake valves. After this time interval, only the emergency brake will be available.

On aircraft → [202] after T.O. 1A-7D-596 or T.O. 1A-7D-685 and [203] →, following PC 2 failure, hydraulic pressure trapped in the utility brake accumulator system is available for backup braking only with the ANTI-SKID switch in the BRAKE ACCUM position. Antiskid protection is bypassed and will not be available. This system prevents bleed off leakage and bypass pressure loss, provided the ANTI-SKID switch remains in the OFF or ANTI-SKID position until just prior to landing.

With only the PC 1 system operating, CONT AUG or ATTD must be engaged, and the ROLL AFCS advisory light must be off, or the only lateral control available is roll trim. Roll AFCS is automatically disengaged and the advisory light illuminates when the aircraft reaches an angle of attack of approximately 22 units. If roll AFCS is disengaged, there will be no response to lateral stick deflections. Reset the roll AFCS as soon as possible by first actuating the AFCS disconnect switch, and then placing the AFCS engage switch in CONT AUG or by moving the AFCS engage switch to OFF and then back to CONT AUG. If roll AFCS will not reset and lateral control cannot be maintained with roll trim, use procedure for failure of all PC systems in Section III.

Check valves are installed in the rudder actuator to delay the complete loss of hydraulic fluid and to provide time to slow to safe speed and avoid rudder flutter. Actuation of the rudder pedals after failure of both PC 2 and PC 3 will increase fluid loss rate and thereby reduce the time available for speed reduction.

WARNING

If all hydraulic fluid is drained from the rudder actuator, destructive flutter of the rudder occurs at speeds above 200 KIAS. Destructive flutter causes catastrophic failure of the rudder and vertical stabilizer.

PC 1 and PC 3 System Failure.

With loss of both PC 1 and PC 3 systems, flight control is available through full normal stick and rudder control authority on the horizontal stabilizer rudder, and right aileron and spoiler. Right wing down trim is required to balance the effects of the floating unpowered left aileron and spoiler. The lateral trim required varies with angle of attack and Mach number. Lateral control effectiveness is significantly reduced and roll response to the left (into the unpowered aileron) is degraded more than response to the right.

When operating on PC 2 only, lateral stick deflections will produce pitching moments. The aircraft will pitch nose up when rolling right and nose down when rolling left. If lateral stick deflections are not abrupt, the pitching tendency is easily controllable. The severity of the pitching tendency increases with increased lateral stick deflection, rate of deflection, and increased airspeed. Yaw stabilization and rudder trim are inoperative. A slight steady side slip may exist which will require pedal force in order to maintain balanced flight. A shallow bank may be required to maintain heading.

Longitudinal stability and pitch control are essentially unchanged. However, during dive recoveries, pull ups, or high g turns, a left wing down rolling tendency may be encountered. At high IMN the rolling tendency may reverse to right wing down.

In the landing configuration, control is adequate but will feel sluggish and require increased lateral stick forces. Rudder should be used to reduce adverse yaw and to improve roll rate. An approach end barrier engagement, if available, should be made as soon as practicable. Fly a smooth straight in approach at the normal approach angle of attack. Stabilize at final approach speed as early as possible in the approach to minimize lateral trim changes. If a normal landing rollout is required, the flap handle should be placed in the DN position after touchdown to restore normal brakes and nose gear steering.

PC 1 and PC 2 System Failure.

Flight control is available through full normal stick and rudder control authority on the horizontal stabilizer, rudder, and left aileron and spoiler. Left wing down trim is required to balance the effects of the floating unpowered right aileron and spoiler. The lateral trim required varies with angle of attack and Mach number. Lateral control effectiveness is significantly reduced and roll response to the right (into the unpowered aileron) is degraded more than response to the left.

When operating on PC 3 only, lateral stick deflection will produce pitching moments. The aircraft will pitch nose up when rolling left and nose down when rolling right. If lateral stick deflections are not abrupt, the pitching tendency is easily controllable. The severity of the pitching tendency increases with increased lateral stick deflection, rate of deflection, and increased airspeed.

Longitudinal stability and pitch control are essentially unchanged. However, during dive recoveries, pullups, or high g turns, a right wing down rolling tendency may be encountered. At high IMN, the rolling tendency may reverse and become left wing down.

In the landing configuration, flight characteristics are similar to those encountered in dual PC 1 and PC 2 system failures. Approach techniques and procedures are the same except that nose wheel steering and normal brakes will not be available.

LEVEL FLIGHT.

CRUISE-SUBSONIC.

A light to moderate buffet may occur at speeds greater than approximately 0.87 IMN while in 1g flight. The same buffet may occur at slightly lower speeds under conditions of accelerated flight. Buffet intensity increases as g force is increased, but does not increase as speed is increased. The intensity decreases when engine rpm is decreased.

When carrying external stores, a slight general airframe buffet may be detectable above 0.80 IMN and 20,000 feet. At lower altitudes, the buffet may be detected at slightly lower speeds.

Longitudinal trim changes resulting from increases in IMN are as follows:

Up to 0.80 IMN	Noseup tendency
0.80 to 0.85 IMN	Stable (no change)
0.85 to 0.95 IMN	Nosedown tendency
0.95 IMN and up	Noseup tendency

RAM AIR TURBINE (RAT) EXTENDED.

Trim changes associated with RAT extension are small. If thee RAT is extended at airspeeds below 125 KIAS, satisfactory generator spinup may not occur. Once generator spinup has occurred, the only speed minimums to be observed are those related to electrical and hydraulic output. See Ram Air Turbine, Section I.

If the RAT cannot be retracted or must be left extended due to an emergency, the increased aerodynamic drag decreases specific range by approximately 5% while in the maximum cruise condition.

CRUISE-TRANSONIC.

The noseup tendency described under Cruise-Subsonic is more apparent at speeds above 0.95 IMN. Pitch tendencies in the transonic speed range do not present a problem because relatively high aircraft drag precludes rapid acceleration. Also, control power is more than adequate for positive attitude control.

Precise trimming is possible in the transonic speed range.

MAXIMUM SPEED.

Refer to Appendix I for the maximum speed capability of the aircraft for military thrust in level flight for all configurations of external loads as represented by drag values. Actual speeds achieved may exceed or fail to reach the values shown, depending on gross weight, atmospheric conditions and engine trim.

AFT CG CHARACTERISTICS.

When the aircraft is loaded so that an aft cg condition exists, the aircraft's pitch sensitivity is increased. Longitudinally trimmed flight conditions are difficult to establish and maintain. Small changes in trim result in relatively large changes in pitch attitude and the aircraft does not exhibit a strong tendency to return to stable trimmed flight after a disturbance. A large change in airspeed is accompanied by small changes in stick forces. During this flight condition (particularly with control augmentation off), some longitudinal oscillations may be encountered as a result of pilot-induced or gust-induced perturbations.

CAUTION

Flight with the stability augmentation system disengaged or inoperative when the center of gravity is near the aft limit should be performed with caution.

AIRCRAFT STABILITY.

The aircraft has sufficient natural stability to be flown safely throughout the flight envelope without stability augmentation. However, yaw stabilization and control augmentation modes of AFCS are normally engaged to provide improved damping and handling characteristics.

The effects of AFCS modes on aircraft stability are as described below:

Yaw Stabilization Engaged

With yaw stabilization engaged, damping is positive around the vertical axis at all speeds and altitudes. Yaw damping reveals a positive dihedral effect (roll due to yaw) which damps satisfactorily in 1 cycle. As speed increases, roll due to yaw decreases and damping occurs more rapidly. Wing-mounted stores degrade yaw damping only slightly.

Yaw Stabilization Disengaged

With yaw stabilization disengaged, stability characteristics are basically the same as with yaw stab engaged; however, additional cycles are required to damp yaw disturbances.

Control Augmentation Engaged

With control augmentation engaged, stability is improved over flight with only yaw stab engaged. Lateral-directional stability is improved by reduced roll due to yaw. Damping from longitudinal inputs occurs more positively.

MANEUVERING FLIGHT.

MANEUVERING STICK FORCE GRADIENTS.

The cg position has a marked effect upon stick force gradients. Stick forces per g vary depending upon g applied and cg position and are more linear with control augmentation on. When the cg is close to the aft limit, the stick force gradient during maneuvering flight at low g levels is light (approximately 2 to 3 pounds per g). As the g level increases above approximately 4g the stick force gradient increases to moderate (approximately 4 to 6 pounds per g). These aft cg stick force gradients are markedly different from those stick force gradient characteristics of maneuvering flight at intermediate or forward cg positions which increases to normal (approximately 6 to 8 pounds per g at low g levels decreasing to approximately 3 pounds per g at high levels). When the cg is near the aft limit, maneuvering flight will be characterized by some difficulty in achieving and maintaining a definite g level below 4g, particularly with control augmentation off. Mild aircraft "dig-ins" or g-overshoots may be experienced during the roll into a turn. Regardless of cg position, the maximum total stick force at high g levels (near 7g) is heavy (approximately 30 pounds).

Horizontal stabilizer effectiveness at high speed and low altitude is sufficient to permit the pilot to inadvertently exceed the aircraft structural limits in abrupt maneuvers especially at an aft cg position. This is due to the relatively light longitudinal stick forces and the heavy gross weights associated with an aft cg condition. As the aircraft cg approaches the aft limit, greater pilot concentration is required to prevent overstressing the aircraft.

Note

The aircraft can be maneuvered easily at 17 to 18 units angle of attack by using light buffet as an indicator, provided gear, flaps, and speed brake are retracted. When maneuvering above 18 units angle of attack, monitor the angle-of-attack indicator to avoid inadvertent departure from controlled flight.

ANGLE OF ATTACK.

Angle of attack (AOA) is of major importance, especially during maneuvering and slow speed flight. AOA is defined as the angle formed by the fuselage centerline and the aircraft flightpath (relative wind). When rates of change in angle of attack and sideslip angles are small, the indicated AOA is accurate. A lag error in AOA indication is induced when AOA is increasing rapidly or as a result of high rate rolls at slow airspeed or when sideslipping the aircraft. This lag error can be as much as three units (indicated AOA lower than actual AOA) for a slow speed high rate roll input to the right or sideslip to the right. The reverse is true for slow speed high rate roll inputs and sideslips to the left (indicated AOA higher than actual AOA). All references to angle of attack are for indicated AOA and do not take this lag error factor into consideration.

ADVERSE YAW.

At high angles of attack, attempts to roll the aircraft with aileron will result in adverse yaw (yaw opposite the direction of intended turn or roll). This yaw is produced by the induced drag of the downward deflected aileron which inhibits the roll. Adverse yaw is more severe at high angles of attack (20 to 25 units), and aileron inputs provide very low roll rates. At very high angles of attack (above 25 units) near stall, aileron inputs cause increased adverse yaw and a roll opposite to that intended. The natural tendency to raise the wing with aileron must be avoided. Aileron deflection at that point can cause departure from controlled flight. The effect of adverse yaw on specific maneuvers is included as appropriate in the following paragraph.

Dihedral Effect.

Dihedral effect is the roll caused by sideslip. At cruise, angle of attack attempts to yaw the aircraft with rudder will produce roll in the same direction as the rudder input as well as a slight increase in AOA. While the rudder should be used to coordinate maneuvering at high angle of attack, it must be used judiciously, since accompanying increases in AOA may lead to loss of control. Rudder roll performance decreases above 20 units AOA.

ROLLS.

Rolls are accompanied by an adverse yaw tendency at low speeds. As speed is increased, the yaw tendency decreases. Roll performed at high subsonic and transonic speeds are accompanied by no yaw or favorable yaw. With yaw stab disengaged, the aileron-rudder interconnect is inoperative and adverse yaw tendency is slightly greater. Full aileron rolls are characterized by a pitch-down tendency below 0.80 IMN.

Above 0.80 IMN the aircraft has a slight pitchup tendency. As the cg position nears the aft limit, the susceptibility to inadvertent longitudinal stick inputs during rolling maneuvers increases due to light longitudinal stick forces, shallow stick force gradient, and increased aircraft pitch sensitivity. Pitch tendencies are slightly greater with control augmentation off. Due to their flexibility, multiple bomb racks may shake in a beat frequency during aileron reversals and rudder inputs. Some lateral directional oscillations may occur during rapid aileron reversals.

ROLLING PULLOUT.

The characteristics of rolling pullouts (rolling while pulling g, as in breaking off a gunnery pass) fall roughly into two categories, low indicated airspeed and high indicated airspeed.

Note

Due to the location of the accelerometer above the aircraft roll axis, the instrument indicates less than the true load factor at the cg during rolls. The true load factor may be as much as 1.0g higher than that indicated during full aileron rolls in the high indicated airspeed region.

Low Indicated Airspeed Rolling Pullout.

Rolling pullouts at low g are fairly smooth and the rate of roll is quite high when full aileron is used. Some adverse yaw accompanied by a decrease in roll rate may be noticed. The roll rate will be high initially and then decrease as adverse yaw builds up.

High Indicated Airspeed Rolling Pullout.

Rolling pullouts at high indicated airspeeds are affected by the same factors that prevail at low speeds. However, the buffet boundary in this region is so high that the structural limits of the aircraft can be exceeded before buffet or adverse yaw becomes a major factor. For this reason, rolling pullouts will be smooth and generally free of buffet. Above 0.80 IMN application of lateral stick results in an increase in positive g without aft stick application due to noseup pitching moment induced by aileron and spoiler deflection. The load factor can increase as much as 2.0 g during full aileron rolls.

WARNING

To prevent exceeding rolling pullout limitations at high indicated airspeeds with load factors in excess of 3.0g, observe the following:

1. Avoid rapid lateral stick movement which may lead to inadvertent aft stick movement.

2. Do not exceed moderate rate rolls.

   Erroneous accelerometer indications and aircraft pitching tendency while rolling, increase as roll rate is increased.

SYMMETRICAL PULLOUT.

Symmetrical pullouts may be performed during dive recoveries, steady state turns, and air combat maneuvers. Stick force gradient is normal (6 to 8 pounds per g).

Be particularly alert during maneuvering and avoid abrupt control application. Caution must be exercised to avoid overcontrolling. At low altitude and high speed, horizontal stabilizer effectiveness is sufficient to exceed the aircraft structural limits.

At high airspeeds, the aircraft should be flown as nearly in trim as possible because the control system is least sensitive when operated near trim. The amount of horizontal stabilizer movement provided by a given amount of stick movement is variable due to the action of the variable gain linkage. The gain is at a minimum near trim and increases with increasing stick displacement.

Special care should be exercised during high Mach number low altitude pullouts to avoid exceeding limit load factor. As the aircraft accelerates from approximately 0.88 to 0.92 IMN, noseup trim (or aft stick) must be applied to counteract the normal, transonic, nosedown pitching tendency. If trim is used and the aircraft subsequently decelerates through the 0.88 to 0.92 range, it will be out of trim in the noseup direction and a 2 to 2 1/2g pullout will occur without pilot effort. Similarly, if a 4g pullout is begun above 0.92 IMN and stick position maintained as the aircraft decelerates through the 0.88 to 0.92 range, a pitchup of 6 or more g will occur. This characteristic is caused by changes in the pressure distribution on the wing and reduced horizontal stabilizer effectiveness at the higher Mach numbers. As may be expected, wing heaviness is noticeable during pullouts with asymmetrical store loadings. It is recommended that the pilot become familiar with the stick force gradient at all altitudes before using the aircraft to its maximum capabilities.

Figure 6–1 illustrates the normal maneuver capability of the aircraft from sea level to 20,000 feet through out the entire speed envelope.

AEROBATICS.

Aerobatics are typical of most contemporary jet aircraft. No special knowledge or techniques are required. For over-the-top maneuvers, g level is maintained as desired until light buffet occurs, then angle of attack is maintained as speed decays. Pulling into heavier buffet should be avoided throughout the maneuver. Rolls may be performed at most speeds without the use of rudder; however, rudder and aileron coordination provide the best results.

DIVE.

In a dive, the aircraft gains speed rapidly until the drag rise is reached. Stability and control characteristics are generally good during the dive. Below 10,000 feet, aileron effectiveness deteriorates as speed increases above 0.90 IMN. Roll rate for maximum lateral control inputs decreases to 50° per second at low altitude and transonic speeds.

If the yaw stabilization system malfunctions, the result is a rapid return of the rudder to neutral and loss of rudder trim. If this malfunction occurs at high airspeeds, or when a large amount of rudder trim is required, an abrupt yaw occurs. Decreased damping about the yaw axis is noticeable and rudder pedal force is required to maintain trim.

DIVE RECOVERY.

Dive recovery charts with speed brake extended and speed brake retracted are presented in figures 6–2 and 6–3.

Altitude loss during dive recovery is based on military thrust. If less than military thrust is used, altitude loss is proportionally less than that illustrated.

WARNING

AAU-19/A altimeter indications are unreliable during high g maneuvers and must not be used during dive recoveries to estimate terrain clearance.

LANDING CONFIGURATION.

Aircraft handling qualities permit good positive aircraft control in the landing configuration. Mild airframe buffet is present at all speeds with full flaps down, but disappears when the trailing edge flaps are retracted to 30°. Landing gear retraction is accompanied by very little, if any, attitude change. Full flap retraction is accompanied by a slight settling tendency.

On final approach, speed control and engine response are such that precise aircraft control is easily maintained to touchdown.

HIGH ANGLE OF ATTACK.

The recognition of a stall is a subjective pilot decision. The stall may occur at slightly different angles of attack above 20.5 units AOA depending on pilot experience. The departure is a maneuver which usually occurs because the pilot is not devoting his full attention to the near-stall condition of his aircraft. It can be triggered by failure to control yaw with rudder or by large lateral stick deflections at high angle of attack. As defined in this section, a departure (a maneuver) can occur without pilot recognition of a stalled condition. In fact, pilot awareness that he is about to lose control and his decision to reduce angle of attack will normally preclude departure (unless it is triggered in the short interval between decision and action).

There are several physical factors which make the aircraft susceptible to departure from controlled flight when operated in a high angle of attack environment. Because of these factors, flight at excessively high angles of attack should be avoided. The four basic factors which govern the behavior of the aircraft at high angles of attack are degraded directional stability, adverse yaw, mass distribution, and, to some extent, aircraft gross weight. These factors determine, in general terms, the basic stall, out-of-control, and recovery characteristics of the aircraft. Other variables may be present which influence the behavior of the aircraft under specific circumstances. These include deceleration rate, g-loading, configuration, power setting, symmetry of external store loading, and others. If the aircraft must be flown at angles of attack greater than 21 units, control inputs must be made with caution to avoid loss of control.

Of the four basic factors affecting the aircraft, by far the most important is the deterioration of directional stability during the approach to a stall. Positive directional stability is the tendency of the aircraft to return to the initial directional trim conditions when disturbed. Positive directional damping is the tendency of succeeding overshoots from the trim condition to decrease with time. With yaw stab operating, the aircraft exhibits excellent positive directional stability and damping at cruise and approach angle of attack. As angle of attack increases above 20 to 21 units, directional stability and damping decrease rapidly. While degraded directional stability at high angles of attack is typical of many swept-wing aircraft, in this aircraft directional stability may become neutral or negative just before stall angle of attack. This accounts for directional nose wander at high angles of attack or, in many cases, an abrupt yaw which the pilot cannot control.

Accompanying these weak or negative directional stability characteristics at high angle of attack is another characteristic, dihedral effect (roll due to sideslip). Near stall angle of attack, dihedral effect becomes very weak. Rudder control effectiveness also decreases as angle of attack is increased. This means that the aircraft is not prone to roll in response to yaw angle nor is the rudder as effective in countering any yaw excursions or in generating roll response. Thus, departure from controlled flight is typified by first an excursion in yaw or nose slice, followed by roll in the direction of yaw. Flight tests show that in unaccelerated conditions the first noticeable directional instability occurs at approximately 23 units angle of attack and that directional divergence can be expected above approximately 24 units angle of attack.

Above approximately 23 units angle of attack, the aircraft becomes very sensitive to any directional disturbance, whether supplied by the pilot, the AFCS, or air turbulence. The outboard location and large amounts of control authority of the ailerons make them a primary source of directional disturbances due to induced adverse yaw (yaw opposite to commanded roll) at high angles of attack. The reason for this is that the downward deflected aileron produces induced drag (drag due to lift). Therefore, a left control stick deflection while the aircraft is at high angle of attack results in a yaw to the right. Large sideslip angles at high angles of attack can cause departure from controlled flight. These large sideslip angles can result from rudder inputs or from being grossly out of trim. The rudder is not as critical in this regard as the aileron, because of the restricted rudder authority (6°) and because of overriding influence of the ailerons. On aircraft → [16] [18] → [26] after T.O. 1A-7D-524 and [17] [27] →, in a landing gear down condition 24° of rudder authority is available. Under this condition, with the wing flaps up, rudder inputs may be as critical as aileron inputs in inducing departures from controlled flight. Since the most critical factor in maintaining the control of the aircraft is maintaining balanced directional flight, the pilot must concentrate on keeping the ball in the center. The rudder is limited in control authority and degree of deflection (in cruise configuration) which restricts pilot control capability as angle of attack is increased still further.

This aircraft, like most modern high performance aircraft, has more inertia in pitch than in roll. This is true for any external store loading. While this does not significantly affect stall characteristics, it does have a profound effect on spin and spin recovery characteristics.

Flight tests of high angle-of-attack maneuvers have shown the aircraft to be highly spin resistant in all symmetrical loadings tested. Of the spins experienced, most recovered unaided when controls were released. On rare instances, positive antispin controls had to be applied to effect recovery. The relatively greater inertia in pitch dictates use of aileron for prime spin recovery control. Applying lateral stick in direction of rotation produces an antispin yawing moment and will effect recovery from the spin.

The effect of increased gross weight alone, aside from increasing stall speeds, is found to be negligible in influencing the stall, departure, and spin characteristics. The chief effect of increased gross weight is to increase substantially the altitude required for pullout following recovery from a high angle of attack maneuver. Recovery from a severe departure at high gross weight may take 8,000 to 10,000 feet.

NORMAL OR 1G STALLS.

CRUISE CONFIGURATION.

Stall characteristics of the aircraft in a cruise configuration vary from relatively mild to violent. Constant attention to lateral and directional control is required during the stall approach once 23 units angle of attack is exceeded. The cruise configuration stall normally is defined by a mild yaw excursion. The rudder should be used to make both small roll and yaw corrections once the angle of attack exceeds approximately 22 units and may be used as a recovery control during the early portion of a departure.

Aerodynamic stall warning is first evidenced by light onset buffet which begins at approximately 16 to 17 units angle of attack with power on (above 80% rpm). Buffet intensity increases steadily throughout the approach to the stall. At 20.5 units angle of attack, the rudder shaker activates for additional stall warning, though its effects are largely masked by natural airframe buffet. Above 23 to 24 units angle of attack, a heavy low frequency secondary buffet occurs which is super-imposed upon the primary buffet. This unmistakable pounding buffet serves as final warning to the pilot that an excessive angle-of-attack condition exists. This pounding buffet is present regardless of power setting, store loading, or approach rate. The value of the pounding buffet as a stall warning cue is lost during accelerated stalls with a very high deceleration rate because it may occur simultaneously with departure.

Above 23 units angle of attack, small sideslip motions resulting from lateral or directional control inputs may lead to departure from controlled flight in the form of an abrupt yaw. Lateral control inputs result in yaw in the direction away from the control input. Rudder inputs result in yaw in the same direction as the control input. When inputs of the same general magnitude from both controls exist at the stall, the lateral control will determine the direction of the yaw. Departure will usually be followed immediately by poststall gyrations. Recovery during departures resulting from 1g stalls is usually within one turn in yaw if the control stick is immediately released. Simultaneously applying full opposite rudder may assist in terminating yaw rate, provided this action is taken before excessive yaw (approximately 10° to 15°) is reached. If the application of opposite rudder is unsuccessful in terminating the departure, a state of out-of-control should be accepted by the pilot and rudder pedal forces relaxed. Inadvertent pro-spin lateral stick inputs can result if the control stick is not released even if the pilot concentrates on keeping the stick centered. The positive centering action of the control stick linkage will center the stick within approximately 1 second and will keep it centered regardless of the severity of forces in the cockpit.

Stall characteristics with and without external stores are similar except that early stall warning may be partially altered by stores buffet. With heavy wing stores aboard, tests have shown that initial yaw rates during departure are somewhat slower in coming on, and that these rates are slower to dissipate during hands-off recovery. The presence of mild lateral oscillations or wing rock was frequently noted during stall tests with heavy external stores loadings both in the clean and landing configurations; however, this characteristic was not sufficiently reliable to serve as additional stall warning. Center of gravity position, inertia distribution, or store loading do not appear to affect in any way the propensity of the aircraft to depart from controlled flight during normal or accelerated stalls and have only a small effect on stall and departure characteristics. Roll AFCS should disengage automatically at 22 units AOA. However, if it does not, roll augmentation will supply sufficient aileron deflection to initiate and to occasionally sustain spins because during a departure with hands off the controls, the pilot is commanding zero roll rate while the aircraft is, in fact, rolling in the direction of the yaw. To counter this situation, roll augmentation applies up to 9° of aileron opposite to the roll, which constitutes a pro-spin aileron input.

WARNING

Disengage all AFCS functions except yaw stabilization by actuation of the AFCS disconnect switch when approaching stalls even though roll augmentation will automatically disengage when angle of attack reaches approximately 22 units. With roll augmentation on, the AFCS can introduce pro-spin aileron deflection in response to roll. Avoid the use of ailerons above 22 units angle of attack.

Note

Extension of the speed brake decreases aerodynamic buffet at high angles of attack. Monitor angle of attack indicator to avoid departure from controlled flight.

VERTICAL RECOVERY.

Recovery from an extremely steep attitude at or near a stall condition is accomplished by neutralizing the controls and allowing the aircraft to fall through. After airspeed is regained, roll and pitch attitudes can be controlled and power added to increase airspeed. Engine operation should be closely monitored during vertical recovery since this maneuver can severely distort inlet airflow and induce compressor stalls and possible overtemperature. If compressor stalls occur, the throttle should be retarded to maintain TOT within limits.

CAUTION

In no case should recovery be attempted by pulling through the vertical at high angle of attack or by applying rudder to slip the aircraft into a nose low attitude. These actions place the aircraft in a high angle of attack situation with yaw rate and may result in loss of control.

LANDING CONFIGURATION.

With landing gear down and flaps up, aerodynamic stall warning and stall characteristics will be similar to those of the cruise configuration. With 24° of rudder authority available, the aircraft can be more easily departed with rudder alone. With flaps extended, heavy airframe buffet which is characteristic of the cruise condition stall warning does not occur. Additionally, the light prestall buffet will be partially masked by a general airframe buffet. Because of the lack of aerodynamic stall warning the aircraft is provided with an artificial stall warning device. Primary stall warning in the landing condition consists of a right rudder pedal shaker which activates at 20.5 units indicated AOA and continues to vibrate until the AOA is reduced below 20.5 units indicated.

In the flaps extended landing configuration, yaw or roll excursions occur at approximately 23 units angle of attack followed by stall at approximately 25 units. Stall is characterized by a nose drop and a roll in either direction. Recovery is immediate when power is applied and aft stick pressure is released. There is no pronounced tendency toward nose slice during flight with gear and flaps extended providing control inputs are kept to a reasonable magnitude.

See figure 6–4 for stall speed charts.

ACCELERATED STALLS.

Accelerated stalls can occur whenever excessive aft stick is used for maneuvering, such as in dive pullouts or in turning flight. The accelerated stall usually occurs at 23 to 27 units aircraft angle of attack. However, departure may be possible at 20 units angle of attack during abrupt uncoordinated maneuvers because of AOA indicator lag errors induced by excessive sideslip or rapidly increasing angle of attack. The approach to stall is characterized by heavy buffet and very frequently a high yaw rate at the stall. Longitudinal control force stability both with control augmentation on and off, remains positive with a relatively linear gradient throughout the approach to stall and during the stall itself. The aircraft does not exhibit a tendency to pitch itself into a higher angle of attack during approach to the stall. Buffet warning during an accelerated stall is similar to that associated with a normal stall, except that the entire band of buffet warning is compressed. For very rapid entries into accelerated stalls, buffet onset may not be apparent to the pilot at all. Under these circumstances, buffet warning consists of a brief band of moderate buffet followed quickly by very heavy buffet.

Note

> The rudder pedal shaker is not an effective warning device during accelerated stalls because its effect is masked by the moderate to heavy aerodynamic buffet.

If the stall is approached rapidly, warning of an impending departure from controlled flight will be less apparent and behavior at departure will be more violent.

WARNING

> When AOA is changing rapidly, the cockpit angle of attack indicator may significantly lag the actual aircraft angle of attack. Also, under all flight conditions, indicator accuracy will be degraded by aircraft sideslip. The indicated angle of attack of the aircraft will be lower than actual with a right sideslip and higher than actual with a left sideslip.

The aircraft, when symmetrically loaded, may depart in either direction regardless of entry attitude, the direction determined by the last yaw-inducing input. If departure occurs, the pilot should disengage the AFCS control augmentation and physically remove his hand from the control stick. He may attempt to counter the initial yaw excursion with rudder. Because of the rapid yaw acceleration associated with accelerated stalls, recovery using rudder inputs is not likely. If the nose does not respond to the rudder inputs, an excessive yaw has developed. Rudder forces should be relaxed and the pilot should accept a state of out-of-control.

Note

> Extension of speed brake decreases aerodynamic buffet at high angles of attack. Monitor angle of attack indicator to avoid departure from controlled flight.

STALL AVOIDANCE PROCEDURE.

At the first indication of impending stall, the following actions should be taken:

1. Immediately decrease angle of attack by forward stick, neutralize ailerons, and apply rudder as necessary to counteract yaw excursions.
2. Do not use aileron, even if inverted, until the aircraft is clearly unstalled and airspeed is increasing.
3. Add power to increase airspeed.

DEPARTURE FROM CONTROLLED FLIGHT.

Departure from controlled flight is characterized primarily by a rapid initial yaw. Characteristics are similar for 1g and accelerated entries, although yaw rates are substantially higher in an accelerated entry. Yaw rates exceeding 125° per second may be encountered and are normally accompanied by high roll rates. In severe cases involving departures entered at 4 to 5g's, peak yaw rate may be attained in 1 second and lateral accelerations as high as 4.5g may be experienced across the cockpit. Such accelerated maneuvers are extremely disorienting and may cause the pilot concern over the structural integrity of the aircraft. It is noteworthy, however, that spin tests involving several such departures were free of significant structural failures. Further, high energy entries are, if anything, less prone to result in spins because the large roll and pitch oscillations tended to unstall the aircraft earlier. Departures entered with the center of gravity near the aft limit are more disorienting because of larger pitch oscillations experienced. The high lateral accelerations associated with most departures can cause inadvertent pro-spin aileron inputs if the pilot continues to hold the stick even if conscious efforts are made to keep the stick centered. Departure characteristics without stores and with symmetrical store loadings are similar; however, departures with asymmetrical store loadings are more abrupt.

WARNING

> Recovery attitude from most departures, regardless of entry conditions, is 90° to 110° nosedown at low airspeed. Because of the extreme altitude loss associated with pullout from this condition, particularly at high aircraft gross weight, particular attention should be given to avoiding departures below 15,000 feet AGL.

Once a departure has occured, whether entered from a 1g or an accelerated maneuver, proper corrective action is to manually disengage all AFCS functions except yaw stabilization by actuation of the AFCS disconnect switch, relax any rudder forces used in an attempt to correct initial yaw, and release the control stick. The pilot should then wait with hands off the stick to see if the aircraft recovers from the departure or enters a spin.

WARNING

Attempts to fly out of departures using rudder, aileron, or forward stick inputs can cause redepartures or spin entries. Turns to recovery and altitude loss are minimized by allowing the aircraft to recover itself.

At times, rolling motion may be present which should not be confused with a spin. If airspeed is increasing through 200 KIAS, the aircraft is definitely not entering a spin. Reference to the angle-of-attack indicator will assist in determining if the aircraft will recover. If the angle of attack is oscillating to below 23 units angle of attack, recovery is imminent. Angle of attack oscillating below 30 units but above 23 units angle of attack (airspeed increasing) indicates that the aircraft has not entered a fully developed spin mode (one requiring positive antispin controls for recovery) and will probably recover hands off.

If recovery from departure is not apparent after waiting two turns with hands off the stick and angle of attack becomes pegged at 30 units AOA, the aircraft is spinning. Then the pilot should attempt to positively ascertain the yaw direction by reference to the horizon or to the turn needle (turn needle will point to direction of rotation.)

Note

Fully developed spins will always have the angle of attack pegged and steady at 30 units. If yaw rate continues beyond the two-turn point, a spin must be assumed.

Refer to Spins, this section, for spin characteristics and spin recovery procedures.

DEPARTURE RECOVERY PROCEDURES.

Upon recognizing that departure has occurred, the following actions should be taken:

1. Immediately disengage all AFCS functions except yaw stabilization by actuation of the AFCS disconnect switch, relax rudder forces, and relase the stick (to avoid inadvertent pro-spin lateral control inputs) until either recovery occurs or a spin is clearly indicated
2. Do not use aileron, even if inverted, until the aircraft is clearly unstalled and airspeed is increasing
3. Following departure recovery, add power as necessary to increase airspeed. The angle of attack indicator should be closely monitored during pullout. Pull out using 20 units angle of attack. Do not exceed 22 units angle of attack

CAUTION

Do not exceed 22 units AOA or loss of control may occur.

SPINS.

CHARACTERISTICS.

Fully developed spins will always have the angle of attack pegged and steady at 30 units. If yaw rate continues beyond the two-turn point, a spin must be assumed and positive antispin controls applied.

Note

Intentional spins are prohibited.

Erect Spins.

Two factors, a high angle of attack and a high yaw rate, must be present before a spin will occur. The high angle of attack is obviously produced with excessive aft stick and once this condition is present, lateral stick causes the aircraft to yaw in the opposite direction. This is due to adverse yaw characteristics at this high angle of attack. To avoid spins, avoid excessive angle of attack (beyond 22 units) and if at a high angle of attack, avoid lateral stick inputs.

The erect spin characteristics of the aircraft are a function of the external loading. With a maximum spanwise ordnance load, rotational rates fall between 70° and 90° per second and the spin is somewhat oscillatory in pitch and roll. With no external stores, two spin modes may be experienced. The first is quite oscillatory in the pitch and roll axis with yaw rates between 80° and 100° per second. The second mode tends to be flatter with little or no pitch or roll oscillation and rates of rotation of up to 120° per second. Altitude loss in the spin is a function of spin rate and varies from 900 to 1,400 feet per turn, stores on or off.

Engine Characteristics In The Spin.

Engine operation is stall free (only mild fluctuations in TOT, fuel flow, and TOP) during a departure and spin with the throttle remaining in the original pre-stall/spin position. If the throttle is inadvertently retarded to idle, compressor stalls may result during the departure. Should TOT start to rise with the throttle in the entry position, slowly retard throttle and monitor TOT. A precautionary throttle reduction at departure would, therefore, be the most conservative procedure. Such a reduction has not been made part of the procedure at departure because:

1. Flight tests indicate that compressor stall is unlikely.
2. Throttle reduction would add to pilot workload in a high stress situation.
3. The noises (occasional compressor stalls) which may accompany engine deceleration in a departure/spin could be an added source of concern to the pilot.

If stalls are heard, the throttle should be retarded to maintain TOT within limits.

Erect Spin Recovery.

If high yaw rate remains following a departure; spin direction should be established by observing terrain over the nose or by referring to the turn needle (turn needle points to the direction of spin). Rudder should then be applied in the direction opposite to nose motion with full lateral stick applied in the direction of the spin. Longitudinal stick should be maintained in the neutral position. Depending on the rate of rotation, yaw rate should decrease to zero in one-half to two turns following application of recovery controls. When yaw rate reaches zero, return aileron and rudder controls to neutral with 1 to 2 inches of forward stick. Recovery occurs in a steep dive and some rolling motion may develop, usually opposite the direction of spin. When angle of attack has decreased below 22 units, begin pullout to complete the recovery. Spin recoveries with symmetrically loaded stores are the same as those for the basic pylon configured aircraft. Refer to Section III for spin recovery procedures.

WARNING

If a confirmed spin occurs below 10,000 feet AGL, EJECT. Recovery from a fully developed spin below 10,000 feet is considered doubtful since 6,000 to 8,000 feet are required to obtain level flight after rotation is stopped.

CAUTION

Spin recovery may not be easily recognized if the pilot is looking outside the cockpit because a pure roll (resulting from continued anti-spin controls) in conjunction with a steep dive recovery attitude may be incorrectly interpreted as a continued spin. Misinterpretation will be avoided if angle of attack and airspeed indicators are monitored. If recovering, aircraft will be below stall angle of attack and airspeed will be increasing. To complete recovery, neutralize anti-spin controls and fly out of the dive.

The aircraft will spin and can be recovered with speed brake extended. Although little or no difference in either the spin or recovery exists with the brake extended, it should be retracted as an aid to regaining speed following recovery. Similarly, power should be added to increase airspeed during recovery.

WARNING

The ailerons are the primary control for both entry and recovery. The ailerons are very effective and extreme care should be used to ensure that the ailerons are applied in the proper direction for recovery (stick in the direction of the turn needle).

Asymmetrical Loading Spin and Recovery.

Departure and spin characteristics as well as proper pilot corrective action with asymmetrical store loadings are similar to those with symmetrical store loadings.

CAUTION

Spin recovery characteristics with asymmetrical store loadings up to 13,000 pound-feet asymmetry have been flight tested and found to be satisfactory; however, there may be a greater asymmetrical loading with which the aircraft will not recover from a spin. Should normal recovery procedures not prove effective, an alternative is to attempt jettison of external store(s); however, there is a possibility that the jettisoned store(s) may strike the aircraft.

Departures in either direction may occur; however, departures into the heavy wing predominate. Departure is more abrupt with asymmetrical store loadings. Corrective action, should departure occur, is to disengage the AFCS and release the stick. The aircraft is more prone to spin following departures with asymmetrical store loadings. Spins with the larger load toward the outside normally occur even though the departure is usually in the opposite direction. Spin recovery controls are the same as for symmetrical store loadings, however more turns are required for recovery. Recovery controls should be initiated as soon as spin direction can be determined. More turns are required for recovery if recovery control application is delayed; for example, with a 13,000 pound-foot asymmetry recovery turns varied from one turn for immediate recovery control applications to three turns when recovery controls were applied after several turns. During the longer recoveries, impending recovery may not be apparent for several turns after recovery controls are applied.

Inverted Spins and Inverted Spin Recovery.

Inverted spins are unlikely and are not sustainable. If an inverted spin occurs it will be of short duration and may be recognized by negative g, negative angle of attack, and rotation. Refer to Section III for inverted spin recovery procedures.

WARNING

If recovery of controlled flight has not been attained by 10,000 feet AGL, EJECT. Recovery from the extremely low nose attitudes may require 6,000 to 8,000 feet once control is regained.

MANEUVERABILITY

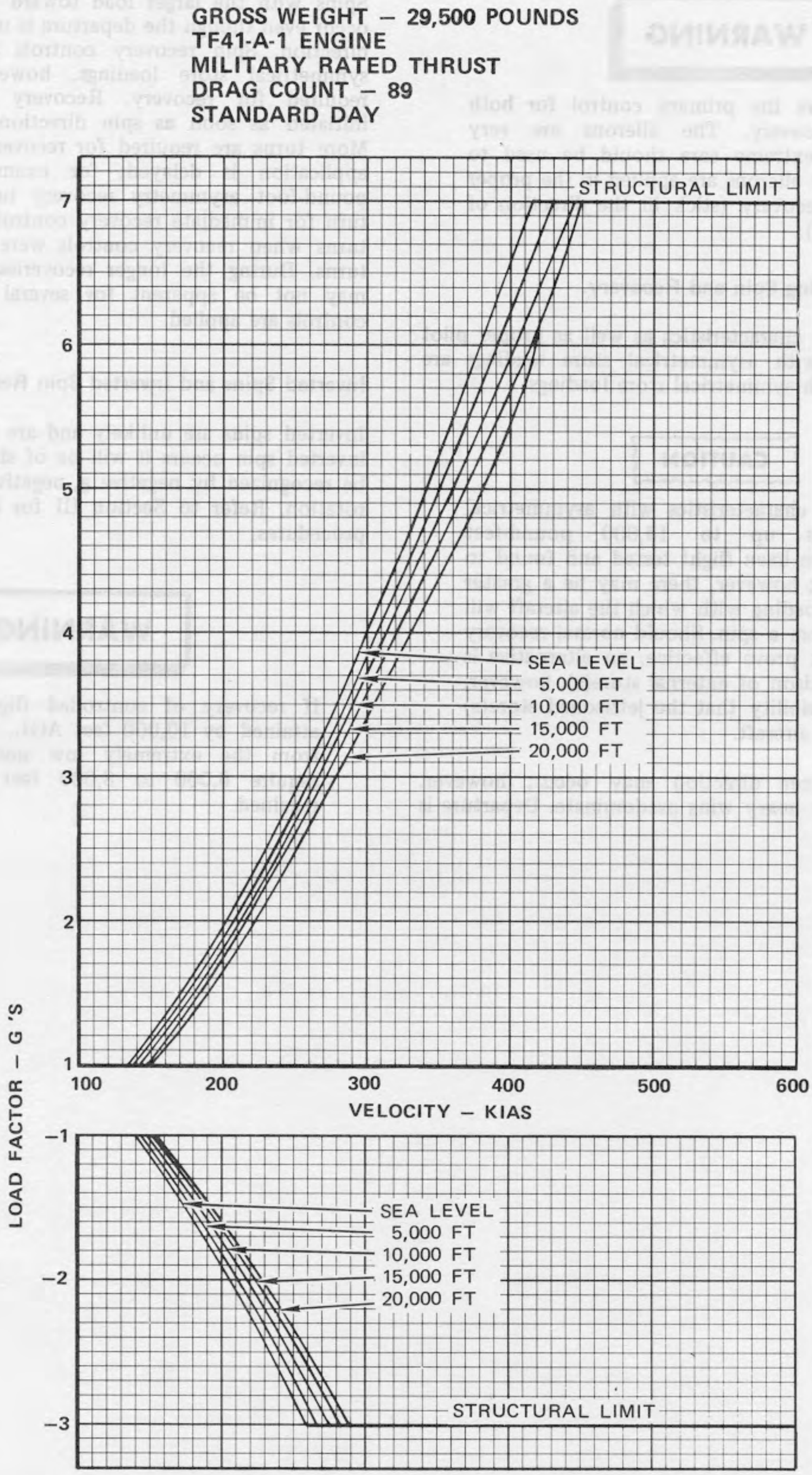

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Figure 6–1

DIVE RECOVERY CHART

SPEED BRAKE CLOSED

GROSS WEIGHT 29,570
TF41-A-1 ENGINE
DRAG COUNT 109
MILITARY RATED THRUST
STANDARD DAY

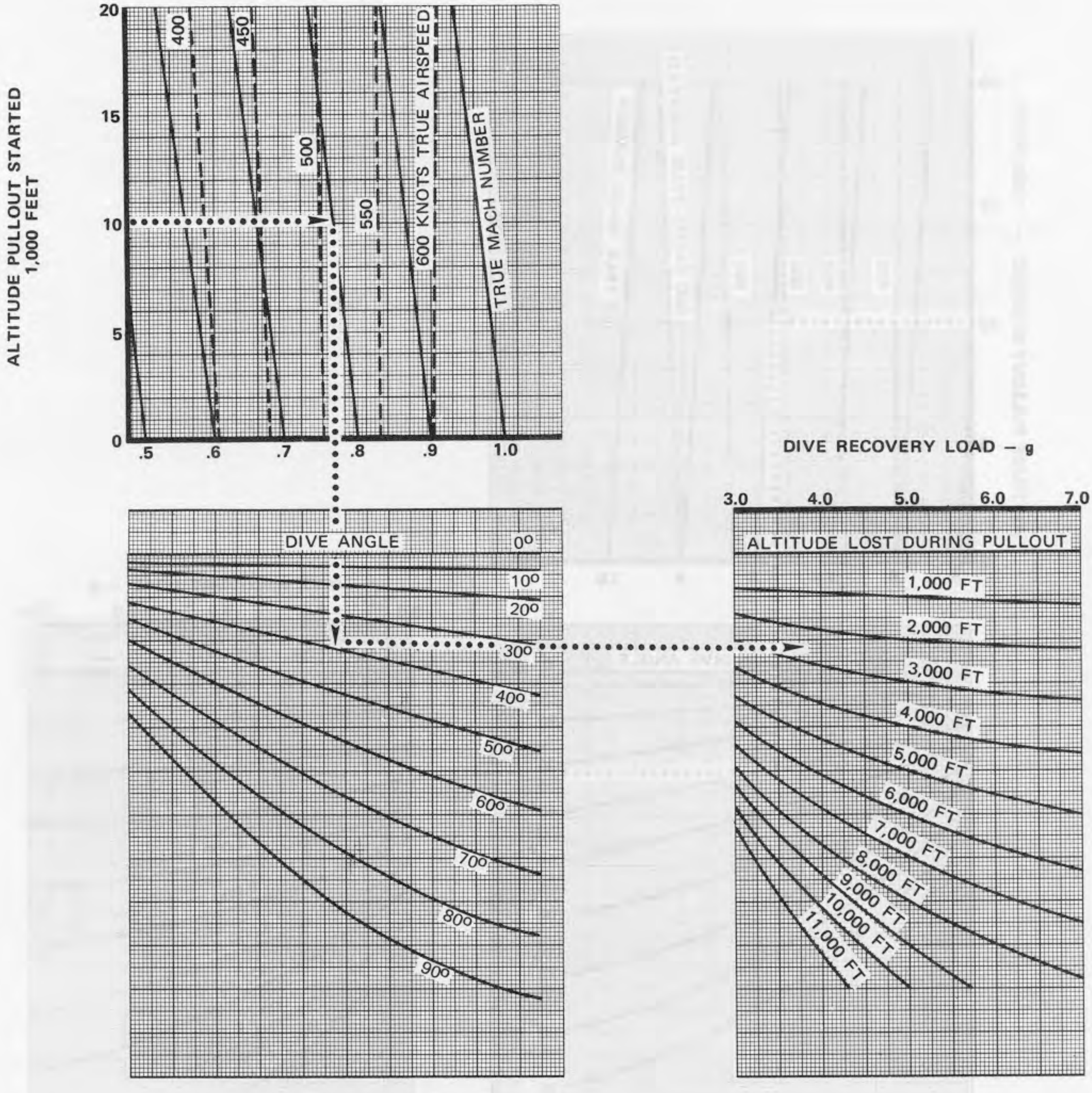


Figure 6–2

DIVE RECOVERY CHART

SPEED BRAKE EXTENDED 60°

GROSS WEIGHT 29,570
TF41-A-1 ENGINE
DRAG COUNT 109
MILITARY RATED THRUST
STANDARD DAY

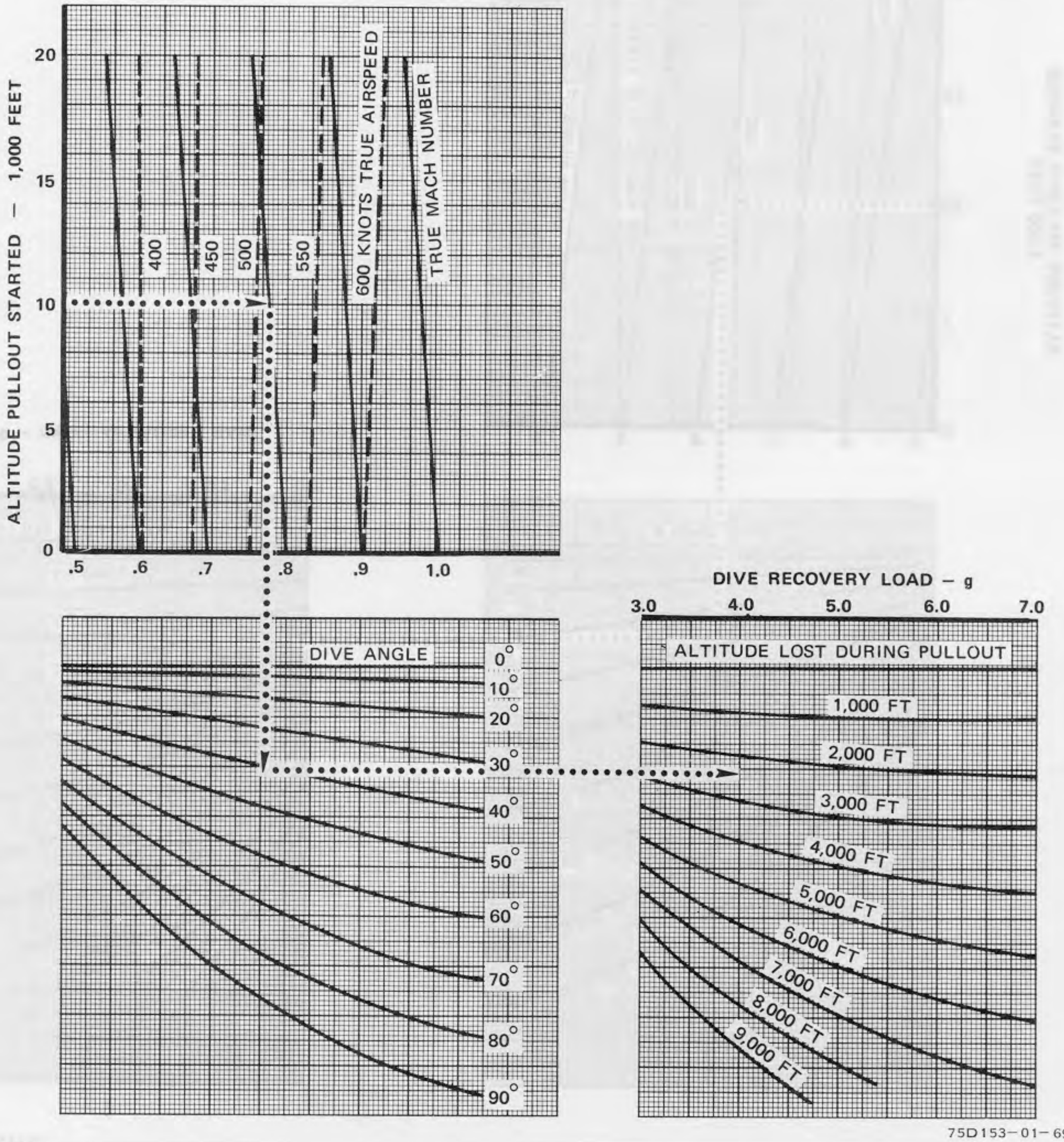


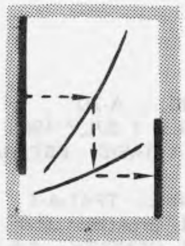
Figure 6–3

STALL SPEED CHART

MODEL: A-7D
DATE: 1 JULY 1968
DATA BASIS: **ESTIMATED**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

ALL CONFIGURATIONS
FLAPS AND GEAR DOWN
POWER-OFF (IDLE THRUST)



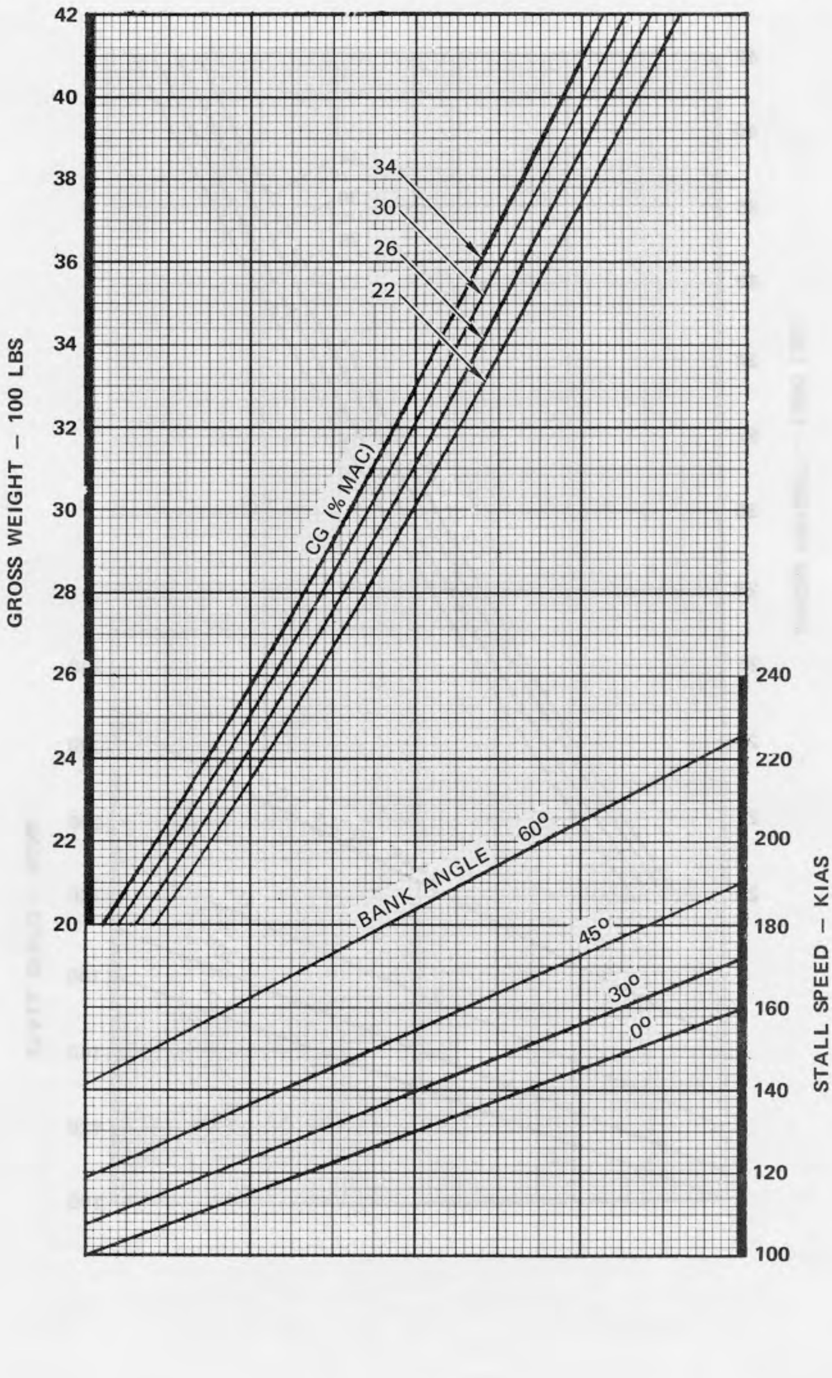
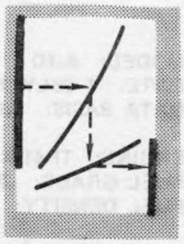


Figure 6–4 (Sheet 1)

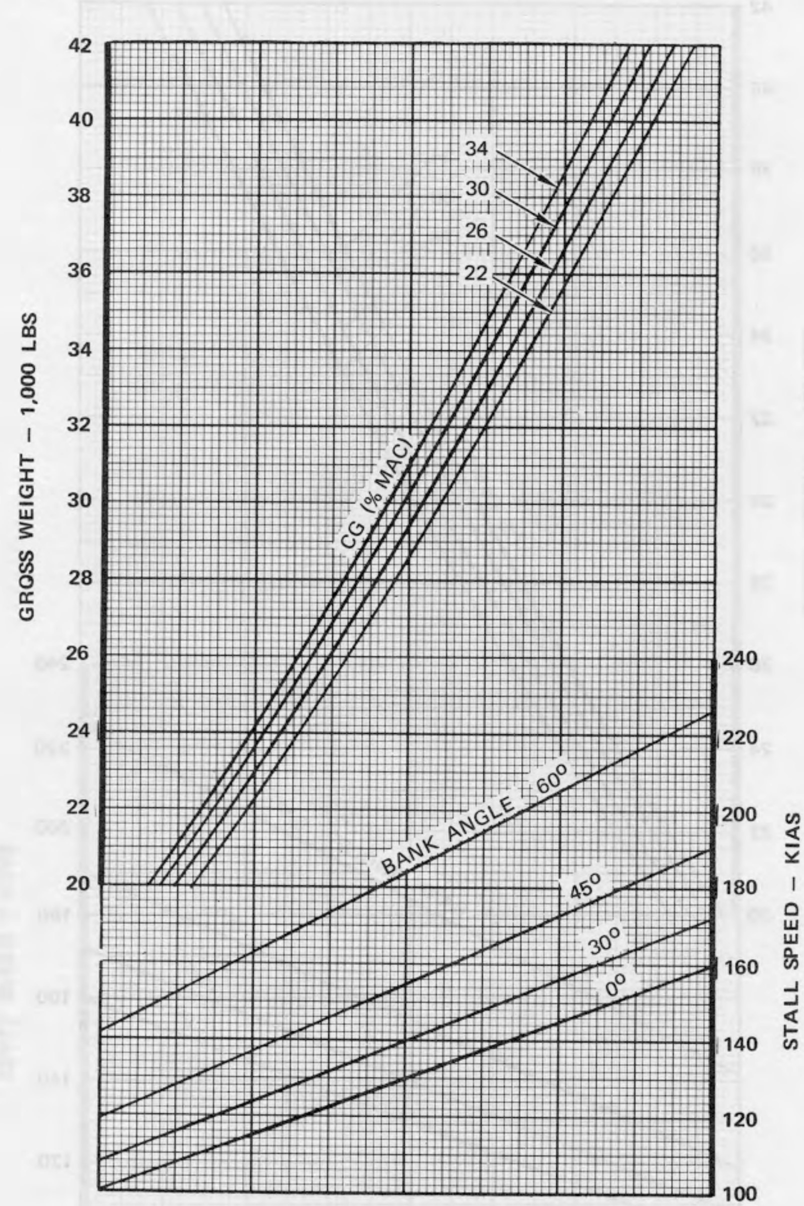
STALL SPEED CHART

ALL CONFIGURATIONS
FLAPS AND GEAR DOWN
POWER OFF (IDLE THRUST)
LE FLAPS = DOWN
TE FLAPS = 25°



MODEL: A-7D
DATE: 1 JULY 1968
DATA BASIS: ESTIMATED

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL



75D215(2)–02–69

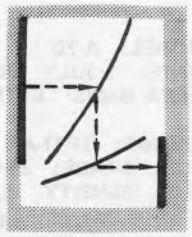
Figure 6–4 (Sheet 2)

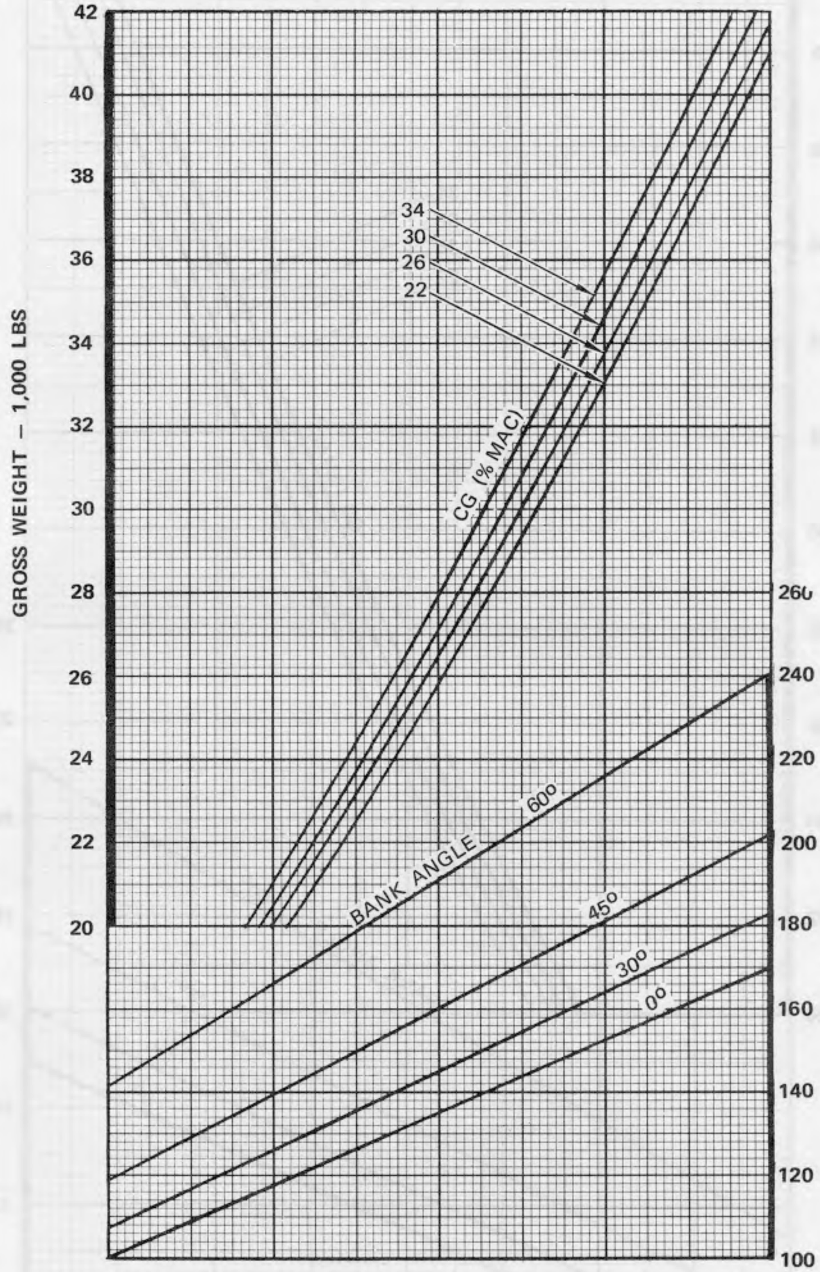
STALL SPEED CHART

MODEL: A-7D
DATE: 1 JULY 1968
DATA BASIS: ESTIMATED

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

ALL CONFIGURATIONS
FLAPS AND GEAR UP
POWER OFF (IDLE THRUST)





75D215(3)–02–69

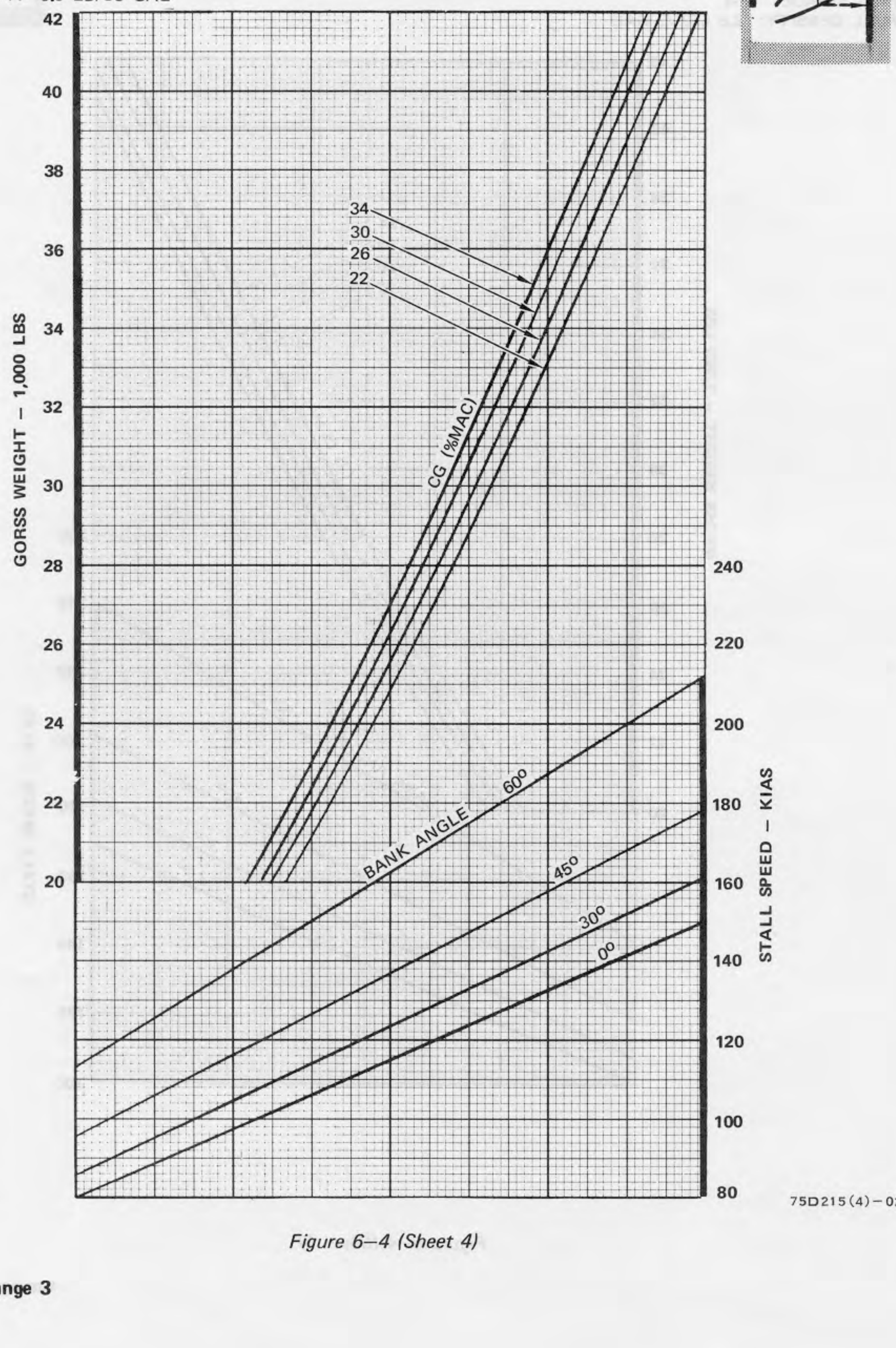
Figure 6–4 (Sheet 3)

STALL SPEED CHART

MODEL: A-7D
DATE: 1 JULY 1968
DATA BASIS: **ESTIMATED**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

ALL CONFIGURATIONS
FLAPS AND GEAR DOWN
APPROACH POWER



75D215(4)–02–69

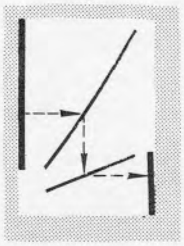
Figure 6–4 (Sheet 4)

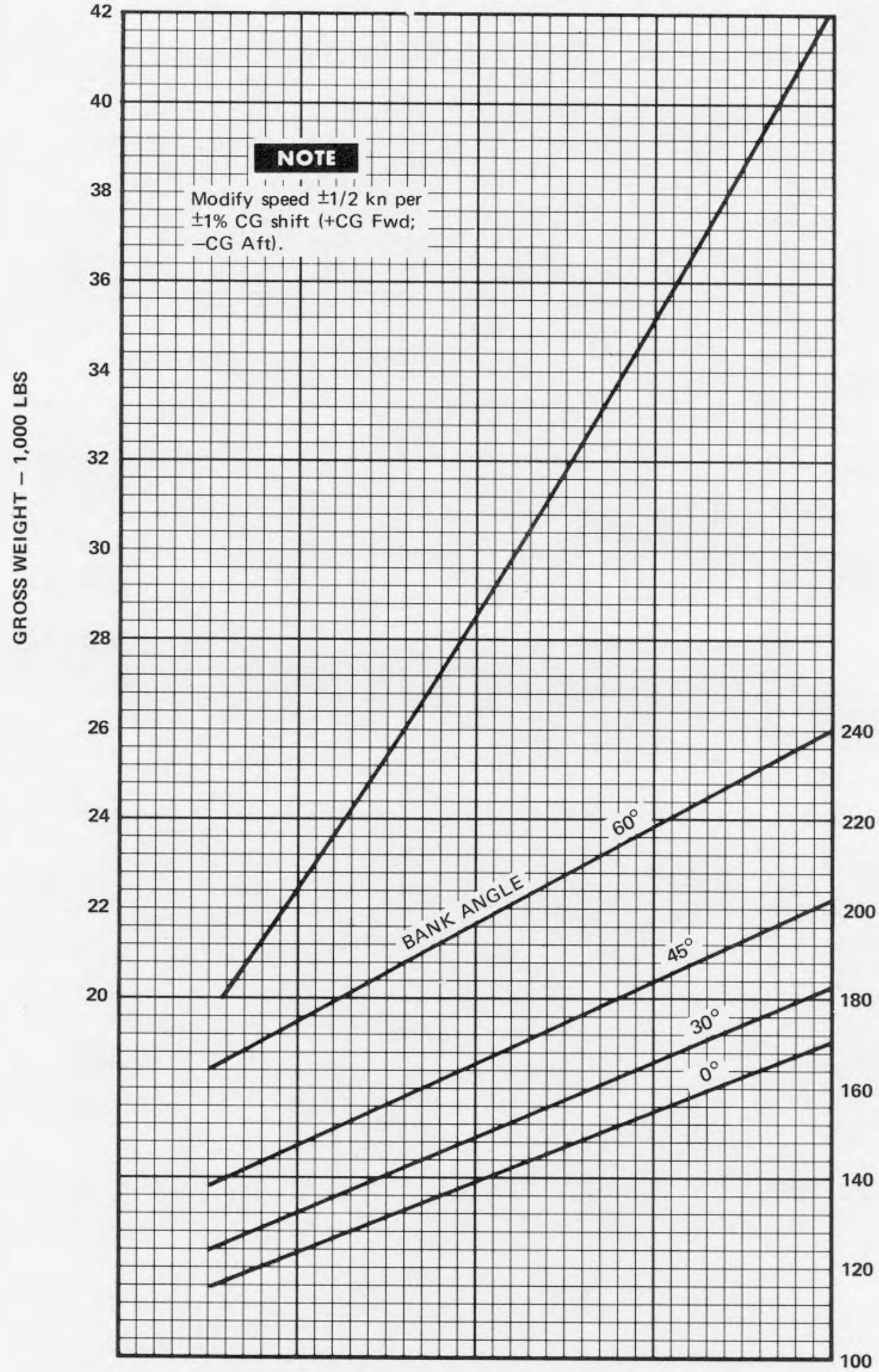
STALL SPEED CHART

MODEL: A-7D
DATE: 30 SEPTEMBER 1970
DATA BASIS: **ESTIMATED**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

ALL CONFIGURATIONS
FLAPS UP GEAR DOWN
APPROACH POWER
CG 26%





75D215(5)–12–70

Figure 6–4 (Sheet 5)

ALL WEATHER OPERATION

SECTION VII

TABLE OF CONTENTS.

In general, this section consists of procedures and information which differ from, or are supplementary to, the normal operating procedures in Section II. Except for some repetition necessary for emphasis or clarity, only those procedures required for all-weather operation are discussed.

INSTRUMENT FLIGHT PROCEDURES.

Aircraft handling characteristics and stability provide for proper attitude control and should not present a problem during flight under instrument flight conditions. The AFCS functions of ATTD HOLD, NAV/HDG SEL, and ALTITUDE HOLD, when properly used, reduce the pilot's control workload and allow more time for planning ahead and communicating. Maximum use of the AFCS is recommended during instrument flight. Instrument flight planning shall take into account possible delays in departure, climb to assigned altitude, holding, and descent. These factors shall be considered and proper allowances made for all known or suspected deviations.

Note

Prior to an instrument takeoff, the IMS should be allowed to achieve a good ground alignment (IMS not aligned light out). Failure to do so causes the HUD Flightpath Marker and pitch lines to shift noticeably and provide erroneous information at approximately 80 KIAS during the takeoff roll. This is a result of erroneous computed velocity and the large resolution of the display. HUD scales information are usable as are ADI attitude and heading. The HUD display gradually improves and is completely usable 3 minutes after good Doppler information is received.

GROUND OPERATION.

Operate the aircraft and systems as conditions dictate. Refer to Cold Weather Operation, this section, if appropriate. Rain removal or rain repel should be used when needed to improve forward visibility.

BEFORE INSTRUMENT TAKEOFF.

1. Navigation aids set as desired.
2. Heading Mode – MAN HDG to provide ADI steering on runway heading.

3. HUD — Under computer control with SCALES selected to provide magnetic heading reference.

4. Select destination of first assigned fix if desired. Flight director symbol will provide steering cues to fix.

5. ANTI-ICE Switch — As required.

Note

Do not use pitot heat for prolonged periods on the ground.

6. Line up visually with the runway centerline.

7. Check HUD, ADI, and HSI heading.

8. Rotate HDG SEL knob on HSI to center bank steering bar on ADI.

9. Aircraft systems runway checks — Complete.

Note

Refusal speed is considerably lower and emergency stopping distance greater on wet or icy runways.

INSTRUMENT TAKEOFF.

Maintain runway heading using outside reference, the HUD magnetic heading and/or the ADI vertical needle in MAN HDG mode. Rotate to 5° noseup on ADI and maintain this attitude until reaching climb schedule. Rotation must be based on airspeed; initial climb can be based on optimum angle of attack or airspeed. The HUD greatly eases the transition from visual to instrument flight as flightpath, airspeed, angle-of-attack, and altitude information is available on the HUD as well as on normal cockpit instruments.

Note

The flightpath marker is a velocity vector, not an attitude reference. With the aircraft on the runway, the FPM remains caged until the aircraft becomes airborne, at which time the FPM becomes a velocity vector. Adequate fixed references such as scales are available on the HUD to judge initial rotation. The FPM indicates climb angle as the aircraft becomes airborne. The transition is normal and natural and should not cause a problem.

INSTRUMENT CLIMB.

Maintain a positive climb angle until reaching climb schedule. The optimum climb schedule recommended in Appendix I is suitable for instrument flight.

HOLDING.

Holding should be accomplished at an airspeed slightly above that for minimum fuel flow for the altitude, gross weight, and drag conditions. A close approximation of the best holding speed is 250 KIAS. Maximum endurance holding should be accomplished at 13.4 units angle of attack. The holding pattern can most easily be flown with the AFCS functions ALT and NAV engaged. Altitude is held automatically and the aircraft flies the desired headings as dialed with the HDG SEL knob on the HSI. The holding pattern can be flown manually with reference to the ADI bank steering bar by setting the holding TACAN radial with the CRS knob and the outbound heading with the HDG knobs on the HSI. The heading mode switch can then be moved to TACAN to provide steering information to capture and track the inbound radial, and to MAN HDG to capture and track the outbound heading. The AFCS or steering command maximum bank angle is slightly less than 30°.

WARNING

For accurate HUD altitude display during approach at destination, insert destination MSLP in the NAV WD Computer before descent. The cockpit altimeter is set separately.

PENETRATION.

Approximately 5 minutes before beginning descent, select CANOPY DEFOG. If canopy fogging is still encountered, increase cabin temperature. The defog system is adequate to prevent canopy fog at any selected power setting. Select the proper approach plate or map on the projected map display, estimate the angle of descent required, and set up the approach and missed approach navigation aids as desired. When ready to begin penetration, retard throttle to approximately 80% rpm, lower the nose, extend the speed brake, and maintain approximately 250 KIAS. Regardless of configuration or speed, each degree of negative flightpath angle (FPM displayed) gives 100 feet of descent per nautical mile. Each approach is different, but 7° to 8° negative flightpath angle as shown on the HUD usually results.

SLOW SPEED PENETRATION.

If a penetration is to be made while in the landing configuration, slow to 180 KIAS and extend the landing gear and flaps when approaching the penetration fix. At the fix, retard the throttle to around 80% and lower the nose to maintain approximately 180 KIAS. Lead level off altitude by 1,000 feet and establish desired airspeed.

RADAR/ILS APPROACH.

WARNING

Raw ILS information must be monitored during all approaches. If command steering ever disagrees with the raw ILS information, disregard the command steering and fly the approach using only the raw information. False command steering may be encountered due to internal/external equipment malfunction.

Note

The FDC ILS steering commands should be monitored for premature sensing of the localizer beam. Cycle the LDG master function switch if sensing is premature.

The aircraft handles exceptionally well in the GCA pattern. It is very stable directionally and is responsive to minor corrections about all axes. Directed heading should be manually set on the HSI with the HDG SET knob. With the NAV mode of the AFCS engaged, the aircraft assumes and maintains the directed heading. All information necessary to control the aircraft during the approach is displayed on the HUD, facilitating visual acquisition of the runway at breakout.

The ILS approach is normally entered from a radar vector, TACAN approach, or from NWDS navigation to the IAF. Refer to figure 7–1 for illustration of phases of FDC/ILS intercept and figure 7–2 for typical radar/ILS approach.

ILS Approach Procedures are as follows:

1. ILS Power switch – Power
2. ILS FREQ select knob – Set

   Set the ILS FREQ selector knob to the frequency of the localizer to be used for the approach, and adjust volume control for identification.

3. Radar altimeter – Check on

WARNING

On aircraft → [16] [18] → [26], the LOW ALT light can be mechanically dimmed by rotating the lens cap.

4. HUD combiner position lever – Aft
5. Horizontal situation indicator – Set

   a. Set the inbound heading of the localizer in the course window. The FDC utilizes this information in conjunction with the localizer signals to position the ADI vertical pointer in relation to ILS centerline.

WARNING

Erroneous command steering will result if the inbound heading of the ILS localizer is not set in the course window.

   b. Set HDG SET marker to desired localizer intercept heading.

PHASES OF FDC/ILS INTERCEPT

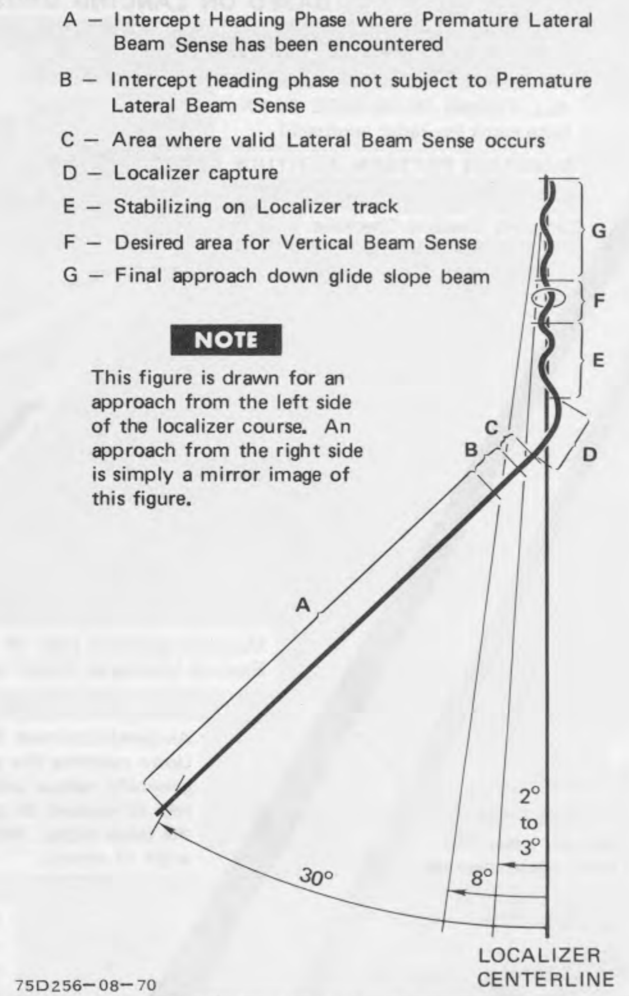


Figure 7–1

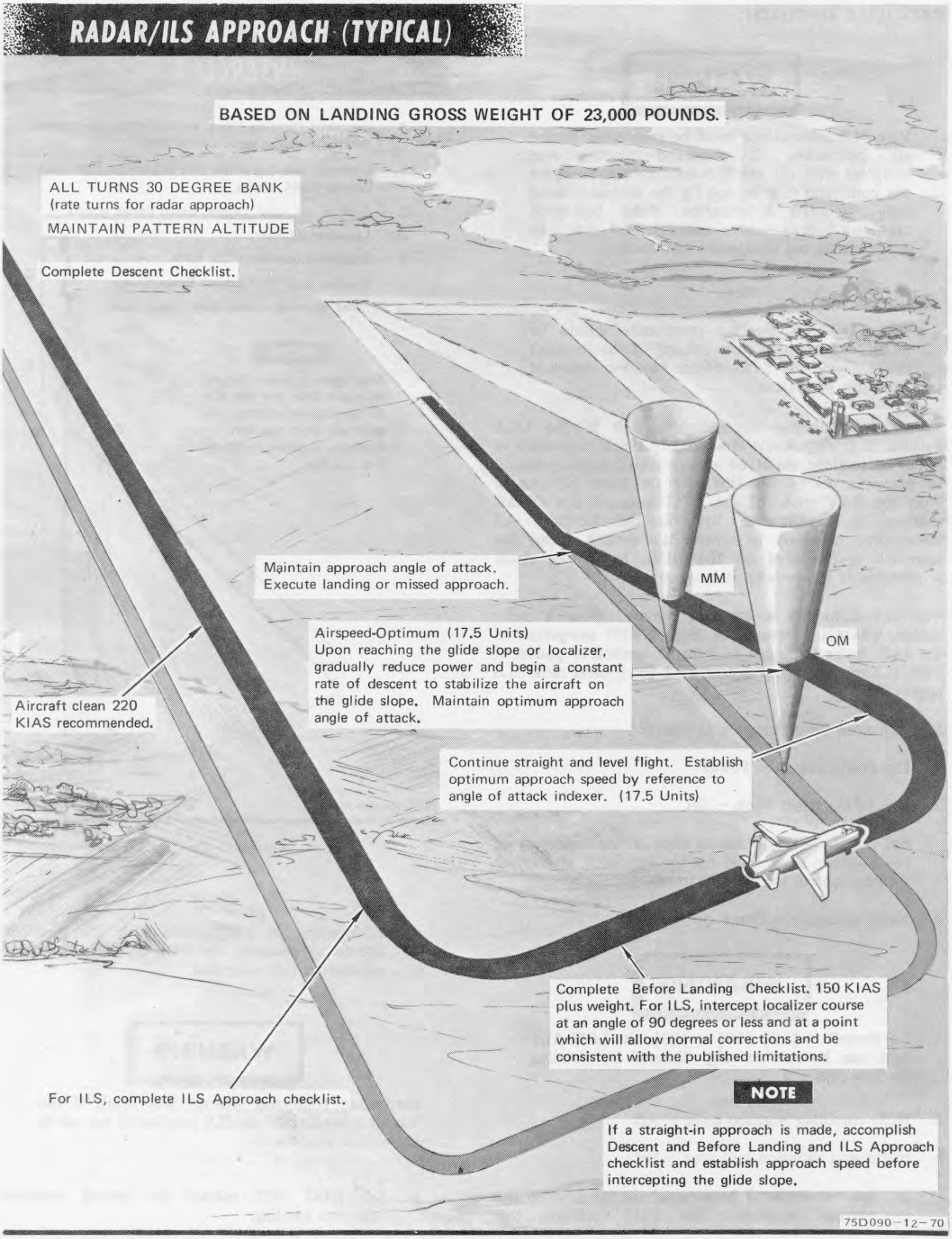

RADAR/ILS APPROACH (TYPICAL)
BASED ON LANDING GROSS WEIGHT OF 23,000 POUNDS.
ALL TURNS 30 DEGREE BANK
(rate turns for radar approach)
MAINTAIN PATTERN ALTITUDE
Complete Descent Checklist.
Maintain approach angle of attack.
Execute landing or missed approach.
MM
OM
Airspeed-Optimum (17.5 Units)
Upon reaching the glide slope or localizer, gradually reduce power and begin a constant rate of descent to stabilize the aircraft on the glide slope. Maintain optimum approach angle of attack.
Aircraft clean 220 KIAS recommended.
Continue straight and level flight. Establish optimum approach speed by reference to angle of attack indexer. (17.5 Units)
Complete Before Landing Checklist. 150 KIAS plus weight. For ILS, intercept localizer course at an angle of 90 degrees or less and at a point which will allow normal corrections and be consistent with the published limitations.
For ILS, complete ILS Approach checklist.
NOTE
If a straight-in approach is made, accomplish Descent and Before Landing and ILS Approach checklist and establish approach speed before intercepting the glide slope.
75D090-12-70

Figure 7–2

6. HDG MODE switch — TACAN or AUTO NAV

   a. Select TACAN if approach is made to a TACAN serviced destination.

   b. Select AUTO NAV if approach is made to a NAV WD system destination.

7. Aircraft positioning

   a. The intercept heading and localizer beam capture phase of the approach should be conducted well below the glide slope to preclude premature vertical beam sensing.

   b. The approach should be started in a sector 30° from runway centerline to activate the intercept heading phase. If the approach is started in a sector less than 4° from runway centerline, the FDC may omit the intercept heading phase and begin with the localizer beam capture phase.

   c. Premature Lateral Beam Sensing (LBS) may occur in the sector between 8° and 30° from runway centerline.

8. LDG master function switch — Press

   The flight director computer steering command is displayed by the ADI bank steering bar and by the HUD flight director symbol. The initial heading command, prior to intercepting the localizer, is that set by the HDG SET knob. No pitch steering information is displayed. The HUD ILS display appears as a single horizontal line displaced in the direction of the localizer. As raw glide slope is received, the ILS perspective lines expand above the horizon (if below glide slope initially).

9. Flying the intercept heading

   a. The LDG mode should be selected after the aircraft is in the positioning sector. If the LDG mode has already been selected, then deselect, pause momentarily, and then reselect to properly initialize FDC logic.

   b. Fly the intercept heading as commanded by the ADI vertical pointer, noting that the pointer commands a turn to the selected intercept heading. If the pointer does not command a turn to the selected intercept heading, then deselect and reselect LDG mode.

   c. As intercept heading is flown, observe the following:

      (1) A full scale displacement of the HSI course bar initially.

      (2) ADI horizontal pointer out of view.

      (3) ADI glide slope displacement pointer indicates glide slope position relative to aircraft. The displacement pointer may be erratic at angles greater than 8° from localizer centerline.

      (4) HUD landing director dot and perspective lines in view. The HUD landing director dot should be clamped in elevation to the flightpath marker until the ADI horizontal pointer starts presenting pitch commands.

10. Evaluation of Lateral Beam Sensing (LBS)

   a. At LBS the FDC will command a turn from selected intercept heading.

   b. A valid LBS occurs when the aircraft is approximately 3° from localizer centerline, and the HSI course bar is displaced approximately one and one-half to two dots and is moving smoothly toward the center of the HSI. At valid LBS, steering commands presented on the ADI and HUD may be followed.

   c. Premature LBS occurs at an angle greater than 8° from localizer centerline. It can be recognized by the HSI course bar not moving smoothly toward center. Localizer signals which cause any erratic movement of the HSI course bar will cause a premature LBS.

WARNING

When a premature LBS occurs, steering commands on the ADI and HUD should not be followed. The LDG mode must be deselected. Pause momentarily and then reselect to initialize FDC logic for valid LBS. Flying the FDC commands following premature LBS will result in a missed approach.

11. Localizer — Intercept

   By turning to keep the HUD flight director symbol centered in the flightpath marker, and the ADI bank steering bar centered, the localizer is captured and tracked. Reduce airspeed to optimum angle of attack approaching glide slope.

12. After ILS localizer capture, the remainder of the ILS approach may be flown using the vertical and horizontal pointers on the ADI and/or HUD presentations.

Note

Frequent cross-checks should still be made with raw information presented on the HSI and ADI.

13. Glide slope — Intercept

The HUD ILS perspective lines decrease to a single horizontal line as the glide slope is approached. The flight director symbol and perspective lines provide steering commands after glide slope capture. The ADI pitch steering bar moves rapidly from the stowed position to a slight pitch-up position just before glide slope intercept. A slight reduction of power and pitch-down provides a smooth glide slope intercept.

14. After glide slope capture, if the localizer deviation displayed on the HSI exceeds 3/4 dot, the lateral FDC commands must be ignored until close tracking (less than 3/4 dot displacement) of the localizer centerline is established.

15. Fly the ON-COURSE commands to minimum altitude.

The flightpath marker shows actual descent angle which should correspond to the published glide slope. The HUD ILS symbol should be a centered (on the fpm) horizontal line. The ADI steering bars are centered. Upon reaching minimum altitude, land visually or make a missed approach as appropriate.

TACAN APPROACH.

The TACAN approacn may be entered from a radar vector or from NAV WD navigation. Figure 7–3 is a typical TACAN approach.

MISSED APPROACH PROCEDURE.

To accomplish a missed approach, advance the throttle (90% rpm minimum) to establish a positive rate of climb and accomplish a go-around. Refer to Landing and Go-Around (Typical), Section II. When a positive climb is indicated, raise the gear. Do not raise the flaps until the wings are level and airspeed is 175 KIAS minimum. Allow the aircraft to accelerate to 220 KIAS while climbing to missed approach altitude.

Note

Military power may cause pressurization fog in the cockpit if defog is not on.

ICE AND RAIN.

The aircraft is equipped with pitot heat and windshield rain removal and rain repel systems. Refer to pitot Heat and Defog Systems, Section I. Flight through areas of known icing is not recommended because there are no provisions for surface anti-icing. When icing is encountered, a change in altitude or course shall be made to prevent ice from accumulating on the aircraft structure. Pitot heat shall be used whenever icing is anticipated.

Turn pitot heat on immediately after starting the engine if there is a possibility of encountering ice during ground operations. To combat windshield and canopy icing, turn DEFOG switch on to direct hot air flow to windshield and side panels. Increase air-conditioning temperature setting to provide hot air to the canopy. The rain removal system is capable of keeping ice from forming; it is less effective in removing ice. Refer to Air-Conditioning System, Section I, for rain removal operation. If ice is allowed to build up on the engine inlet struts and guide vanes, chunks of ice could be blown into the engine and cause compressor damage. The first indication of inlet icing during cruising flight is a drop in engine performance. Be alert to the possibility of compressor stall or engine overtemperature. Use of high power settings (control airspeed with speed brake) is recommended when descending through or into severe icing conditions.

When landing on an ice-covered runway, make a normal approach and touchdown and use aerodynamic braking during rollout. After nose gear contacts the runway, use light continuous wheel braking to avoid locking the wheels and blowing tires. Maintain directional control with rudder and nose gear steering. If necessary, shut down the engine to aid in stopping.

Note

Ground roll can be twice that experienced with ideal runway conditions.

When rain is encountered, the use of pitot heat is recommended. When necessary, use rain removal and rain repel for takeoff and landing. Use the same techniques described for landing on ice. Use minimum power consistent with flight requirements and avoid abrupt throttle movements. Avoid taxiing in slush or deep snow before takeoff. Frozen landing gear microswitches may result in false gear warning when landing gear is extended.

TURBULENCE AND THUNDERSTORMS.

Due to the severity of thunderstorms and towering cumulus clouds, circumnavigate whenever possible. While flying in stratus type cloud formations, be prepared for the possibility of encountering turbulence. The best penetration speed of the aircraft in severe turbulence is 300 KIAS or 0.80 Mach, whichever is lower. Be alert for possible instrument failures, and pitot icing even with the pitot heat on. The angle-of-attack indicator should be used as a backup pitch instrument. Engage the AFCS, if

TACAN APPROACH (TYPICAL)

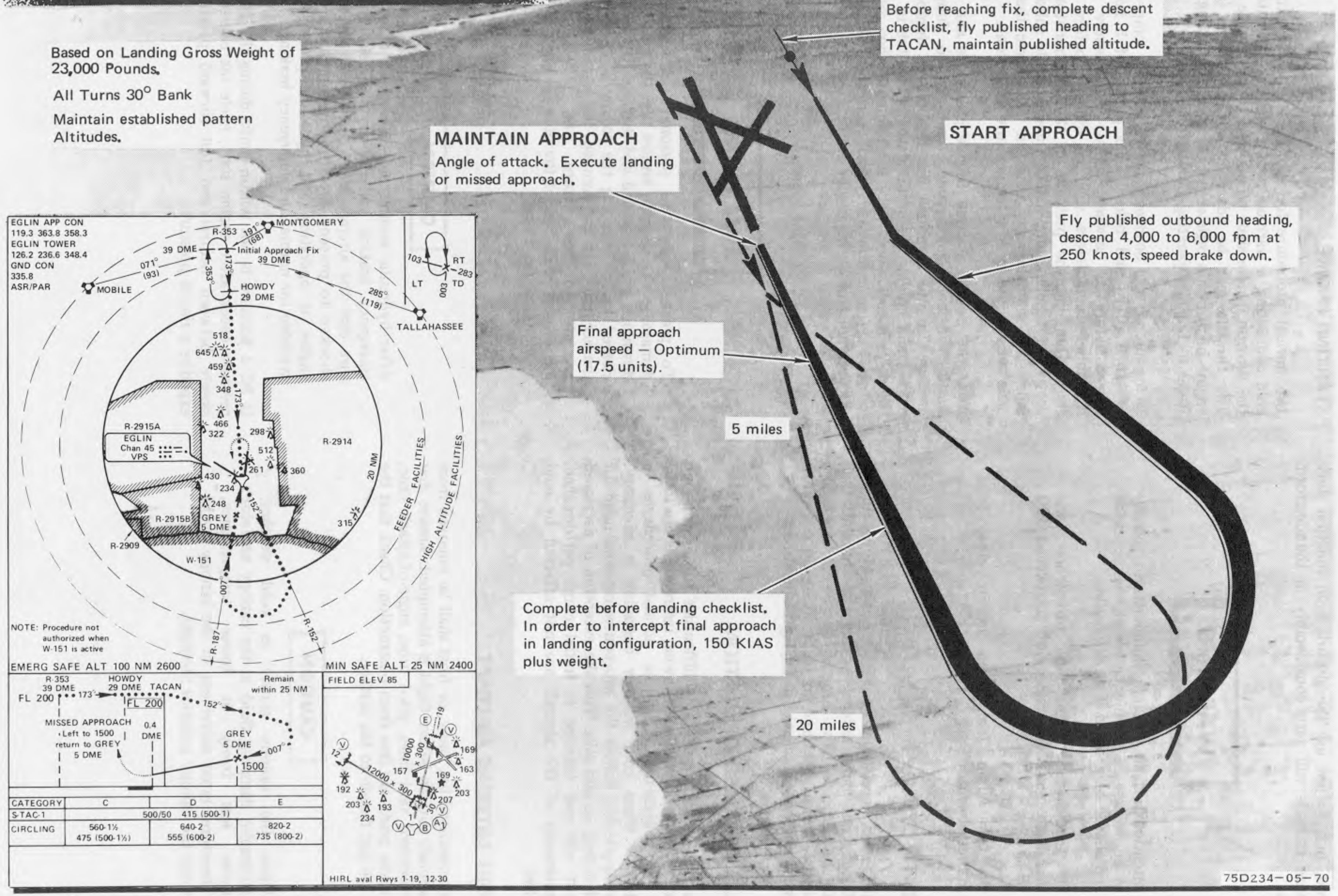


Figure 7–3

desired, but do not use the altitude hold function since pressure altitude will vary considerably in thunderstorm areas.

WARNING

Intentional flight through thunderstorm activity or known severe turbulence is not recommended and should be avoided if at all possible.

If inadvertent flight in turbulence and thunderstorms is experienced,do not exceed **300 KIAS**.

Do not dump fuel when in or close to thunderstorms.

NIGHT FLYING.

Night flight necessitates a high degree of instrument proficiency and more reliance on flight instruments than would be expected for normal day VFR operation. Otherwise, techniques used in night flying do not differ appreciably from those used in daylight operation.

COLD WEATHER OPERATION.

Most cold weather operating difficulties are encountered while on the ground. The following instructions are to be used in conjunction with the normal procedures in Section II when cold weather operation is necessary. When applicable, follow the procedures recommended for flight during ice and rain. With the exception of decreased takeoff roll and increase in initial climb performance, characteristics of the aircraft are not affected by cold weather.

BEFORE ENTERING AIRCRAFT.

All accumulated ice, snow, or frost shall be removed from the aircraft surface before flight is attempted. Ensure that all overboard vent lines, pitot tube, angle-of-attack vane, and static ports are free from obstruction. Check that the tires are not frozen to the surface.

CAUTION

Open the canopy slowly in cold weather. Hydraulic damping fluid in the canopy actuator flows less freely at lower temperatures. Therefore, rapid movement of the canopy could shear the canopy actuator shearpin.

STARTING ENGINE.

Use normal procedure for starting engine. In extremely cold conditions, a warmup period of 2 to 5 minutes with the throttle in idle shall be allowed before engine runup. The throttle may be advanced out of idle as long as engine instruments register within engine operating limits. Refer to Engine Operating Limitations, Section V.

If the aircraft has been exposed to ambient temperatures of -18°C (0°F) and below for a period of 5 hours or longer before or between flights, the pressure in the hydraulic accumulators shall be dumped before engine start. Dumping the pressure in the accumulators will prevent hydraulic pump damage and possible subsequent failure by removing any voids in the system that may have been caused by low temperature conditions.

After the Before Starting Engine procedure and before starting engine, signal ground crewman to dump the pressure in the accumulators. Pressure is dumped by placing and holding the accumulator test switch in DUMP (right main gear wheel well) for 1 minute, then returning it to OFF (cover down). Hydraulic pressure will recharge the accumulators during engine start.

WARNING

To prevent injury to personnel and possible damage to the aircraft, ensure that the nose gear downlock pin is installed and that the flap area is cleared before dumping the accumulators. When the accumulators are dumped, the resulting surge pressure to the return line could cause inadvertent retraction of the nose landing gear or actuation of the flaps.

CAUTION

After hydraulic accumulators have been dumped, emergency braking will not be available. Make sure that the aircraft main gear wheels are well chocked to prevent aircraft movement until the engine is operating and hydraulic pressure is available for normal and emergency braking.

If PC 1 pressure is not within limits during the hydraulic pressure check after engine start, cycle the control stick slowly between neutral and full forward positions to expedite a rise in pressure.

BEFORE TAXI.

Carefully check flight controls and actuate hydraulic systems for proper operation. Cycle flight controls to circulate warm fluid throughout the system while checking controls reaction.

Note

Rudder pedal travel may be restricted when wearing the arctic survival boot. This consequently limits nose gear steering to approximately 45 degrees. Differential braking may be applied as necessary to compensate for the limited nose gear steering due to boot restriction.

TAXI.

WARNING

Nosewheel steering may not be effective when taxiing on ice or snow. A combination of nosewheel steering and wheel braking may be required for directional control. Exercise care and taxi at reduced speed under these conditions.

CAUTION

Painted areas on pavement are significantly more slippery than nonpainted areas, particularly when wet. Painted areas are also subject to condensation which can result in frosty or even icy conditions when overall weather condition is dry.

TAKEOFF.

Takeoff data should reflect reduced braking capability due to ice and snow on the runway in event of an abort. Make normal takeoff.

DESCENT.

Normal procedures apply.

LANDING.

Normal procedures apply.

ENGINE SHUTDOWN.

Normal procedures apply.

BEFORE LEAVING AIRCRAFT.

If the aircraft is to be parked for any length of time, ensure that the canopy cover, intake and tailpipe covers, and tiedowns are placed on the aircraft. Make sure that the aircraft is refueled immediately after flight to minimize condensation in the fuel tanks. Aircraft drain plugs should be checked for water once every 24 hours or on preflight.

HOT WEATHER AND DESERT OPERATION.

Hot weather and desert operation requires that added precautions be taken against damage from dust, sand, and high temperatures. Special attention should be directed to those systems and components susceptible to damage from sand and dust. Components containing plastic or rubber shall receive close attention and frequent inspection for damage. All openings shall be covered or closed when the aircraft is not in operation.

TAKEOFF.

A noticeable decrease in thrust occurs at all power settings; therefore, more acceleration time and greater runway distance are required during hot weather operations. Refer to Appendix I for recommended takeoff speeds and required distances.

DESCENT AND LANDING.

If descending from cold, dry air into warm humid conditions, turn the cockpit heat control to increase and DEFOG switch ON before descent.

For landing, maintain recommended approach and landing speeds as shown in Appendix I. Anticipate a longer landing roll resulting from increased true airspeed.

CAUTION

During approach and landing, be cautious of gusts and windshift near the ground. Add 1/2 gust factor in computing final approach and touchdown speed.

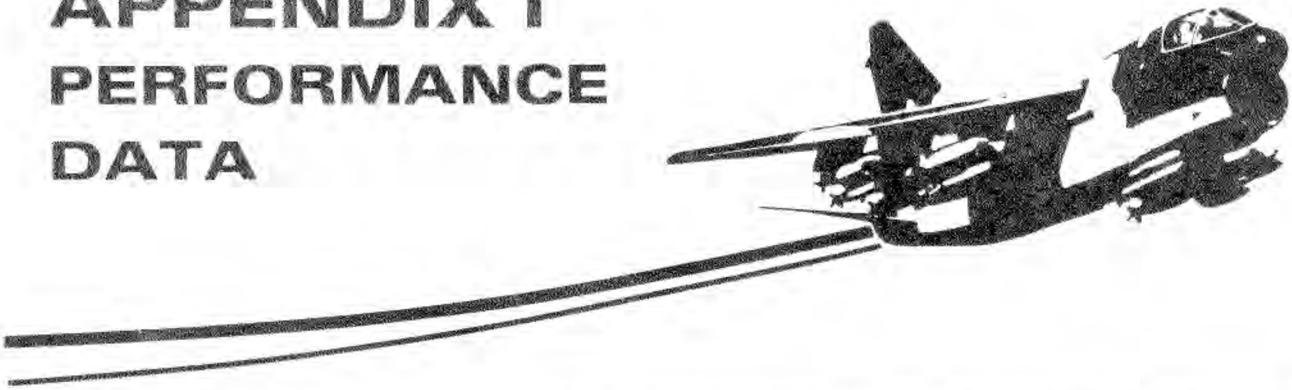
ENGINE SHUTDOWN.

Normal procedures apply.

BEFORE LEAVING THE AIRCRAFT.

Leave the canopy open if the aircraft is exposed to direct sunlight and there is no blowing dust or sand. This prevents excessive heat buildup within the cockpit. In desert locations, keep the canopy and all vents and ducts covered.

APPENDIX I PERFORMANCE DATA



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ABBREVIATIONS AND DEFINITIONS

ALT	Altitude.
AOA	Angle of attack.
CA	Calibrated altitude. Indicated altitude corrected for any instrument and installation errors of the altimeter.
CG	Center of gravity.
fpm	Feet per minute.
G	Load factor or G-loading.
GS	Groundspeed (knots). Speed over the ground equal to true airspeed corrected for headwind (subtract) or tailwind (add).
IA	Indicated altitude. The uncorrected reading of a barometric altimeter.
IMN	Indicated Mach number. Indicated Mach reading uncorrected for instrument error. (Instrument error assumed to be zero in all performance charts of this appendix.)
KCAS	Calibrated airspeed (knots). Indicated airspeed corrected for instrument error and position error (pitot-static system error and errors induced by aircraft attitude).
KEAS	Equivalent airspeed (knots). Calibrated airspeed corrected for compressibility.
KIAS	Indicated airspeed (knots). Airspeed indication uncorrected for instrument error.
kn	Knot.
KTAS	True airspeed (knots). Calibrated airspeed corrected for density and compressibility.
MAC	Mean aerodynamic chord.
Mach	A number expressing the ratio of the true airspeed of a moving body in the air surrounding it with the speed of sound.
nmi	Nautical miles.
nmi/lb	Nautical miles per pound.
press.	Pressure.
RCR	Runway condition reading.

SL	Sea level.
STD	Standard.
temp	Temperature.
TMN	True Mach number. Indicated Mach reading corrected for position error.
Δ TEMP	Temperature correction.

Part 1
Introduction

TABLE OF CONTENTS.

INTRODUCTION.

The appendix contains the performance data required for accurate preflight planning of missions. These data are presented in proper sequence for mission planning, with descriptive text in each part which discusses and explains the use of the charts. Most of the charts are presented in graphical form, using the drag index method to identify the various external loadings.

PERFORMANCE DATA BASIS.

Flight performance information is based on flight test data. All charts are presented for US standard atmosphere conditions, although ambient temperature correction scales are provided in a number of charts where temperature effects are significant. The temperature correction scale is shown on some charts as actual ambient temperature. On other charts the temperature correction is shown as an incremental change applied to the standard day temperature at all altitudes: ie, standard plus 10°C. All performance and operating weight ranges are based on the use of JP-4 fuel at a nominal density of 6.5 pounds per US gallon.

Because of the variation in center-of-gravity (CG) position caused by the wide variety of external stores carried on A-7D aircraft and because of the sensitivity of takeoff and landing performance to CG position, provisions are made in Parts 2 and 7 for correcting the data for the effect of CG position. The effect of CG position on other phases of performance is not significant and is not accounted for in the manual.

A detailed explanation of the use of the performance charts is provided in each Part of the Appendix. In addition, each chart contains a miniature guide box in the upper right corner with "chase-through" guidelines for reference to chart entry.

DESCRIPTION OF DRAG INDEX SYSTEM.

The performance charts of this appendix use a method that presents all possible external store loadings permitted. This method, called the Drag Index System, permits a drag value to be established for a particular aircraft configuration.

In the drag index system, each item of the external store configuration, such as a bomb or pylon, is assigned a drag number whose value depends on the size and shape of the item, its location on the aircraft, and the aircraft Mach No. These numbers are not drag coefficients. The summation of the store drag numbers for a particular loading defines a drag index for that configuration. This drag index, when used in the performance charts, determines the aircraft performance for that external store configuration. Performance should be interpolated in the charts for intermediate values of drag index.

Three types of drag must be considered when determining the total drag index with external stores. These are basic store drag, interference drag, and trim drag. A clean aircraft without pylons, racks, or weapons is considered as having a drag index of zero.

To demonstrate the method of computing each type of drag, a typical close support and interdiction mission is used. The aircraft configuration is as follows:

Station	*Store Load*
1	Pylon and MAU-12B/A rack
2	TER with three Mk 82 LDGP's
3	MER with four Mk 82 LDGP's
4	Aero 3B with AIM-9B missile
5	Aero 3B with AIM-9B missile
6	MER with four Mk 82 LDGP's
7	TER with three Mk 82 LDGP's
8	Pylon with ALQ-71 ECM pod

The problem of computing total drag is simplified if the load being carried is symmetrical and homogeneous and if stores on adjacent pylons are far enough apart so that interference drag is not a factor.

BASIC STORE DRAG.

The curves of the inflight performance charts include a factor for drag of the clean aircraft. Therefore, basic store drag is the additional drag imposed when external stores are carried. This information is found in column 3 of figure A1–1 opposite the applicable station load. Using the example station 1 load, a pylon with a MAU-12B/A rack, the basic store drag at MN 0.6 is 6.0. The drag for each of the other stations (including fuselage stations) is similarly found and recorded. The total of the drag on all stations is the drag index for that external store configuration.

Note

Basic drag numbers for external stores at Mach numbers between 0.6 and 0.9 are provided in figure A1–1. To obtain performance data for an external store configuration not specifically listed in Section V, External Stores Limitations charts, the drag index must be computed using this table.

INTERFERENCE DRAG.

Interference drag develops when pressure builds up in the areas between stores on adjacent wing stations. The magnitude of this drag is a function of the distance between stores on adjacent stations, to the airspeed at which the stores are carried, and to the makeup of each station load (single or multiple). In general, drag increases as the distance between stores on adjacent wing stations decreases and as airspeed increases above 0.60 IMN. Once interference drag is determined, curves of the inflight performance charts automatically compensate for drag rise due to increasing airspeed. Interference drag between the fuselage station and wing stations 3 and 6 is minimal and can be disregarded.

Note

There is no interference drag between an empty MER, TER, or pylon and any adjacent store.

Interference drag is obtained from figure A1–2, sheets 1 and 2. The distance between outboard and center pylons is 39.4 inches and the distance between center and inboard pylons is 36.0 inches.

To use the charts, it is necessary to first obtain the distance the load on each pylon extends toward the load on the adjacent pylon. This information is obtained from column 4 of figure A1–1. For example, using the sample configuration, the three Mk 82's on station 2 extend 15.0 inches toward the Mk 82's on station 3; the Mk 82's extend 15.0 inches toward station 2. Distances between stations 6 and 7 are similarly obtained.

Use.

Interference drag between stations 1 and 2 and between 7 and 8 is found in figure A1–2, sheet 1. Enter the chart with the distance from pylon center to edge of store in inches on station 1 or 8. Move horizontally right to the distance from pylon center in inches on station 2 or 7, proceed vertically up to the appropriate drag curve, and then horizontally left to read interference drag number. This value is the interference drag between stations 1 and 2 or 7 and 8. Interference drag between stations 2 and 3 and stations 6 and 7 is found in figure A1–2, sheet 2 and is obtained in the same manner.

Figure A1–2, sheets 1 and 2 present accurate drag numbers for airspeeds up to 0.6 MN. For airspeeds between 0.6 and 0.9 MN, the delta factor obtained from figure A1–2, sheet 3 must be applied. Enter figure A1–2, sheet 3 with the desired Mach number and move vertically up to the appropriate drag curve, then move horizontally left to obtain drag delta correction to be added to interference drag number at 0.6 MN.

Interference drag between stations 2 and 3 and stations 6 and 7 for the sample problem is 11.0 and 11.0 respectively.

DETERMINE TRIM DRAG.

Drag due to trim is a factor only when the aircraft is asymmetrically loaded. As can be seen from figures A1–3 and A1–4, trim drag effects are minor at high Mach numbers and lower altitudes, but have an appreciable effect on total drag at lower Mach numbers and higher altitudes.

To determine trim drag, the weight of each station is converted into pound-feet of rolling moment. This information is obtained from figure A1–1, column 6, opposite the applicable station load. Since rolling moment is the result of multiplying station weight by the distance in feet between the station and the aircraft centerline, rolling moments are given for each station on which the load may be carried.

Note

Entry of a rolling moment in column 6 (figure A1–1) does not constitute authority to carry the load on that station.

After the rolling moment for each station is obtained, the moments for the left wing stations are summed as are those for the right wing stations. The difference between the total rolling moments on the left and right wing stations is the asymmetrical rolling moment (2,276 pounds in the sample problem) which is used to enter the trim drag chart, figure A1–4. The drag is found by reading up to the desired cruise Mach number (0.60), across to the cruise altitude (25,000 feet), and then down to obtain drag due to trim (1.0 drag number). Trim drag is then added to the basic and interference drag values to obtain total configuration drag.

Basic drag and store weights for the sample aircraft configuration at MN 0.6 is determined for takeoff.

External Store Item	*Drag No.*	*Weight (Lb)*
Two fuselage pylons with Aero 3B launchers and AIM-9B missiles	15.0	434
One outboard pylon with MAU-12B/A rack	6.0	274
One outboard pylon with MAU-12B/A and one ALQ-71 ECM pod	12.0	474
Two center pylons with MAU-12B/A racks and 6 Mk 82's on TER's	55.0	3,902
Two inboard pylons with MAU-12B/A racks and 8 Mk 82's on MER's	65.0	5,204
Trim drag at MN 0.6	1.0	
Interference drag	22.0	
Drag index and total store weight	176.0	10,288

As the mission is flown and stores are expended, the drag index of the aircraft and the store weights change. Referring again to figure A1–1, the following is determined:

A. After dropping the 6 Mk 82 LDGP's and firing one missile —

External Store Item	*Drag No.*	*Weight (Lb)*
One fuselage pylon with Aero 3B launcher	2.5	62
One fuselage pylon with Aero 3B launcher and AIM-9B missile	7.5	217
Two inboard pylons with MAU-12B/A racks and 8 Mk 82's on MER's	65.0	5,204
Two center pylons with MAU-12B/A racks and TER's	26.0	734
One outboard pylon with MAU-12B/A rack	6.0	274
One outboard pylon with MAU-12B/A rack and one ALQ-71 ECM pod	12.0	474
Trim drag at MN 0.6	1.0	
Interference drag	0.0	
Drag index and total store weight	120.0	6,965

B. After all bombs are dropped and missiles are fired —

External Store Item	*Drag No.*	*Weight (Lb)*
Two fuselage pylons with Aero 3B launchers	5.0	124
Two inboard pylons with MAU-12B/A racks and empty MER's	46.0	926
Two center pylons with MAU-12B/A racks and empty TER's	13.0	734
One outboard pylon with MAU-12B/A rack	6.0	274
One outboard pylon with MAU-12B/A rack and ALQ-71 ECM pod	12.0	474
Trim drag at MN 0.6	1.0	
Interference drag	0.0	
Drag index and total store weight	83.0	2,532

POSITION ERROR CORRECTION.

These charts (figure A1–5, sheets 1, 2, 3, 4, and 5) present the corrections that must be added to indicated airspeed, altitude, and Mach number to obtain calibrated airspeed, pressure altitude, and true Mach number. Two altitude correction charts are provided. Figure A1–5 (sheet 1) is applicable to the pneumatic (STBY) mode of AAU-19/A altimeter operation and figure A1–5 (sheet 2) is applicable to the servo (RESET) mode of operation. For example, assume a STBY mode indicated altitude of 30,000 feet and an indicated airspeed of 350 knots. The altimeter correction is 60 feet. This correction is added to indicated altitude to give a pressure altitude of 30,060 feet. For the same example in the RESET mode, the altimeter correction is 310 feet and the pressure altitude is 30,310 feet.

For calibrated airspeed, reading vertically up from 350 KIAS to a pressure altitude of 30,000 feet gives an airspeed correction of 0.5 knots which, when added to indicated airspeed, gives 350.5 KCAS. Mach number corrections for obtaining true Mach, considering indicated Mach-versus-pressure altitude, are found from the chart in the same manner. Landing configuration charts are used in a similar manner. For previous examples, instrument errors have been assumed zero.

AIRSPEED – MACH NUMBER CONVERSION.

This chart (figure A1–6) gives the true Mach number, calibrated airspeed, and true airspeed for standard and nonstandard atmospheric temperatures. For example, assume a CAS of 400 knots at an altitude of 20,000 feet with a free air temperature of -35°C.

Enter the chart at 400-knot CAS line and project vertically to the 20,000-foot true pressure altitude curve. At this intersection, project horizontally to the left to obtain a true Mach number of 0.86. Following the true airspeed curve from the CAS and altitude intersection to the right will give a standard atmosphere TAS of 523 knots. If the temperature is not standard for the altitude, project horizontally to the right, from the CAS and altitude intersection, to the sea level curve, then downward to the -35°C free air temperature curve and horizontally to the right to obtain a corrected TAS of 517 knots.

RUNWAY WIND COMPONENTS.

The runway wind components chart (figure A1–7) provides the means of converting surface wind velocities into components parallel to the runway. The headwind or tailwind component is used to compute takeoff and landing distances, and crosswind component is used to determine the feasibility of operations.

STORES COMPUTATIONS.

Inflight performance charts include the drag of the clean aircraft plus store drag curves as a function of Mach number. The drag indexes shown on these charts represent the drag at 0.6, 0.7, 0.8, and 0.9 MN. If the clean aircraft (no external stores, pylons, or racks installed) is to be considered, a drag index of 0 will yield the correct results. When external stores are carried, the drag index at each Mach number must be used to obtain the correct drag for a given configuration. This drag index variation with Mach number accounts for the store drag rise (increase of drag with Mach number). Drag indexes at intermediate Mach numbers may be obtained by linear interpolation.

Note

1. Drag index number includes drag for pylons, racks, and launchers.
2. Where two distances are given, the smaller is the distance for a store mounted on the bottom station of a MER or TER.
3. Weights include all mount/store weight except pylon and MAU-12B/A or MAU-12C/A rack.
4. Rolling moments include all mount/store weight except pylon and MAU-12B/A or MAU-12C/A rack which can be ignored with symmetrical pylons installed.
5. If applicable, add the weight of M61A1 gun ammunition to the basic weight of the aircraft. The weight of 20mm ammunition is 0.565 pound per round (565 pounds per 1,000 rounds).

Store	*Mount/No. of Stores*	*Basic Drag Index (Note 1)* *MN =0.6*	*MN =0.7*	*MN =0.8*	*MN =0.9*	*Distance from Pylon Center to Edge of Store (in Inches) (Note 2)*	*Weight Pounds (Note 3)*	*Rolling Moment Station 1 or 8 Station 2 or 7 Station 3 or 6 (Note 4)*
Wing Pylons and Suspension Equipment:								
Pylon 1 or 8 with		6.0	7.0	10.0	14.0		(204)	
MAU-12C/A							284 (80)	
MAU-12B/A							274 (70)	
Pylon 2 or 7 with		6.0	7.0	10.0	14.0		(201)	
MAU-12C/A							281 (80)	
MAU-12B/A							271 (70)	
Pylon 3 or 6 with		6.0	7.0	10.0	14.0		(173)	
MAU-12C/A							253 (80)	
MAU-12B/A							243 (70)	
MER		23.0	24.0	29.0	40.5		220	
TER		13.0	15.0	24.0	39.0		96	
Fuselage Pylons and Suspension Equipment:								
Pylon with		2.5	2.5	2.5	2.5		(13)	
Aero 3B							62 (49)	
Mk 82 LDGP	6/MER	37.5	39.0	46.5	66.5	15.0	3,382	38,498
								27,394
								17,248

Figure A1-1 (Sheet 1)

STORE COMPUTATIONS

Store	Mount/No. of Stores	Basic Drag Index (Note 1) MN =0.6	MN =0.7	MN =0.8	MN =0.9	Distance from Pylon Center to Edge of Store (in Inches) (Note 2)	Weight Pounds (Note 3)	Rolling Moment Station 1 or 8 Station 2 or 7 Station 3 or 6 (Note 4)
	4/MER	32.5	34.0	40.5	58.0	15.0 5.5	2,328	26,500 18,857 11,873
	2/MER	27.5	29.0	34.5	48.5	5.5	1,274	14,502 10,319 6,497
	3/TER	27.5	30.0	44.0	72.0	15.0	1,677	19,090 13,584 8,553
	2/TER	22.5	25.0	37.5	61.0	15.0 5.5	1,150	13,091 9,315 5,865
	1/Pylon	8.0	9.0	12.0	21.0	5.5	527	5,999 4,269 2,688
Mk 82 Snakeye, Mk 36 Destructor	6/MER	53.0	55.0	62.0	84.0	15.0	3,580	40,752 28,998 18,258
	4/MER	43.0	44.5	51.0	69.5	15.0 5.5	2,460	28,003 19,926 12,546
	2/MER	33.0	34.0	40.0	55.0	5.5	1,340	15,254 10,854 6,834
	3/TER	38.0	40.0	51.5	78.5	15.0	1,776	20,217 14,368 9,058
	2/TER	29.5	31.5	42.0	65.5	15.0 5.5	1,216	13,842 9,850 6,202
	1/Pylon	11.0	11.5	15.0	24.0	5.5	560	6,375 4,536 2,856
Mk 84 LDGP	1/Pylon	11.0	11.5	15.0	24.0	9.0	1,970	22,425 15,957 10,047
M117A1 with M131A1 Fins and MAU103-A/B Fins	6/MER	72.5	76.5	92.0	155.0	19.5	5,158	58,714 41,780 26,306
	4/MER	56.0	59.0	71.0	117.0	19.5 8.0	3,512	39,978 28,447 17,911

Figure A1–1 (Sheet 2)

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STORE COMPUTATIONS

Store	Mount/No. of Stores	Basic Drag Index (Note 1) MN =0.6	MN =0.7	MN =0.8	MN =0.9	Distance from Pylon Center to Edge of Store (in Inches) (Note 2)	Weight Pounds (Note 3)	Rolling Moment Station 1 or 8 Station 2 or 7 Station 3 or 6 (Note 4)
	2/MER	39.5	41.5	50.0	78.5	8.0	1,866	21,241 15,115 9,517
	3/TER	39.0	45.5	63.0	125.0	19.5	2,565	29,198 20,777 13,082
	2/TER	30.5	35.5	50.0	96.5	19.5 8.0	1,742	19,830 14,110 8,884
	1/Pylon	16.0	16.5	20.0	31.0	8.0	823	9,368 6,666 4,197
BLU-1C/B Finned	3/MER	48.5	49.0	81.0	147.0	21.5	2,136	24,320 17,301 10,894
	2/TER	30.0	31.0	52.0	110.0	21.5 9.5	1,520	17,307 12,312 7,752
	1/Pylon	14.5	15.0	24.0	49.5	9.5	712	8,107 5,767 3,631
BLU-1C/B Unfinned	3/MER	48.5	49.0	81.0	147.0	21.5	2,311	26,313 18,719 11,786
	2/TER	30.0	31.0	52.0	110.0	21.5 9.5	1,490	16,965 12,069 7,599
	1/Pylon	14.5	15.0	24.0	49.5	9.5	697	7,936 5,645 3,554
BLU-27/B Finned	3/MER	48.5	49.0	81.0	147.0	21.5	2,689	30,617 21,780 13,714
	2/TER	30.0	31.0	52.0	110.0	21.5 9.5	1,742	19,834 14,110 8,884
	1/Pylon	14.5	15.0	24.0	49.5	9.5	823	9,371 6,666 4,197

Figure A1–1 (Sheet 3)

STORE COMPUTATIONS

Store	*Mount/No. of Stores*	*Basic Drag Index (Note 1)* *MN =0.6*	*MN =0.7*	*MN =0.8*	*MN =0.9*	*Distance from Pylon Center to Edge of Store (in Inches) (Note 2)*	*Weight Pounds (Note 3)*	*Rolling Moment Station 1 or 8 Station 2 or 7 Station 3 or 6 (Note 4)*
BLU-27/B Unfinned	3/MER	48.5	49.0	81.0	147.0	21.5	2,644	30,104 21,416 13,484
	2/TER	30.0	31.0	52.0	110.0	21.5 9.5	1,712	19,493 13,867 8,731
	1/Pylon	14.5	15.0	24.0	49.5	9.5	808	9,200 6,544 4,121
CBU-24B/B CBU-49B/B	6/MER	84.0	90.0	103.0	139.0	19.5	5,212	59,330 42,217 26,581
	4/MER	63.5	68.0	78.5	106.5	19.5 8.0	3,548	40,388 28,739 18,095
	2/MER	43.5	46.0	53.5	73.5	19.5 8.0	1,884	21,446 15,260 9,608
	3/TER	55.0	65.0	83.0	128.0	19.5 8.0	2,592	29,506 20,995 13,219
	2/TER	41.0	48.5	63.5	98.5	19.5 8.0	1,760	20,035 14,256 8,976
	1/Pylon	17.0	18.0	21.0	33.5	8.0	832	9,471 6,739 4,243
MK 20 Cluster Bomb	6/MER	70.0	74.0	87.0	118.0	17.0	3,136	35,698 25,402 15,994
	4/MER	54.5	57.5	67.5	92.0	17.0 6.5	2,164	24,634 17,528 11,036
	2/MER	38.5	40.5	48.5	66.5	17.0 6.5	1,192	13,569 9,655 6,079
	3/TER	47.0	51.5	71.0	114.0	17.0	1,554	17,690 12,587 7,925
	2/TER	35.5	39.5	55.5	89.0	17.0 6.5	1,068	12,157 8,651 5,447

Figure A1–1 (Sheet 4)

STORE COMPUTATIONS

Store	Mount/No. of Stores	Basic Drag Index (Note 1) MN =0.6	MN =0.7	MN =0.8	MN =0.9	Distance from Pylon Center to Edge of Store (in Inches) (Note 2)	Weight Pounds (Note 3)	Rolling Moment Station 1 or 8 Station 2 or 7 Station 3 or 6 (Note 4)
	1/Pylon	14.0	14.5	18.0	27.5	6.5	486	5,532 3,937 2,479
SUU-42/A or SUU-42A/A	1/Pylon	13.0	14.0	18.0	35.0	11.5	831	9,460 — —
SUU-20/A	1/Pylon	11.0	12.0	17.0	27.0	10.0	451	— 3,653 —
SUU-20A/A, -20/A-M, SUU-20B/A	1/Pylon	11.0	12.0	17.0	27.0	10.0	522	— 4,223 —
AER No. 45-9534 300-Gal. Fuel Tank	1/Pylon	20.0	20.5	25.5	56.0	13.5	2,191 empty 229	FULL EMPTY 24,941 2,607 — — 11,174 1,168
AIM-9B	1/Fus Pylon	7.5	7.5	7.5	7.5		155	
AIM-9E	1/Fus Pylon	7.5	7.5	7.5	7.5		166	
TDU-11/B	1/Fus Pylon	5.0	6.0	10.0	20.0		215	
ECM Pod								
ALQ-101(V)-1	1/Pylon	12.0	13.0	16.5	24.0	5.0	249	2,835
ALQ-101(V)-3	1/Pylon	12.0	13.0	16.5	24.0	5.0	400	4,555
ALQ-101(V)-4	1/Pylon	12.0	13.0	16.5	24.0	5.0	470	5,352
ALQ-101(V)-6	1/Pylon	12.0	13.0	16.5	24.0	5.0	490	5,579
ECM Pod								
ALQ-71(V)-1	1/Pylon	12.0	13.0	16.5	24.0	5.0	200	2,277
ALQ-71(V)-3	1/Pylon	12.0	13.0	16.5	24.0	5.0	340	3,871
ALQ-71(V)-4	1/Pylon	12.0	13.0	16.5	24.0	5.0	450	5,124
ECM Pod ALQ-87	1/Pylon	12.0	13.0	16.5	24.0	5.25	300	3,415

Figure A1–1 (Sheet 5)

STORE COMPUTATIONS

Store	Mount/No. of Stores	Basic Drag Index (Note 1) MN =0.6	MN =0.7	MN =0.8	MN =0.9	Distance from Pylon Center to Edge of Store (in Inches) (Note 2)	Weight Pounds (Note 3)	Rolling Moment Station 1 or 8 Station 2 or 7 Station 3 or 6 (Note 4)
BDU-33A/B or BDU-33B/B	6/MER	28.0	30.0	33.5	49.0	9.2	364	4,143 2,948
	3/TER	16.0	18.0	26.0	42.5	9.2	168	1,912 1,360
LAU-68/A	3/TER	25.0	27.5	40.5	68.0	14.3 5.0	750	8,540 6,075 3,825
	2/TER	21.0	23.5	35.0	49.0	14.3 5.0	532	6,058 4,310 2,714
	1/Pylon	8.0	9.0	12.0	19.5	5.0	218	2,483 1,766 1,112
LAU-3/A LAU-95	3/TER	38.0	44.0	61.0	100.0	19.5 8.0	1,521	17,318 12,320 7,757
	2/TER	29.5	34.5	48.5	80.5	19.5 8.0	1,046	11,910 8,473 5,334
	1/Pylon	11.5	12.0	15.0	23.5	8.0	475	5,409 3,848 2,423
CBU-12A/A	3/TER	40.5	47.5	66.0	111.5	19.1 7.8	2,067	23,535 16,743 10,542
	2/TER	31.5	36.0	52.0	87.5	19.1 7.8	1,410	16,054 11,421 7,191
	1/Pylon	15.5	17.5	24.0	38.5	7.8	657	7,481 5,322 3,351
CBU-30/A	1/Pylon	20.0	23.0	28.0	38.0	7.2	385	4,384 3,119 1,964
CBU-38/A	1/Pylon	20.0	23.0	28.0	38.0	7.2	704	8,016 5,703 3,591

Figure A1–1 (Sheet 6)

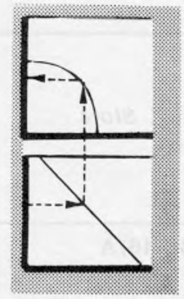
STORE COMPUTATIONS

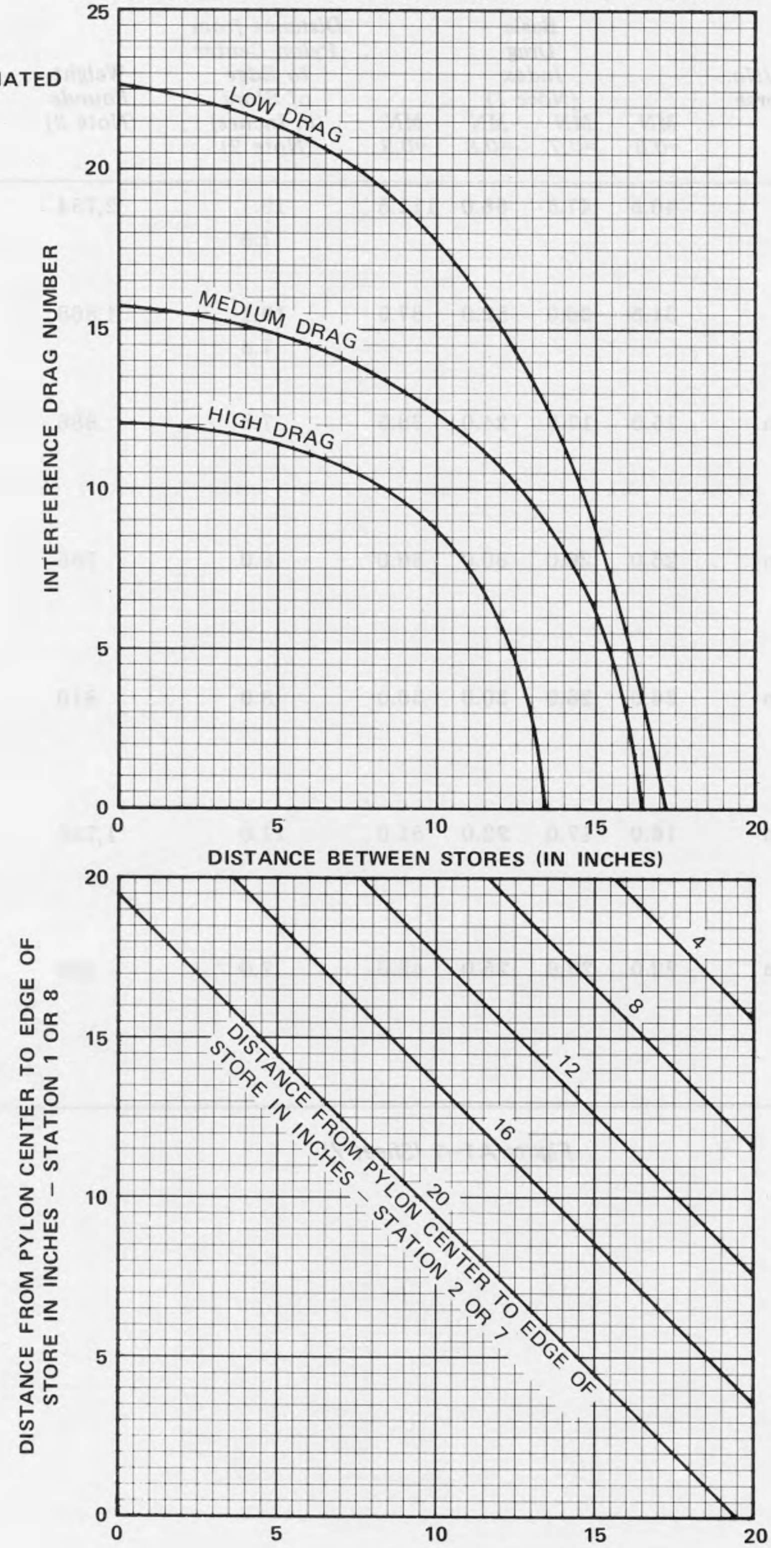
Store	Mount/No. of Stores	Basic Drag Index (Note 1) MN =0.6	MN =0.7	MN =0.8	MN =0.9	Distance from Pylon Center to Edge of Store (in Inches) (Note 2)	Weight Pounds (Note 3)	Rolling Moment Station 1 or 8 Station 2 or 7 Station 3 or 6 (Note 4)
CBU-46/A	3/TER	40.5	47.5	66.0	111.5	19.1	2,754	31,357
						7.8		22,308
								14,046
	2/TER	31.5	36.0	52.0	87.5	19.1	1,868	21,269
						7.8		15,131
								9,527
	1/Pylon	15.5	17.5	24.0	38.5	7.8	886	10,088
								7,177
								4,519
CBU-52A/B	1/Pylon	26.0	26.0	30.0	50.0	8.0	785	8,938
CBU-52B/B								6,359
								4,004
CBU-58/B	1/Pylon	26.0	26.0	30.0	50.0	8.0	810	9,223
								6,561
								4,131
SUU-23A	1/Pylon	16.0	17.0	22.0	51.0	11.0	1,730	19,698
								14,013
								8,823
SUU-25C/A	1/Pylon	22.0	22.0	25.0	42.0	7.0	480	5,466
								3,888
								2,448

Figure A1–1 (Sheet 7)

INTERFERENCE DRAG
BETWEEN STATIONS 1 AND 2 OR 7 AND 8

MODEL: A-7D
DATE: JULY 1968
DATA BASIS: ESTIMATED





NOTE

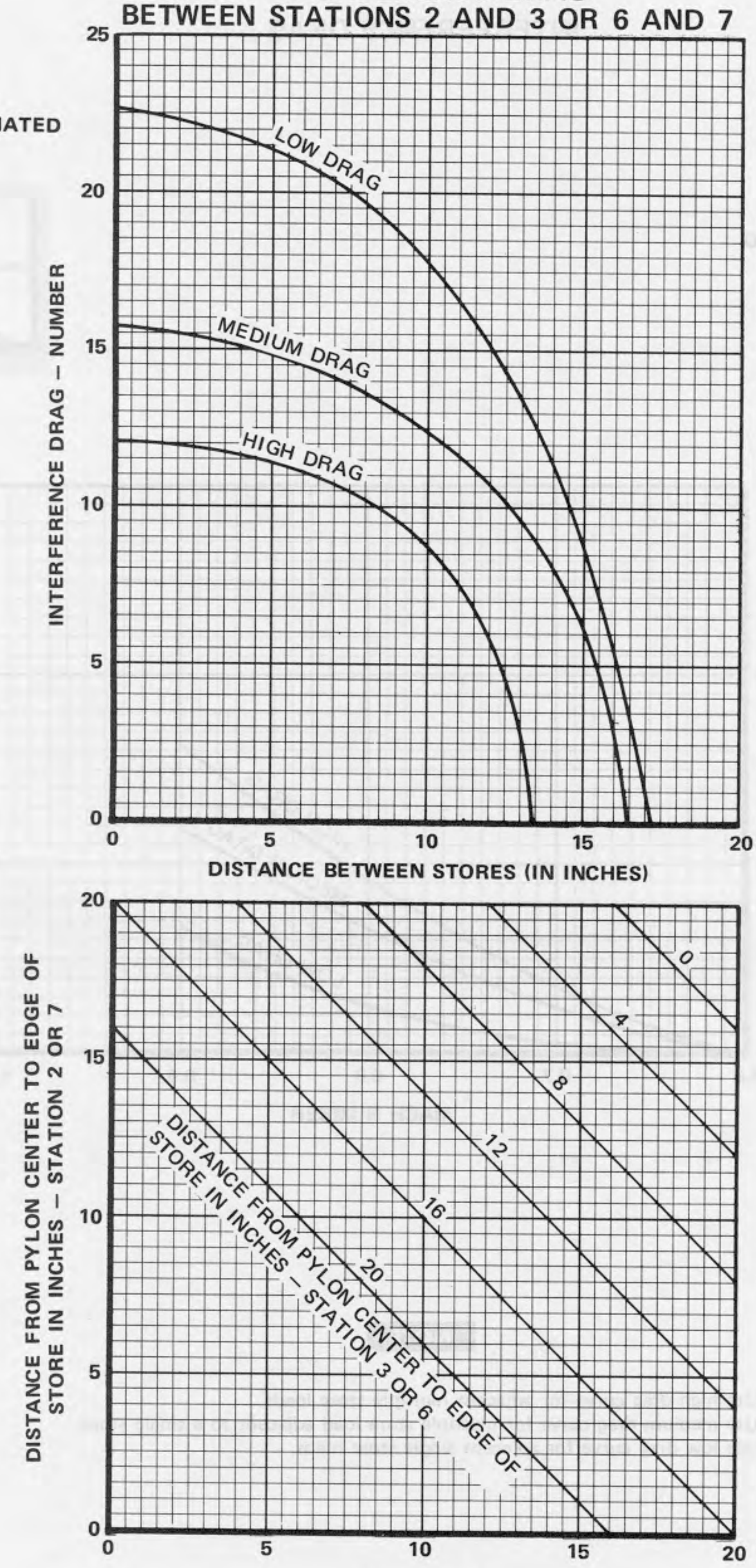
Use high drag curve for adjacent multiple store loads.
Use medium drag curve for multiple store load adjacent to a single store.
Use low drag curve for adjacent single store loads.

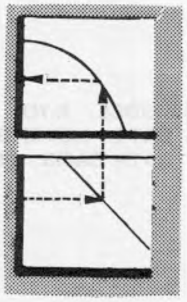
75D188–03–71

Figure A1–2 (Sheet 1)

INTERFERENCE DRAG BETWEEN STATIONS 2 AND 3 OR 6 AND 7

MODEL: A-7D
DATE: JULY 1968
DATA BASIS: ESTIMATED





NOTE

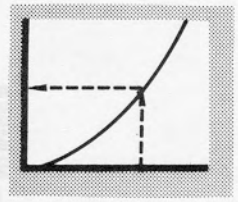
Use high drag curve for adjacent multiple store loads.
Use medium drag curve for multiple store load adjacent to a single store.
Use low drag curve for adjacent single store loads.

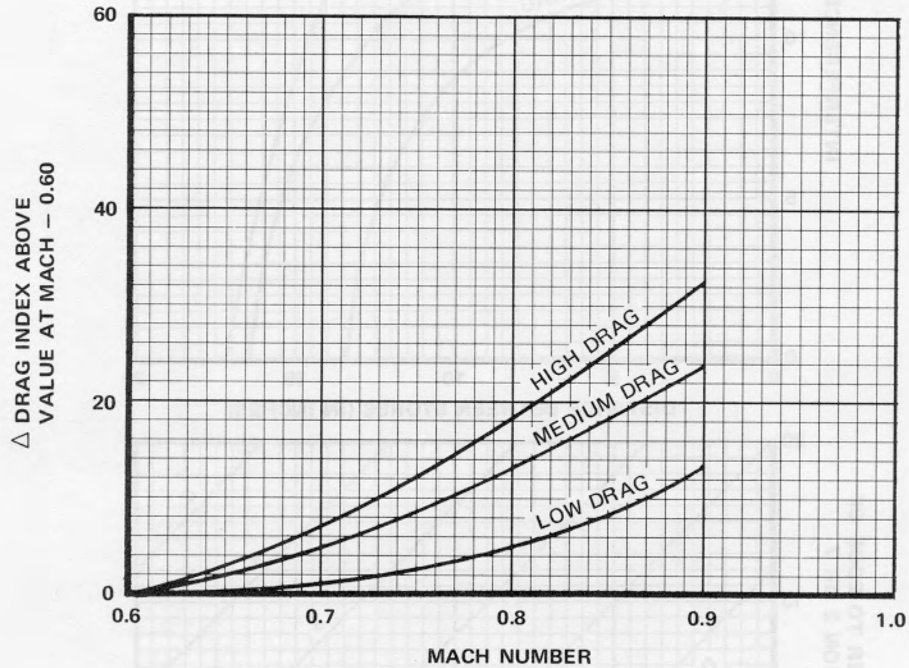
75D189–03–71

Figure A1–2 (Sheet 2)

INTERFERENCE DRAG

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **ESTIMATED**





NOTE

Use high drag curve for adjacent multiple store loads.
Use medium drag curve for multiple store load adjacent to a single store.
Use low drag curve for adjacent single store loads.

75D264–06–71

Figure A1–2 (Sheet 3)

SAMPLE DRAG COMPUTATION

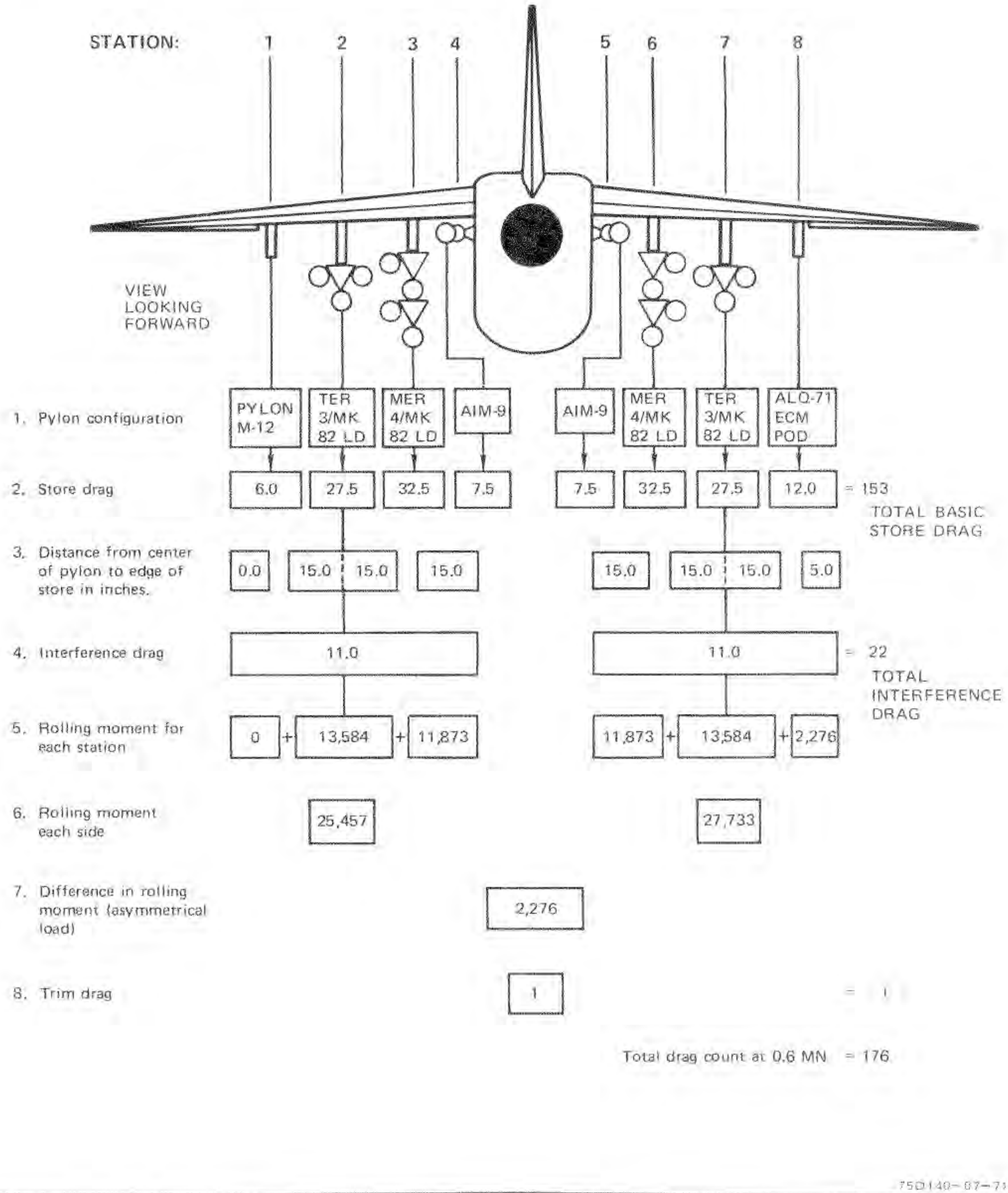
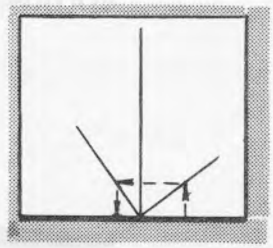


Figure A1–3

TRIM DRAG DUE TO ASYMMETRICAL STORE LOAD

MODEL: A-7D
DATE: JULY 1968
DATA BASIS: ESTIMATED



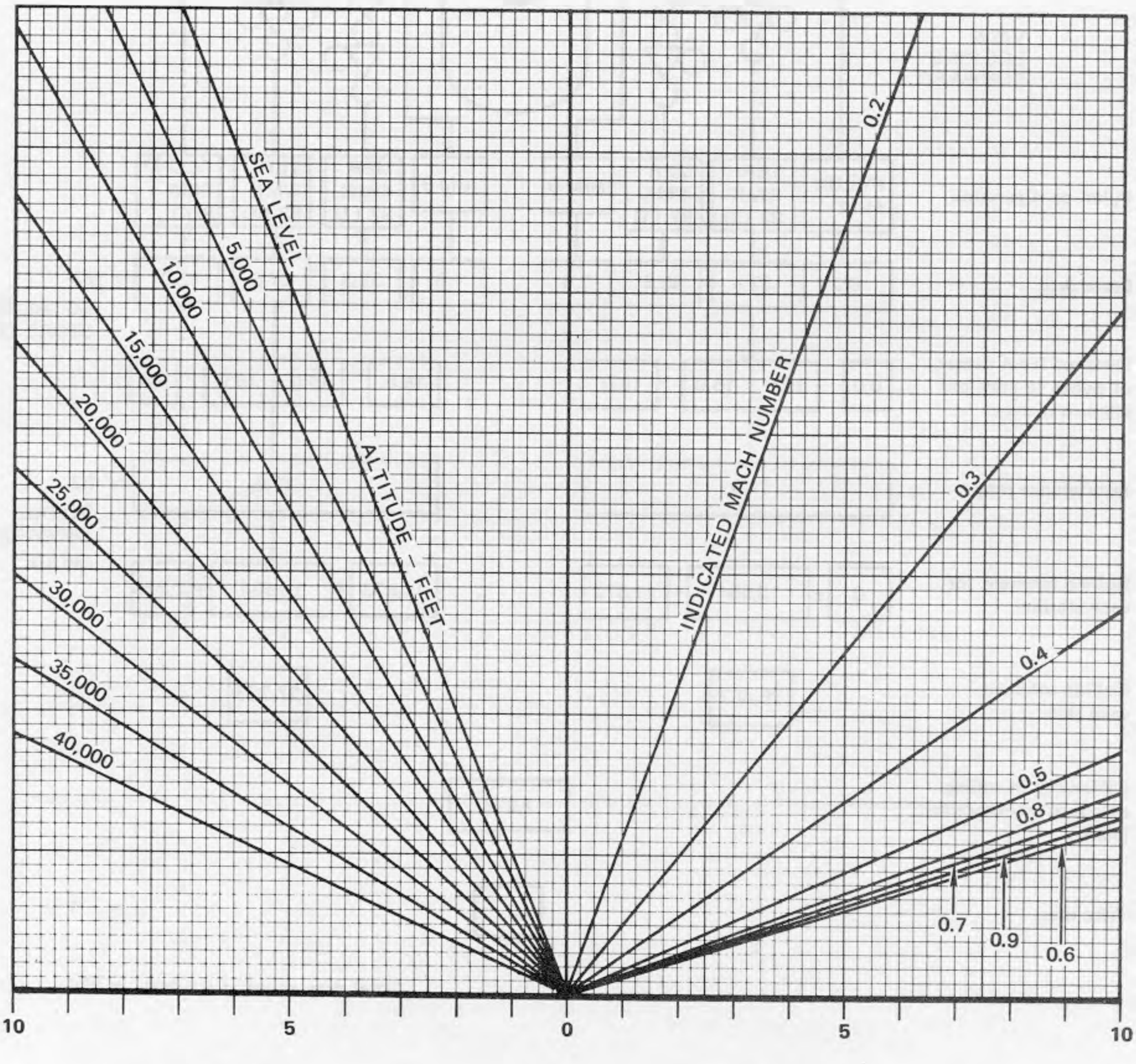
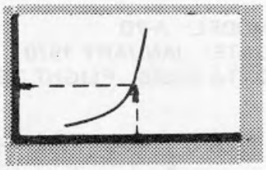


Figure A1–4

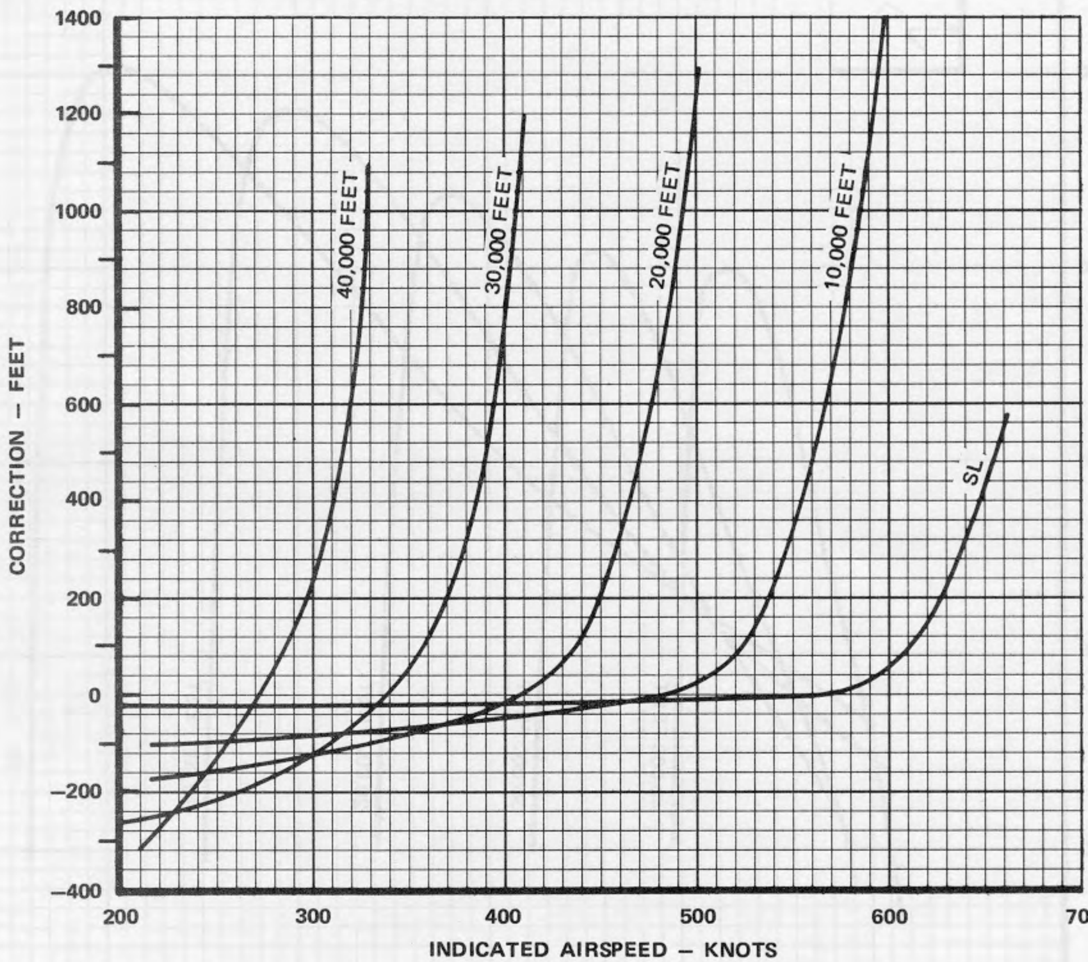
POSITION ERROR CORRECTION

ALTITUDE CORRECTION
CRUISE CONDITION
AAU-19/A PNEUMATIC (STBY) MODE



MODEL: A-7D
DATE: OCTOBER 1968
DATA BASIS: FLIGHT TEST

PRESSURE ALTITUDE (CALIBRATED ALTITUDE) = INDICATED ALTITUDE + CORRECTION



NOTE

Position error in landing condition is negligible.

75D144-03-71

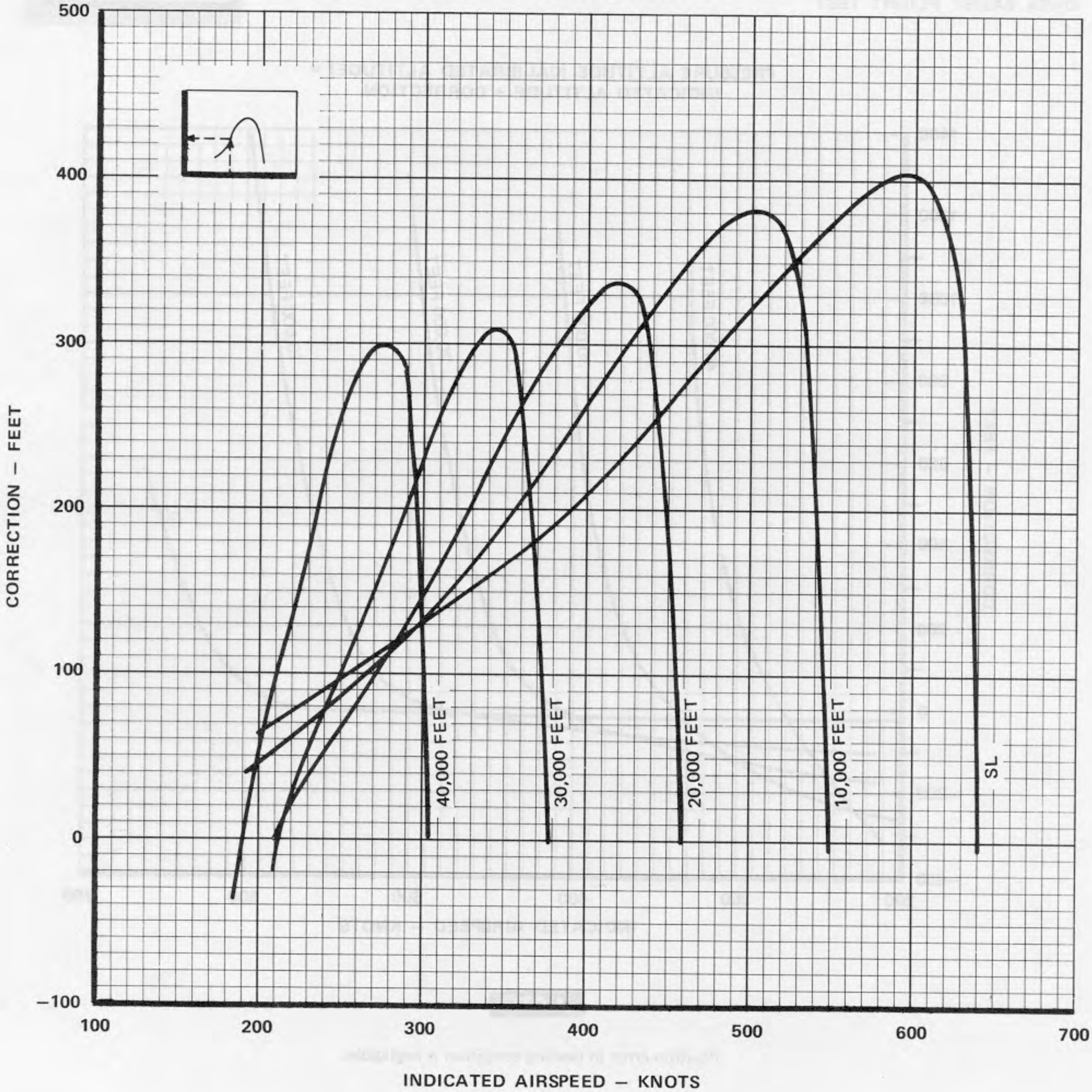
Figure A1–5 (Sheet 1)

POSITION ERROR CORRECTION

ALTITUDE CORRECTION
CRUISE CONDITION
AAU-19/A SERVO (RESET) MODE

MODEL: A-7D
DATE: JANUARY 1970
DATA BASIS: FLIGHT TEST

PRESSURE ALTITUDE (CALIBRATED ALTITUDE) = CORRECTION + INDICATED ALTITUDE



75D249(1)–03–71

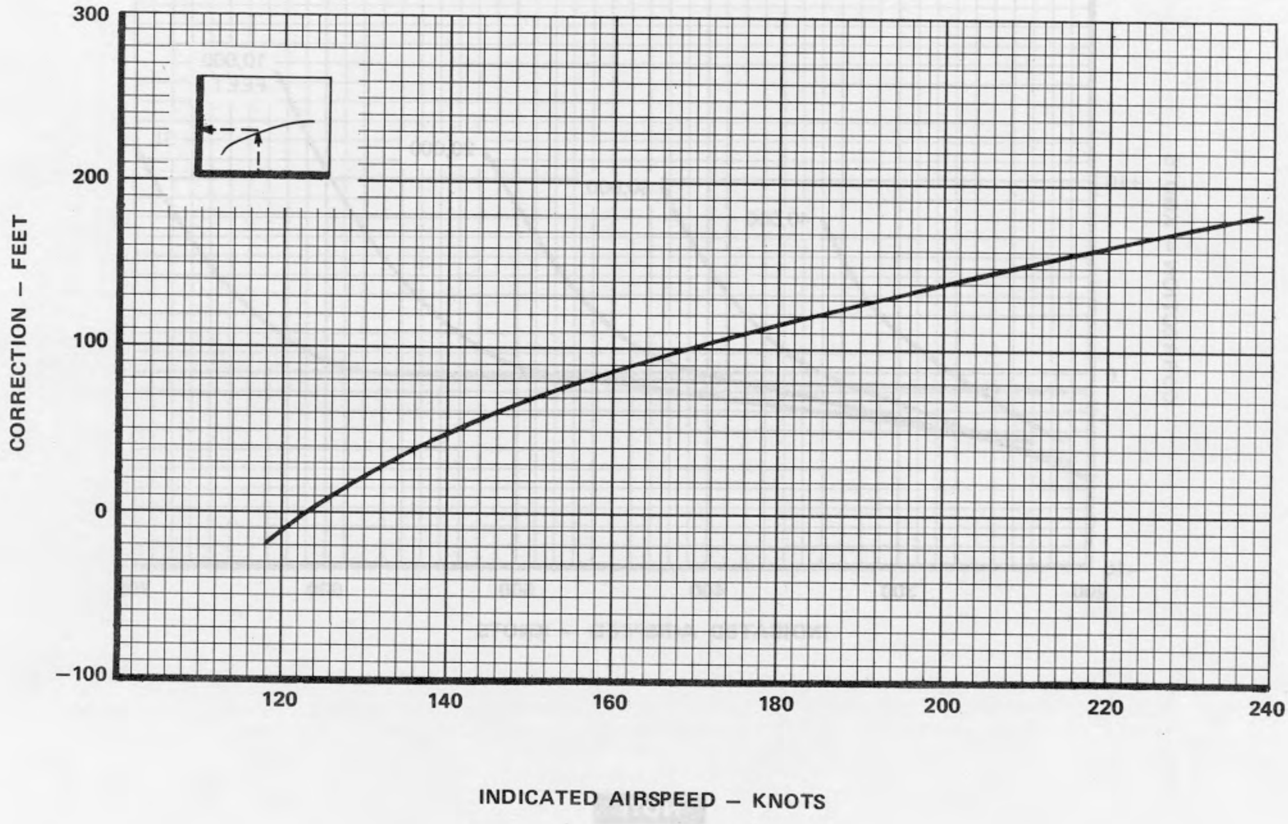
Figure A1–5 (Sheet 2)

POSITION ERROR CORRECTION

ALTITUDE CORRECTION
LANDING CONDITION
AAU-19/A SERVO (RESET) MODE

MODEL: A-7D
DATE: JANUARY 1970
DATA BASIS: FLIGHT TEST

PRESSURE ALTITUDE (CALIBRATED ALTITUDE) = CORRECTION + INDICATED ALTITUDE



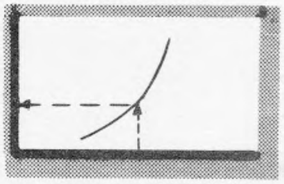
75D249(2)−03−71

Figure A1–5 (Sheet 3)

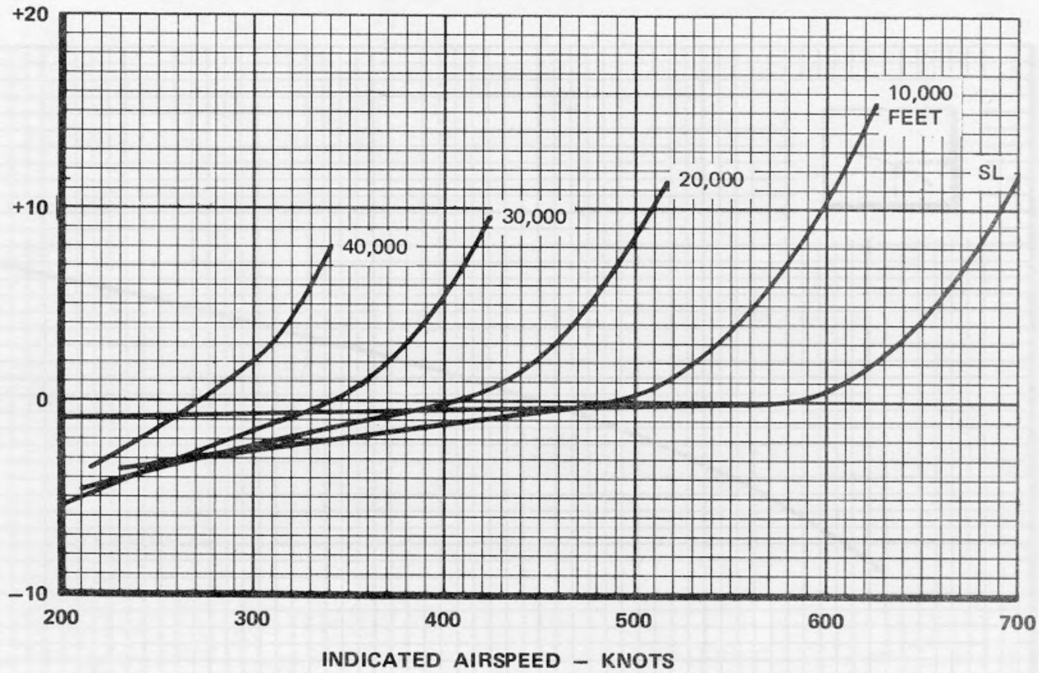
POSITION ERROR CORRECTION

AIRSPEED CORRECTION
CRUISE CONDITION

MODEL: A-7D
DATE: JULY 1970
DATA BASIS: FLIGHT TEST



CALIBRATED AIRSPEED = INDICATED AIRSPEED + CORRECTION



NOTE

Position error in landing condition is negligible.

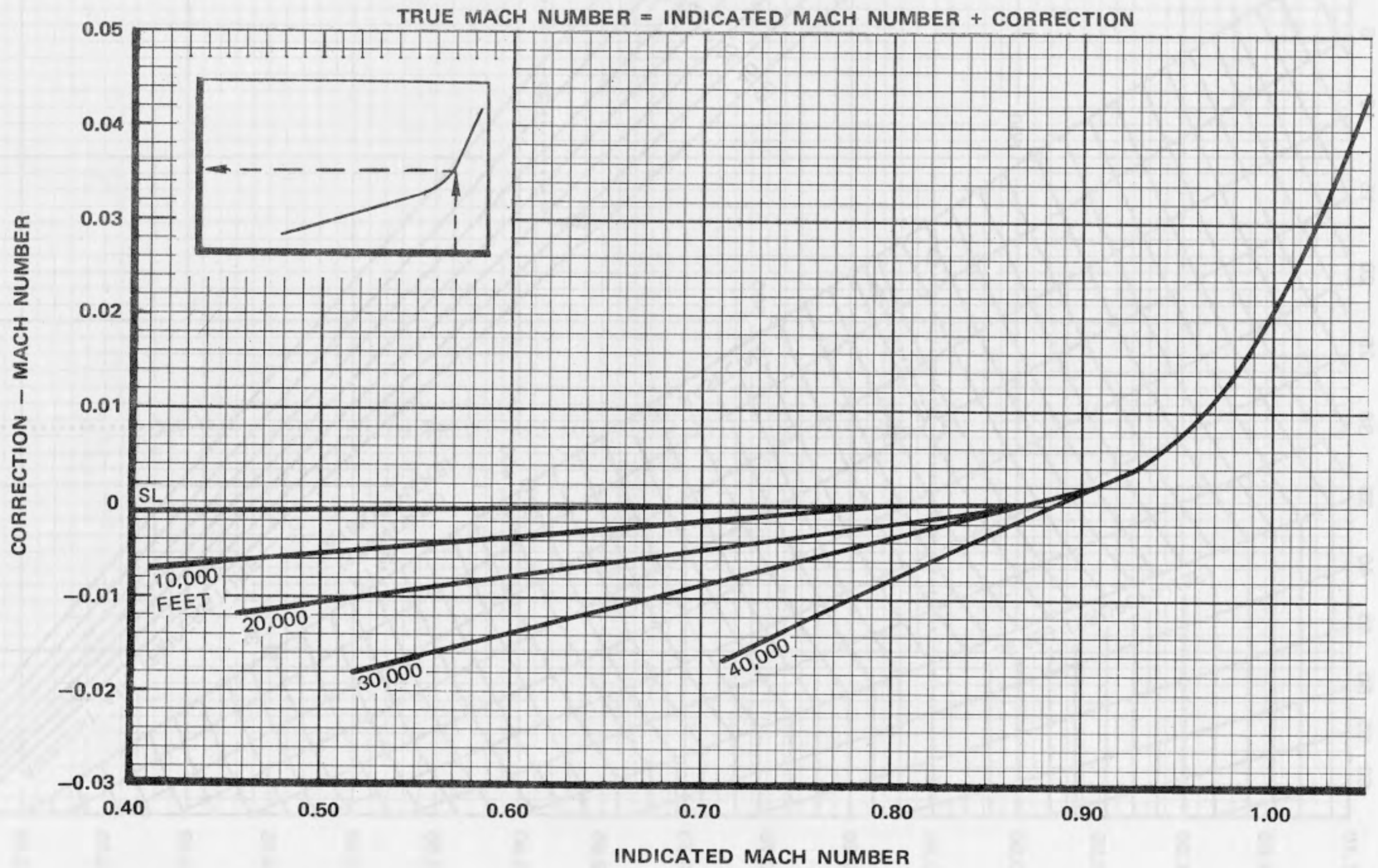
75D143–03–71

Figure A1–5 (Sheet 4)

POSITION ERROR CORRECTION

MACH NUMBER CORRECTION

MODEL: A-7D
DATE: MARCH 1971
DATA BASIS: FLIGHT TEST



75D142–03–71

Figure A1–5 (Sheet 5)

AIRSPEED-MACH NUMBER CONVERSION

MODEL: A-7D
DATA BASIS: CALCULATED

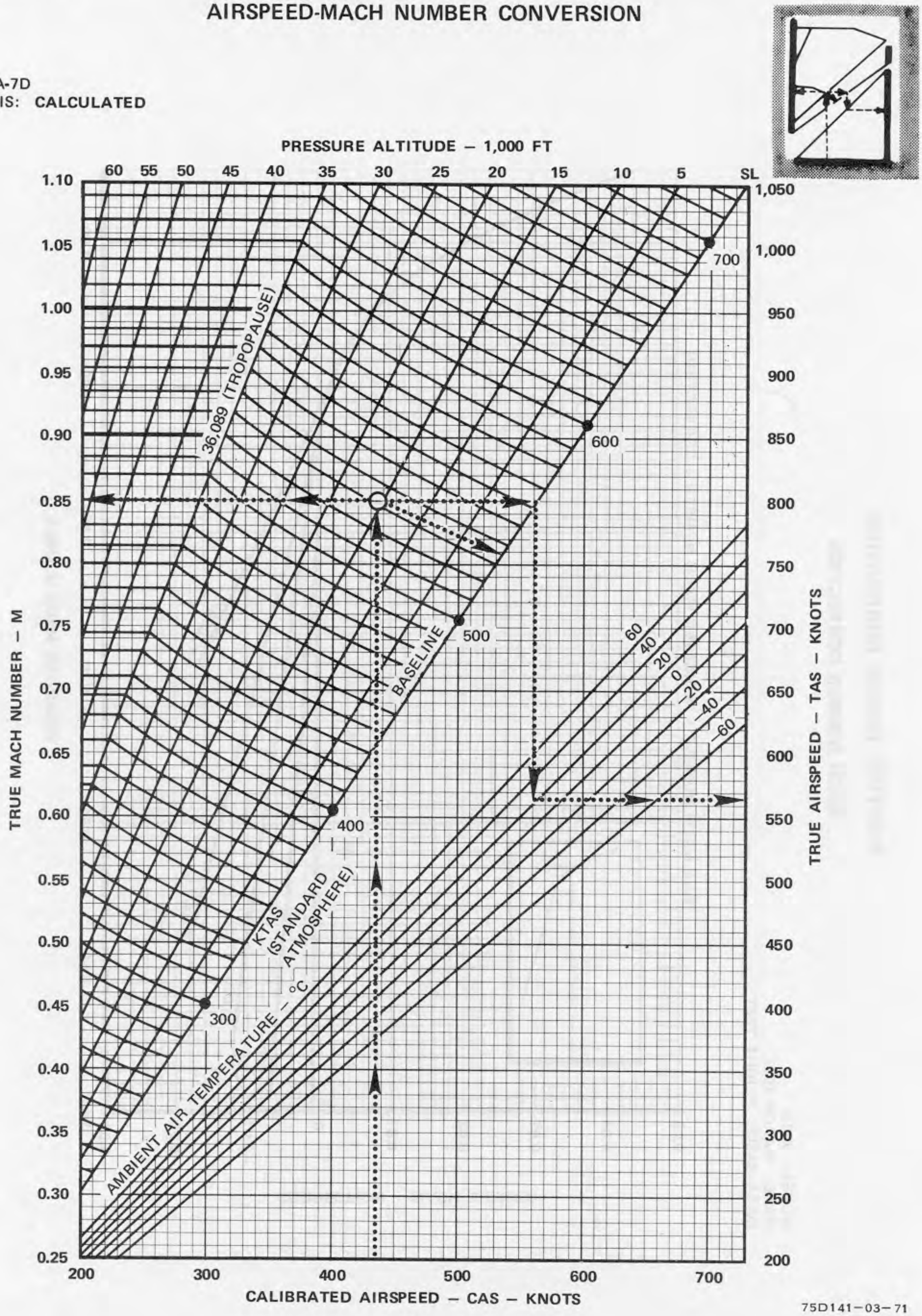
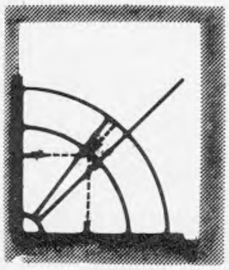
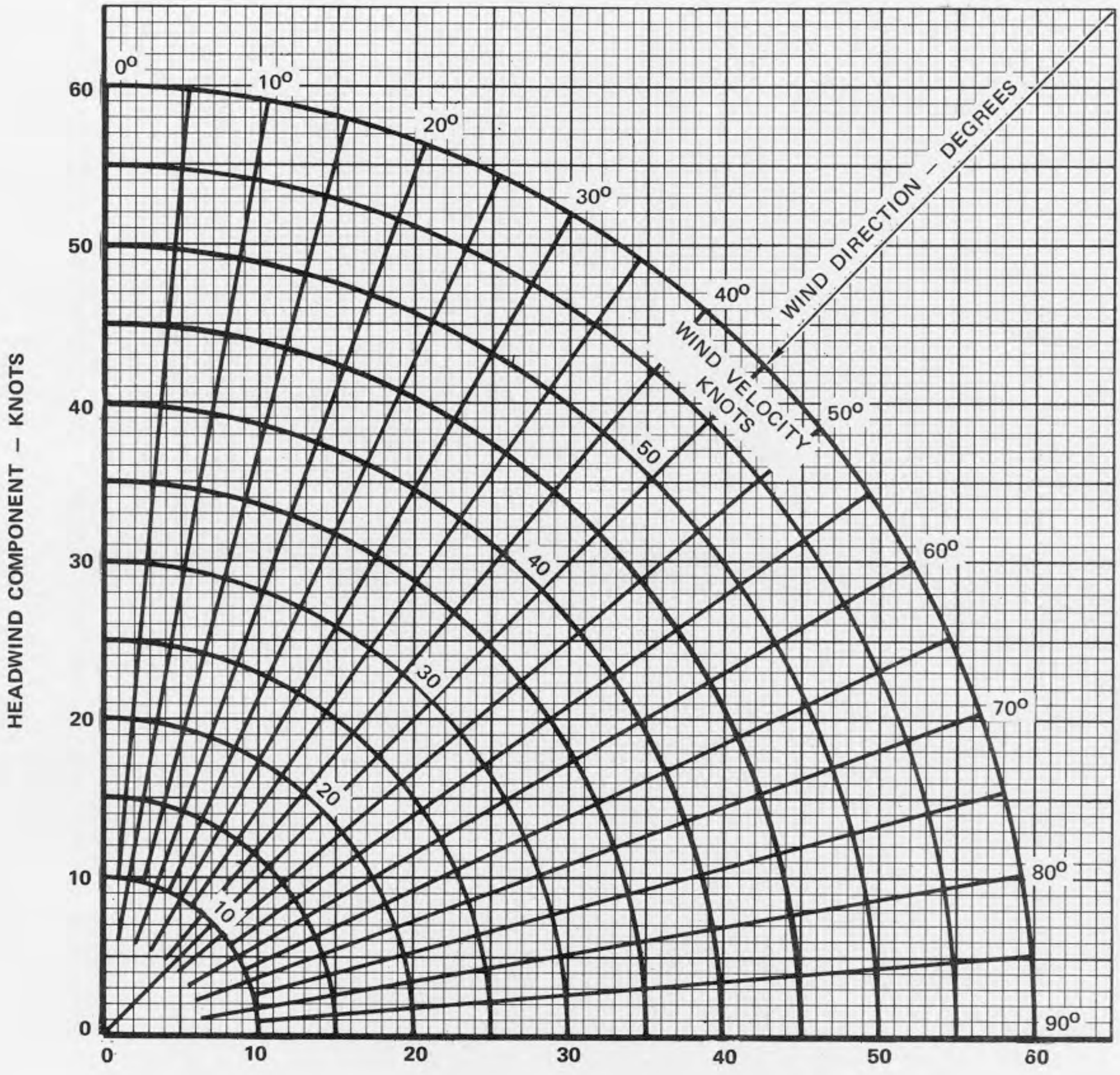


Figure A1–6

RUNWAY WIND COMPONENTS

MODEL: A-7D
DATA BASIS: **CALCULATED**





NOTE

Enter chart with steady wind to determine headwind or tailwind component and with maximum gust velocity to determine crosswind component.

75D024–03–71

Figure A1–7

Part 2
Takeoff

TABLE OF CONTENTS.

TAKEOFF PERFORMANCE CHARTS (GENERAL).

Takeoff charts provide a means of determining takeoff performance under normal operating conditions. Abort performance is also presented to provide information for planning safe operating procedures for use in the event that abnormal engine operation is experienced during takeoff. The charts present takeoff speeds and distances based on normal engine operation for dry, hardsurfaced runways, using takeoff procedures contained in Section II. A definition of the takeoff terms pertaining to each chart precedes the explanation of the use of the chart.

Note

Fuel allowance for starting engine and taxi is 200 pounds.

TAKEOFF AND 50-FT OBSTACLE CLEARANCE SPEED CHART.

The Takeoff and 50-Ft Obstacle Clearance Speed chart is presented in figure A2–1. The takeoff and obstacle clearance speeds are figured at military power for 25° flap setting.

DEFINITIONS.

TAKEOFF SPEED: Speed at which main gear lifts from runway.

OBSTACLE CLEARANCE SPEED: Speed necessary to obtain obstacle clearance distance.

USE.

Enter the takeoff and obstacle clearance speed chart with the takeoff gross weight, proceed vertically up to the lift-off speed, and then move horizontally left and read takeoff speed. Extend the gross weight line vertically to obstacle clearance speed and then move horizontally to obtain obstacle clearance speed.

SAMPLE PROBLEM.

Given:

A. Takeoff gross weight is 36,500 lb.

B. Takeoff is with military power and 25° flaps.

C. Headwind is 10 kn.

D. Runway pressure altitude is 1,000 ft.

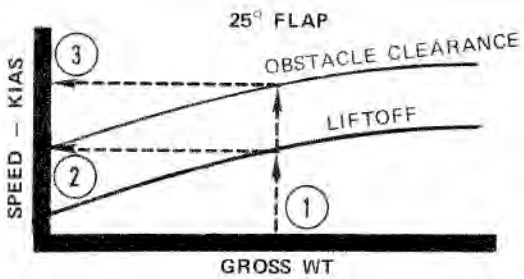
E. Runway temperature is 25°C.

Calculate:

Takeoff and obstacle clearance speeds, using Takeoff and 50-Ft Obstacle Clearance Speed chart (figure A2–1).

(1)	Gross weight	36,500 lb
(2)	Takeoff speed	159 KIAS
(3)	Obstacle clearance speed	174 KIAS

SAMPLE TAKEOFF AND 50-FT OBSTACLE CLEARANCE SPEED



75D154-03-71

TAKEOFF GROUND DISTANCE AND 50-FT OBSTACLE CLEARANCE DISTANCE CHARTS.

Takeoff ground distance is presented in figure A2–2, sheet 1. Obstacle clearance distance is presented in figure A2–2, sheet 2.

DEFINITIONS.

TAKEOFF GROUND DISTANCE: Ground run in feet from brake release to lift-off.

RUNWAY SLOPE: Expressed in percent (uphill or downhill), runway slope is the change in runway height divided by the runway length multiplied by 100.

OBSTACLE CLEARANCE DISTANCE: Horizontal distance from brake release to 50-foot obstacle.

USE.

Enter the takeoff ground distance chart with temperature and proceed vertically up to pressure altitude; then proceed horizontally right to takeoff gross weight. From this point, proceed vertically down to the wind baseline. Contour the guidelines for headwind or tailwind to the wind velocity. (If zero wind conditions prevail, proceed directly through.) From this plot, proceed vertically down to read the takeoff ground distance required. If a runway slope correction is necessary, add or subtract the appropriate distance (see note on chart) to or from the ground distance to obtain actual takeoff ground run distance.

For total obstacle clearance distance, enter 50-foot obstacle clearance distance chart with the takeoff ground run distance (or takeoff ground run distance corrected for wind velocity and runway slope). Proceed vertically down from takeoff ground run distance to the windline (interpolate as necessary). Then go left to scaled edge for computed distance required to clear a 50-foot obstacle.

Note

To determine takeoff distance for aircraft without double datum amplifier, increase the ground run and obstacle clearance distances shown by 10% when the ambient temperature is higher than 39°F (4°C). For temperatures lower than 39°F, the distances are the same as shown on the chart.

SAMPLE PROBLEM.

Given:

A. Temperature is +20°C

B. Pressure altitude is 2,000 ft.

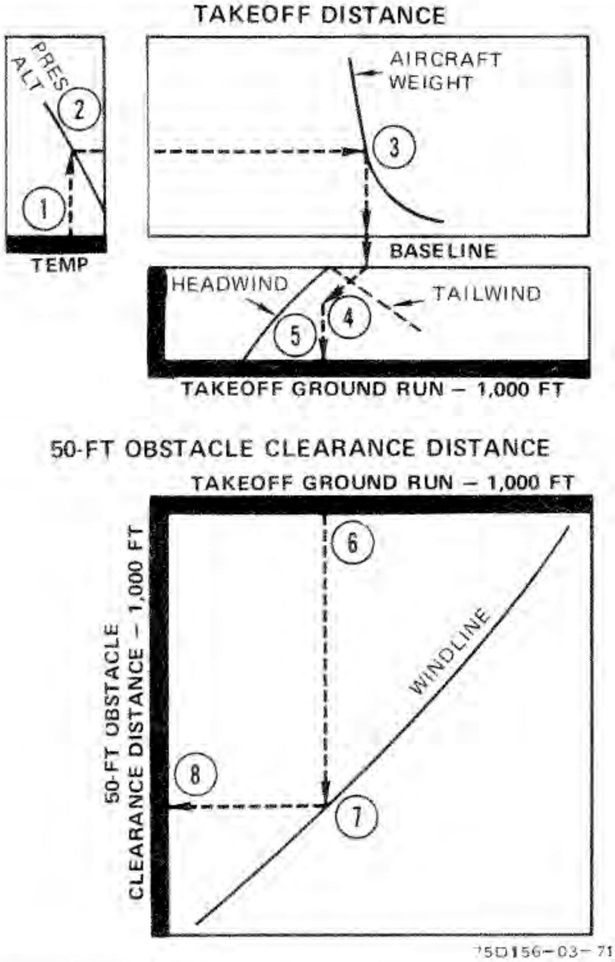
C. Takeoff gross weight is 36,500 lb.

D. Runway headwind is 10 kn.

E. Runway surface is dry.

F. Runway slope is 1% uphill.

SAMPLE TAKEOFF GROUND DISTANCE AND 50-FT OBSTACLE CLEARANCE DISTANCE



Calculate:

Takeoff ground run and 50-ft obstacle clearance distance.

(1)	Temperature	+20°C
(2)	Pressure altitude	2,000 ft
(3)	Aircraft weight	36,500 lb
(4)	Headwind	10 knots
(5)	Takeoff ground run	4,700 ft
(6)	Takeoff ground run	4,700 ft
(7)	Windline	10 knots
(8)	50-ft obstacle clearance	6,900 ft

For 1% uphill runway slope add 5%:
235 ft + 4,700 ft = 4,935 ft

Obstacle clearance with 1% uphill slope = 7,250 ft

REFUSAL SPEED CHARTS.

The refusal speed charts for antiskid braking are presented in figure A2–3, sheets 1 and 2. Maximum refusal speed is a function of gross weight, pressure altitude, temperature, runway length, and RCR.

DEFINITION.

REFUSAL SPEED: Maximum speed to which an aircraft can accelerate and then stop in the remaining runway length.

USE.

Enter figure A2–3, sheet 1 with temperature in degrees centigrade. Proceed horizontally right to the proper pressure altitude. Proceed vertically up from this point to the gross weight curve and then proceed horizontally right to determine the reference number. Enter figure A2–3, sheet 2 with the reference number and proceed horizontally right to runway length then read vertically down for refusal speed. Proceed vertically down to the RCR baseline and follow the contour of the curves to the corresponding RCR number and then proceed vertically down and read the maximum refusal speed.

Note

To determine refusal speed and maximum refusal speed for manual braking, subtract 2 knots from antiskid refusal speeds.

SAMPLE PROBLEM.

Given:

A. Takeoff gross weight is 36,500 lb.

B. Antiskid braking.

C. Temperature is +20°C.

D. Pressure altitude is 2,000 ft.

E. Actual runway length is 10,000 ft.

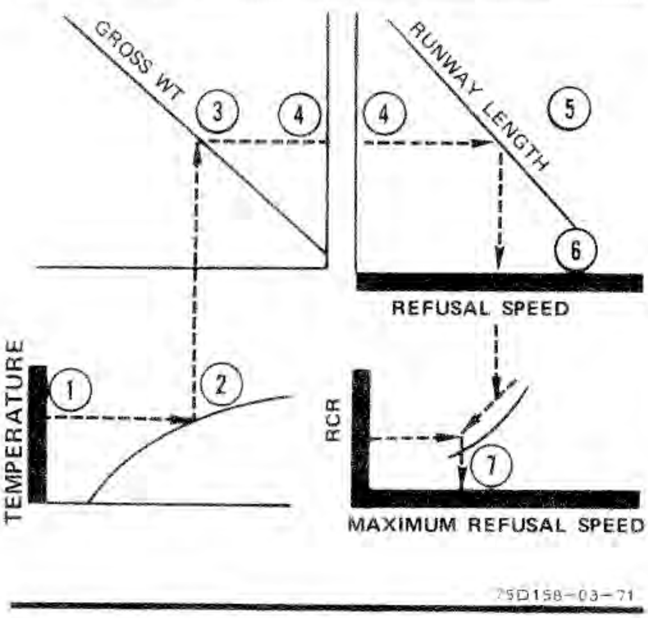
F. RCR is 15.

Calculate:

Refusal speed, using Refusal Speeds chart (figure A2–4, sheets 1 and 2).

(1)	Temperature	+20°C
(2)	Pressure altitude	2,000 ft
(3)	Gross weight	36,500 lb
(4)	Reference number	1.8
(5)	Runway length	10,000 ft
(6)	Refusal speed	146 KIAS
(7)	Maximum refusal speed	136 KIAS

SAMPLE REFUSAL SPEED AND MAXIMUM REFUSAL SPEED



VELOCITY DURING TAKEOFF GROUND RUN CHART.

The Velocity During Takeoff Ground Run chart in figure A2–5 is used to determine the acceleration check speed at the acceleration check decision point.

Note

If a definite failure occurs prior to reaching the acceleration check distance marker, the aircraft should be stopped. If the marker is reached and partial failure is indicated by the fact that the aircraft speed is less than that predicted for the marker, the pilot must not apply aft stick pressure to takeoff until liftoff speed is attained.

DEFINITIONS.

ACCELERATION CHECK DISTANCE: Distance to the runway marker which is the next lower 1,000-foot marker short of the refusal distance. The final decision to continue or abort the takeoff must be made at this point.

ACCELERATION CHECK SPEED: Minimum allowable speed at the acceleration check marker.

REFUSAL DISTANCE: Distance required to accelerate from brake release to refusal speed.

USE.

Enter the chart by establishing a point on the chart which is defined by the takeoff speed and takeoff ground distance (uncorrected for winds) read from figures A2–1 and A2–2, respectively. After this point is located on the chart, construct a line through the point with a slope contouring that of the nearest guideline. Any point on this line represents the normal speed/distance relationship of that particular configuration during takeoff with no wind. The acceleration check distance is determined by entering the bottom of the chart with refusal speed (uncorrected for winds), and proceeding vertically upward and intersecting the constructed normal acceleration line. Move horizontally left from the intersection and read the refusal distance on the acceleration distance scale. The acceleration check distance is the nearest 1,000-foot reading on the acceleration distance scale below the refusal distance value. The 1,000-foot runway marker representative of the distance is the acceleration check marker. Reenter chart at the acceleration check distance, and proceed horizontally right to intersect the constructed normal acceleration line. From this intersection, drop vertically downward and read the acceleration check speed. Add headwind to or subtract tailwind from zero wind acceleration check speed.

SAMPLE PROBLEM.

Given:

A. Dry runway, 1% uphill slope, 25° flaps, and military power.

B. Gross weight is 36,500 lb.

C. Temperature is 20°C.

D. Pressure altitude is 2,000 ft.

E. Headwind is 10 kn.

F. Takeoff speed is 159 KIAS.

G. Takeoff distance (no wind) is 5,400 ft.

H. Runway length is 10,000 ft.

I. Refusal speed (uncorrected) from figure A2–3 is 146 KIAS.

Calculate:

Acceleration check speed, acceleration check distance, and refusal distance, using Velocity During Takeoff Ground Run Chart (figure A2–5).

(1) Establish point on chart defined by takeoff speed of 159 KIAS and takeoff ground run distance of 5,400 ft.

(2) Construct contour line.

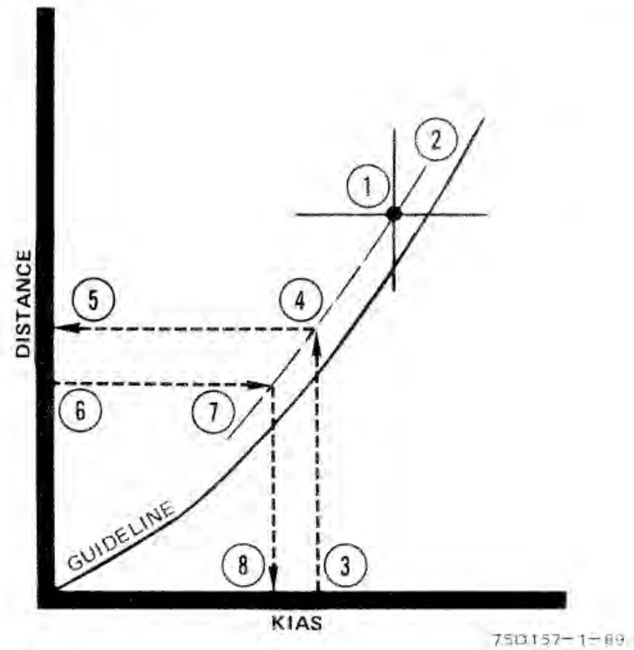
A. Determine refusal speed and distance.

(3)	Refusal speed (uncorrected)	146 KIAS
(4)	Intersect constructed contour line at refusal speed.	—
(5)	Refusal distance	4,600 ft

B. Determine acceleration check distance by selecting next lower 1,000-ft reading from refusal distance on same scale.

(6)	Acceleration check distance	4,000 ft
(7)	Intersect constructed contour line.	—
(8)	Acceleration check speed	137 KIAS
(9)	Acceleration check speed corrected for 10-kn headwind	147 KIAS

SAMPLE VELOCITY DURING TAKEOFF GROUND RUN

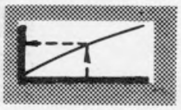


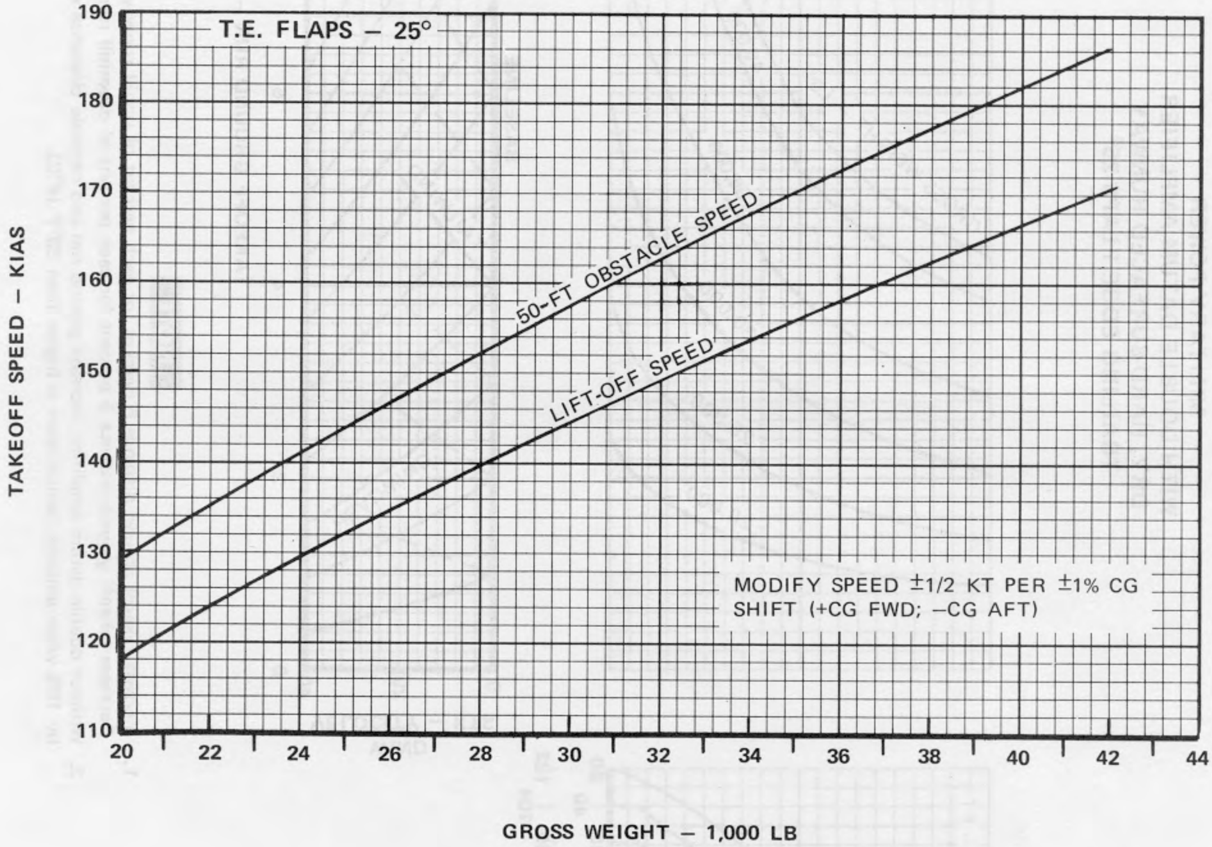
TAKEOFF AND 50-FT OBSTACLE CLEARANCE SPEEDS

TAKEOFF CG 26% SPEEDS

MODEL: A-7D
DATE: JANUARY 1971
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.





75D002–03–71

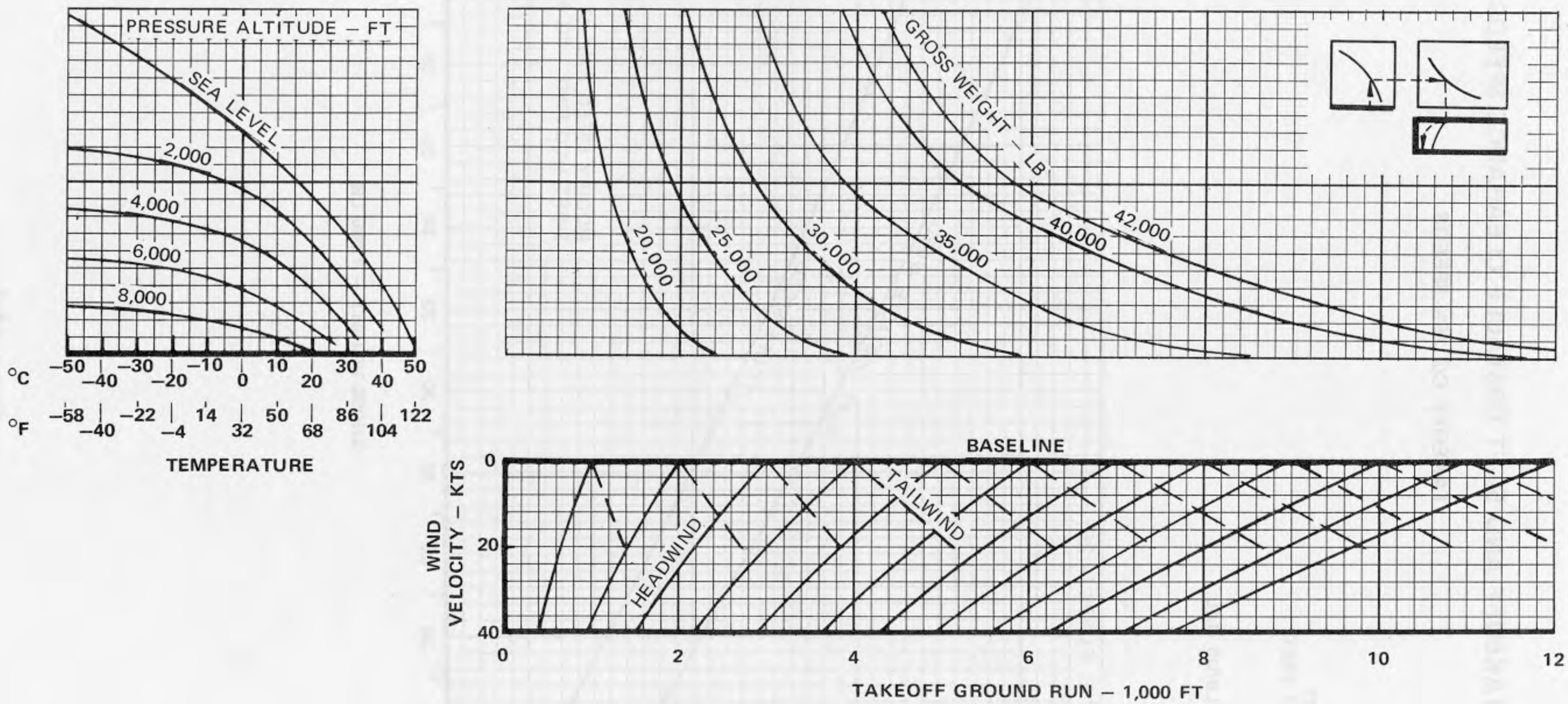
Figure A2–1

TAKEOFF GROUND DISTANCE

MILITARY POWER
WITH DOUBLE DATUM AMPLIFIER
DRY, HARD-SURFACED RUNWAY
TRAILING EDGE FLAPS 25°

MODEL: A-7D
DATE: JANUARY 1971
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



NOTE

1. Increase takeoff ground distance 5 percent for each percent of uphill runway slope. Decrease takeoff ground distance 5 percent for each percent of downhill runway slope.
2. Without double datum amplifier, increase ground run and obstacle clearance distances by 10% when ambient temperature is higher than 39°F (4°C).

75D014–03–71

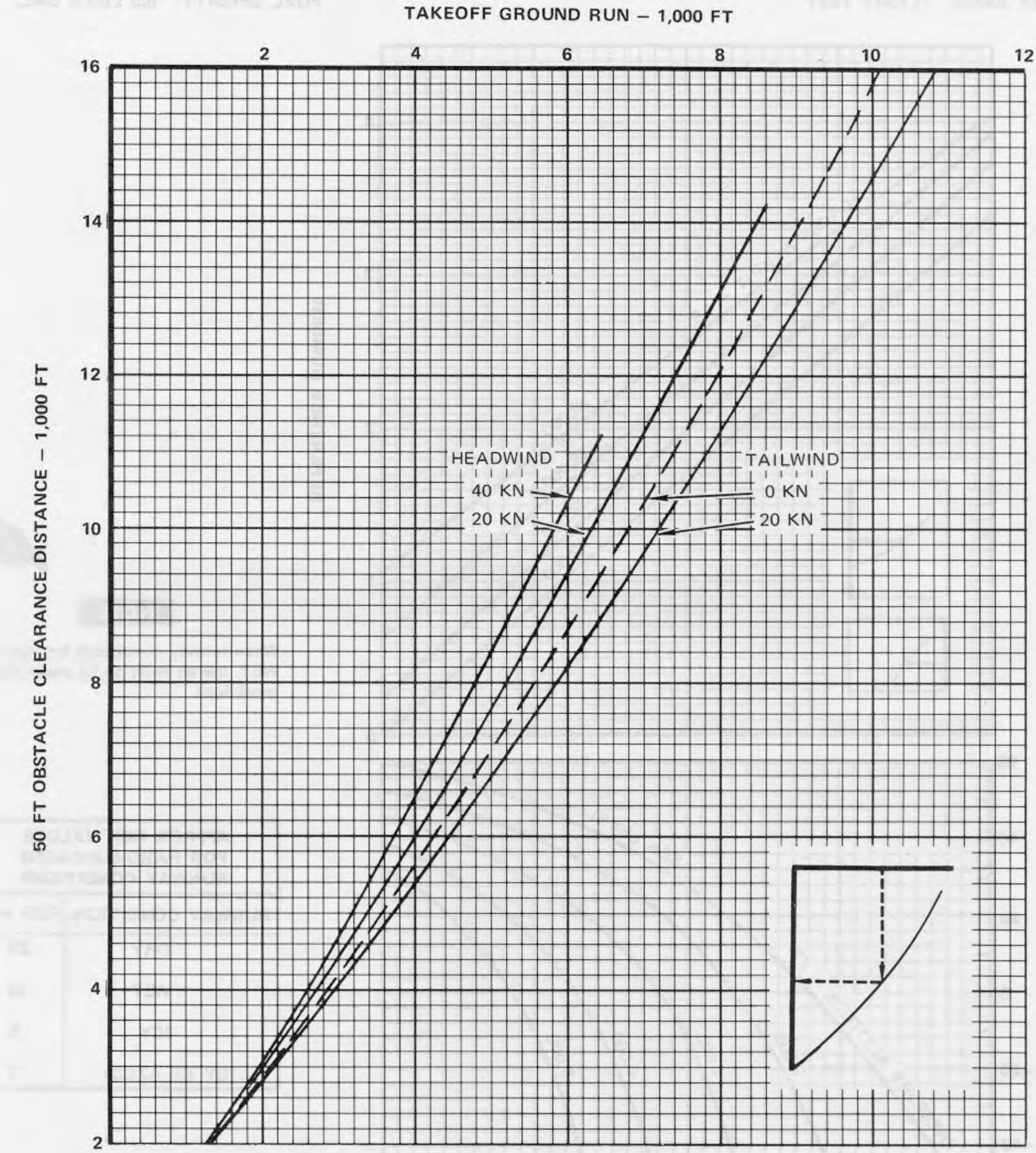
Figure A2–2 (Sheet 1)

50-FT OBSTACLE CLEARANCE DISTANCE

MILITARY POWER
WITH DOUBLE DATUM AMPLIFIER
DRY, HARD-SURFACED RUNWAY
25° FLAPS

MODEL: A-7D
DATE: JANUARY 1971
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



75D136–03–71

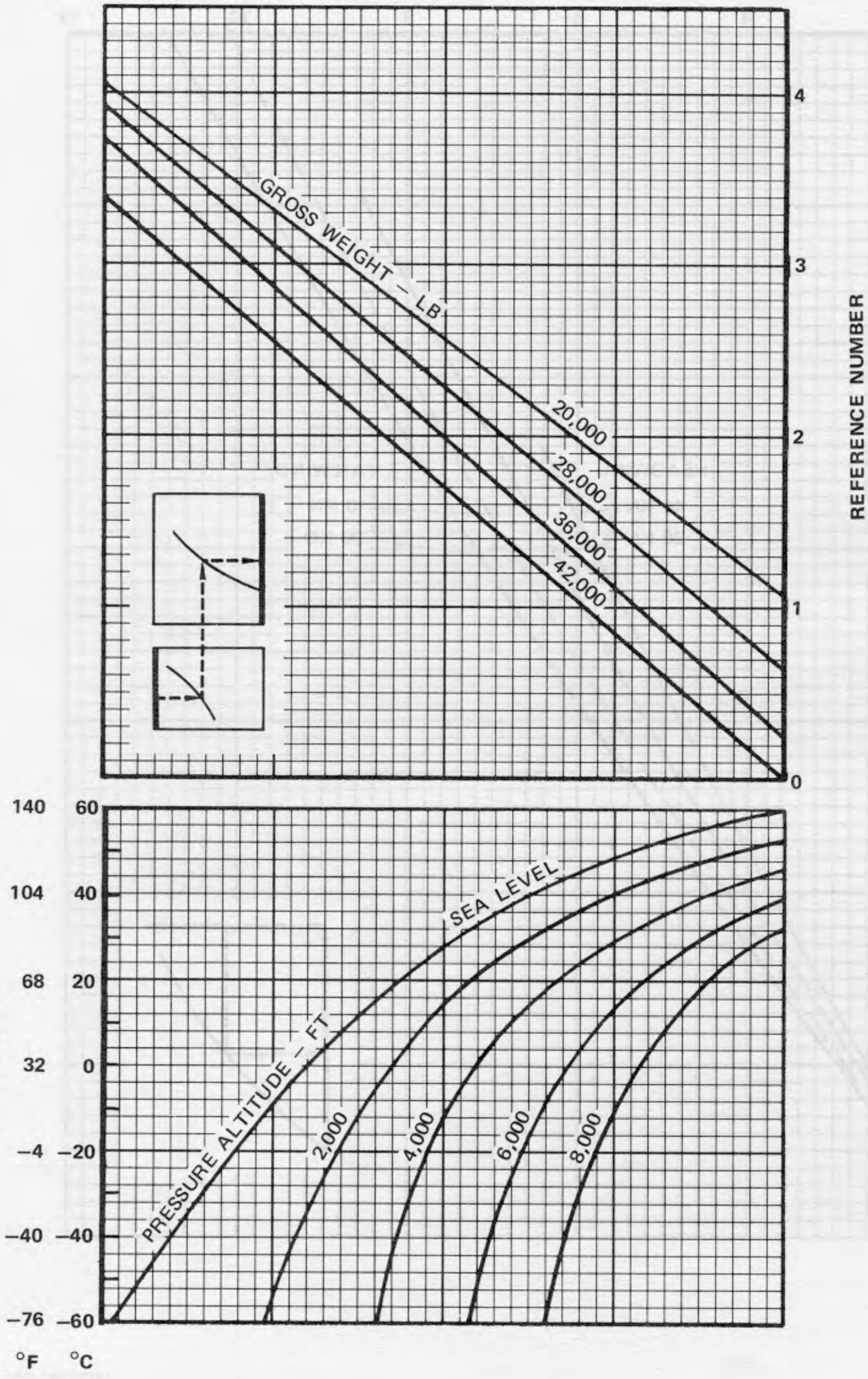
Figure A2–2 (Sheet 2)

REFUSAL SPEED

MILITARY THRUST, 25° FLAPS
ANTI-SKID BRAKING

MODEL: A-7D
DATE: MARCH 1971
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



NOTE

When runway conditions are reported WET, use an RCR of 10 under these conditions.

APPROX RCR VALUES FOR HARD-SURFACED RUNWAY CONDITIONS	
RUNWAY CONDITION	RCR NO.
DRY	23
WET	10
ICY	5
ICY (GLAZED)	2

75D015(3)–04–72

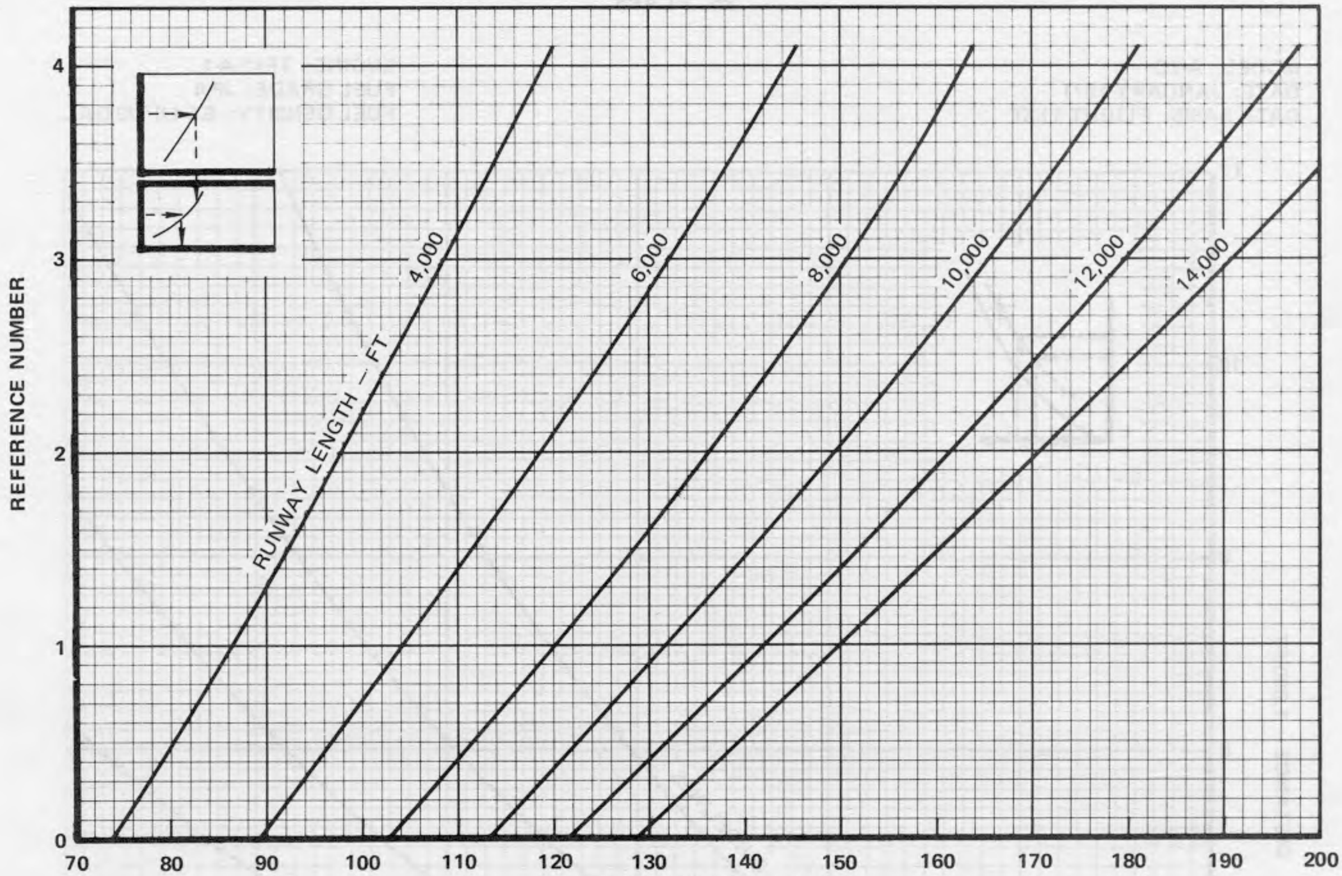
Figure A2–3 (Sheet 1)

REFUSAL SPEED

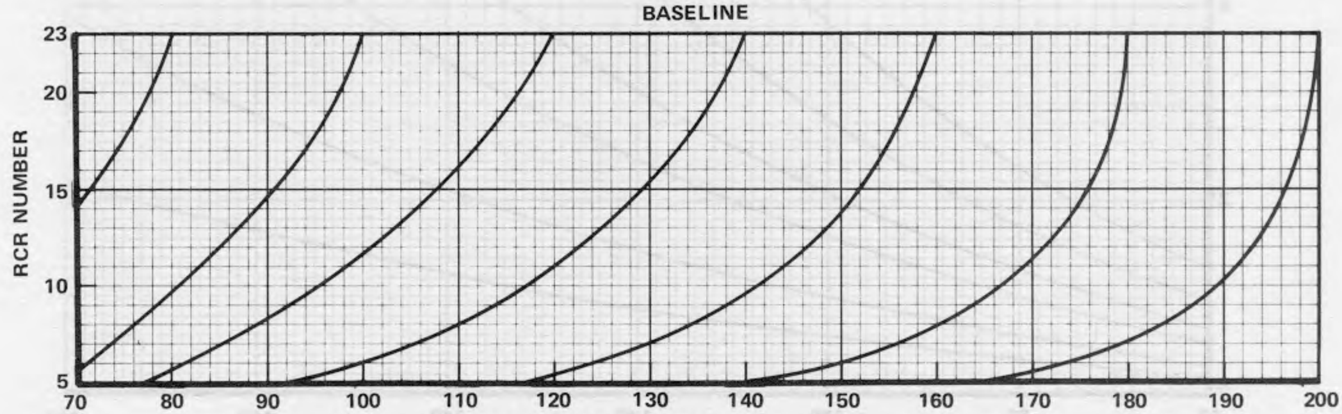
MILITARY THRUST, 25° FLAPS
ANTISKID BRAKING

MODEL: A-7D
DATE: MARCH 1971
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



BASELINE



NOTE

1. Add headwind to or subtract tailwind from refusal speed.
2. For manual braking, subtract 2 knots from antiskid refusal speed.

75D015(4)—04—72

Figure A2—3 (Sheet 2)

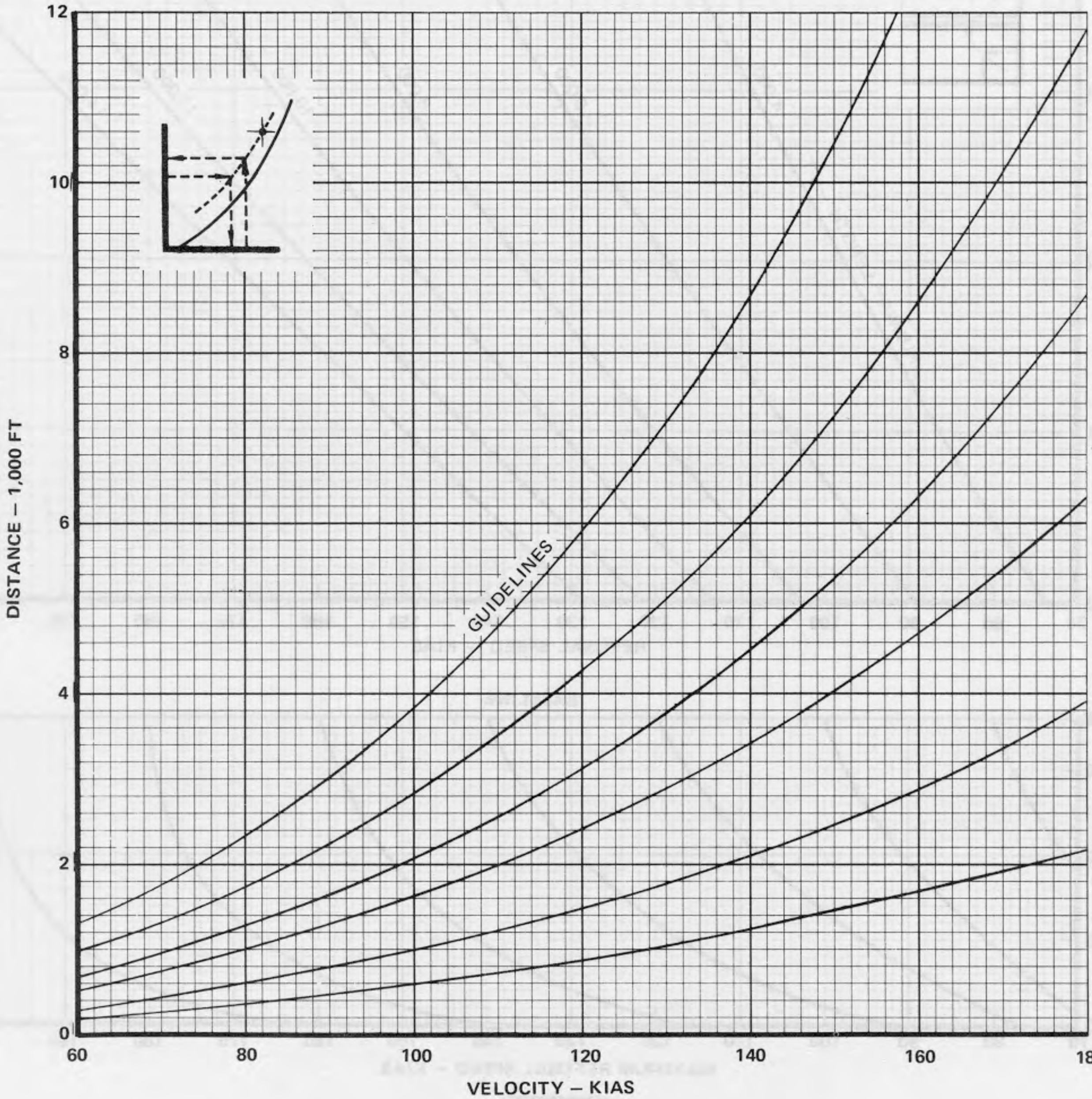
Figure A2—4 deleted.

VELOCITY DURING TAKEOFF GROUND RUN

MILITARY POWER
DRY, HARD-SURFACED RUNWAY
25° FLAPS

MODEL: A-7D
DATE: JANUARY 1971
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



NOTE

To correct for wind effects, add headwind velocity to or subtract tailwind velocity from indicated airspeed (zero wind) values obtained from this chart.

75D016–03–71

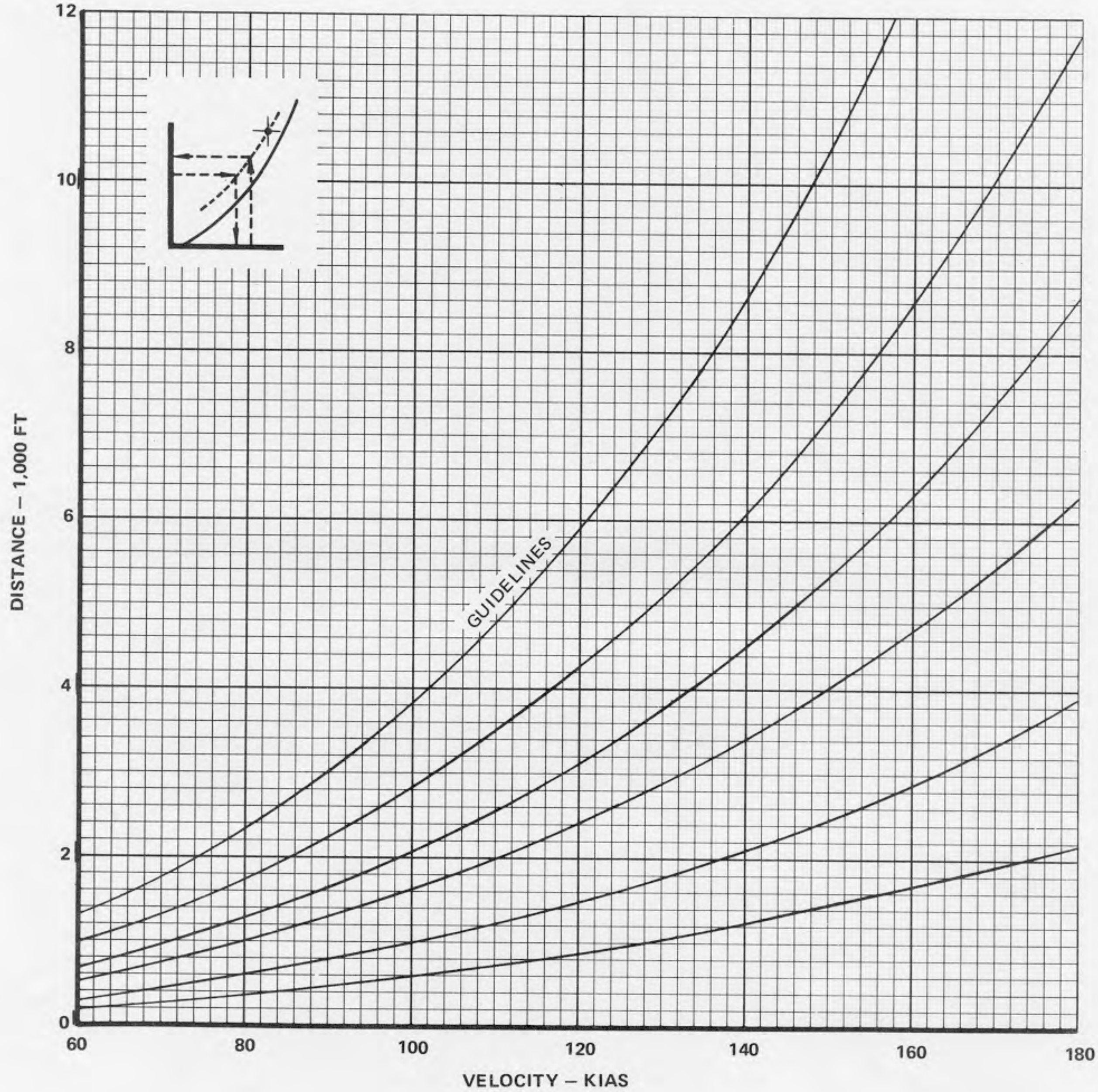
Figure A2–5

VELOCITY DURING TAKEOFF GROUND RUN

MILITARY POWER
DRY, HARD-SURFACED RUNWAY
25° FLAPS

MODEL: A-7D
DATE: JANUARY 1971
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



NOTE

To correct for wind effects, add headwind velocity to or subtract tailwind velocity from indicated airspeed (zero wind) values obtained from this chart.

75D016–03–71

Figure A2–5

Part 3
Climb

TABLE OF CONTENTS.

CLIMB CHARTS (GENERAL).

Climb charts provide a means of determining aircraft climb performance which includes time, distance, and fuel required to climb as well as providing estimated cruise altitude and combat ceiling for various drag indexes. The time, distance, and fuel required to climb from sea level to altitude is presented for all gross weights and drag indexes of 0 to 300 for military thrust.

Note

Fuel allowance for starting engine, taxi, takeoff, and acceleration to best climb speed is 682 pounds.

MILITARY THRUST CLIMB CHARTS.

The charts for military thrust climb are contained in figure A3–1, sheets 1, 2, and 3. Figure A3–1, sheet 1 is used to find fuel used as a function of sea level gross weight, pressure altitude, and drag index. Figure A3–1, sheets 2 and 3 are used to find time to climb and distance traveled as a function of sea level gross weight, pressure altitude, and drag index. The recommended climb schedule for various drag indexes is shown in tabular form on sheet 1. The KIAS climb speed column of the schedule provides a constant climb speed with an increasing Mach number to the airspeed transition altitude (KIAS to 20,000 feet). At the airspeed transition altitude, climb speed is then established at a constant Mach number, which is maintained until desired cruise altitude is reached (IMN to level off).

If the climb starts at sea level, enter the climb performance charts with sea level gross weight and move horizontally to the right to the end climb altitude (or to standard day optimum altitude drag index line if initial climb to optimum altitude is desired), then vertically downward to the drag index value and horizontally left to the fuel, time, or distance scale, and read the value.

Note

The standard day optimum altitude peaks at a drag index of approximately 50. As the drag index increases above 50, the optimum altitude decreases steadily.

The fuel required to climb from an intermediate altitude to a higher altitude can be computed by subtracting the fuel required to climb to the start climb altitude from the total fuel required to climb from sea level to the higher altitude. Time and distance are found in the same manner. The fuel, time, and distance values should be read for a corrected sea level gross weight. This weight is heavier than the start climb gross weight by the amount of fuel required to climb from sea level to the start climb altitude. To determine the corrected sea level gross weight, enter the sea level gross weight scale of the appropriate climb chart with the aircraft weight at the start climb altitude and read the fuel used value for this gross weight. Add this value to the start climb gross weight at altitude to obtain the corrected sea level gross weight.

USE.

Enter figure A3–1, sheet 1 with the sea level gross weight and move horizontally right to the pressure altitude curve. Proceed vertically down to the drag index curve and then horizontally left to read the fuel used.

Enter figure A3–1, sheet 2 with the sea level gross weight and move horizontally right to the pressure altitude curve. Proceed vertically down to the drag index curve and then horizontally left to read time to climb.

Enter figure A3–1, sheet 3 with the sea level gross weight and move horizontally right to the pressure altitude curve. Proceed vertically down to the drag index curve and then horizontally left to read distance traveled.

SAMPLE PROBLEM.

Given:

A. Climb is from 5,000 to 20,000 feet at military thrust.

B. Configuration drag index value is 90.

C. Conditions are standard day.

D. Start climb gross weight (5,000 ft) is 36,000 lb.

Calculate:

Fuel, time, and distance required to climb from 5,000 ft to 20,000 ft, using Military Thrust Climb Chart (figure A3–1, sheet 1).

A. Determine weight of fuel used to climb from sea level to 5,000 ft.

(1)	Start climb gross weight (5,000 ft)	36,000 lb
(2)	Pressure altitude	5,000 ft
(3)	Drag index	90
(4)	Fuel used	130 lb

B. Determine corrected sea level gross weight.

Corrected sea level gross weight = Start climb gross weight at altitude + fuel used.

Thus: 36,130 lb = 36,000 lb + 130 lb

C. Using the corrected sea level gross weight, determine fuel to climb from sea level to 5,000 ft.

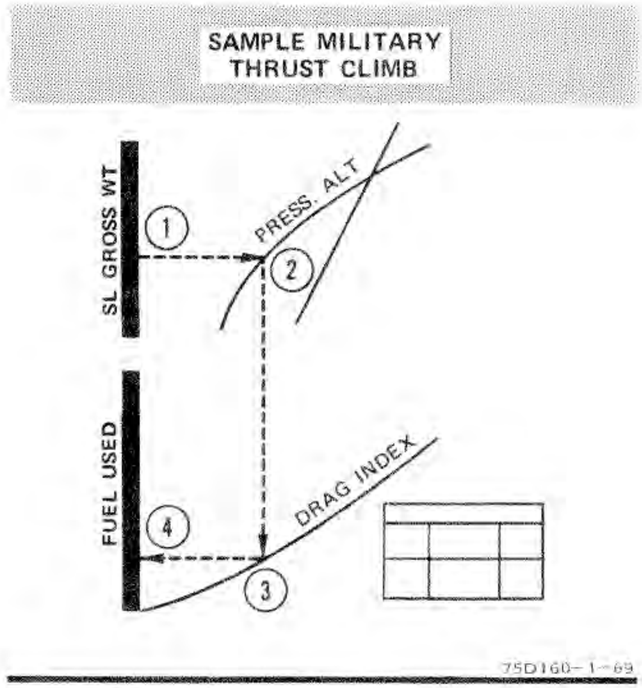
(1)	Correct sea level gross weight	36,130 lb
(2)	Pressure altitude	5,000 ft
(3)	Drag index	90
(4)	Fuel used	140 lb

D. Using the corrected sea level gross weight, determine fuel to climb from sea level to 20,000 ft.

(1)	Corrected sea level gross weight	36,130 lb
(2)	Pressure altitude	20,000 ft
(3)	Drag index	90
(4)	Fuel used	650 lb

E. Fuel required to climb from 5,000 to 20,000 ft = Fuel used (required) to 20,000 ft – fuel used to 5,000 ft.

Thus: 510 lb = 650 lb – 140 lb



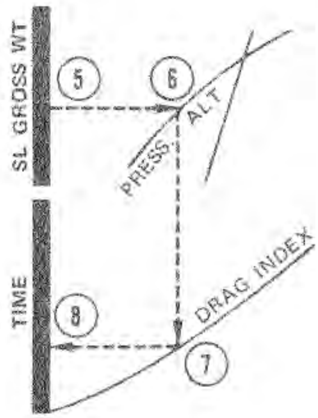
F. Use figure A3–1, sheet 2 to determine time for climb to 20,000 ft. Using the corrected sea level gross weight, determine time and distance for climb to 5,000 ft.

(5)	Corrected sea level gross weight	36,130 lb
(6)	Pressure altitude	5,000 ft
(7)	Drag index	90
(8)	Time	1 minute

G. Using the corrected sea level gross weight, determine time for climb to 20,000 ft.

(5)	Corrected sea level gross weight	36,130 lb
(6)	Pressure altitude	20,000 ft
(7)	Drag index	90
(8)	Time	5 min

SAMPLE MILITARY THRUST CLIMB



75D161-06-71

H. Time required to climb from 5,000 to 20,000 ft = Time required to climb to 20,000 ft − time required to climb to 5,000 ft.

Thus: 4 min = 5 min − 1 min.

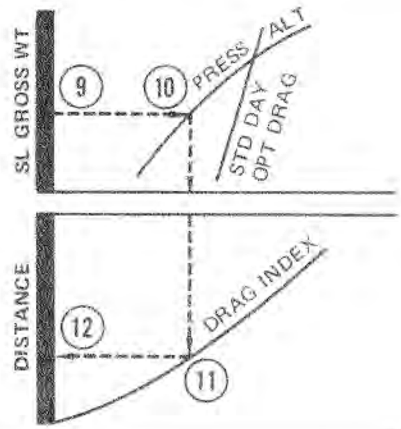
I. Use figure A3–1, sheet 3 to determine distance for climb to 20,000 ft. Using the corrected sea level gross weight, determine distance for climb to 5,000 ft.

(9)	Corrected sea level gross weight	36,130 lb
(10)	Pressure altitude	5,000 ft
(11)	Drag index	90
(12)	Distance	5 nmi

J. Using the corrected sea level gross weight, determine distance for climb to 20,000 ft.

(9)	Corrected sea level gross weight	36,130 lb
(10)	Pressure altitude	20,000 ft
(11)	Drag index	90
(12)	Distance	32 nmi

SAMPLE MILITARY THRUST CLIMB



75D265-06-71

K. Distance required to climb from 5,000 ft to 20,000 ft = Distance required to climb to 20,000 ft − distance required to climb to 5,000 ft.

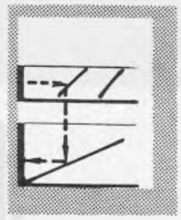
Thus: 27 nmi = 32 nmi − 5 nmi.

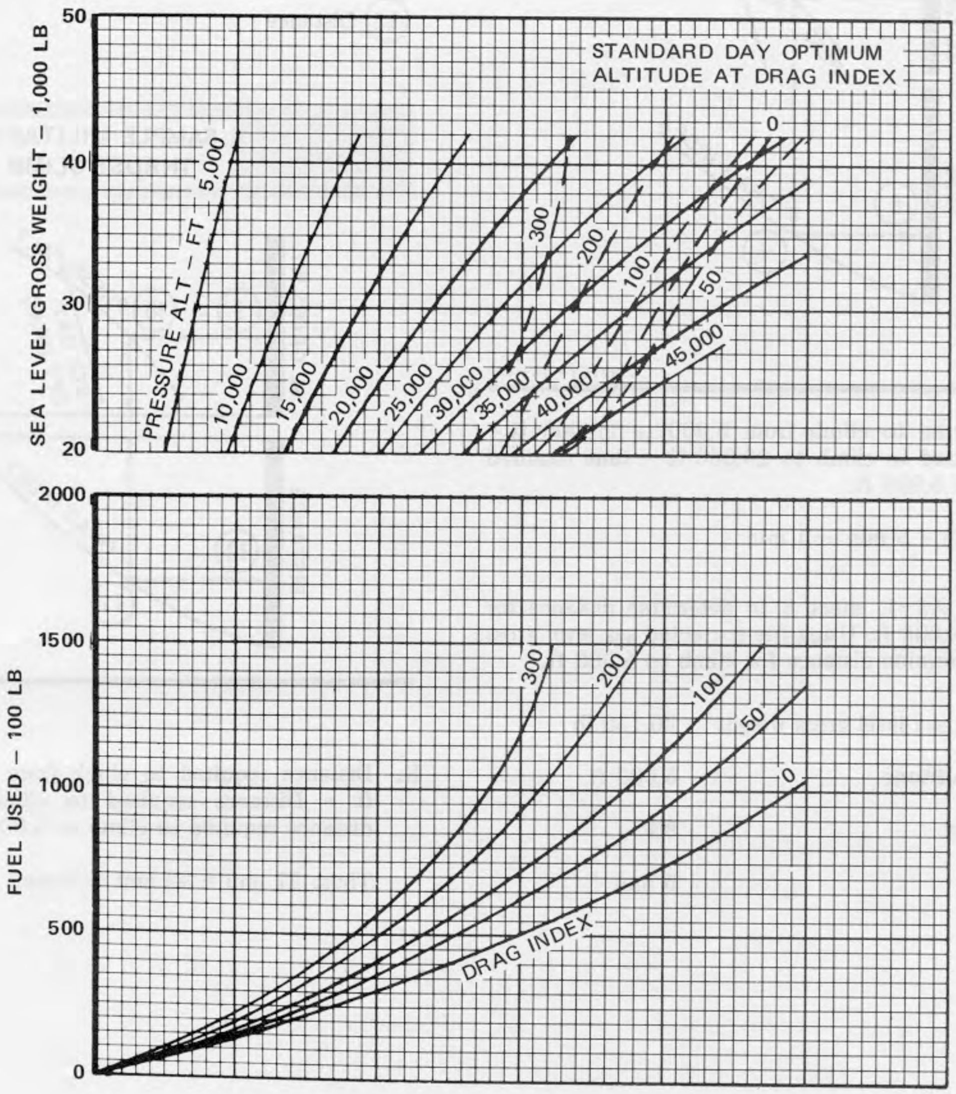
MILITARY THRUST CLIMB

FUEL USED
STANDARD DAY

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL





CLIMB SPEED SCHEDULE

DRAG INDEX	KIAS TO 20,000 FT	IMN TO LEVEL-OFF
0	390	0.833
50	361	0.775
100	335	0.724
150	313	0.680
200	294	0.642
250	277	0.609
300	265	0.580

75D003(1)–06–71

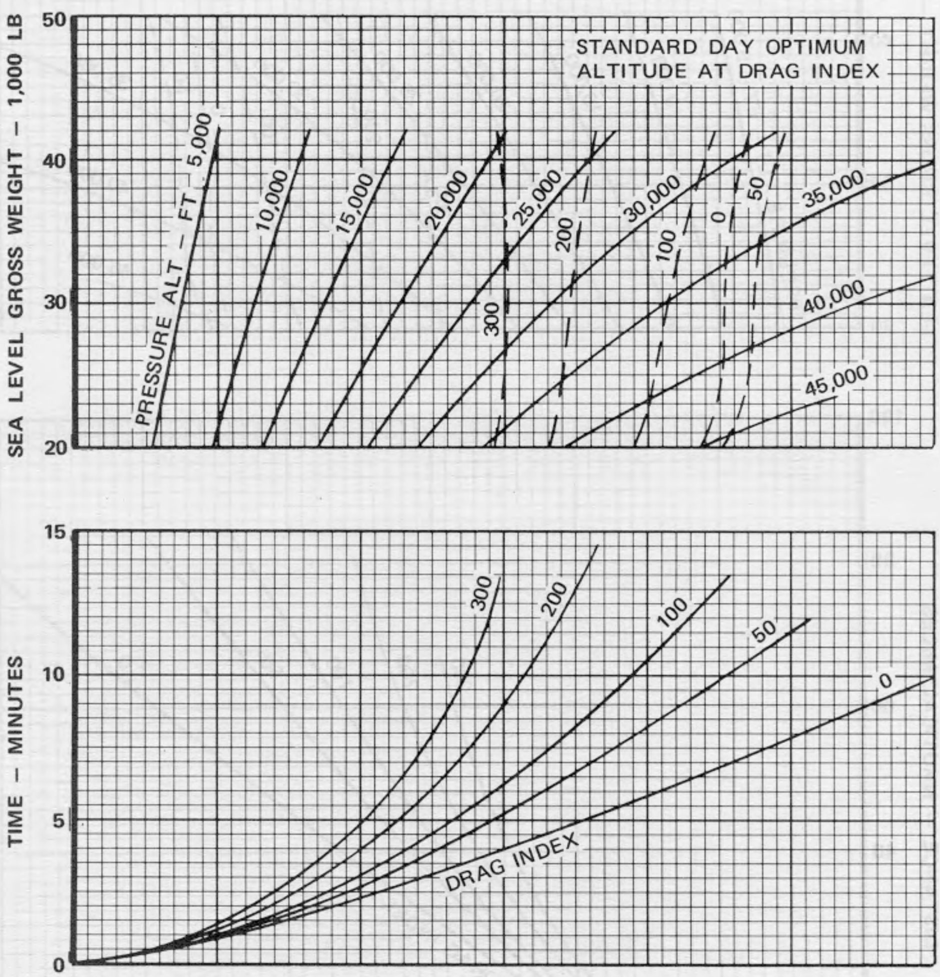
Figure A3–1 (Sheet 1)

MILITARY THRUST CLIMB

TIME TO CLIMB
STANDARD DAY

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL



75D003(2)–06–71

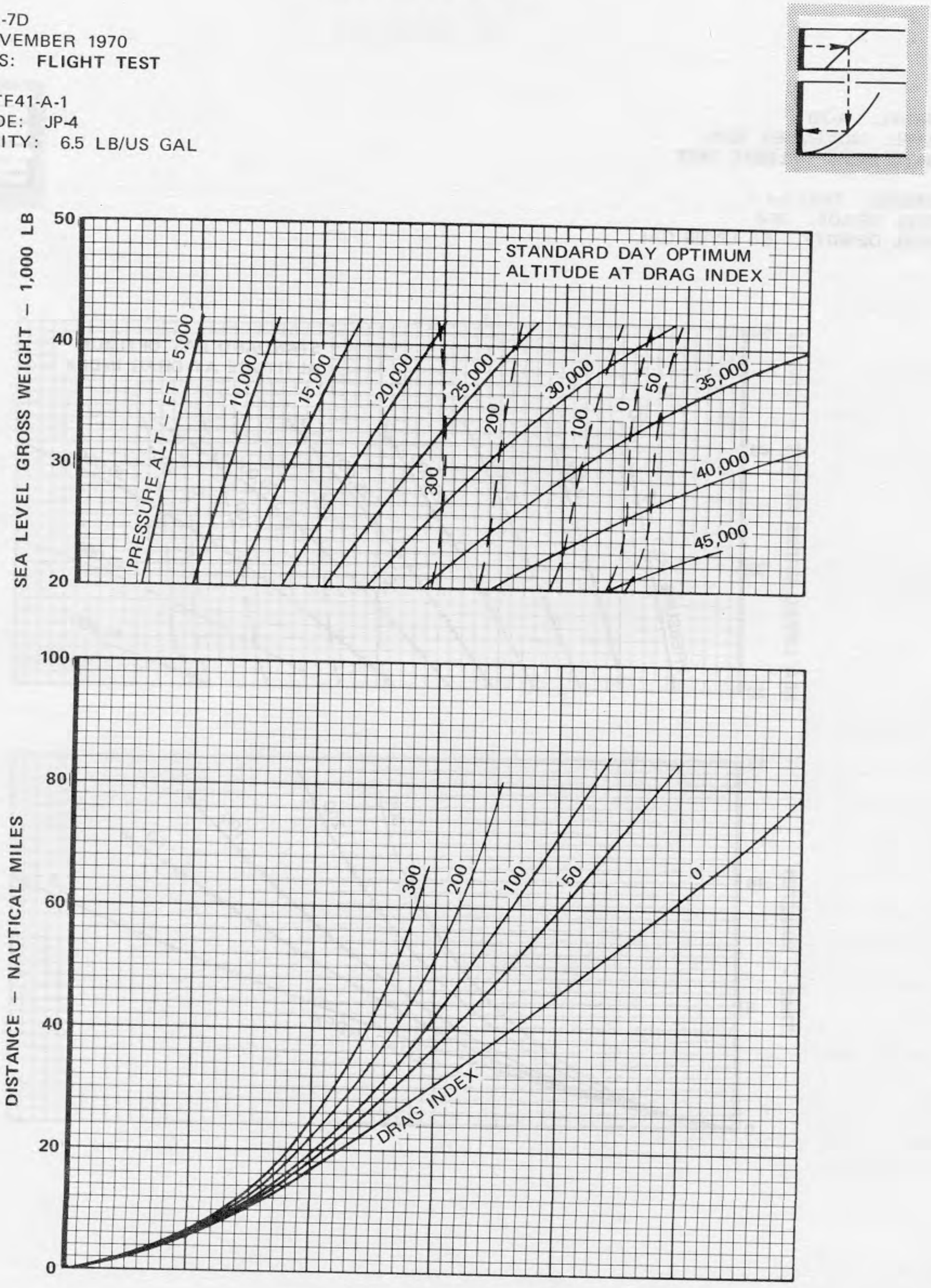
Figure A3–1 (Sheet 2)

MILITARY THRUST CLIMB

DISTANCE TRAVELED
STANDARD DAY

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL



75D003(3)–06–71

Figure A3–1 (Sheet 3)

Part 4
Range

TABLE OF CONTENTS.

RANGE CHARTS (GENERAL).

The range charts provide the means of determining the optimum conditions under which the aircraft can be operated during cruise in order to obtain the maximum distance per pound of fuel; or conversely, to determine the feasibility of operation under a given set of conditions.

NAUTICAL MILES PER POUND OF FUEL CHARTS.

The Nautical Miles Per Pound of Fuel charts (figure A4–1, sheets 1 through 20) provide cruise and loiter data throughout the speed range from maximum endurance to military thrust. The charts may be entered with either the gross weight of interest or the average gross weight of a mission to determine the specific range (nautical miles per pound of fuel) and fuel flow. The charts utilize the parameters of weight, altitude, drag index, Mach number, temperature, true airspeed, fuel flow, and nautical miles per pound of fuel. They cover the entire range of external store configurations for drag indexes of 0 to 300.

Figure A4–1, sheets 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19 provide a reference number which is representative of a specific drag index configuration, true Mach number at the cruise gross weight, and selected altitude.

Figure A4–1, sheets 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20 provide specific range (nautical miles per pound of fuel), fuel flow, and true airspeed. The temperature curve converts true Mach number to true airspeed (KTAS). It should be noted that these sheets are identical for all drag indexes and are repeated after each drag index chart for pilot convenience.

USE.

Enter the appropriate drag index sheet(s) of figure A4–1 with the cruise gross weight, move vertically up to the pressure altitude curve (or to optimum cruise altitude curve if cruise at optimum altitude is desired), and then horizontally right to the baseline. From the point of intersection with the baseline, contour a guideline between the maximum endurance curve to the military thrust curve. If cruise true Mach number has been previously selected, project vertically up to intersect the contoured guideline and then proceed horizontally right to read reference number.

Note

> The standard day optimum altitude peaks at a drag index of approximately 50. As the drag index increases above 50, the optimum altitude decreases steadily.

If it is desired to cruise at the Mach number for maximum range, the specific range at various Mach numbers must be found and plotted and the peak selected from this plot. Use figure A4–1, sheet 21.

Enter figure A4–1 (appropriate even numbered sheet) true Mach number scale with the cruise Mach number, and proceed vertically down to the temperature curve applicable to the cruise pressure altitude. From this point proceed horizontally left and read the true airspeed (KTAS). Next, enter the reference number scale with the reference number obtained from the appropriate odd numbered sheet and proceed horizontally right to the appropriate pressure altitude curve. At this point proceed vertically down and read nautical miles per pound. Fuel flow is obtained by entering the true airspeed scale with appropriate true airspeed and proceeding horizontally right until intersecting with the nautical miles per pound vertical line. This procedure applies to all even numbered sheets of figure A4–1.

SAMPLE PROBLEM.

Given:

A. Initial gross weight is 32,500 lb.

B. Pressure altitude for cruise is 25,000 ft.

C. Temperature at cruise altitude is −25°C.

D. Store configuration is six pylons, eight M117A1's and two MER's at stations 2 and 7.

From stores computations table, Appendix I, Part 1:

	Basic Drag Index			
	MN =0.6	*MN =0.7*	*MN =0.8*	*MN =0.9*
4 wing pylons, stations 1, 3, 6, 8	24	28	40	56
2 X 4/MER (M117A1)	112	118	142	234
Total Drag Index	136	146	182	290

Calculate:

Mach number and maximum specific range (It may be necessary to obtain values at intermediate Mach numbers using linear interpolation.)

A. Interpolate between MN 0.60 and MN 0.80 for intermediate drag counts.

	MN =0.65	*MN =0.75*
Drag index	141	164

B. From the Nautical Miles Per Pound of Fuel charts, obtain reference number and true Mach number for maximum range using gross weight of 32,500 pounds and pressure altitude of 25,000 feet and 0.60 Mach number (figure A4–1, sheet 11).

C. Drag index of 100 (figure A4–1, sheet 11).

(1)	Gross weight	32,500 lb
(2)	Pressure altitude	25,000 ft
(3)	Baseline	—
(4)	Contour guideline	—
(5)	True Mach No.	0.60
(6)	Contour guideline	—
(7)	Reference No.	4.80

Repeat the preceding steps for Mach 0.65 and 0.70

Calculate true airspeed and fuel flow using Fuel Flow and True Airspeed chart (figure A4–1, sheet 12).

(1)	True Mach No.	0.60
(2)	Temperature	–25°C
(3)	True airspeed	370
(4)	Reference No.	4.80
(5)	Pressure altitude	25,000 ft
(6)	Specific range nmi/lb	0.128
(7)	True airspeed	370
(8)	Fuel flow	2,900

Repeat the preceding steps for Mach 0.65 and 0.70

Information obtained:

	MN =0.60	*MN =0.65*	*MN =0.70*
Reference number	4.80	4.92	4.90
Specific range	0.128	1.33	1.32

D. Drag index of 150 (figure A4–1, sheets 13 and 14).

Using the same sample guide as for drag index of 100, calculate for the following:

	MN =0.60	*MN =0.65*	*MN =0.70*	*MN =0.75*	*MN =0.80*
Reference number	4.28	4.33	4.28	4.15	3.95
Specific range	0.114	0.116	0.114	0.112	0.106

E. Drag index of 200 (figure A4−1, sheets 15 and 16).

Using the same sample guide as for drag index of 100, calculate the following:

	MN =0.75	*MN =0.80*
Reference number	3.62	3.40
Specific range	0.097	0.091

F. Using linear interpolation between the drag indexes for the particular loading, determine the specific range at each Mach number.

	MN =0.60	*MN =0.65*	*MN =0.70*	*MN =0.75*	*MN =0.80*
Drag index	136	141	146	164	182
Specific range	0.118	0.119	0.115	0.108	0.096

G. By plotting specific range versus Mach number and then drawing a curve to cross each point marked for Mach numbers 0.60, 0.65, 0.70, 0.75, and 0.80, (figure A4−1, sheet 21), the maximum specific range is determined by the highest point of the plotted curve. This is determined to be Mach 0.63 and specific range 0.119 nmi/lb.

(1)	Plotted curve	—
(2)	True Mach No.	0.63
(3)	Specific range	0.119 nmi/lb

H. Enter the Fuel Flow and True Airspeed chart (figure A4−1, sheet 14) with Mach 0.63 obtained from figure A4−1, sheet 21.

(1)	True Mach No. (obtained from plot)	0.63
(2)	Temperature	−25°C
(3)	True airspeed	388 KTAS

True airspeed at cruise altitude is determined to be 388 KTAS.

Enter the same chart at point (6) with specific range nmi/lb obtained from figure A4−1, sheet 21.

(6)	Specific range nmi/lb (obtained from plot)	0.119 nmi/lb
(7)	True airspeed	388 KTAS
(8)	Fuel flow	3,300 pph

Fuel flow at cruise altitude is determined to be 3,300 pph.

I. If optimum cruise altitude is desired, use the drag index at Mach No. 0.6. Determine optimum cruise altitude by using Nautical Miles Per Pound chart (figure A4−1, sheets 11 and 13).

Drag index of 100

(1)	Gross weight	32,500 lb
(2)	Optimum cruise altitude	33,000 ft

Drag index of 150

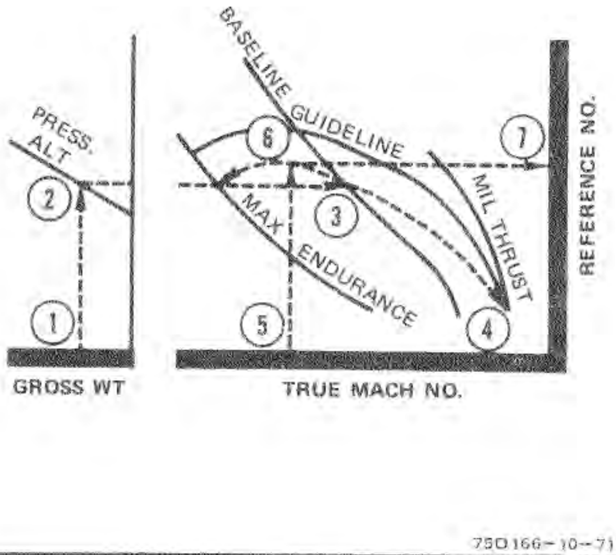
(1)	Gross weight	32,500 lb
(2)	Optimum cruise altitude	30,000 ft

Using linear interpolation for a drag index at Mach 0.60 of 136, the optimum cruise altitude is 31,000 feet.

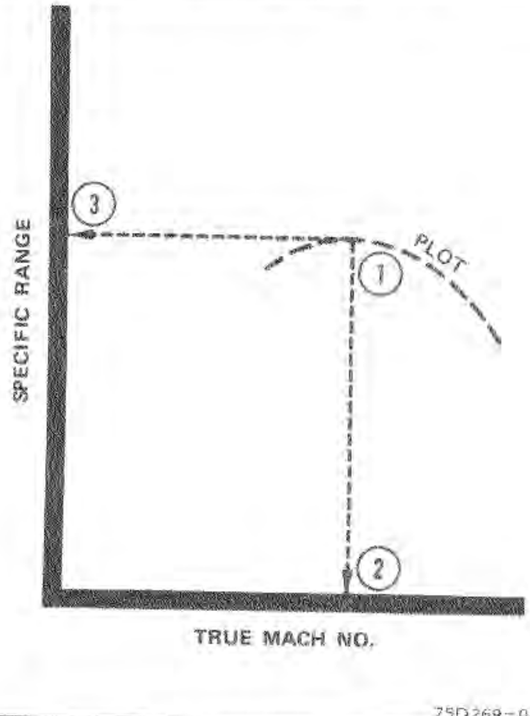
Having selected the optimum altitude of 31,000 feet, true Mach number and reference number can be calculated in the same manner as in the example for 25,000-foot altitude.

J. Combat ceiling altitude can be calculated in the same manner.

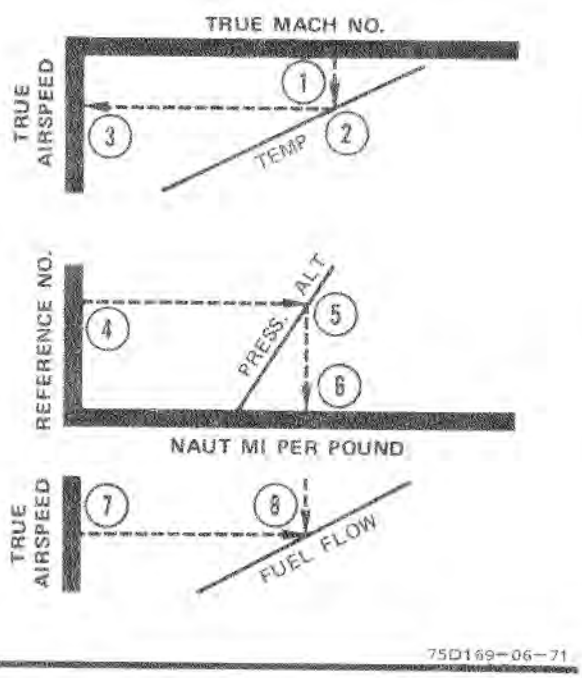
SAMPLE TRUE MACH NUMBER AND REFERENCE NUMBER



SAMPLE SPECIFIC RANGE VS TRUE MACH NO.



SAMPLE FUEL FLOW AND TRUE AIRSPEED



COMBAT CEILING.

Combat ceiling is the highest pressure altitude at which the aircraft can climb at the rate of 500 fpm.

DIVERSION RANGE SUMMARY TABLE.

The table shows, in quick reference form, the range obtainable and the time required to return to base with 1,500, 2,000, 2,500, or 3,000 pounds of fuel available. The range pertains to a configuration with six wing pylons and two MER's and is based on having 1,000 pounds of fuel remaining for the approach and landing.

Range and time data are shown in the table for two optional return profiles, together with the optimum altitude for the cruise. The optimum altitude is the altitude which provides the maximum range for the particular type of flight profile used. Cruise speeds and descent information are contained at the bottom of the diversion range chart.

The two types of flight profiles are:

A. Cruise at initial altitude to base, and descent to sea level at idle rpm and speed brake in.

B. Climb on course to optimum cruise altitude, cruise at optimum altitude, and descend on course to base at maximum range descent, idle rpm, and speed brake in.

SAMPLE PROBLEM.

Given:

A. Configuration is with six wing pylons and two MER's.

B. Initial altitude is 30,000 ft.

C. Distance to base is 195 nmi.

D. Fuel remaining is 2,200 lb.

Calculate:

Diversion range information using Diversion Range Summary Table (figure A4–2).

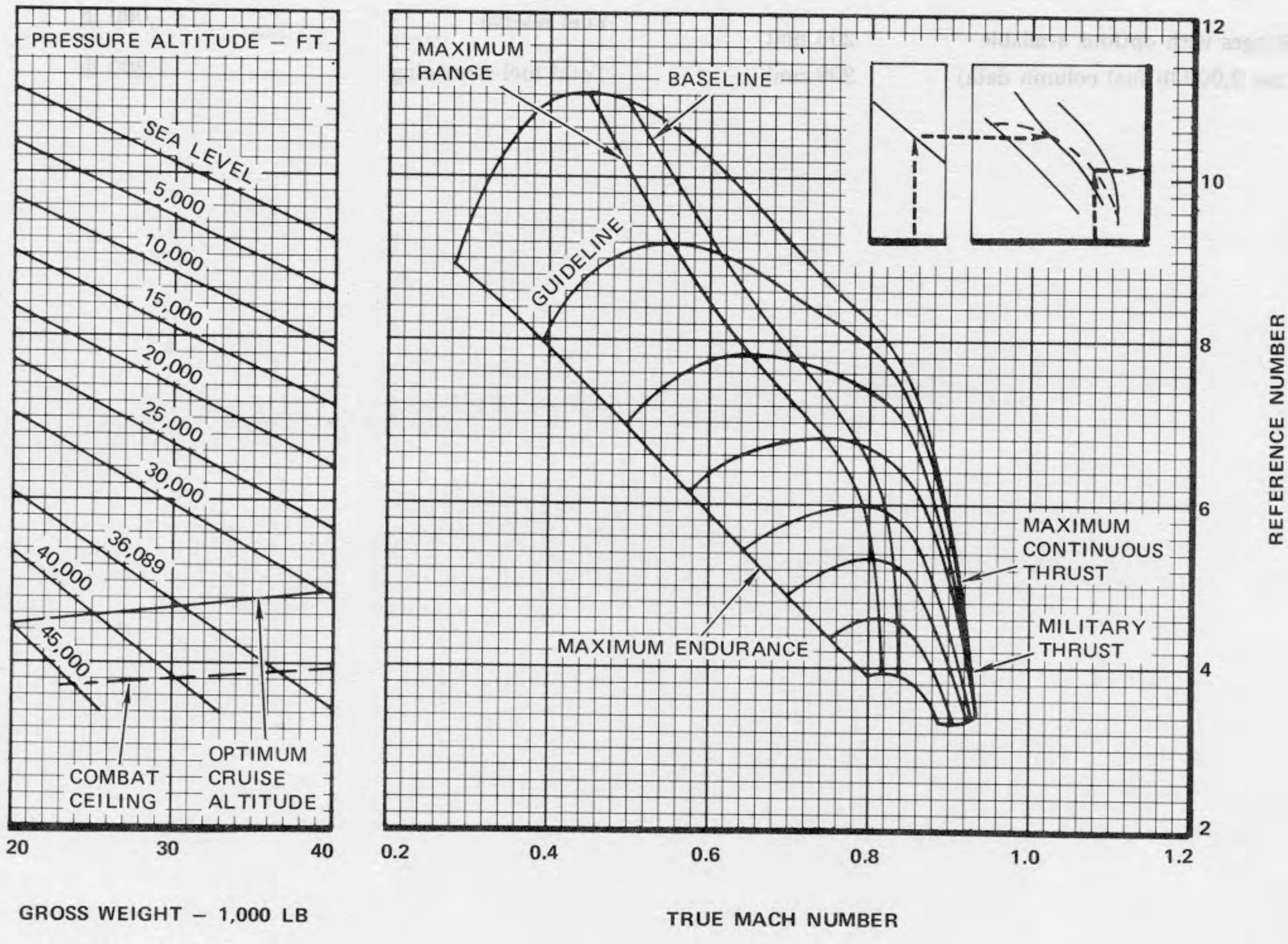
Ranges with options available	203 nmi
(use 2,000-lb fuel column data)	209 nmi
Option selected (nearest value)	203 nmi
Cruise altitude	30,000 ft
Cruise Mach No.	0.66 IMN
Cruise distance (on course)	128 nmi
Descent distance (on course)	67 nmi
Descent conditions	220 KIAS Idle thrust Speed brake in
Time required (no wind)	37 min
Fuel remaining (2,200 lb – 2,000 lb)	200 lb (approx)
Fuel reserve	1,000 lb
Total fuel remaining	1,200 lb

NAUTICAL MILES PER POUND

CONFIGURATION DRAG INDEX – 0.0

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



75D263 (1)–03–72

Figure A4–1 (Sheet 1)

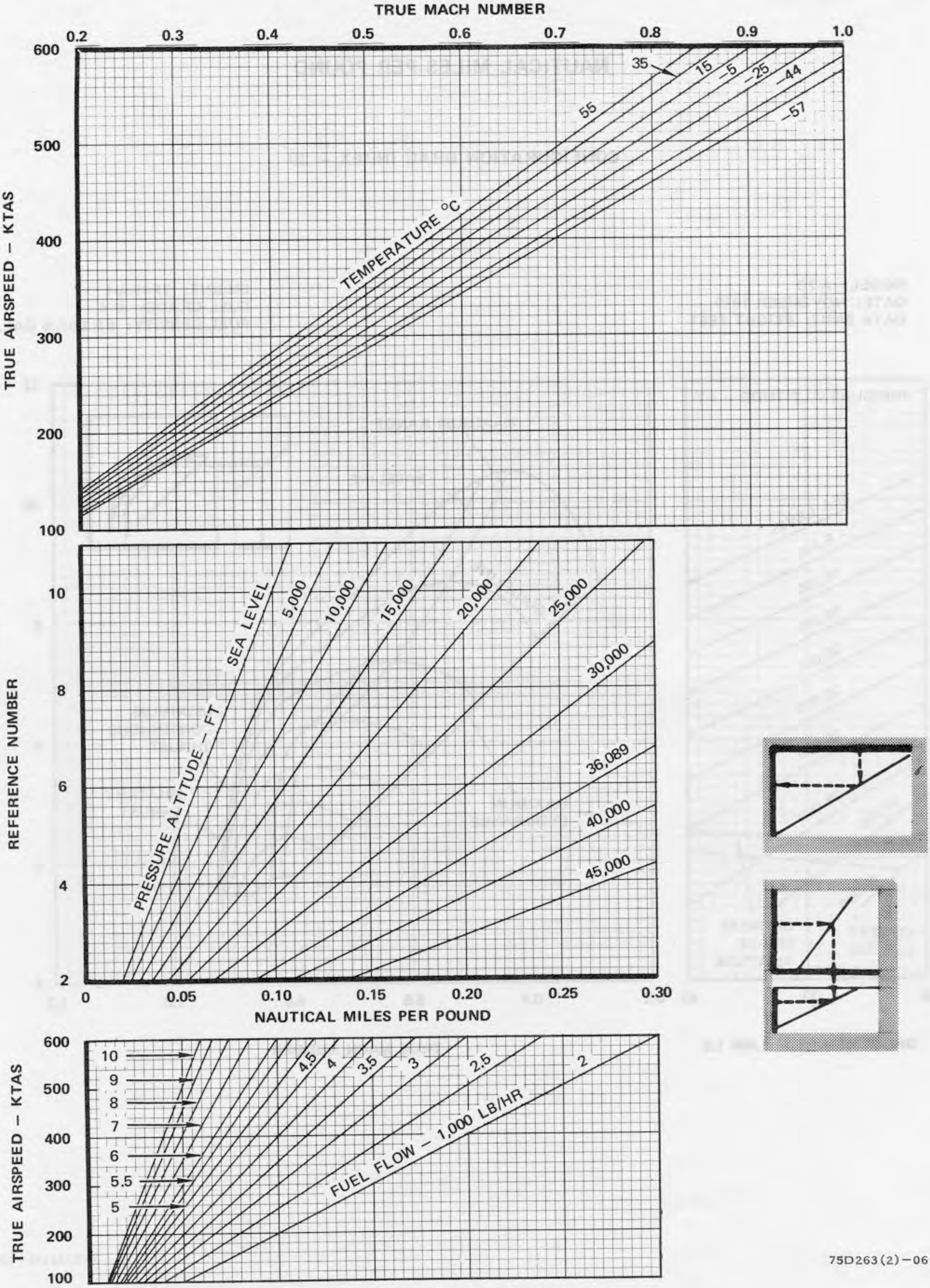


Figure A4–1 (Sheet 2)

NAUTICAL MILES PER POUND

CONFIGURATION DRAG INDEX – 20

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.

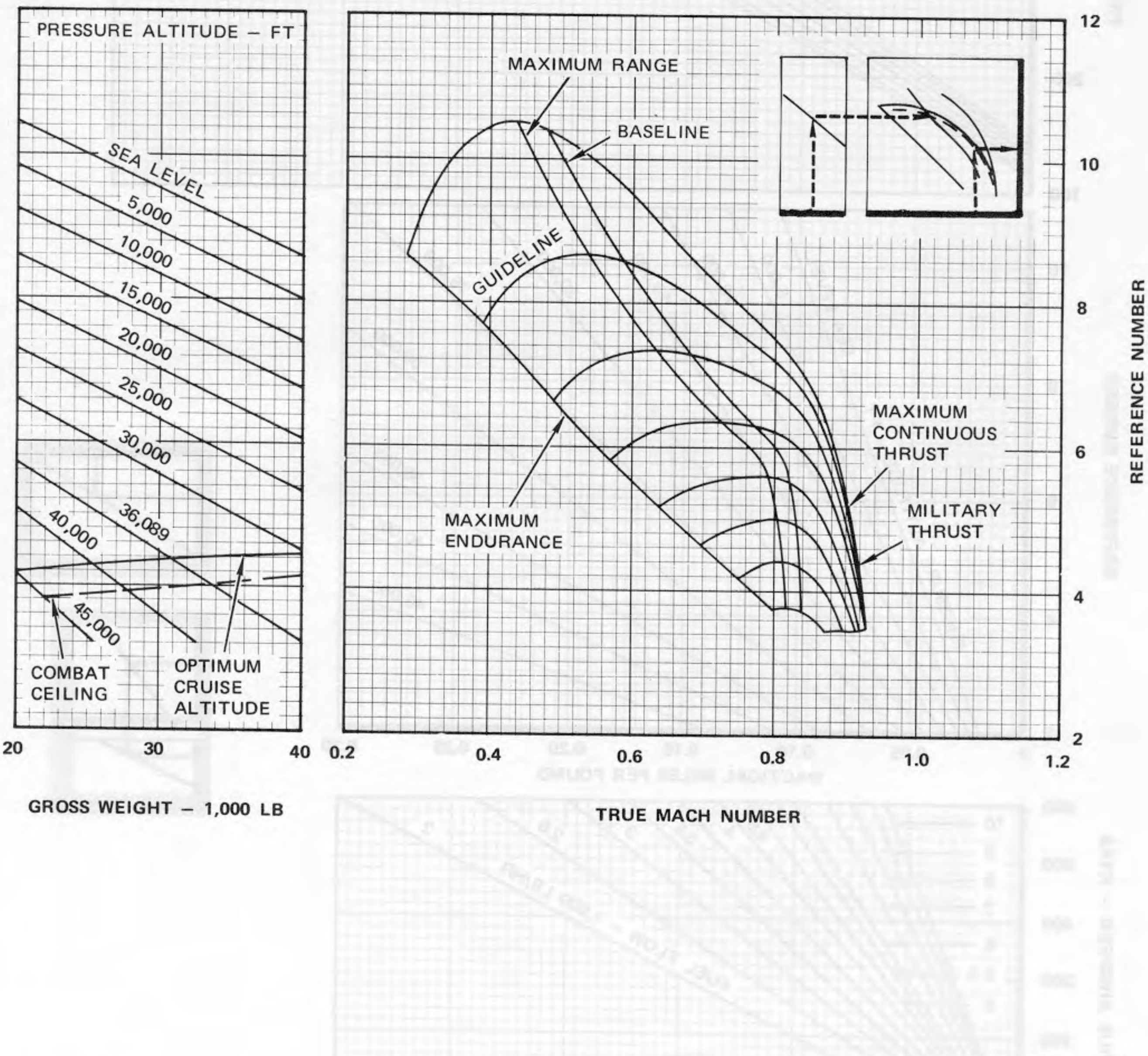


Figure A4–1 (Sheet 3)

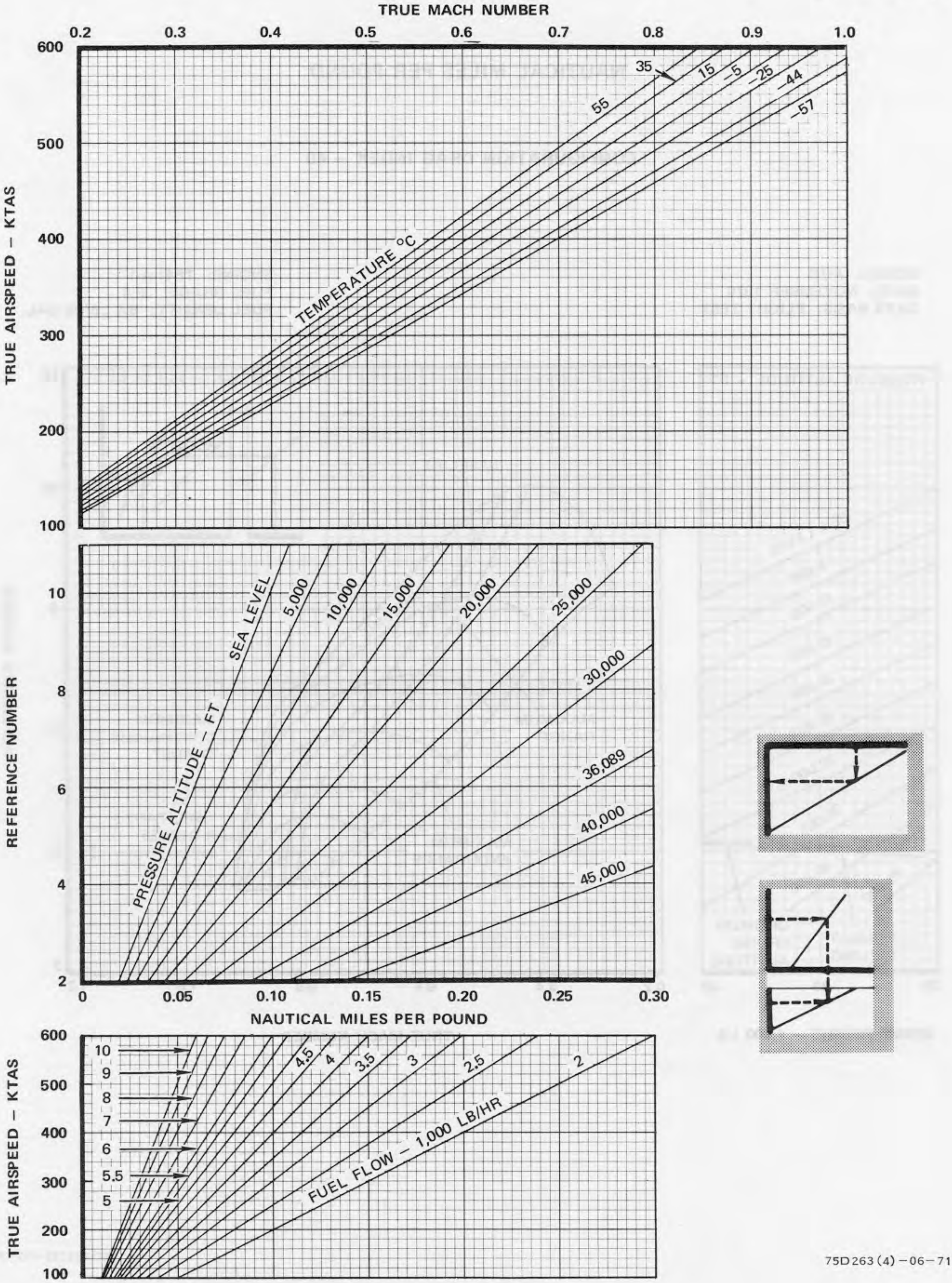


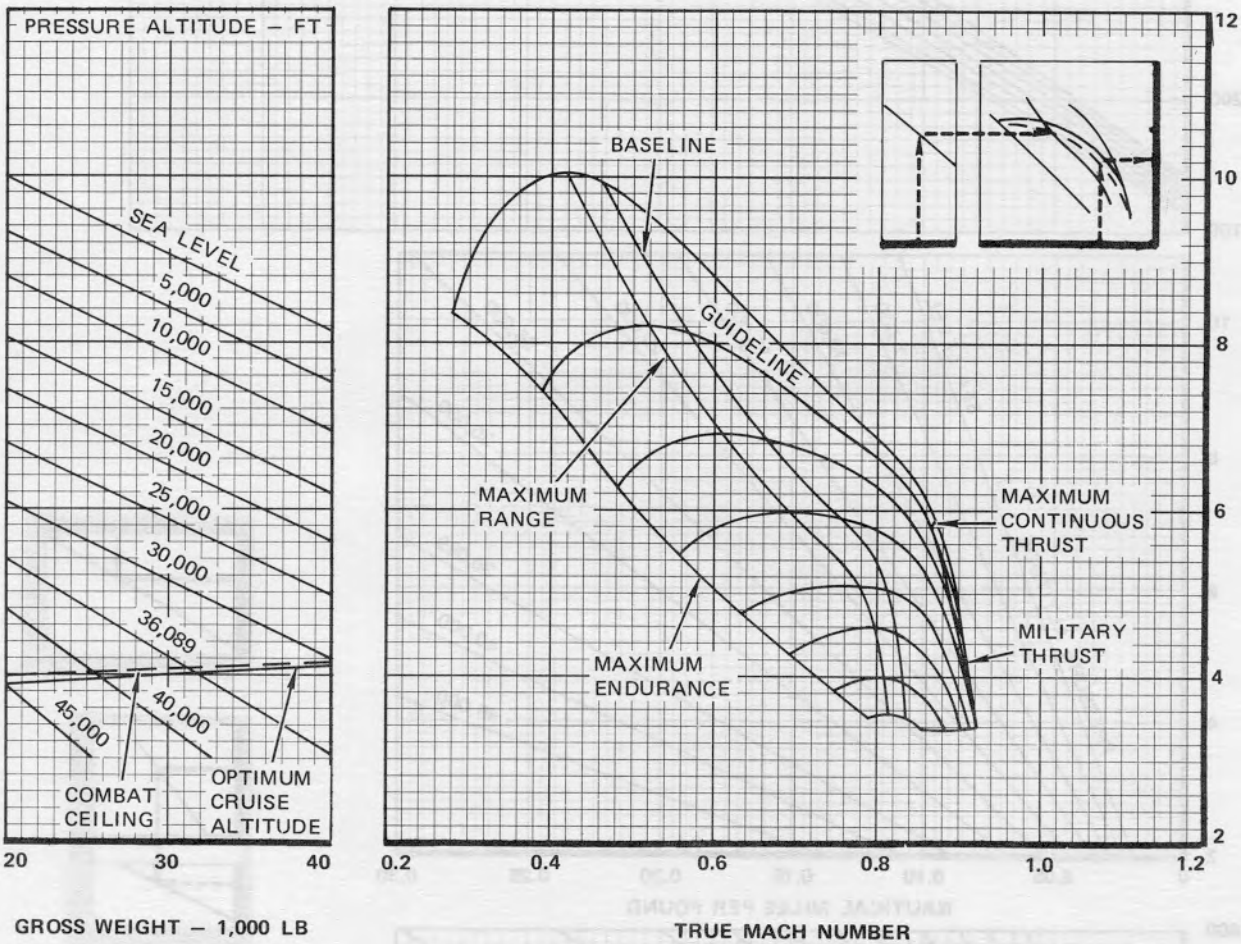
Figure A4–1 (Sheet 4)

NAUTICAL MILES PER POUND

CONFIGURATION DRAG INDEX – 40

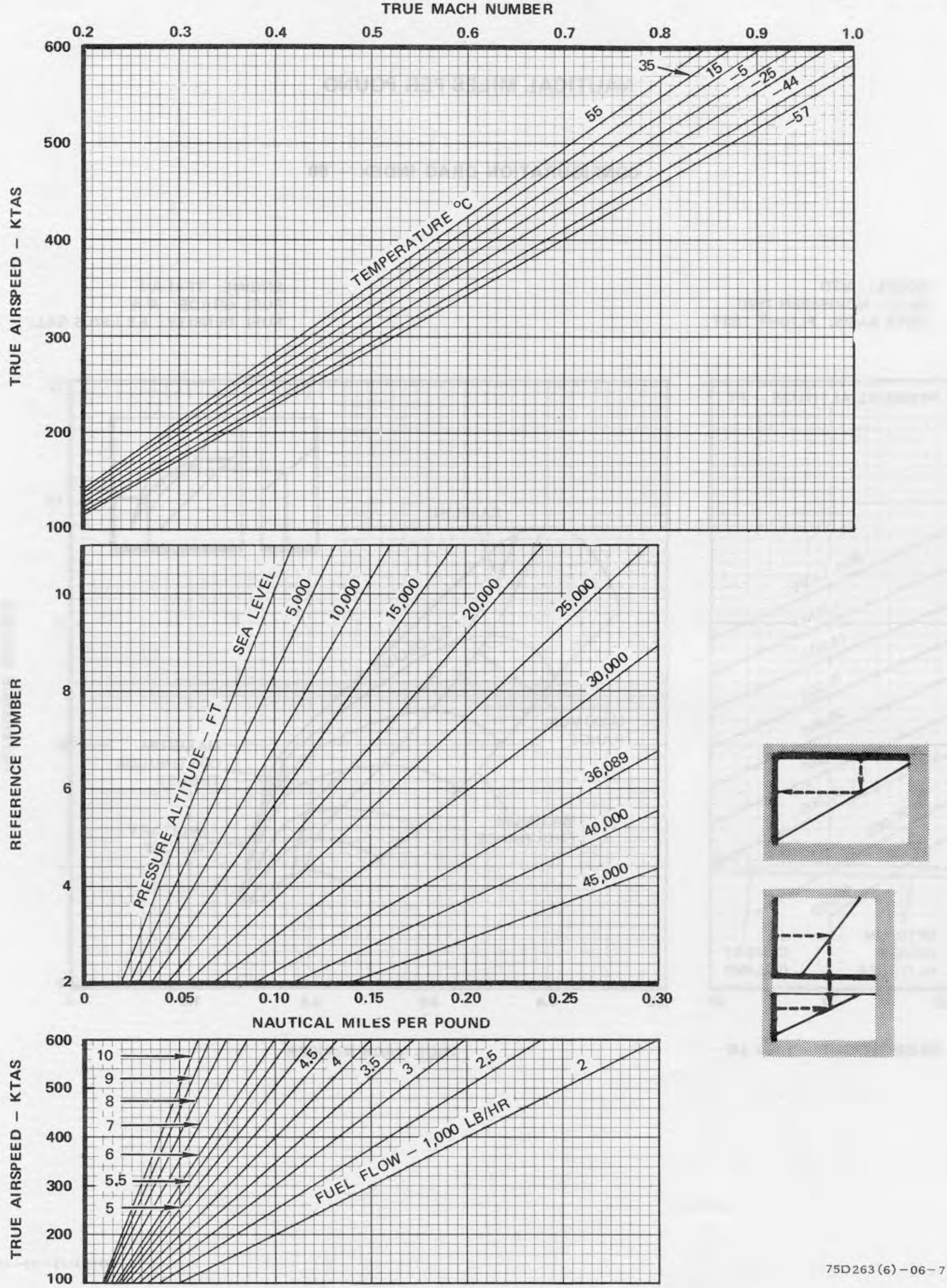
MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



75D263(5)–03–72

Figure A4–1 (Sheet 5)



75D263(6)–06–71

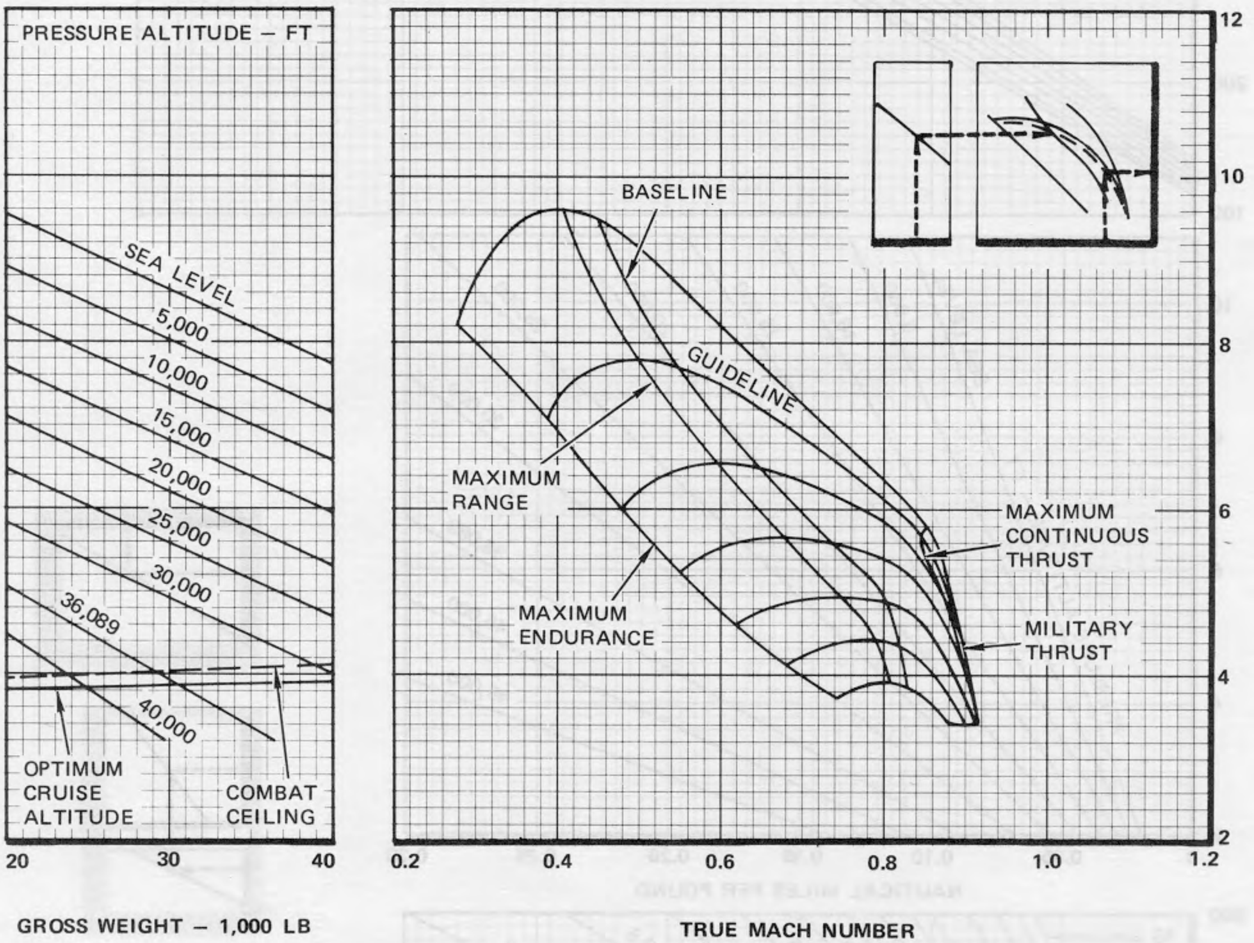
Figure A4–1 (Sheet 6)

NAUTICAL MILES PER POUND

CONFIGURATION DRAG INDEX – 60

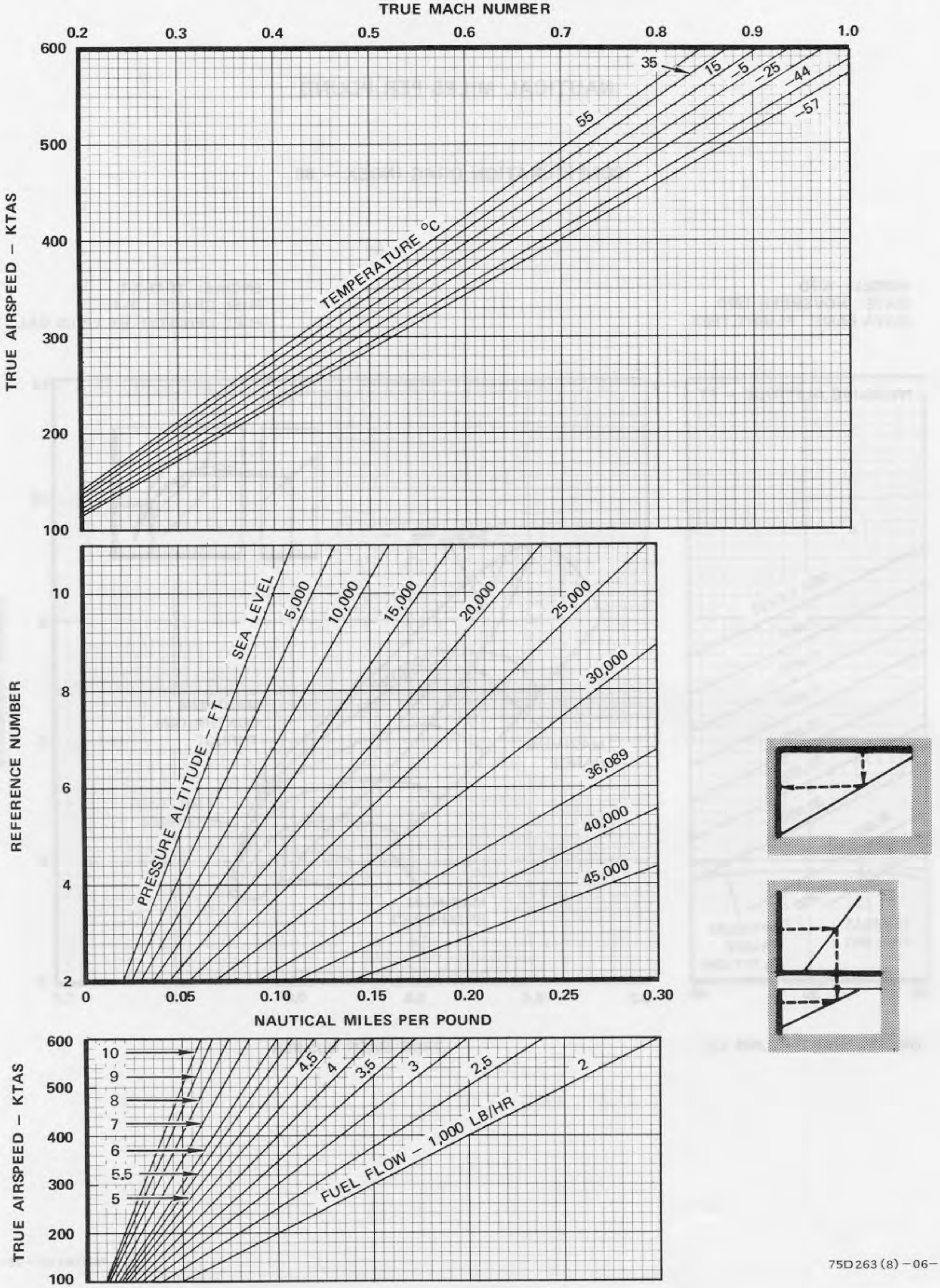
MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



75D263 (7)–03–72

Figure A4–1 (Sheet 7)



75D263(8)–06–71

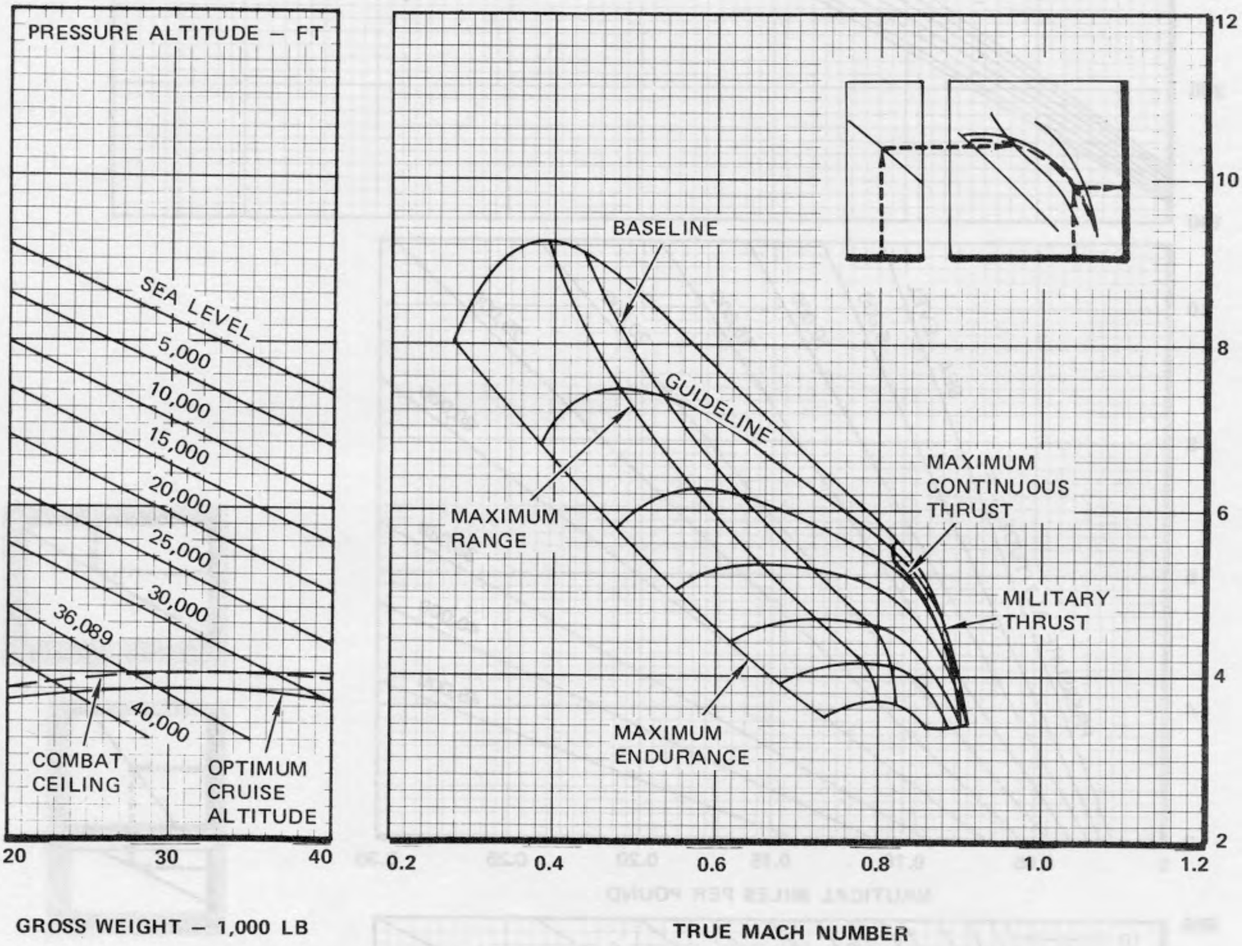
Figure A4–1 (Sheet 8)

NAUTICAL MILES PER POUND

CONFIGURATION DRAG INDEX – 80

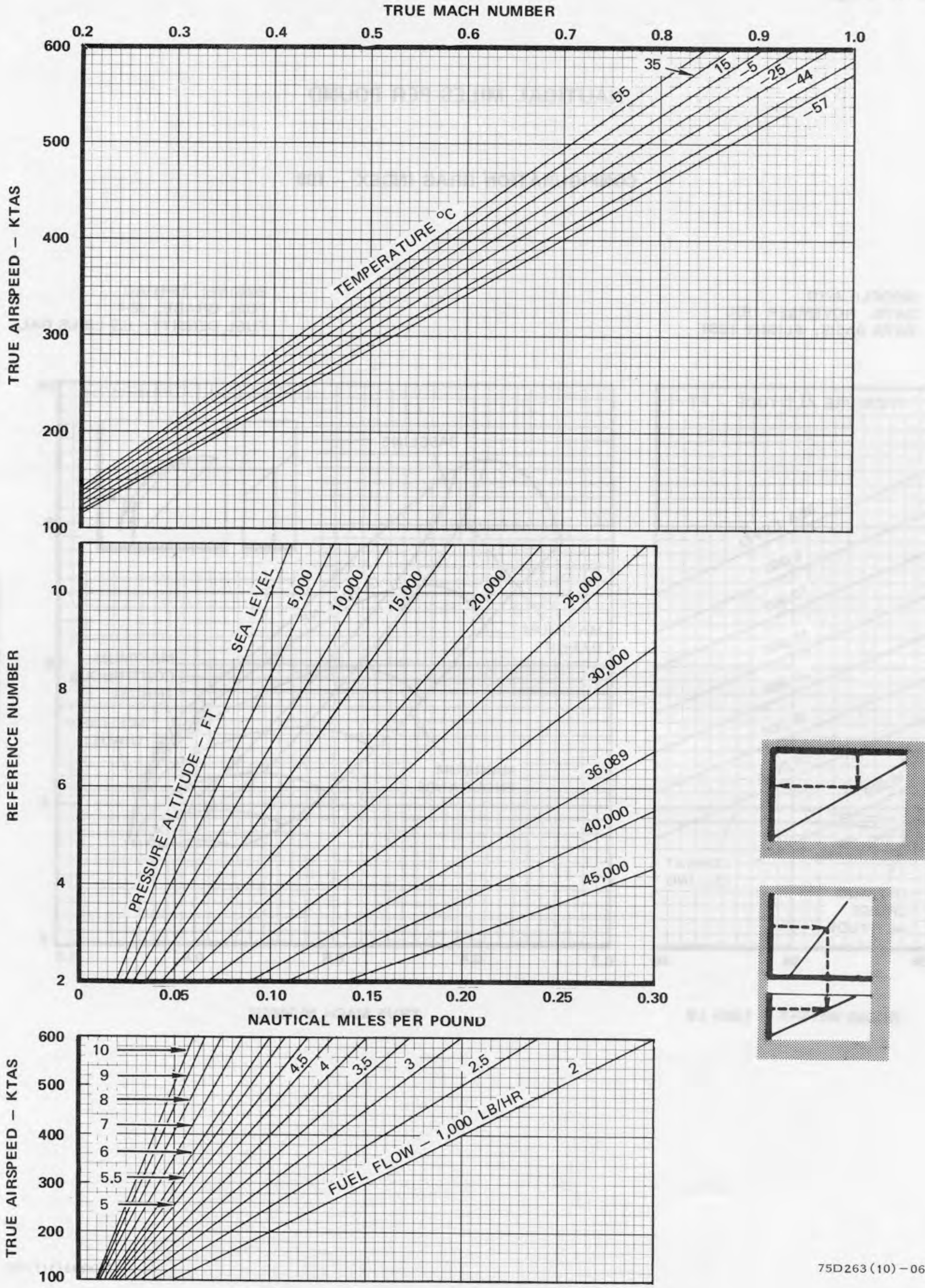
MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



75D263 (9) – 03 – 72

Figure A4–1 (Sheet 9)



75D263(10)–06–71

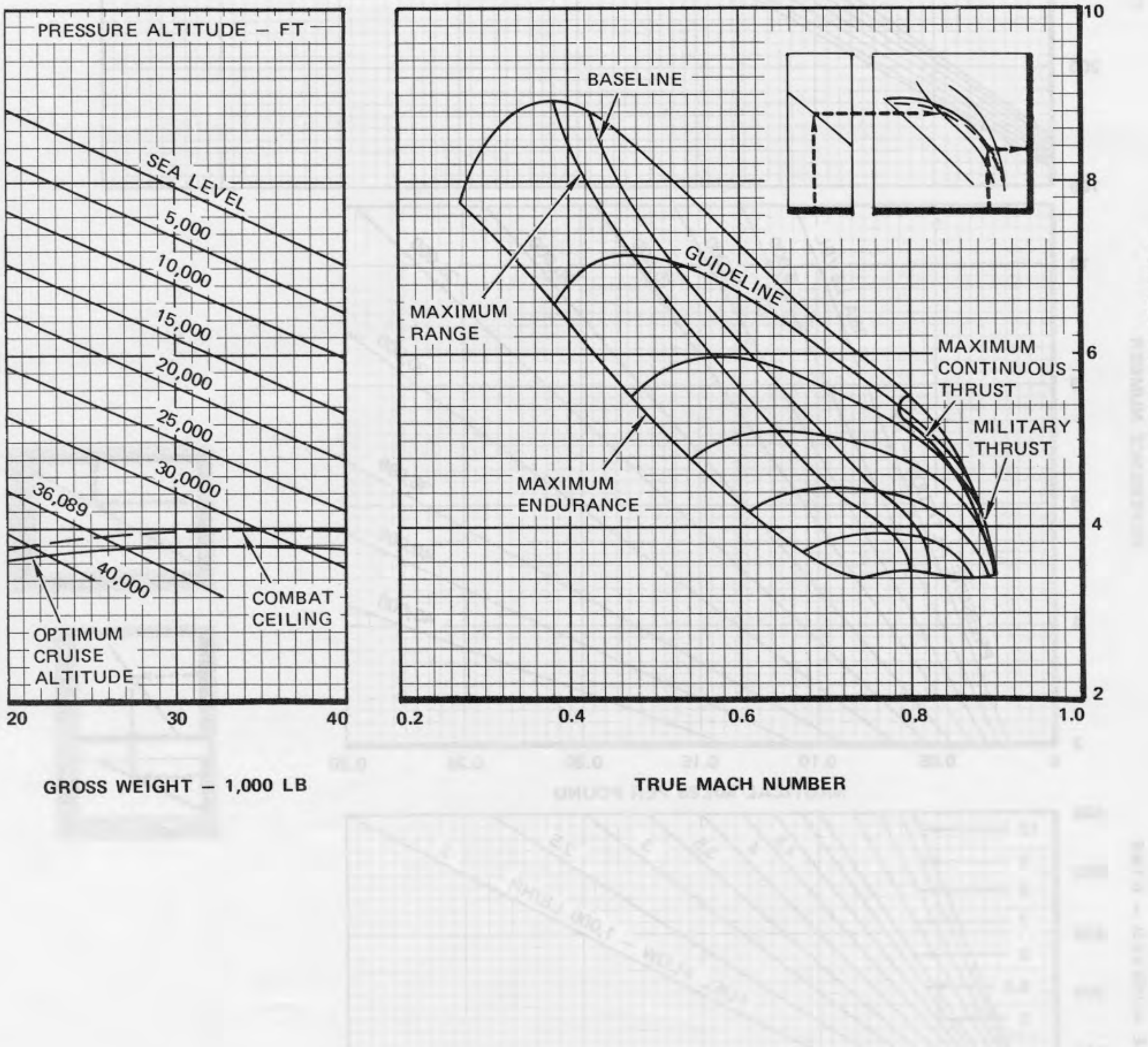
Figure A4–1 (Sheet 10)

NAUTICAL MILES PER POUND

CONFIGURATION DRAG INDEX – 100

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



75D263(11)–03–72

Figure A4–1 (Sheet 11)

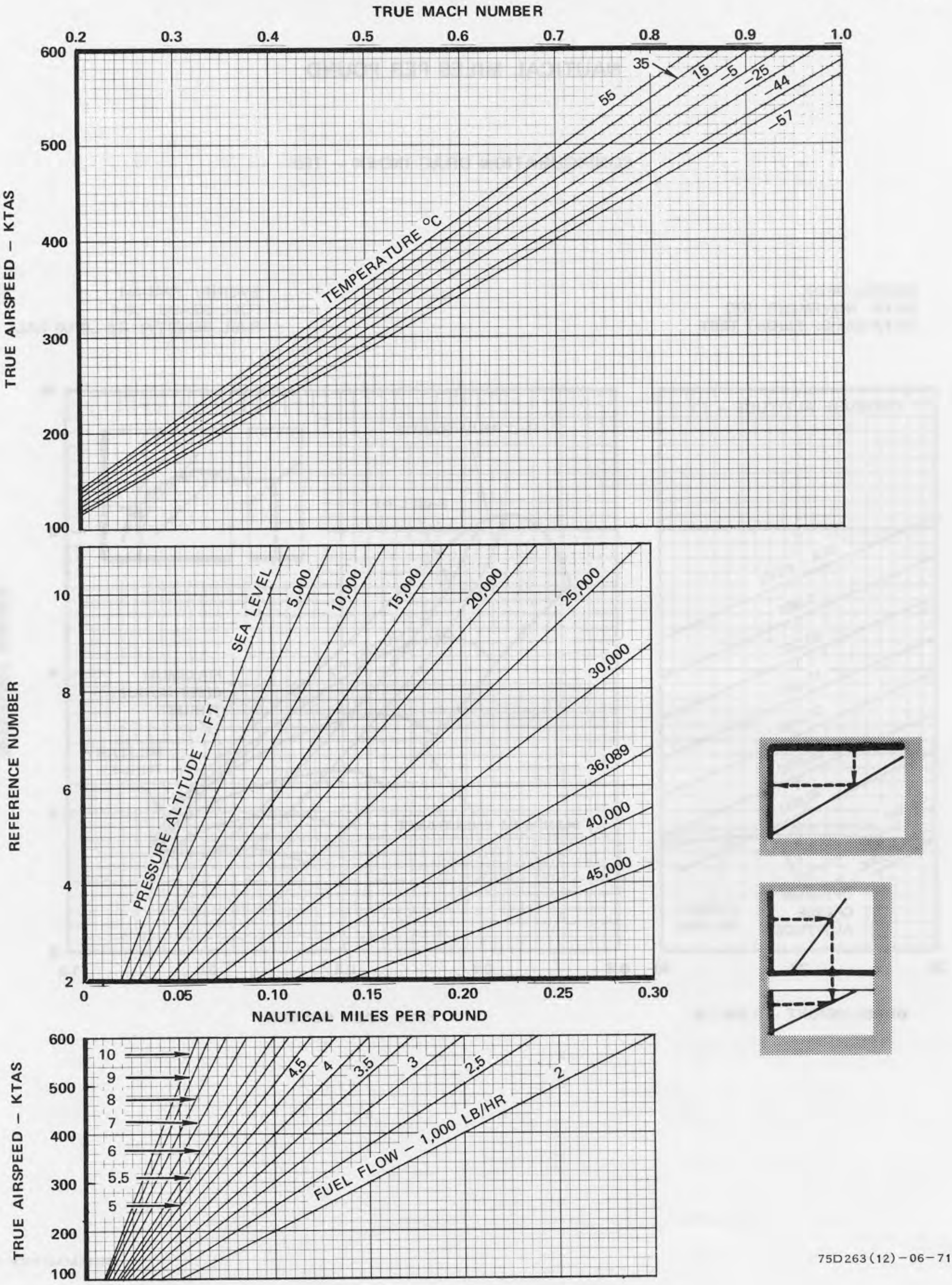


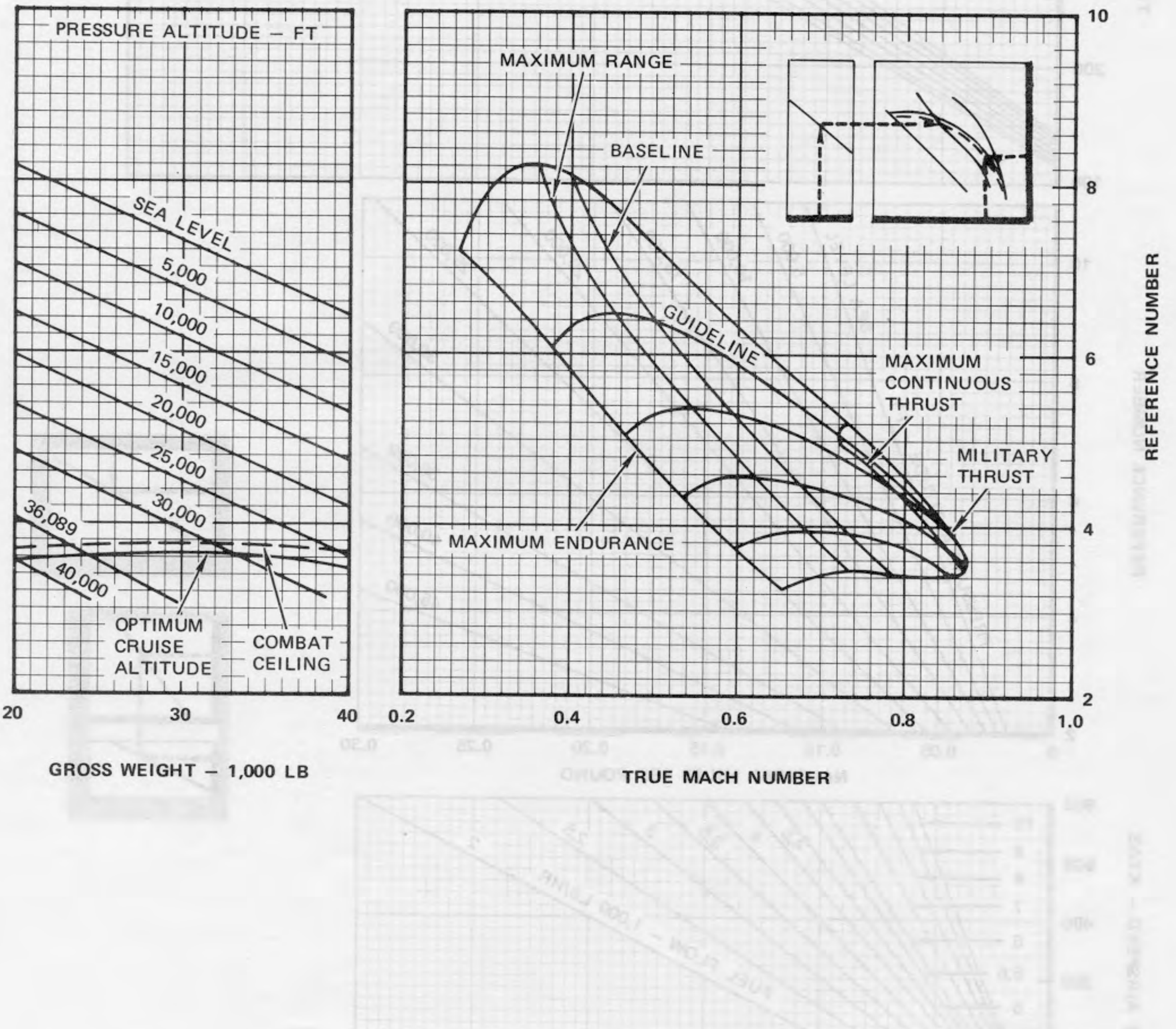
Figure A4–1 (Sheet 12)

NAUTICAL MILES PER POUND

CONFIGURATION DRAG INDEX – 150

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



75D263(13)–03–72

Figure A4–1 (Sheet 13)

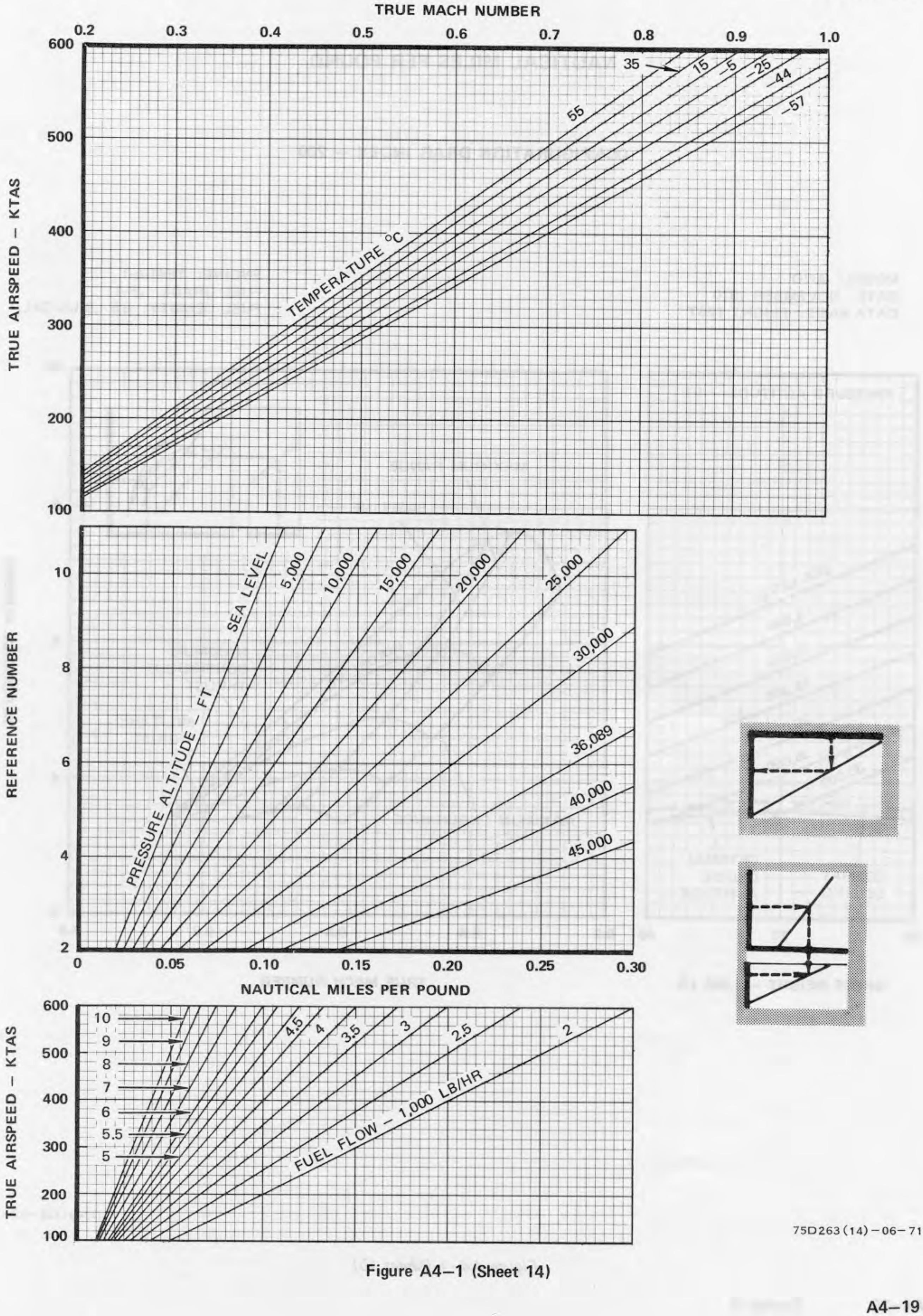


Figure A4–1 (Sheet 14)

NAUTICAL MILES PER POUND

CONFIGURATION DRAG INDEX – 200

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.

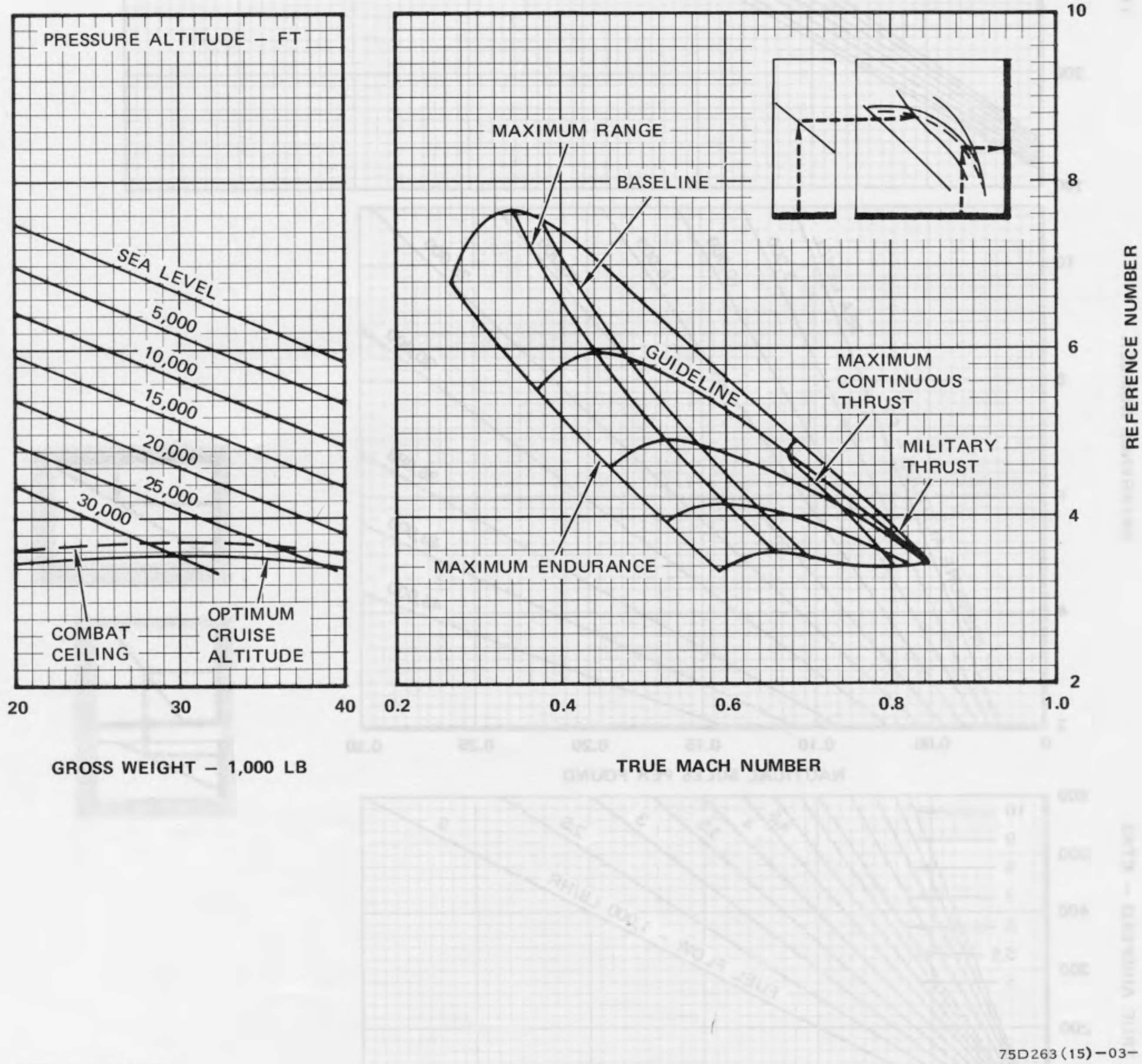


Figure A4–1 (Sheet 15)

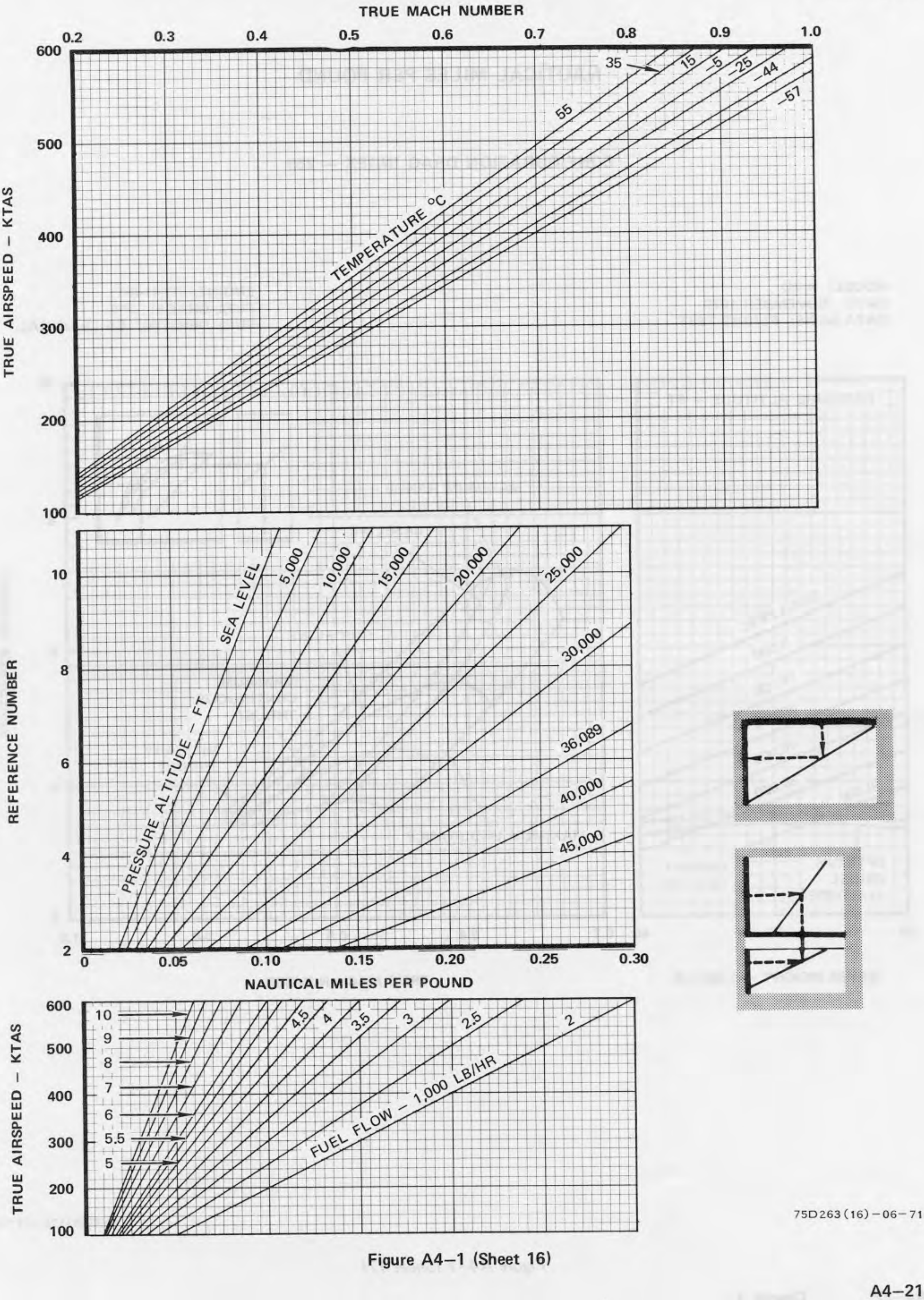


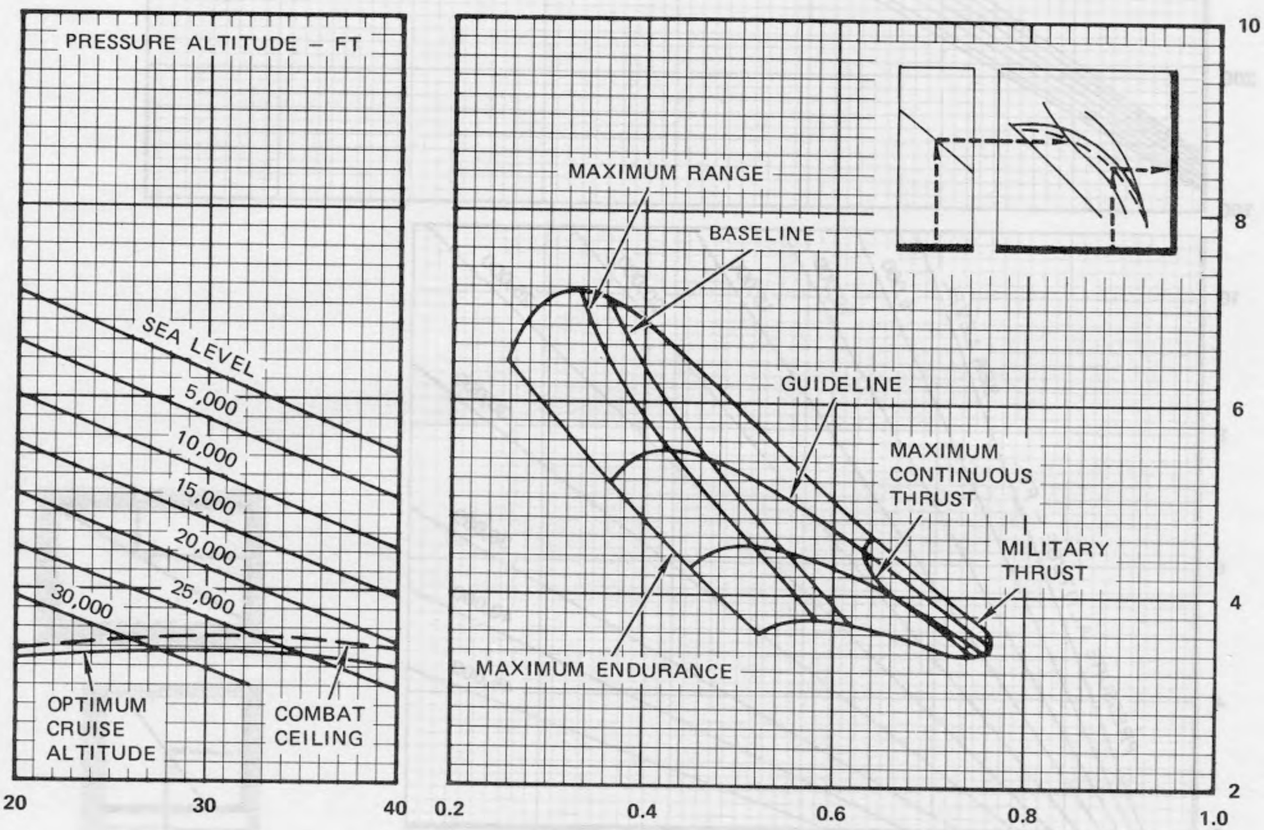
Figure A4–1 (Sheet 16)

NAUTICAL MILES PER POUND

CONFIGURATION DRAG INDEX – 250

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



75D263(17)–03–72

Figure A4–1 (Sheet 17)

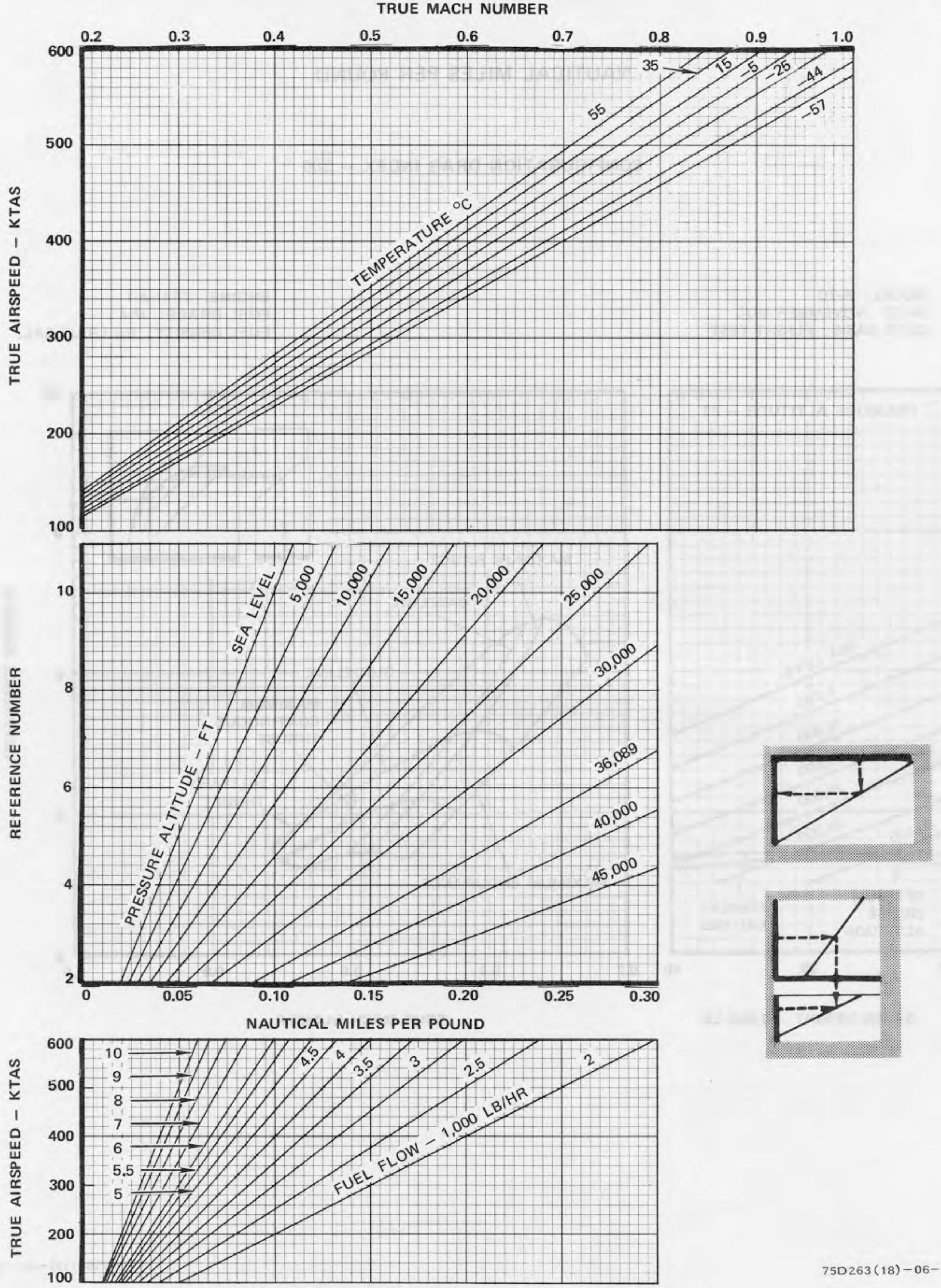


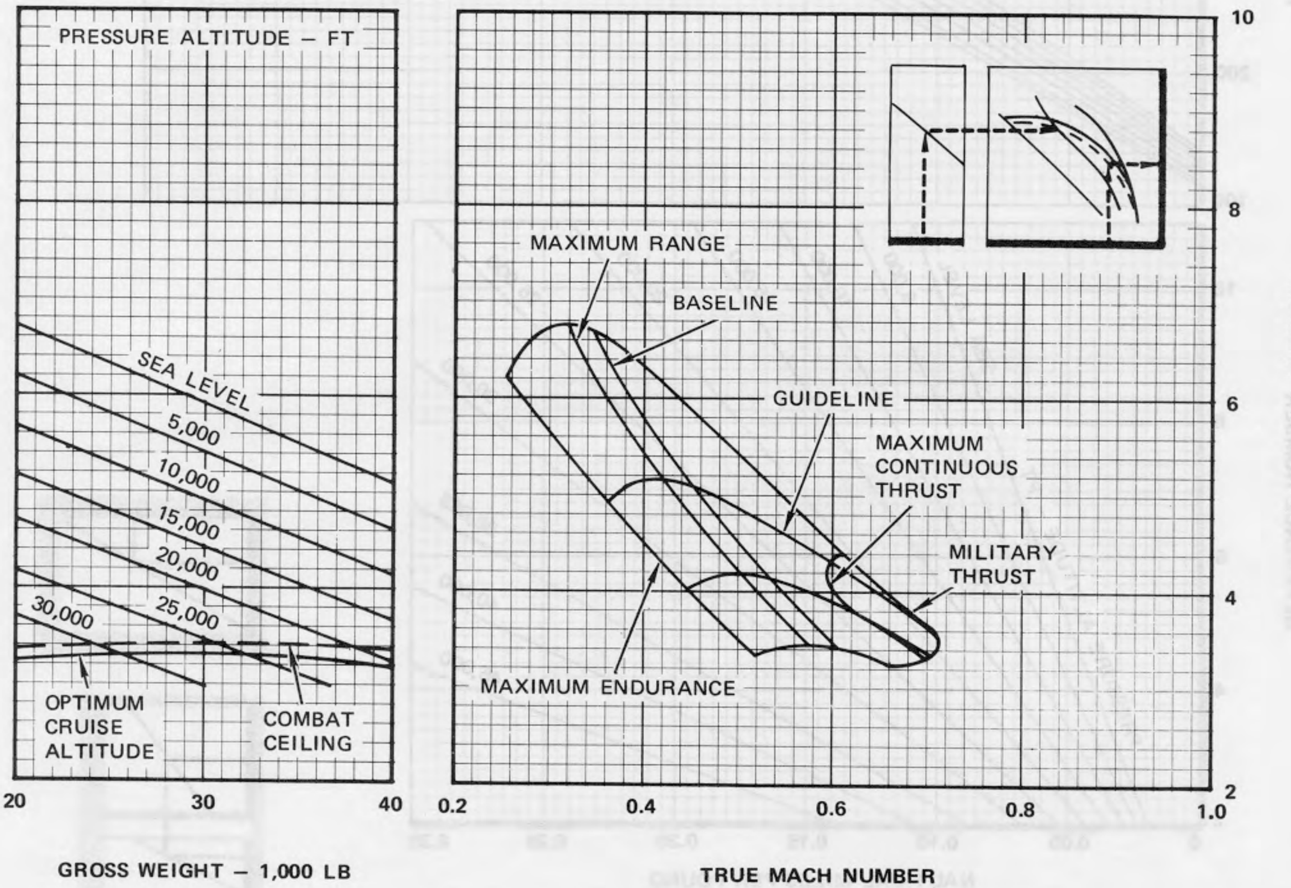
Figure A4–1 (Sheet 18)

NAUTICAL MILES PER POUND

CONFIGURATION DRAG INDEX – 300

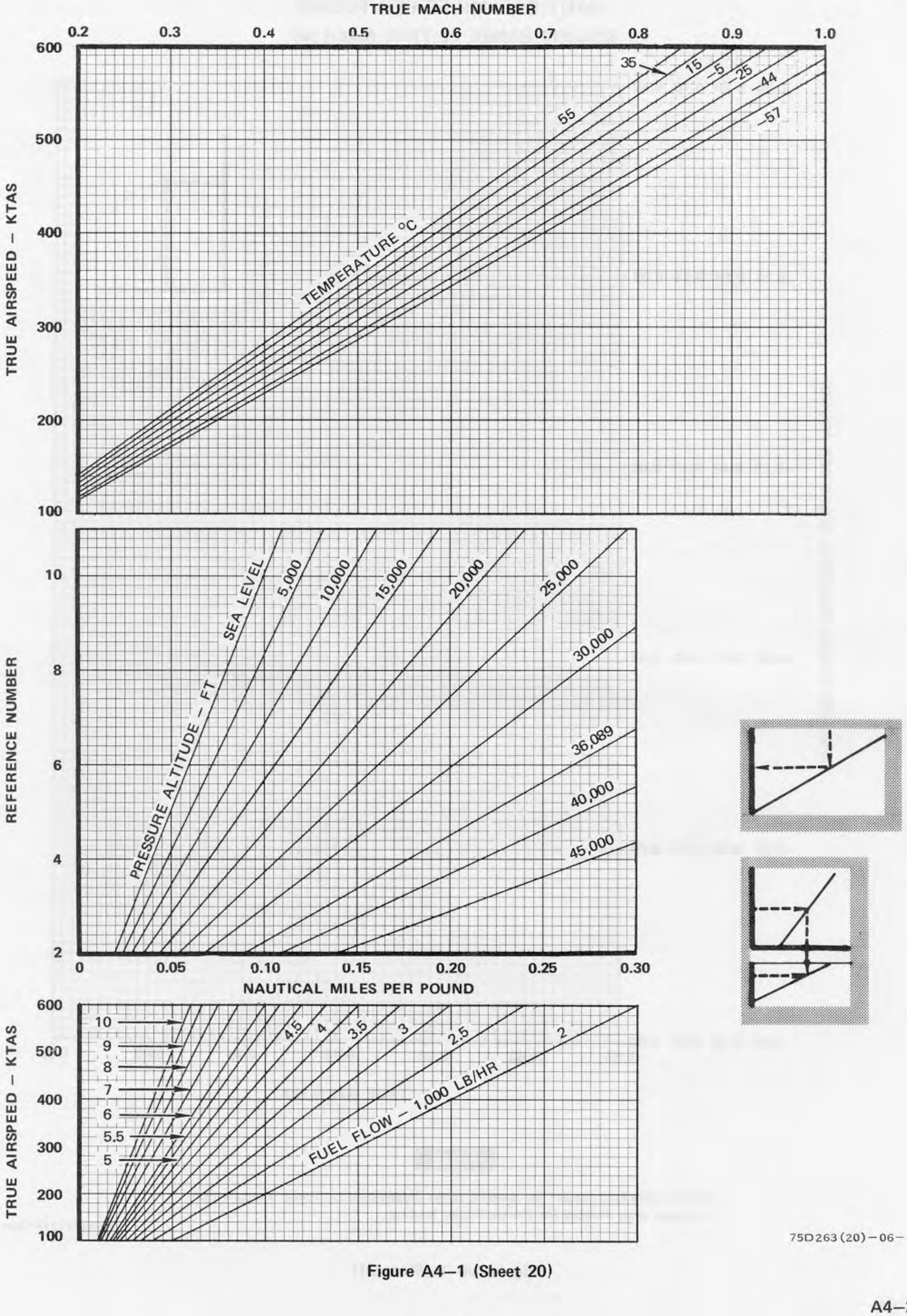
MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



75D263 (19)–03–72

Figure A4–1 (Sheet 19)

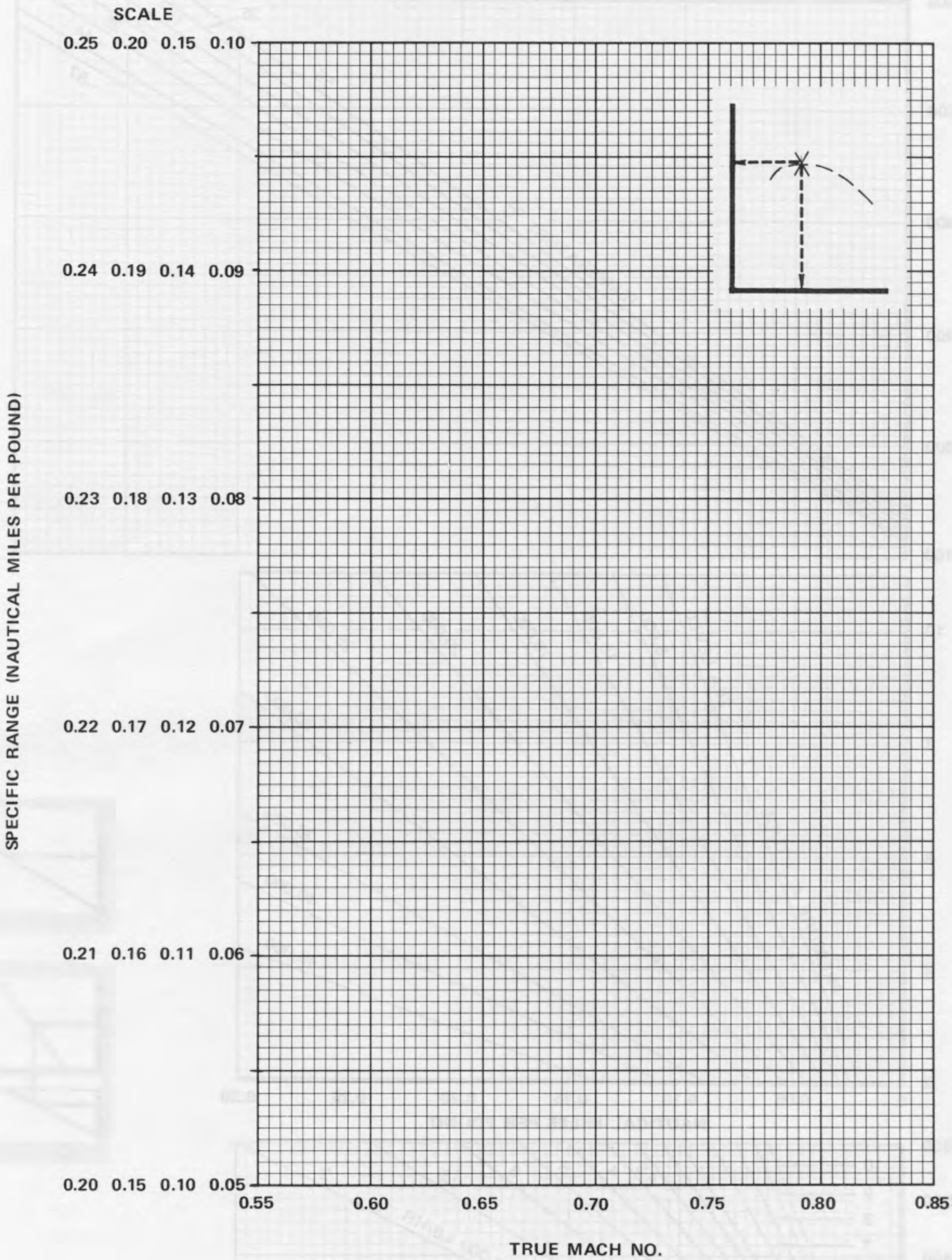


75D263(20)–06–71

Figure A4–1 (Sheet 20)

NAUTICAL MILES PER POUND

SPECIFIC RANGE VS TRUE MACH NO.



NOTE

Select scale appropriate for specific range determined by linear interpolation between drag indexes for the particular loading.

75D263(21)–08–71

Figure A4–1 (Sheet 21)

DIVERSION RANGE SUMMARY TABLE

SIX PYLONS WITH TWO MERS
STD DAY – ZERO WIND

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

RANGE AND TIME REMAINING WITH 1,000 LB RESERVE AT SEA LEVEL										PROCEDURE
FUEL	1,000 FT	SL	5	10	15	20	25	30	35	Initial Altitude
1,500 LB	NMI MIN	46 10	56 12	66 15	77 17	88 19	101 21	114 23	125 25	Cruise at initial altitude and descend on course.
1,500 LB	1,000 FT	15	20	20	25	30	30	35	35	Optimum Altitude
1,500 LB	NMI MIN	53 12	66 14	75 16	85 18	95 20	104 21	115 23	125 25	Climb to optimum altitude and descend on course.
2,000 LB	NMI MIN	90 20	107 23	125 26	144 29	162 32	183 35	203 37	220 39	Cruise at initial altitude and descend on course.
2,000 LB	1,000 FT	35	35	40	40	40	40	40	40	Optimum Altitude
2,000 LB	NMI MIN	136 26	154 28	167 30	179 32	190 34	200 36	209 37	218 38	Climb to optimum altitude and descend on course.
2,500 LB	NMI MIN	135 29	157 34	181 38	207 41	233 45	260 48	291 50	314 52	Cruise at initial altitude and descend on course.
2,500 LB	1,000 FT	40	40	40	40	40	40	40	40	Optimum Altitude
2,500 LB	NMI MIN	230 40	248 42	263 44	275 45	285 47	296 49	306 50	316 52	Climb to optimum altitude and descend on course.
3,000 LB	NMI MIN	180 39	208 44	239 49	270 54	306 58	342 61	381 64	409 66	Cruise at initial altitude and descend on course.
3,000 LB	1,000 FT	40	40	40	40	40	40	40	40	Optimum Altitude
3,000 LB	NMI MIN	325 53	344 55	359 57	370 59	381 60	391 62	401 63	410 65	Climb to optimum altitude and descend on course.

		SL	5	10	15	20	25	30	35	40
CRUISE ALTITUDE		SL	5	10	15	20	25	30	35	40
CRUISE TMN		0.42	0.44	0.47	0.51	0.56	0.61	0.66	0.70	0.75
DESCEND	DESCENT DISTANCE (NMI)		11	22	33	43	55	67	81	98
220 KIAS	DESCENT TIME (MIN)		3	6	8	11	14	16	19	21
IDLE	DESCENT FUEL (LB)		75	115	152	189	222	254	293	328

NOTE

- Fuel, distance and time included for climb to optimum altitude cruise and oncourse maximum range descent to sea level destination.
- Tabulated descent data for maximum range descent to sea level, idle rpm, and speed brake in.
- Climb at 0.73 TMN or 330 KIAS, whichever is lower, with military thrust.
- With more than 3,000 lb of fuel, cruise at 0.75 TMN at 40,000 ft pressure altitude.

75D197–06–71

Figure A4–2

Part 5
Endurance

ENDURANCE CHARTS.

Endurance charts provide a means of determining the optimum Mach number and the fuel required to loiter at a given altitude for a specified period of time. A correction grid to gross weight for bank angle and an ambient temperature correction grid (for other than standard conditions) to fuel flow are provided for optional use. If optimum conditions are desired, optimum altitude is determined as a function of gross weight and drag index and read in the constant altitude grids to obtain the corresponding values of Mach number and fuel flow. The endurance charts provide data for drag indexes of 0 through 300.

USE.

Enter the Maximum Endurance chart with gross weight. The gross weight should be corrected for bank angle if the loiter period requires turning flight. A correction grid (gross weight vs bank angle) is provided for compensation of g-loading during turning flight. To use this particular grid, enter with gross weight on the left scale and contour the guide lines to the right; also project vertically up from the bottom bank angle scale. At the point of intersection of the two projections, proceed horizontally left and read gross weight corrected for bank angle.

If loiter period requires turning flight, enter figure A5−1, sheet 3 with desired bank angle and proceed vertically up to the average gross weight curve. Then move horizontally left to obtain corrected gross weight for entering figure A5−1, sheet 1.

Enter figure A5−1, sheet 1 with corrected gross weight and move horizontally right to the desired loiter altitude curve. Read vertically down to bottom of chart to obtain reference number. If optimum endurance altitude is desired, enter with corrected gross weight and continue horizontally right to the appropriate drag index curve. Then move vertically down to obtain optimum endurance altitude.

Enter figure A5−1, sheet 2 with the reference number obtained from sheet 1 and move vertically down to the appropriate drag index curve. Move horizontally right to the fuel flow curve for temperature correction. For standard day temperatures, proceed directly through the temperature scale to obtain fuel flow. (To correct for warmer than standard day temperatures, follow the solid chase lines to the temperature correction. To correct for colder than standard day temperatures, follow the broken chase lines.) Then proceed horizontally right to the desired loiter time and move vertically down to read fuel flow required.

Enter figure A5−1, sheet 3 with desired bank angle and proceed vertically up to the average gross weight curve. Continue horizontally right to loiter altitude then vertically down to drag index curve. Then proceed horizontally left and read true Mach number for bank angle selected.

The preceding steps are based on obtaining loiter fuel or time for gross weight at start or end of loiter. To obtain average gross weight, subtract one-half the fuel required from start gross weight. For loiter time of short duration (approximately 10 minutes), the correction to average gross weight is not significant.

SAMPLE PROBLEM.

Given:

A. Average gross weight of 25,000 lb

B. Drag index is 60.

C. Desired loiter time is 30 min with bank angle of 20°.

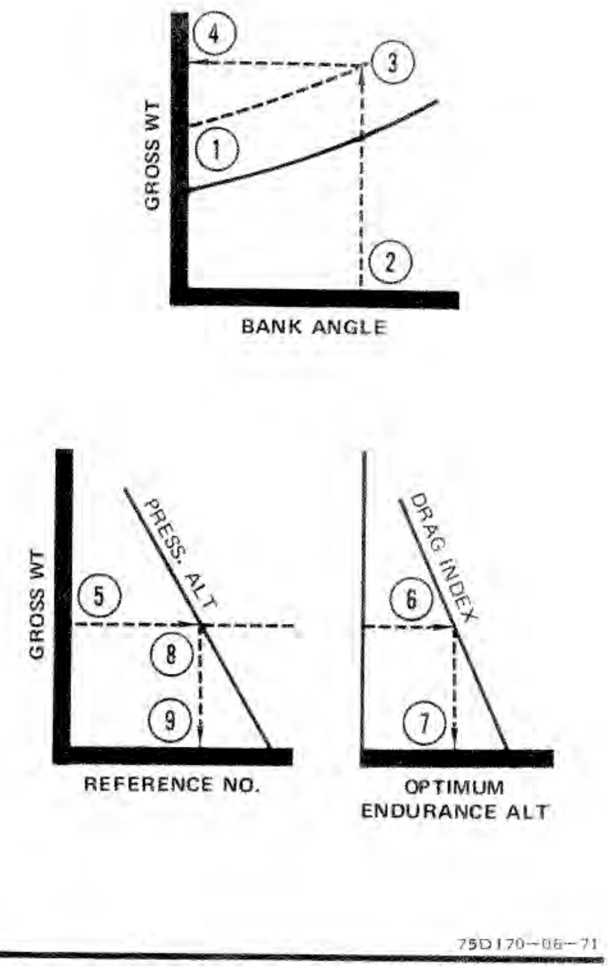
D. Ambient temperature at altitude is 10°C hotter than standard.

Calculate:

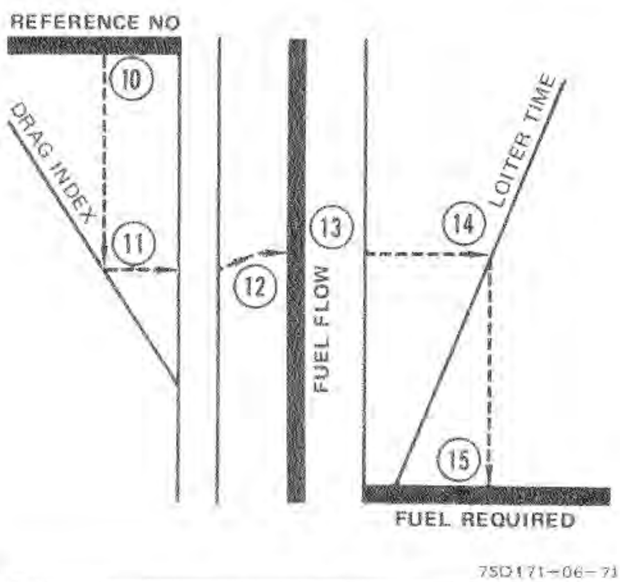
Fuel required and true Mach number for loiter, using Maximum Endurance – Time, Fuel, Mach Number, and Optimum Altitude.

(1)	Average gross weight	25,000 lb
(2)	Bank angle	20°
(3)	Intersection	—
(4)	Corrected average gross weight	26,500 lb
(5)	Corrected average gross weight	26,500 lb
(6)	Drag index	60
(7)	Optimum altitude	30,000 ft
(8)	Pressure altitude	30,000 ft
(9)	Reference number	6.2
(10)	Reference number	6.2
(11)	Drag index	60
(12)	Ambient temperature	10°C hotter
(13)	Fuel flow	2,160 lb/hr
(14)	Loiter time	30 min
(15)	Fuel required	1,080 lb
(16)	Corrected average gross weight	26,500 lb
(17)	Pressure altitude	30,000 ft
(18)	Drag index	60
(19)	True Mach No.	0.59

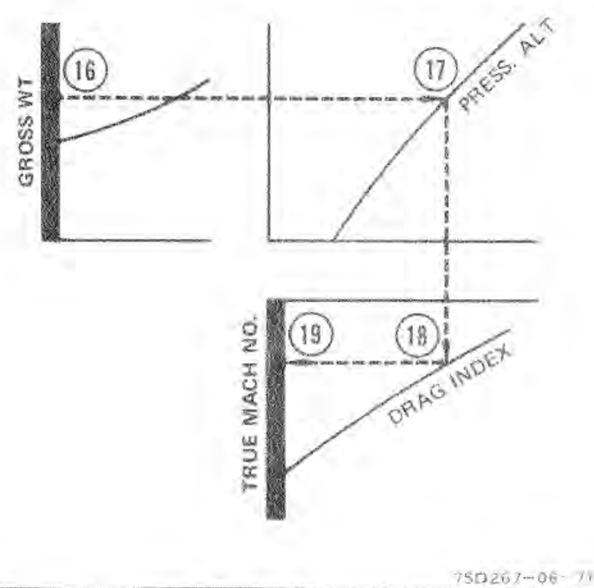
SAMPLE MAXIMUM ENDURANCE



SAMPLE MAXIMUM ENDURANCE

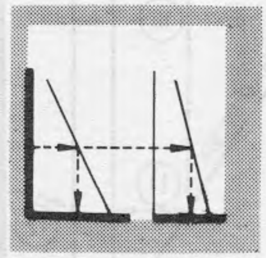


SAMPLE BANK ANGLE AND TRUE MACH NUMBER



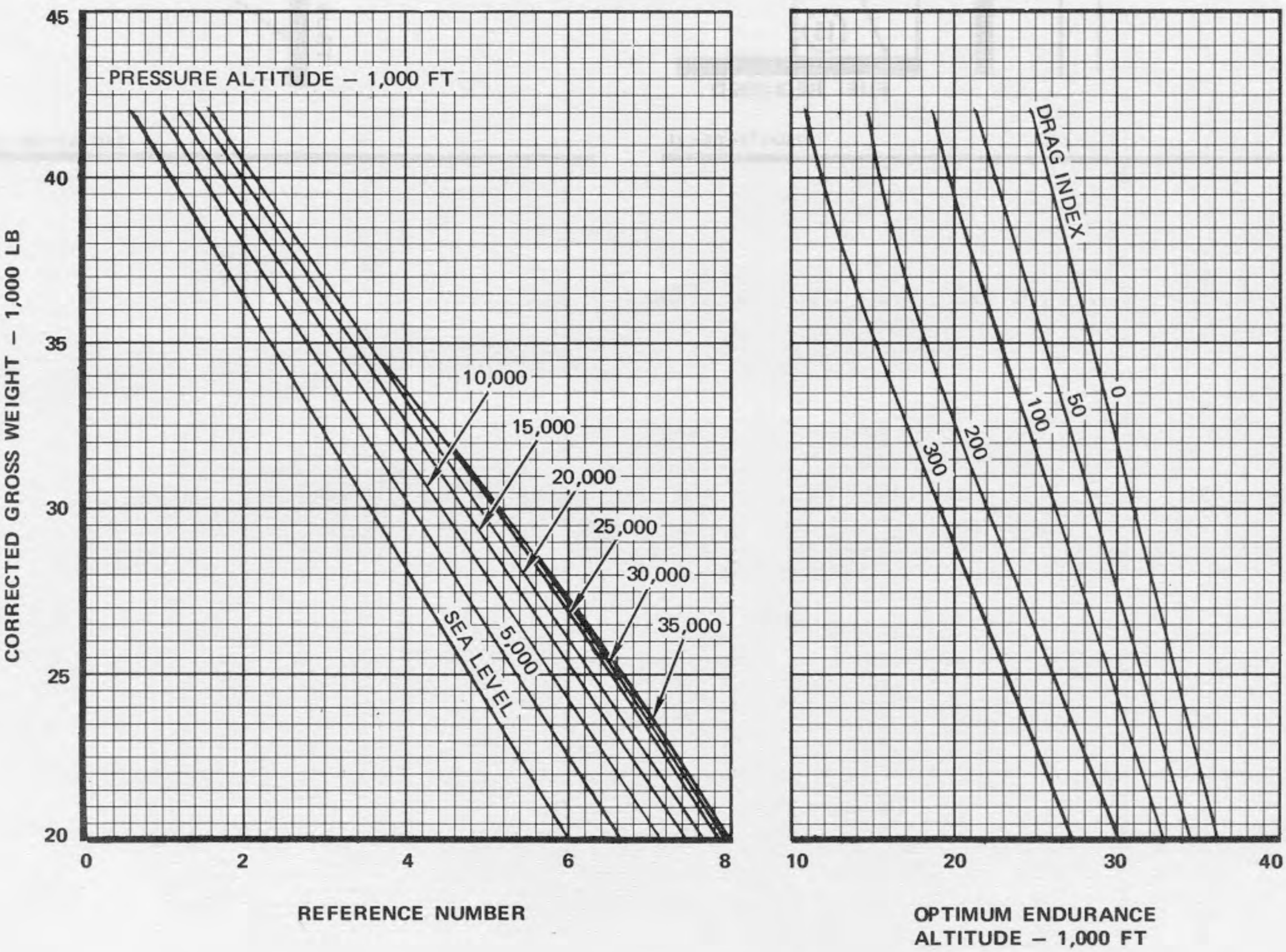
MAXIMUM ENDURANCE

REFERENCE NUMBER AND OPTIMUM ALTITUDE



MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL



75D017(1)–06–71

Figure A5–1 (Sheet 1)

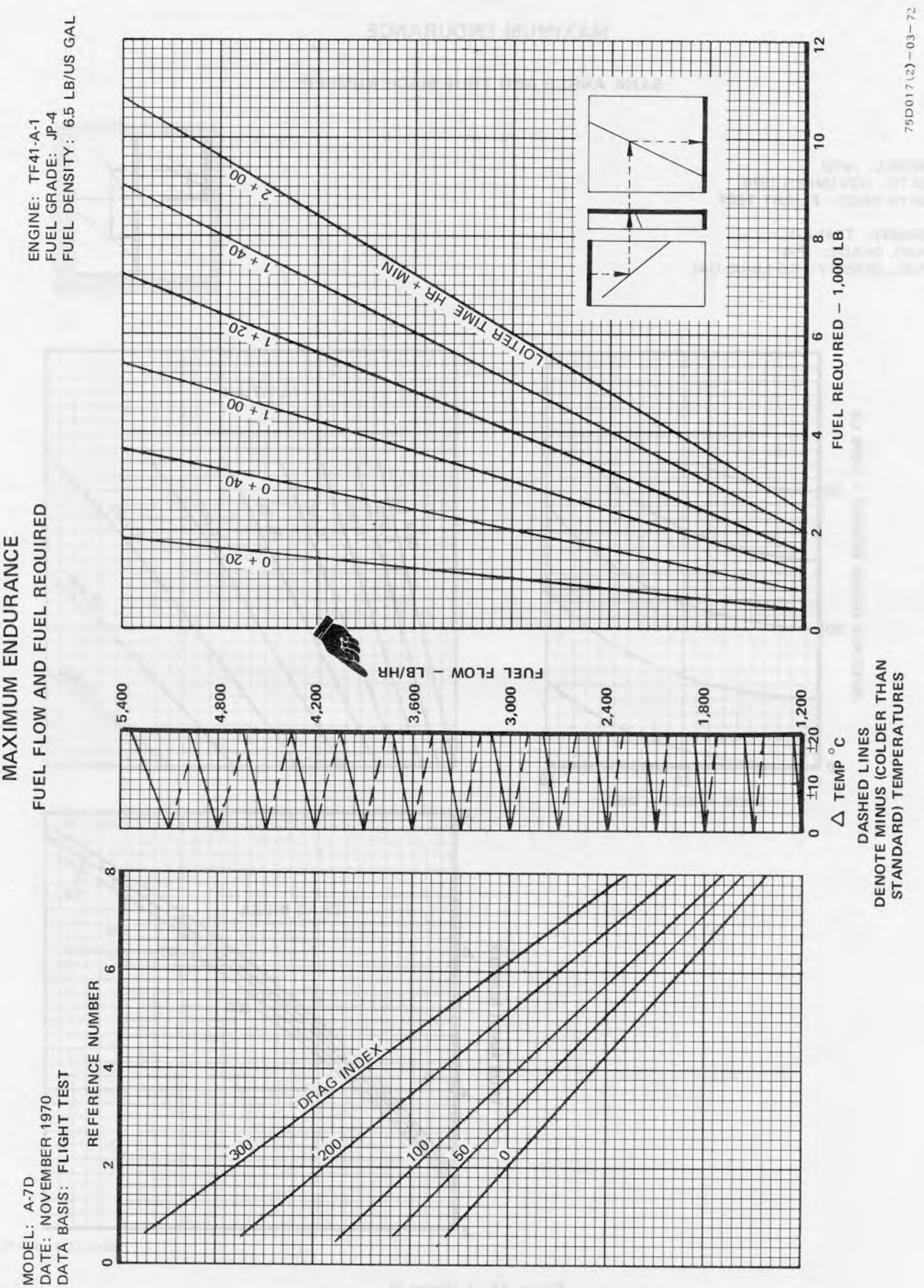


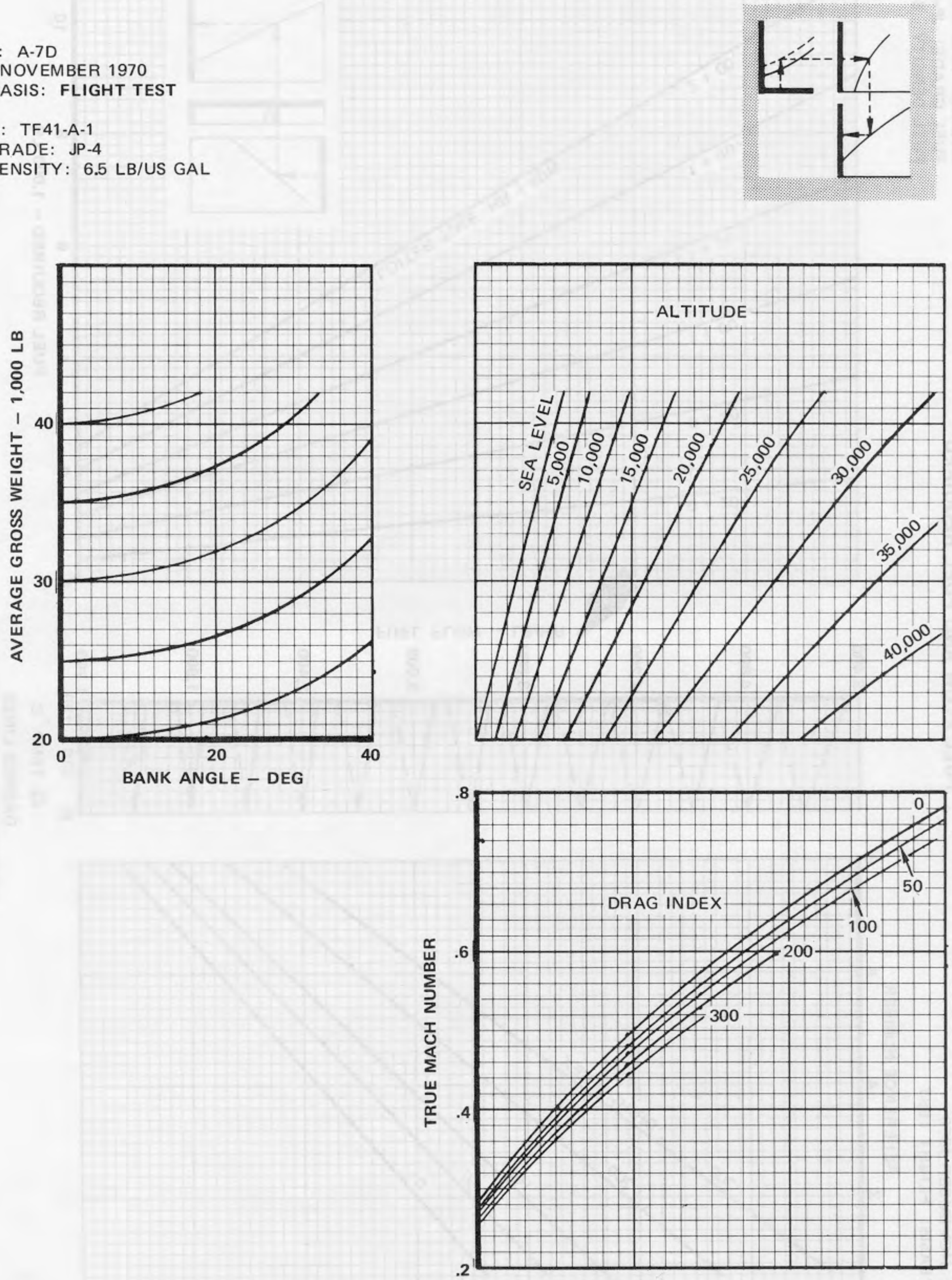
Figure A5–1 (Sheet 2)

MAXIMUM ENDURANCE

BANK ANGLE AND TRUE MACH NUMBER

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL



75D017(3)–06–71

Figure A5–1 (Sheet 3)

Part 6
Descent

MAXIMUM RANGE DESCENT CHARTS.

Maximum range descent charts provide a means of determining fuel, time, and distance required to descend from altitude at idle thrust. This data covers an altitude range from approximately 40,000 feet pressure altitude to sea level at constant calibrated airspeed schedules for various drag index configurations. Two charts are provided, one for light weight (25,000 pounds) and the other for medium weight (35,000 pounds), for descent at idle thrust with speed brake in (figure A6–1).

USE.

Enter chart at initial descent pressure altitude and proceed vertically up to the value of drag index configuration (interpolation required for values between drag index curves on graphs). Read fuel, time, and distance horizontally left from each plotted drag index. To determine fuel, time, and distance required to descend from a higher altitude to an intermediate altitude, take the difference between descent values of each altitude to sea level. To obtain the descent speed schedule, select appropriate airspeed to nearest drag index value in table at lower portion of chart.

SAMPLE PROBLEM.

Given:

A. Descend from 25,000 ft to SL at idle rpm.

B. Drag index is 100.

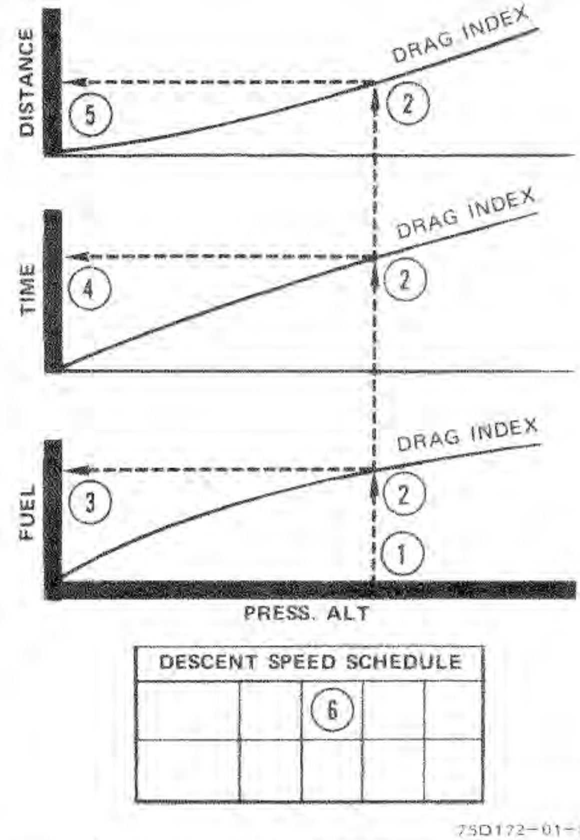
C. Speed brake is in.

D. Gross weight is 25,000 lb.

Calculate:

Fuel, time, distance, and speed schedule required, using Maximum Range Descent chart (figure A6–1).

SAMPLE MAXIMUM RANGE DESCENT



(1)	Pressure altitude	25,000 ft
(2)	Drag index	100
(3)	Fuel	200 lb
(4)	Time	12 min
(5)	Distance	50 nmi
(6)	Descent speed schedule	210 KIAS

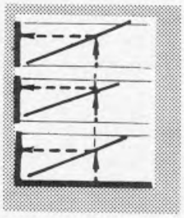
MAXIMUM RANGE DESCENT

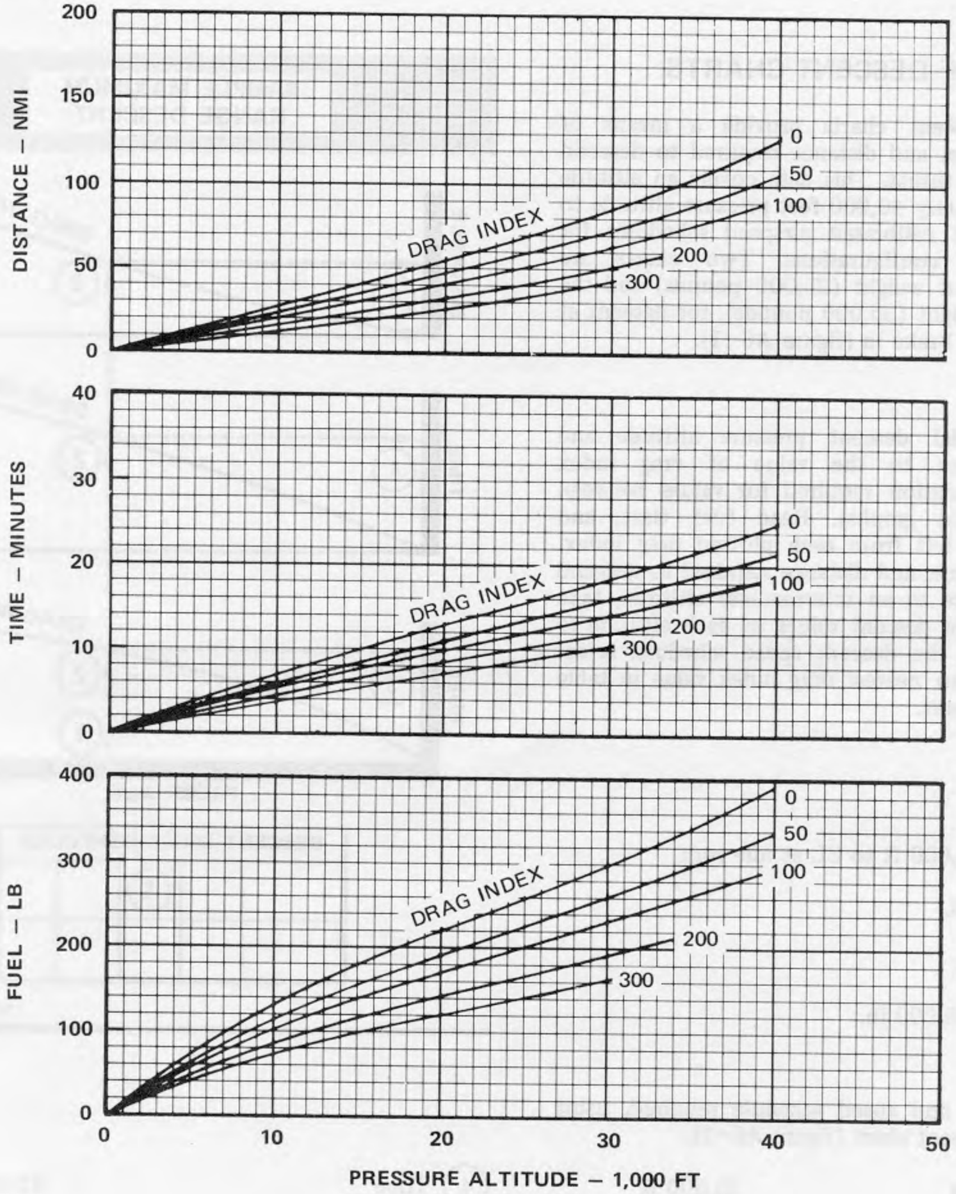
MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.

IDLE THRUST – STANDARD DAY
SPEED BRAKE IN
25,000 LB GROSS WEIGHT

LIGHT WEIGHT





NOTE

The effect of deviations from standard day conditions is negligible.

DESCENT SPEED SCHEDULE

DRAG INDEX	0	50	100	150	200	300
KIAS	224	215	210	206	203	199

75D009(1)–06–71

Figure A6–1 (Sheet 1)

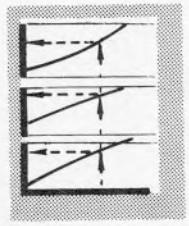
MAXIMUM RANGE DESCENT

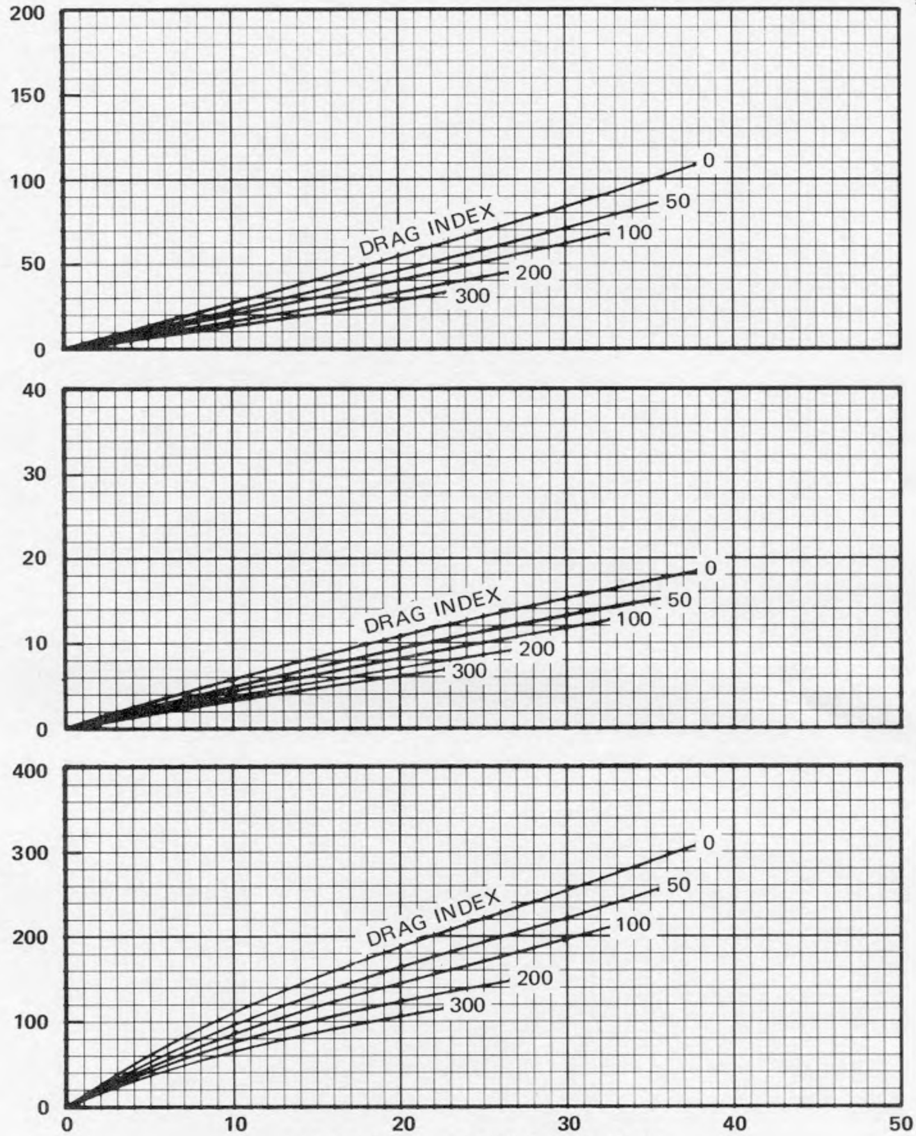
MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.

IDLE THRUST – STANDARD DAY
SPEED BRAKE IN
35,000 LB GROSS WEIGHT

MEDIUM WEIGHT





NOTE

The effect of deviations from standard day conditions is negligible.

DESCENT SPEED SCHEDULE

DRAG INDEX	0	50	100	150	200	300
KIAS	265	255	249	244	240	235

75D009(2)–06–71

Figure A6–1 (Sheet 2)

Part 7
Landing

TABLE OF CONTENTS.

LANDING CHARTS (GENERAL).

Landing charts provide a means of determining normal requirements for final approach speed, touchdown speed, landing distance, and CG correction for landing ground roll. The Landing Distance charts are based on a CG position of 26% MAC with provisions for CG corrections. All data is based on full flap configuration.

Note

Refer to Part 1 of this Appendix for Runway Wind Components chart.

LANDING SPEED SCHEDULE CHART.

The Landing Speed Schedule chart (figure A7–1) presents final approach speed as a function of gross weight and CG position. These speeds are based on 17.5 units AOA.

USE.

Enter figure A7–1 with gross weight, and proceed vertically upward to full flaps or flaps up curve as desired. Proceed horizontally left and read value of final approach speed.

Note

Revise approach speed ±1/2 kn for each 1% CG shift (+ CG forward, - CG aft).

Subtract 5 knots from final approach speed to obtain touchdown speed.

SAMPLE PROBLEM.

Given:

A. Gross weight is 24,000 lb.

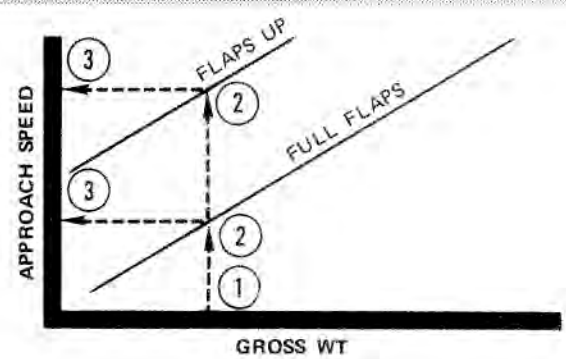
B. Full flaps.

Calculate:

Final approach and touchdown speed, using Landing Speed Schedule chart (figure A7–1).

(1)	Gross weight	24,000 lb
(2)	Full flaps	
(3)	Final approach speed	130 KIAS
(4)	Touchdown speed	125 KIAS

SAMPLE LANDING SPEED SCHEDULE



75D173-03-71

LANDING DISTANCE CHARTS.

Landing Distance charts (figure A7–2) present landing distance as a function of gross weight, runway temperature, pressure altitude, and wind velocity for a CG position of 26% MAC for either antiskid or manual braking.

USE.

Enter figure A7–2 with runway temperature and proceed vertically upward to pressure altitude and then horizontally right to gross weight. From this point proceed vertically downward to the baseline (zero wind line). Move down contouring the appropriate guideline (headwind or tailwind) to wind velocity and then vertically downward and read ground roll distance. Add 1,455 feet to this figure to obtain total distance from 50-foot obstacle.

SAMPLE PROBLEM.

Given:

A. Gross weight is 24,000 lb.

B. Antiskid braking.

C. Pressure altitude is 2,000 ft.

D. Runway temperature is 15°C.

E. Headwind velocity is 5 kn.

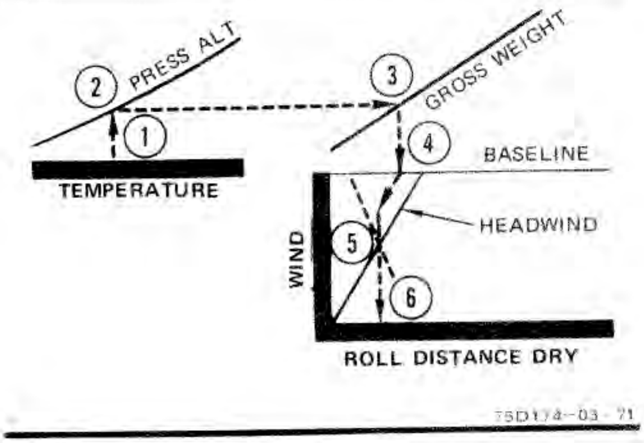
F. CG position is 26% MAC.

Calculate:

Ground roll distance and total distance, using Landing Distance chart (figure A7–2).

(1)	Runway temperature	15°C
(2)	Pressure altitude	2,000 ft
(3)	Gross weight	24,000 lb
(4)	Baseline	—
(5)	Headwind	5 kn
(6)	Ground roll distance	3,400 ft

SAMPLE LANDING DISTANCE



EFFECT OF RUNWAY CONDITIONS (RCR) ON GROUND ROLL DISTANCE CHARTS.

The Effect of Runway Conditions (RCR) on Ground Roll Distance charts are presented in figure A7–3. The charts provide the means of correcting the landing ground roll distance, for either antiskid or manual braking, for changes in braking efficiency caused by variations in runway surface conditions. An RCR of 21 represents heavy braking action, on a dry, hard-surfaced runway, while an RCR of 23 represents maximum continuous braking performance (representative of minimum run landing). An RCR less than 21 represents a decrease in braking efficiency from that for average dry, hard-surfaced runway conditions.

USE.

Enter Effect of RCR on Ground Roll Distance chart (figure A7–3) with ground roll distance for dry, hard-surfaced runway and proceed vertically upward to RCR number. Then proceed horizontally left to read corrected ground roll distance.

SAMPLE PROBLEM.

Given:

A. Ground roll distance for dry, hard-surfaced runway is 3,950 ft.

B. Antiskid braking.

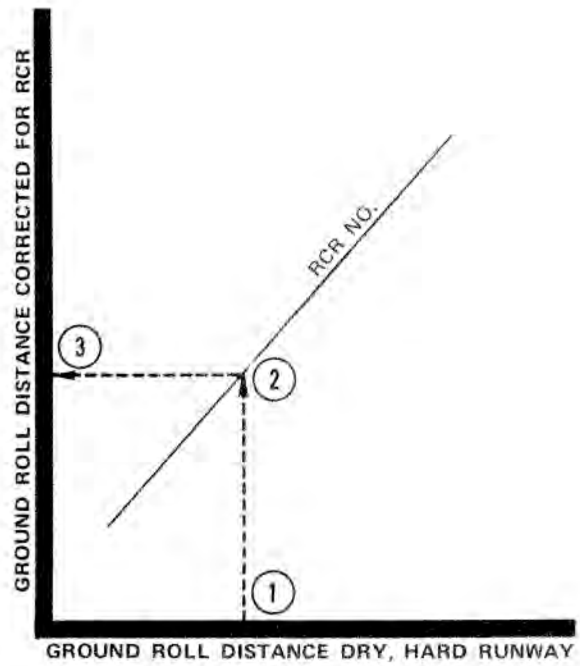
C. RCR number is 12.

Calculate:

Ground roll distance corrected for RCR. Use Effect of RCR on Ground Roll Distance chart (figure A7–3).

(1)	Ground roll distance for dry, hard-surfaced runway	3,950 ft
(2)	RCR number	12
(3)	Ground roll distance corrected for RCR	6,200 ft

SAMPLE EFFECT OF RUNWAY CONDITIONS (RCR) ON GROUND ROLL DISTANCE



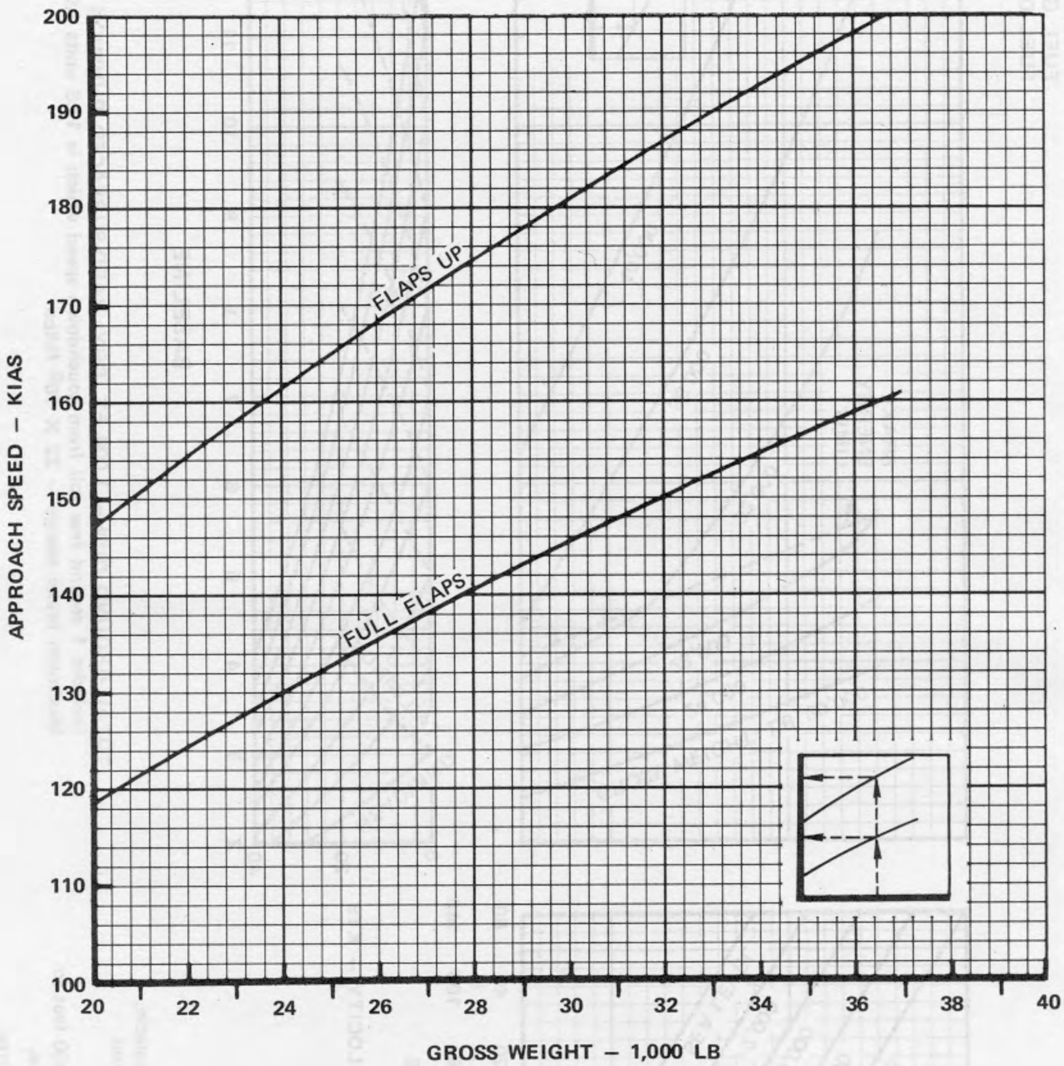
75D186–1–69

LANDING SPEED SCHEDULE

17.5 UNITS ANGLE OF ATTACK
CG = 26% MAC

MODEL: A-7D
DATE: MARCH 1971
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



NOTE

1. Subtract 5 knots for touchdown speed.
2. Modify speed ±1/2 kn per ±1% CG shift (+CG fwd; –CG aft).

75D018–03–71

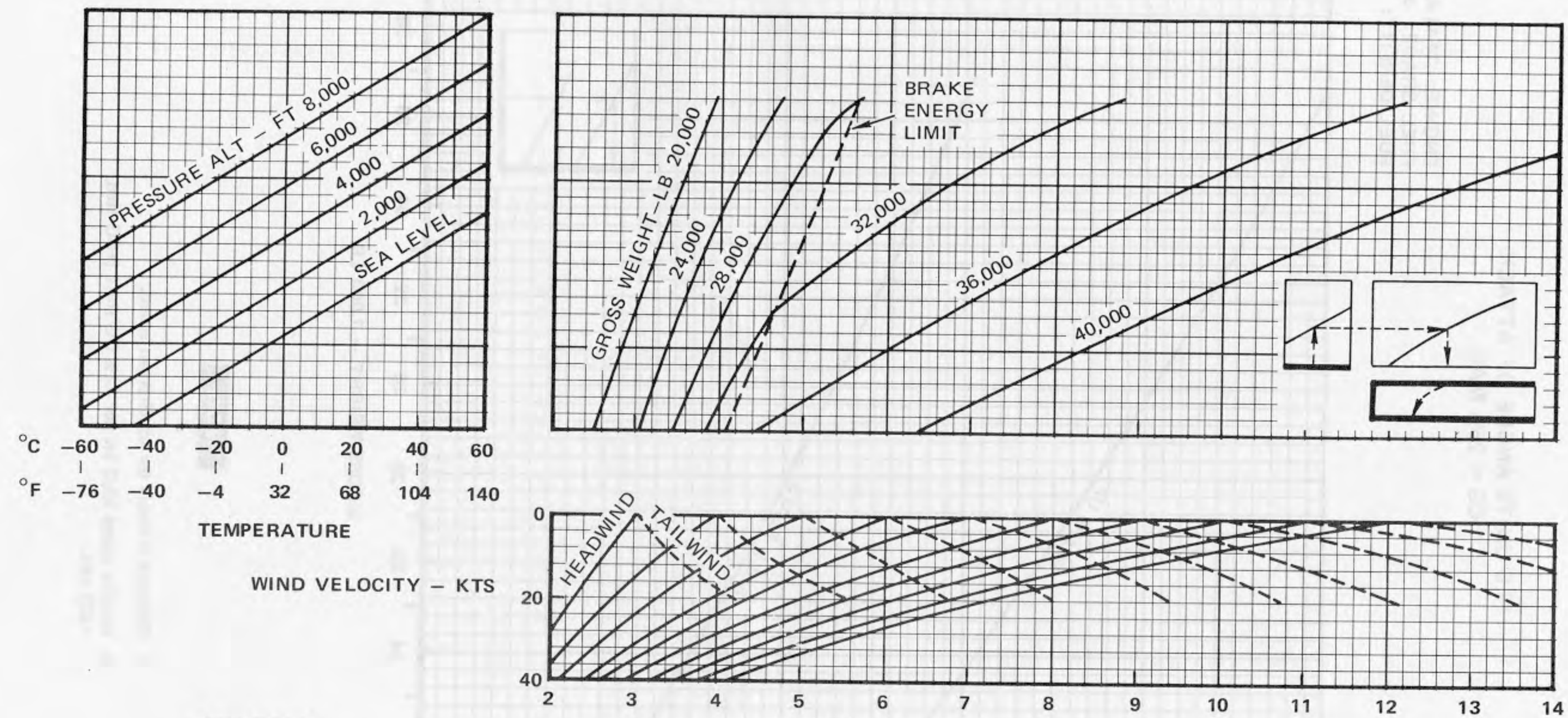
Figure A7–1

LANDING DISTANCE

FULL FLAPS, CG = 26% MAC
ANTI-SKID BRAKING

MODEL: A-7D
DATE: FEBRUARY 1971
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



TOTAL GROUND RUN – 1,000 FT (DRY, HARD-SURFACED RUNWAY)
Includes 1 second free roll from touchdown speed which is 17.5 units AOA less 5 KIAS
Maximum brake energy – 22 X 10^6 ft/lbs

NOTE

1. For distance from 50 ft obstacle, add 1,455 feet to ground run distance.
2. For manual braking, add 300 feet to landing ground run distance.
3. For flaps up landing, add 20% (estimated) to landing distance data.

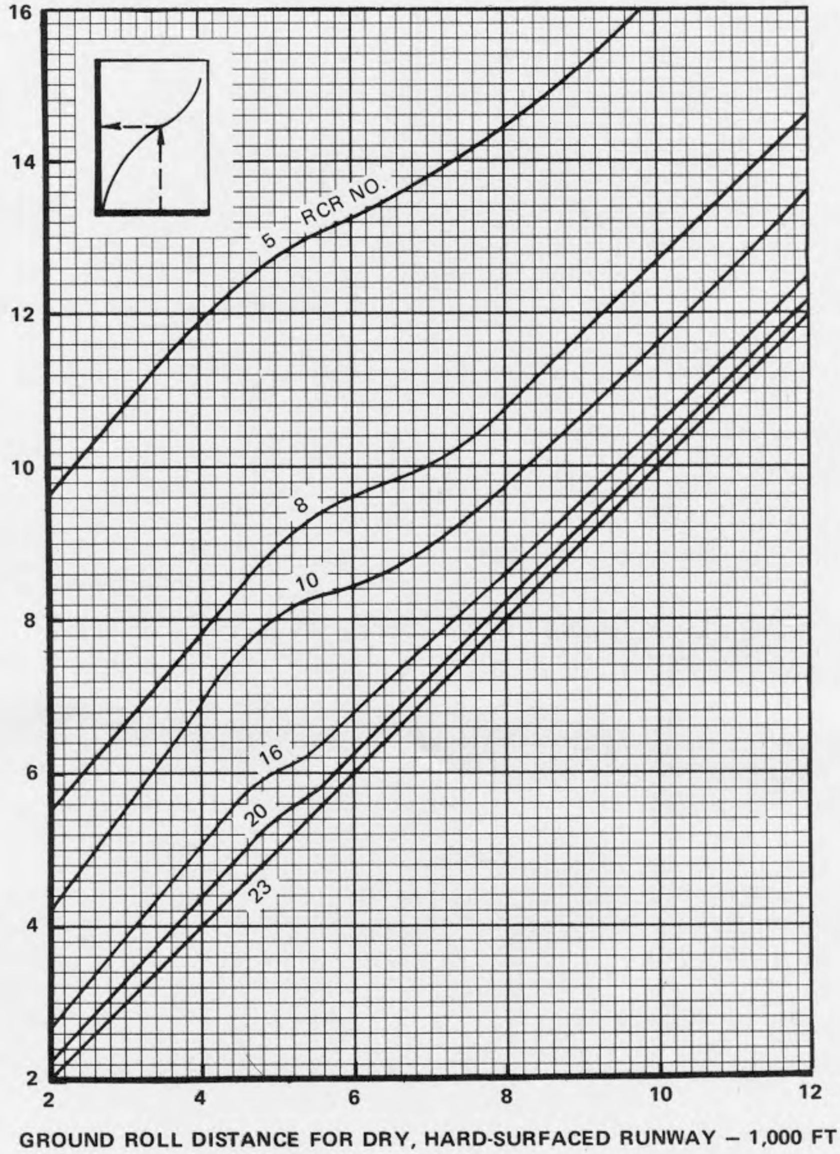
75D019–06–71

Figure A7–2

EFFECT OF RUNWAY CONDITIONS (RCR) ON GROUND ROLL DISTANCE

MODEL: A-7D
DATE: MARCH 1971
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



APPROX RCR VALUES FOR HARD-SURFACED RUNWAY CONDITIONS	
RUNWAY CONDITION	RCR No.
DRY	23
WET	10
ICY	5
ICY (GLAZED)	2

NOTE

When runway conditions are reported WET, use an RCR of 10 under these conditions.

75D187–04–72

Figure A7–3

Part 8
Combat

TABLE OF CONTENTS.

COMBAT PERFORMANCE CHARTS (GENERAL).

Combat performance charts present data for use in maneuvering flight. Military thrust is considered at altitude and low level. Additional charts are provided for steady state turn performance.

LEVEL FLIGHT COMBAT SPEED AND FUEL ALLOWANCE CHARTS.

The Level Flight Combat Speed and Fuel Allowance charts are provided to determine maximum level flight speed and fuel flow. The data is based on takeoff gross weight minus 40% internal fuel, military power, and standard day conditions.

USE.

Plot drag index for desired configuration at Mach number 0.6, 0.7, 0.8, and 0.9 on the Level Flight Combat Speed chart at the appropriate Mach number. A line drawn through these points will intersect the pressure altitude lines on the chart at the maximum Mach number obtainable for that configuration at each altitude.

To obtain fuel flow, enter the Combat Fuel Allowance chart with pressure altitude and proceed horizontally to true Mach number. Move vertically down and read fuel flow in pounds per minute.

SAMPLE PROBLEM.

Given:

A. Intercept altitude desired is 30,000 ft.

B. Conditions are standard day and military thrust.

C. Configuration is 6 pylons, 8 M117A1's on 2 MER's at stations 2 and 7.

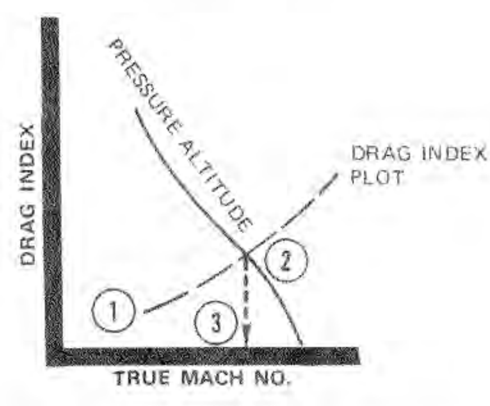
D. Fuel used in 4-minute combat.

Calculate:

Maximum level flight speed obtainable (true Mach No.) using Level Flight Combat Speed and Fuel Allowance chart (figure A8–1, sheet 1).

(1) Plot drag index at 0.6, 0.7, 0.8, and 0.9 MN and construct line through points	See sample in Part 4 for drag index calculation
(2) Pressure altitude	30,000 ft
(3) True Mach No. at 30,000 ft	0.795

SAMPLE LEVEL FLIGHT COMBAT SPEED

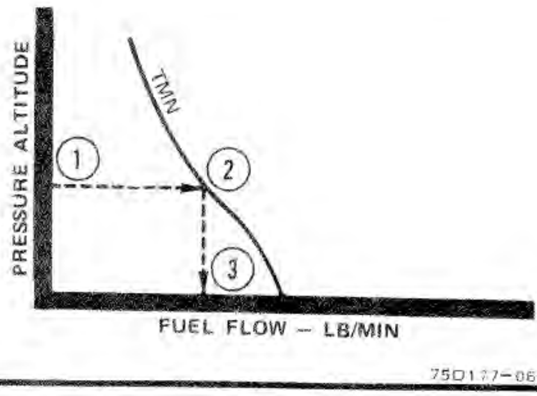


Calculate:

Fuel used in 4-minute combat, using Level Flight Combat Speed and Fuel Allowance chart (figure A8—1, sheet 2).

(1)	Pressure altitude	30,000 ft
(2)	True Mach No.	0.795
(3)	Fuel flow	68 lb/min

SAMPLE COMBAT FUEL ALLOWANCE



A. Fuel used in 4-minute combat = Time x fuel flow lb/min.

Thus: 272 lb = 4 x 68

LEVEL FLIGHT ACCELERATION AT LOW ALTITUDE.

Level Flight Acceleration at Low Altitude for military thrust is shown in figure A8-2. The time, distance, and fuel required to accelerate from 0.3 TMN is presented as a function of drag index at 0.6 MN, initial gross weight, and final desired true Mach number. A drag index of 0 to 300 is covered.

USE.

Enter appropriate chart with initial gross weight and proceed horizontally right to desired true Mach number. From this point proceed vertically down to the drag index curve and horizontally left to read fuel required. Return to the drag index point of intersection, and proceed horizontally right to the distance guideline and then vertically upward, noting the distance, to the time guideline. At this point, move horizontally left and read time in minutes.

SAMPLE PROBLEM.

Given:

A. Accelerate from 0.3 to 0.80 TMN at military thrust.

B. Drag index is 69.

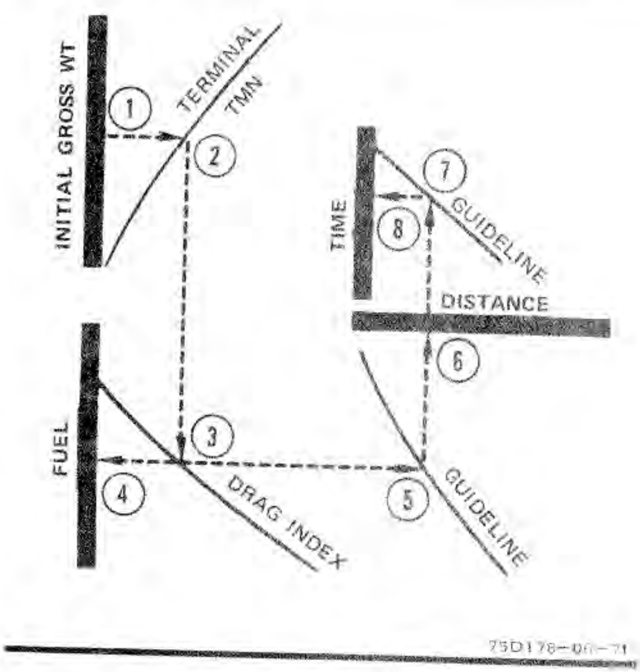
C. Initial gross weight is 30,000 lb.

Calculate:

Time, fuel, and distance required, using Level Flight Acceleration at Low Altitude chart (figure A8—2).

(1)	Initial gross weight	30,000 lb
(2)	Terminal true Mach No.	0.80
(3)	Drag index	69
(4)	Fuel	245 lb
(5)	Distance guideline	—
(6)	Distance	8.2 nmi
(7)	Time guideline	—
(8)	Time	1.44 min

SAMPLE LEVEL FLIGHT ACCELERATION AT LOW ALTITUDE



STEADY STATE TURN PERFORMANCE RADIUS CHARTS.

The Steady State Turn Performance Radius charts provide minimum turn radii for level flight military thrust conditions as a function of constant true Mach number, pressure altitude, and G-loading. The charts are shown for six pylons and two fuselage-mounted Sidewinders configuration and six pylons configuration.

USE.

Enter appropriate chart for pylon configuration with true Mach number. Proceed vertically up to the pressure altitude curve and then horizontally left and read radius turn.

SAMPLE PROBLEM.

Given:

A. Configuration is six pylons and two fuselage-mounted Sidewinders.

B. Mach number is 0.80.

C. Pressure altitude is 25,000 ft.

D. Conditions are standard day and military thrust.

Calculate:

Radius of turn, using Steady State Turn Performance chart (figure A8–3, sheet 1).

(1)	True Mach No.	0.80
(2)	Pressure altitude	25,000 ft
(3)	Radius of turn	1.7 nmi

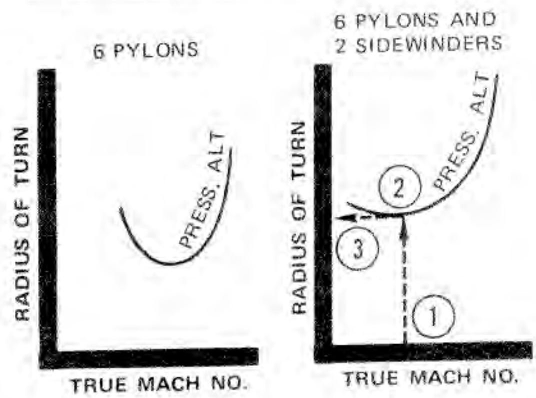
STEADY STATE TURN PERFORMANCE – TIME TO TURN, G-LOADING, AND BANK ANGLE CHART.

The Steady State Turn Performance – Time to Turn, G-Loading, and Bank Angle chart (figure A8–3, sheet 2) provides the time to turn, g-loading, and bank angle as a function of true Mach number, pressure altitude, and turn radius.

USE.

Enter figure A8–3, sheet 2 with true Mach number and proceed horizontally right to pressure altitude curve. Move vertically upward to the two radius of turn curves, and at each point of intersection of the known turn radius proceed horizontally left to read time to turn 180° and g-loading, respectively. From the value of g-loading obtained, proceed horizontally right to intersect the bank angle curve. From this point, move vertically downward and read bank angle.

SAMPLE STEADY STATE TURN PERFORMANCE RADIUS



SAMPLE PROBLEM.

Given:

A. True Mach number is 0.80.

B. Pressure altitude is 25,000 ft.

C. Radius of turn is 1.8 NMI.

Calculate:

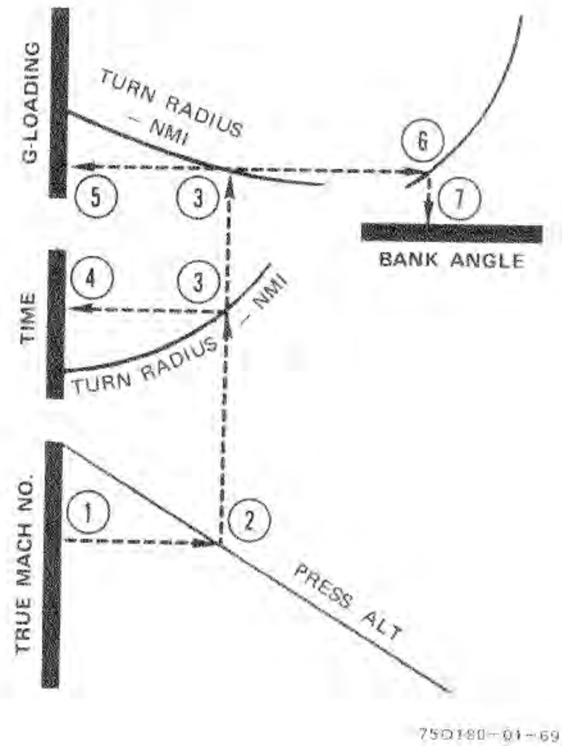
Time to turn 90° and g-loading to maintain steady turn, using Steady State Turn Performance — Time to Turn, G-Loading, and Bank Angle chart (figure A8–3, sheet 2).

(1)	True Mach No.	0.80
(2)	Pressure altitude	25,000 ft
(3)	Radius of turn	1.8 NMI
(4)	Time to turn 180°	0.6 min
(5)	G-Loading	2.2G
(6)	Intersection with bank angle, curve	—
(7)	Bank angle	63°

A. Time to turn 90° = $\frac{\text{Time to turn } 180^\circ}{2}$

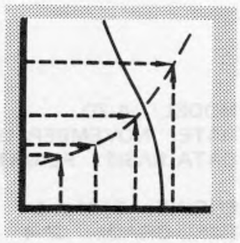
Thus: $0.3 = \frac{0.6}{2}$

SAMPLE STEADY STATE TURN PERFORMANCE TIME TO TURN, G-LOADING, AND BANK ANGLE



LEVEL FLIGHT COMBAT SPEED AND FUEL ALLOWANCE

MILITARY THRUST
STANDARD DAY



MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: **FLIGHT TEST**

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.

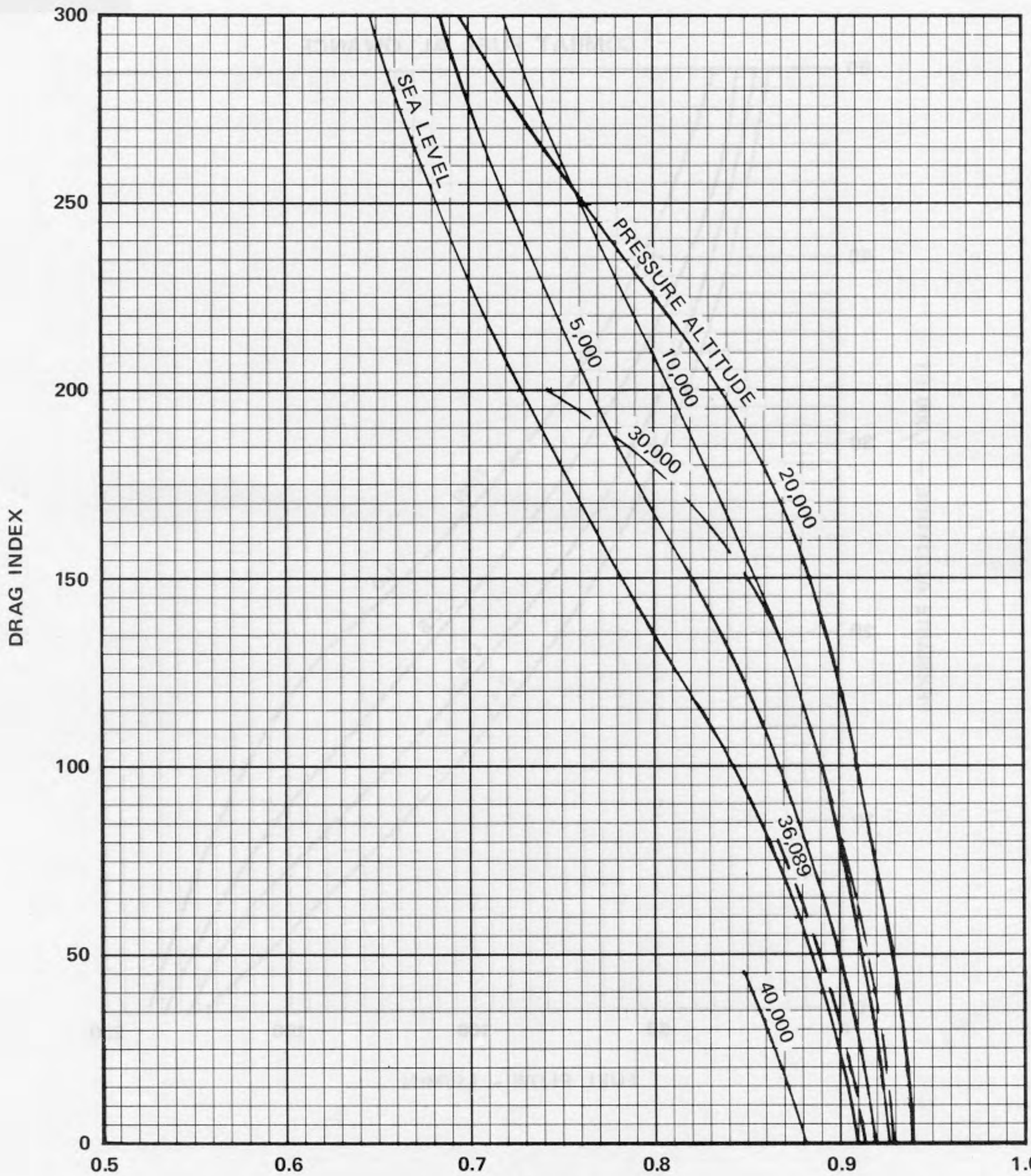


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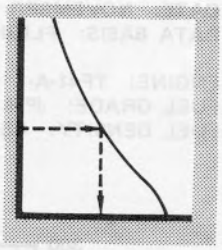
Figure A8−1 (Sheet 1)

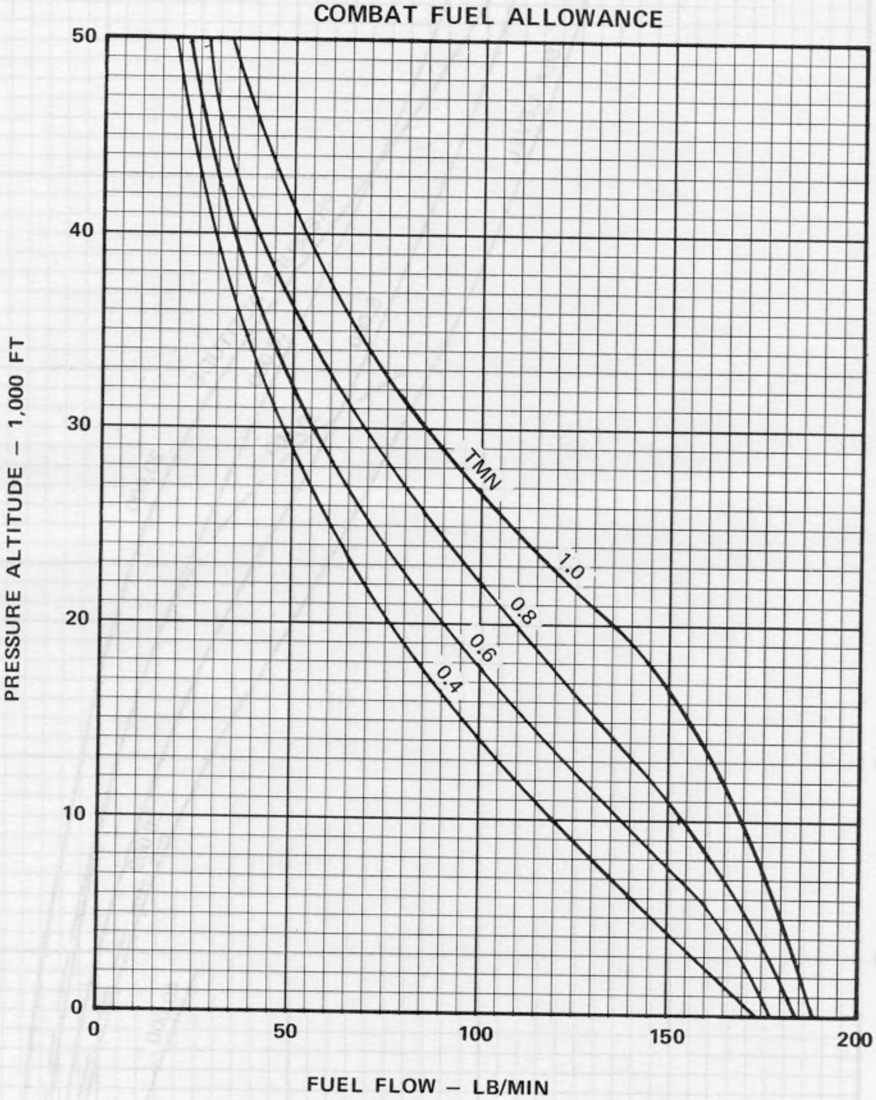
LEVEL FLIGHT COMBAT SPEED AND FUEL ALLOWANCE

MILITARY THRUST
STANDARD DAY

MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.



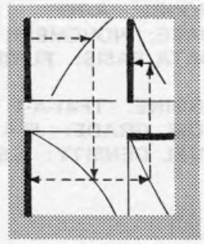


75D010(2)–06–71

Figure A8–1 (Sheet 2)

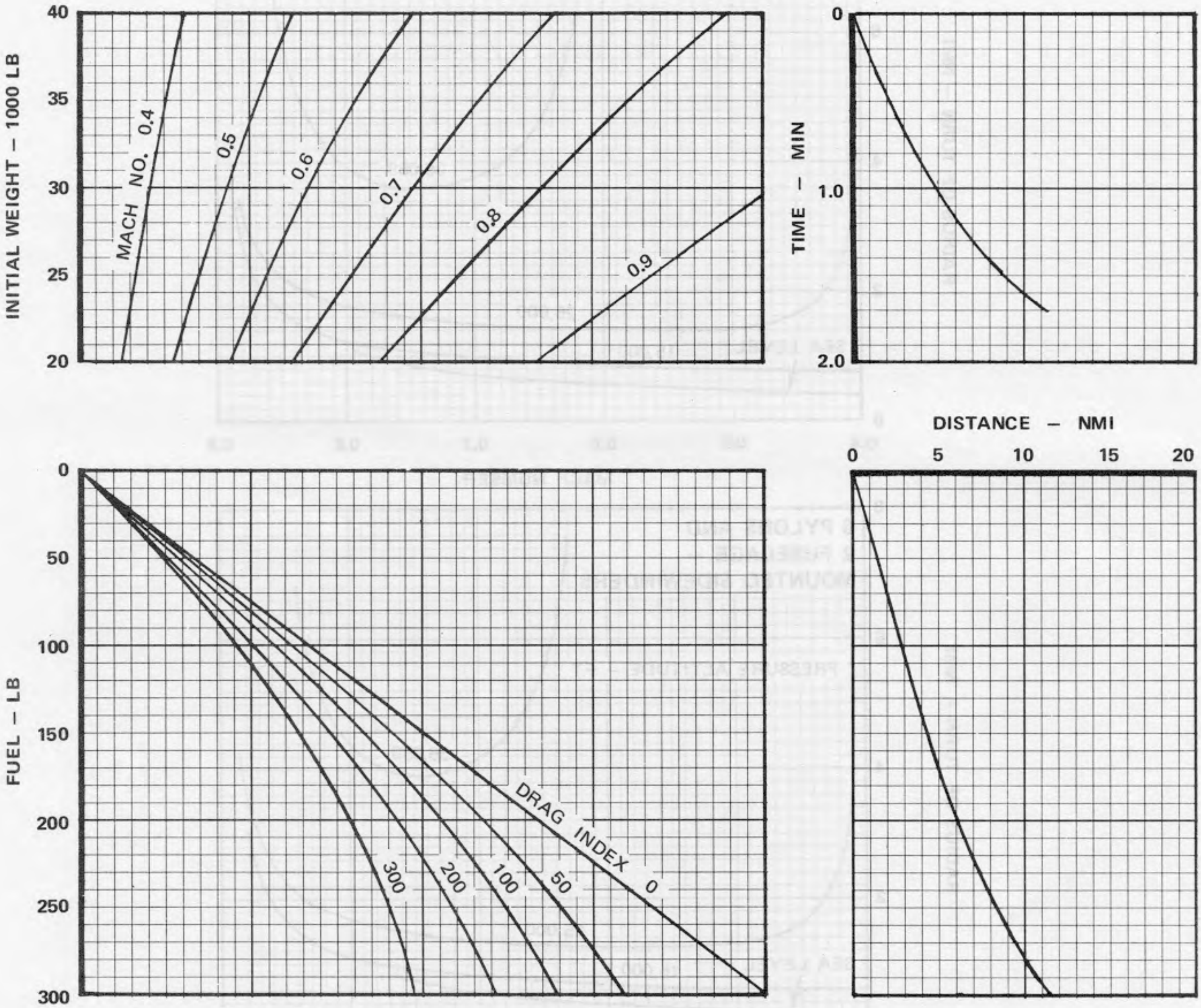
LEVEL FLIGHT ACCELERATION AT LOW ALTITUDE

MILITARY THRUST
INITIAL MACH 0.3
SEA LEVEL TO 5,000 FEET



MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

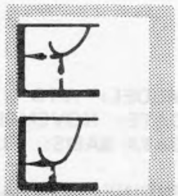


75D008–06–71

Figure A8–2

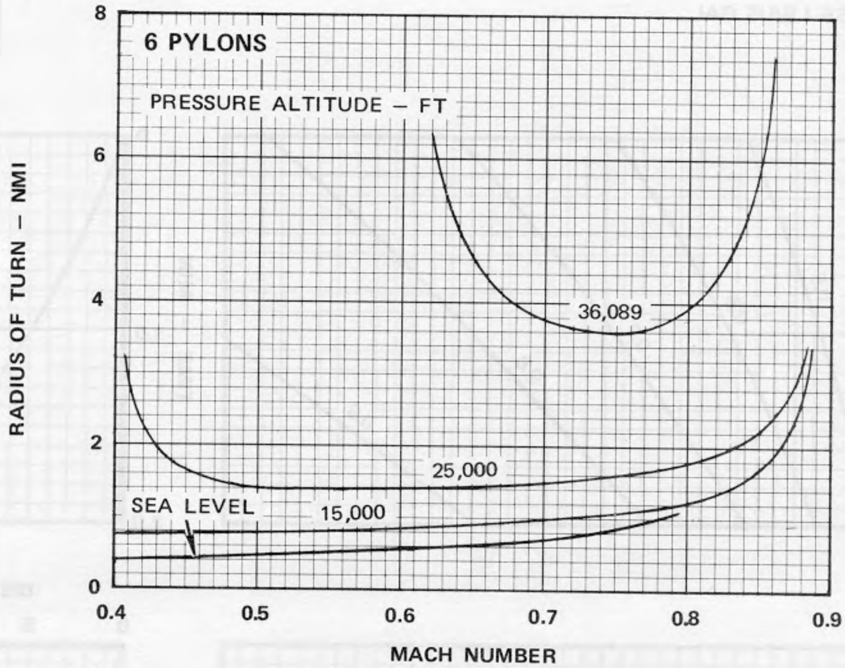
STEADY STATE TURN PERFORMANCE

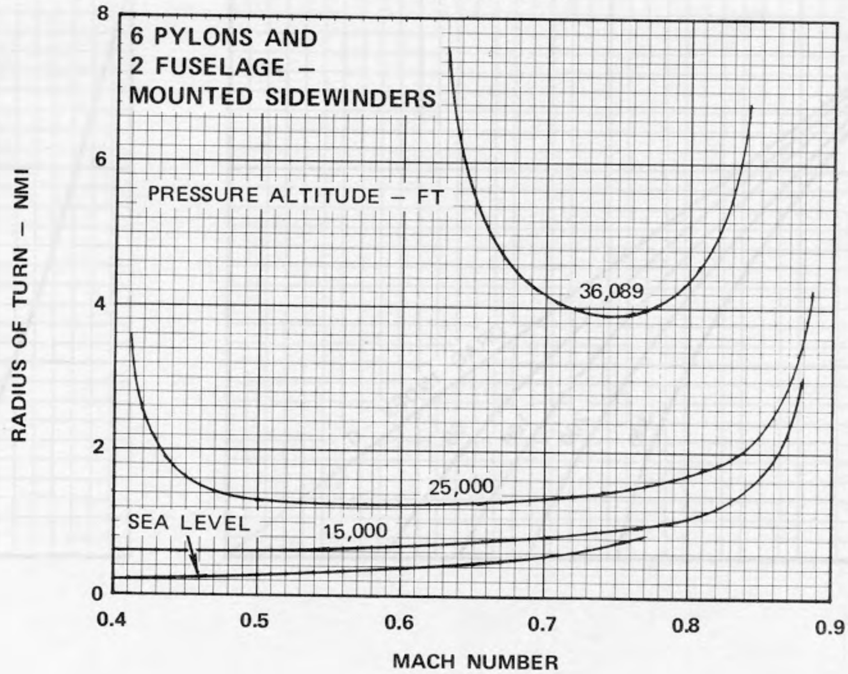
RADIUS
MILITARY THRUST
STANDARD DAY



MODEL: A-7D
DATE: NOVEMBER 1970
DATA BASIS: FLIGHT TEST

ENGINE: TF41-A-1
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL.

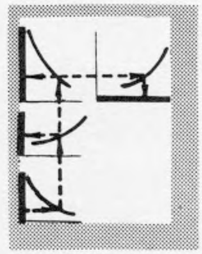




75D006(1)–06–71

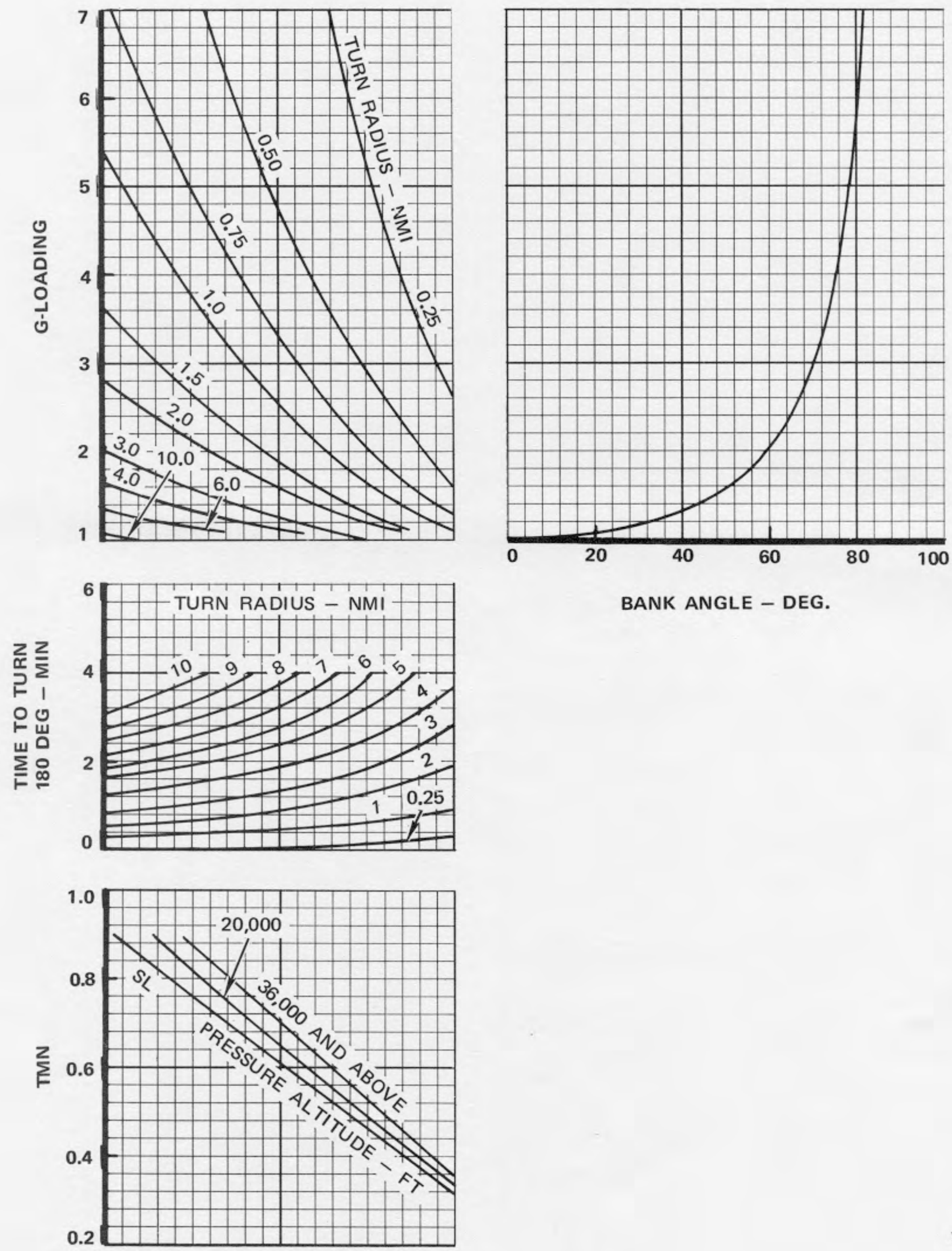
Figure A8–3 (Sheet 1)

STEADY STATE TURN PERFORMANCE



TIME TO TURN, G-LOADING, AND BANK ANGLE STANDARD DAY

MODEL: A-7D
DATA BASIS: **CALCULATED**



75D006(2)–06–71

Figure A8–3 (Sheet 2)

Part 9

Mission Planning

TABLE OF CONTENTS.

PURPOSE OF MISSION PLANNING.

Mission planning can be termed preflight planning. The purpose of preflight planning is to obtain optimum performance from the aircraft for any specific mission. Optimum performance will vary, for example, from maximum time on station to maximum radius with no time on station. Exact requirements will vary, depending upon the types of missions to be flown.

MISSION PLANNING SAMPLE PROBLEMS.

Note

The following problem is an exercise in the use of the performance charts. It is not intended to reflect actual or proposed tactical missions employing this aircraft.

The purpose of this problem is to determine the maximum target radius available with a given bomb load and fuel load. The problem includes calculation for takeoff and climb on course to the target at optimum cruise altitudes as fuel is used. Determine combat fuel allowance for 10 minutes combat, using military thrust at 5,000 feet. Assume that two Sidewinder missiles, eight M117A1's, and half the 20mm ammunition (150 pounds) are expended. Climb on course to optimum altitude and cruise at maximum range constant altitude for return to base. Retain a 900-pound fuel reserve for descent to sea level and landing at the base. Assume zero wind and standard temperature conditions.

SUPPLEMENTAL DATA.

Aircraft loaded gross weight with two Sidewinder missiles and eight M117A1's is 39,184 pounds.

Usable internal fuel load is 9,263 pounds. Aircraft weight with zero fuel and without expended ordnance (eight M117 bombs, two Sidewinder missiles, and 500 rounds of ammunition) is 22,877 pounds. (This weight includes 2 MER's, 500 rounds of unexpended and 500 rounds of expended 20mm ammunition.)

GENERAL COMMENTS.

This type of mission cannot be solved directly as none of the conditions at the maximum radius point, such as fuel used, gross weight, or radius are known. The problem must be worked from both ends, starting with the takeoff weight and the empty weight (zero fuel) and working toward the weight at the start of combat. When the radius from takeoff to combat equals the radius from combat back to base, the problem is solved.

As the outbound weight of the aircraft is heavier than the weight during the return to base, more fuel is required to reach the combat zone than to return. Therefore, as a starting point, assume that 45 percent of the total fuel has been used when combat begins. This will determine the aircraft weight at this point and both the outbound and the return radii can then be computed. By comparing these two radii, the combat weight can be adjusted and the computations revised until the mission is balanced. As the fuel used during combat and during the climb to cruise altitude after combat is hardly affected by small adjustments in the combat weight, the problem of adjusting the two radii to match is quickly resolved.

DETERMINATION OF GROSS WEIGHT AT THE START OF COMBAT.

Total usable fuel for the mission is 9,263 pounds. Total fuel used at start of combat equals 9,263 x .45 = 4,168 pounds. Therefore, the gross weight at start of combat equals 39,184 – 4,168 = 35,016 pounds.

DETERMINATION OF COMBAT ACCELERATION LIMITS.

The gross weight at start of combat is required to determine aircraft acceleration limits during combat. When –3.0g to +7.0g is listed as the symmetrical acceleration limit in figure 5–12, the acceleration limits shown in figure 5–5 must be used. Where acceleration limits other than –3.0g to +7.0g are listed in figure 5–12, the more restrictive of figure 5–12 limits and the limits obtained from figure 5–5 for the particular gross weight shall apply. Rolling pullout acceleration limits are +1.0g to a value equal to 0.80 times the upper symmetrical flight limit.

For the example of eight M117A1's, figure 5–12 lists symmetrical carriage limits of –2.5g to +6.0g. Acceleration limits obtained from figure 5–5 for 35,000 pounds gross weight are –2.6g to +6.1g. Thus, the limits of figure 5–12 apply. Rolling pullout acceleration limits are therefore +1.0g to +4.8g.

CHANGE IN GROSS WEIGHT DURING COMBAT.

For the purpose of obtaining the fuel used during 10 minutes of combat at 5,000 feet at military thrust, use the eight M117A1's and two fuselage-mounted Sidewinders to determine the Mach number.

The following information is from Part 8:

Combat Mach No.	0.78
Combat fuel flow	170 lb/min
Fuel used during combat	170 lb/min x 10 min = 1,700 lb
Bomb weight (eight M117A1's)	823 x 8 = 6,584 lb
Ammunition used	150 lb (500 rounds)
Sidewinder weight (2 x 155)	310 lb
Weight lost during combat	1,700 + 6,584 + 150 + 310 = 8,744 lb

TAKEOFF AND ACCELERATE.

The mission is now worked from takeoff to the combat zone.

Drag index for the takeoff configuration is:

Two fuselage pylons with Sidewinders	15
Two inboard pylons and MAU-12's	12
Two center pylons with eight M117A1's on MER's	112
Two outboard pylons and MAU-12's	12
Drag index at Mach 0.60	151

Fuel to start engine, taxi, takeoff and accelerate to best climb airspeed is 700 pounds.

Distance used during the acceleration is nominally 3 nautical miles.

CLIMB TO OPTIMUM CRUISE-CLIMB ALTITUDE.

Refer to figure A3–1.

Start climb weight	38,484 lb
Drag index	151
Fuel to climb	1,400 lb
Distance to climb	83 nmi
Time to climb	14 min
Weight at end of climb	38,484 – 1,400 = 37,084 lb
Altitude at end of climb (figure A3–2)	28,000 ft

CRUISE TO COMBAT WEIGHT.

Weight at start of cruise	37,084 lb
Weight at end of cruise (estimated for start of combat)	35,016 lb
Fuel for cruise	2,068 lb
Average cruise weight	37,084 -(2,068 ÷ 2) = 36,050 lb
Optimum cruise altitude for average weight	28,000 ft
Specific range (from method in Part 4)	
Cruise Mach No. 0.69	
Nautical miles per lb 0.112	
Cruise range	232 nmi
Climb range	83 nmi
Takeoff and accelerate	3 nmi
Total Range to Combat	318 nmi
Time to cruise 228 nmi	34 min
Weight lost during combat (previously calculated)	8,744 lb
Weight at end of combat	35,016 – 8,744 = 26,272 lb

CLIMB TO OPTIMUM ALTITUDE AND CRUISE TO BASE.

The mission must now be worked from empty weight (no fuel) back toward the end of combat.

Weight with zero fuel and without missiles, bombs, and 150 pounds of ammunition is 22,877 pounds. Weight over the base at end of cruise is 22,877 + 900 (fuel reserve) = 23,777 lb.

The drag index after combat and for the remainder of the mission is:

Two fuselage pylons with Aero 3B's	5
Two inboard pylons with MAU-12's	12
Two center pylons with MAU-12's and MER's	46
Two outboard pylons with MAU-12's	12
Drag index at Mach 0.60	75

The return climb and cruise to base can now be calculated. Start climb weight at end of combat is 26,272 pounds. Use figure A3–1 to obtain the following information:

Fuel to climb	940 lb
Time to climb	12 min
Distance to climb	80 nmi
Start cruise weight	25,332 lb
Cruise altitude	40,000 ft
End cruise weight	23,777 lb
Average cruise weight	24,554 lb
Specific range	0.190 nmi/lb of fuel
Cruise fuel	1,555 lb
Cruise range	295 nmi
Cruise time	40 min
Total range to base	295 + 80 = 375 nmi

BALANCING THE MISSION.

Using the estimated combat weight of 35,016 lb, the ranges out and back are:

Range out	318 nmi
Range back	375 nmi
Difference	57 nmi

In order to balance the mission, the combat weight must be decreased slightly to increase the range out and decrease the range back.

For small differences, the fuel change may be determined by:

$$\Delta \text{ Fuel} = \frac{\Delta \text{ Range}}{\text{Specific range out + Specific range in}}$$

$$\Delta \text{ Fuel} = 57 \div (0.112 + 0.19) = 189 \text{ lb of fuel}$$

The Cruise to Combat Weight range leg must be lengthened and the inbound leg must be shortened for the effect of the 189-pound fuel change.

Outbound

Change of range	0.112 x 189 = 21 nmi
Cruise range	232 + 21 = 253 nmi
Total range	253 + 86 = 339 nmi

Inbound

Change of range	0.19 x 189 = 36 nmi
Cruise range	295 — 36 = 259 nmi
Total range	259 + 80 = 339 nmi

The mission is now balanced and the mission radius is 339 nmi.

Summary of Sample Mission

Segment	*Fuel Used (lb)*	*Time (min)*	*Distance (nmi)*
Start, taxi, takeoff and accelerate	700		3
Climb to 28,000 ft altitude	1,400	14	83
Cruise to Combat zone	2,257	37	253
Combat at 5,000 ft	1,700	10	—
Climb to 40,000 ft altitude	940	12	−80*
Cruise to base	1,366	35	−259*
Landing reserve	900	0	0
	9,263	108	0

*Distances during return to base

TAKEOFF AND LANDING DATA CARD.

The following example illustrates the preparation of the takeoff and landing data card. Takeoff and landing data are obtained from Part 2 and Part 7, respectively. The takeoff weight is the gross weight with full fuel less the 200 pounds fuel allowance for taxi.

For the purpose of the sample problem, the conditions and calculations are as follows:

Gross weight (full fuel) and cg	39,184 lb at 26% MAC
Runway temperature	20°C
Runway pressure altitude	2,000 ft
Wind	Calm
Runway length	10,000 ft
Runway slope	1% uphill
RCR	15
Flap position	25°

The takeoff calculations are as follows:

Taxi fuel allowance	200 lb
Takeoff weight	38,984 lb
Takeoff speed	165 KIAS
Aft stick speed	165 − 6 = 159 KIAS
Takeoff ground distance	6,250 ft
Takeoff ground distance corrected for 1% uphill slope	6,562 ft
Refusal speed	144 KIAS
Maximum refusal speed (RCR 15)	134 KIAS
Acceleration check distance (RCR 15)	3,000 ft
Acceleration check speed	122 KIAS
Limit braking velocity	154 KIAS

The landing conditions are as follows:

	After Takeoff and Go-Around	*Final Landing*
Landing weight	31,900 lb*	23,777 lb†
CG position	26% MAC	26% MAC
Runway pressure altitude	2,000 ft	2,000 ft
Runway temperature	20°C	30°C
Wind (headwind)	Calm	10 kn
Runway length	10,000 ft	10,000 ft
Flap position	Full	Full
RCR	15	23

The landing calculations are as follows:

Final approach speed	150 KIAS	128 KIAS
Touchdown speed	145 KIAS	123 KIAS
Landing distance over 50-ft obstacle	7,955 ft	4,655 ft

SAMPLE TAKEOFF AND LANDING DATA CARD.

CONDITIONS

	Takeoff	*Landing*
Gross weight	38,984 lb (cg 26%)	23,777 lb (cg 20%)
Runway length	10,000 ft	10,000 ft
Runway pressure altitude	2,000 ft	2,000 ft
Runway slope	Uphill 1%	—
Runway temperature	+20°C	+30°C
Runway wind component	0	Headwind 10 kn
RCR	15	23

Takeoff

Acceleration check speed and distance	122 KIAS	3,000 ft
Aft stick speed	159 KIAS	
Takeoff speed and ground run distance	165 KIAS	6,562 ft

Landing

	After Takeoff and Go-Around	*Final Landing*
Final approach speed	150 KIAS	128 KIAS
Touchdown speed	145 KIAS	123 KIAS
Landing distance over 50-ft obstacle	7,955 ft	4,655 ft

*Landing weight after takeoff and go-around assumes 700 lb fuel used and eight M117A1's jettisoned.

†Final landing weight assumes end cruise weight with 900 lb fuel remaining.

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