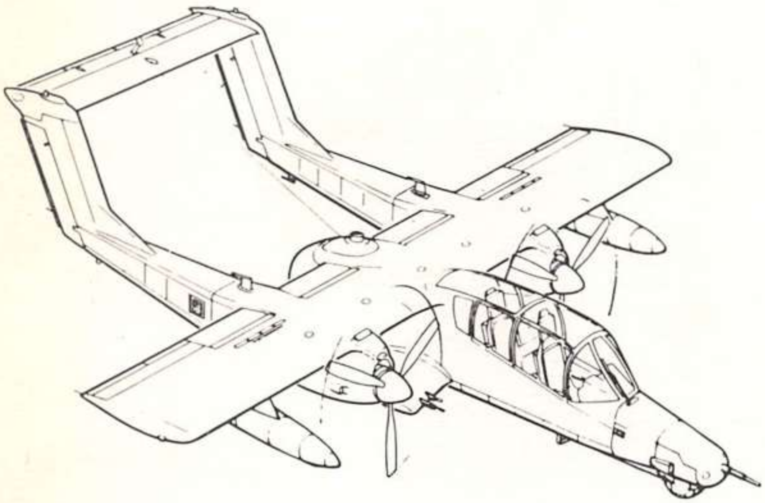
CHANGE NOTICE

THESE ARE SUPERSEDING OR SUPPLEMENTARY PAGES TO SAME PUBLICATION OF PREVIOUS DATE

Insert these pages into basic publication
Destroy superseded pages

A1-010DA-NFM-000

NATOPS FLIGHT MANUAL NAVY MODEL OV-10D SLEP (POST AFC 96 or 97) AIRCRAFT



DISTRIBUTION STATEMENT C — Distribution authorized to U.S. Government agencies and their contractors to protect publications required for official use or for administrative or operational purposes only (1 October 1987). Other requests for this document shall be referred to Commanding Officer, Naval Air Technical Services Facility, 700 Robbins Avenue, Philadelphia, PA 19111-5097.

DESTRUCTION NOTICE — For unclassified, limited documents, destroy by any method that will prevent disclosure of contents or reconstruction of the document.

ISSUED BY AUTHORITY OF THE CHIEF OF NAVAL OPERATIONS
AND UNDER THE DIRECTION OF THE COMMANDER,
NAVAL AIR SYSTEMS COMMAND

1 OCTOBER 1987

0801LP8441501

Change 1 — 1 October 1990

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

LETTER OF PROMULGATION

1. The Naval Air Training and Operating Procedures Standardization Program (NATOPS) is a positive approach toward improving combat readiness and achieving a substantial reduction in the aircraft accident rate. Standardization, based on professional knowledge and experience, provides the basis for development of an efficient and sound operational procedure. The standardization program is not planned to stifle individual initiative, but rather to aid the commanding officer in increasing the unit's combat potential without reducing command prestige or responsibility.

2. This manual standardizes ground and flight procedures but does not include tactical doctrine. Compliance with the stipulated manual procedure is mandatory except as authorized herein. In order to remain effective, NATOPS must be dynamic and stimulate rather than suppress individual thinking. Since aviation is a continuing, progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound. To this end, commanding officers of aviation units are authorized to modify procedures contained herein, in accordance with the waiver provisions established by OPNAVINST 3710.7L, for the purpose of assessing new ideas prior to initiating recommendations for permanent changes. This manual is prepared and kept current by the users in order to achieve maximum readiness and safety in the most efficient and economical manner. Should conflict exist between the training and operating procedures found in this manual and those found in other publications, this manual will govern.

3. Checklists and other pertinent extracts from this publication necessary to normal operations and training should be made and may be carried in naval aircraft for use therein. It is forbidden to make copies of this entire publication or major portions thereof without specific authority of the Chief of Naval Operations.

ROBERT F. DUNN
Vice Admiral, USN
Deputy Chief of Naval Operations
(Air Warfare)

U.S. Navy Distribution

OV-10D SLEP NATOPS FLIGHT MANUAL

SNDL PART I		Copies
21A2	Commander in Chief, U.S. Pacific Fleet	1
24A1	Naval Air Force Commander LANT	1
24A2	Naval Air Force Commander PAC	1
24D1	Surface Force Commander LANT	2
24D2	Surface Force Commander PAC	1
24H2	Fleet Training Command PAC	1
24J1	Fleet Marine Force Command LANT	1
24J2	Fleet Marine Force Command PAC	
	Only: CG FMFPAC, ATTN: AGSSB; CG FMFPAC: AVIA LOG DIV ALD	1
26A1	Amphibious Group LANT	1
26F3	Command Operational Test and Evaluation Force	1
26V1	Landing Force Training Command LANT	1
26V2	Landing Force Training Command PAC	1
42A2	Fleet Air Command PAC	
	Only: COMFAIRWESTPAC, ATTN: TECH LIB BOX 3; COMFAIRWESTPAC LOG DET CUBI PT	1
42D1	Fleet Aviation Specialized Operational Training Group LANT	
	Only: FASOTRAGRULANT DET JACKSONVILLE, ATTN: TPL	2
42S2	Air Test and Evaluation Squadron (VX) and Antarctic Development Squadron (VXE) PAC	
	Only: AIRTEVRON FIVE, ATTN: LIB	10
42T1	Tactical Air Control Group and Squadron LANT (VTC)	
	Only: TACRON TWO TWO	1
42T2	Tactical Air Control Group and Squadron PAC (VTC)	
	Only: TACRON TWELVE	2
45B	Marine Division	
	Only: CG SECOND MARDIV, ATTN: G-3 AIR OFFICER	1
46B	Aircraft Wing	
	Only: CG FIRST MAW; CG FIRST MAW, ATTN: WING SAFETY CTR; CG SECOND MAW, ATTN: CODE ALD-8; CG THIRD MAW, ATTN: ALD F/W TPL	1
46C1	Aircraft Group	
	Only: MAG THREE SIX, ATTN: NATOPS	1
46E	Observation Squadron (VMO)	
	Only: VMO TWO, ATTN: QA	60
	Only: VMO ONE, ATTN: ASSURANCE OFF	100
46M2	Headquarters and Maintenance Squadron	
	Only: HAMS THREE NINE, ATTN: QA/NCOIC; HAMS THREE SIX, ATTN: QA	1
	Only: HAMS THREE SIX, ATTN: OMD QA FLIGHT SEC	3
	Only: HAMS TWO NINE	5

U.S. Navy Distribution (continued)

OV-10D SLEP NATOPS FLIGHT MANUAL

46U	Aviation Weapons and Tactics Squadron	
	Only: MAWTS ONE, ATTN: ASSAULT SUPPORT DIV	5
	Only: MAWTS ONE, ATTN: SAFETY	6
46X	Air Weapons Training Unit	
	Only: AWTU TWO, ATTN: CTPL	1

SNDL PART II		Copies
A3	Chief of Naval Operations	
	Only: OP-095EG	1
A6	Headquarters U.S. Marine Corps	
	Only: CMC, ATTN: AAS; CMC, ATTN: ASA; CMC, ATTN: CODE HQSP-2	1
B2D	Defense Contract Administration Service Region	
	Only: DCASR BOHEMIA	1
C20I	Surface Weapons Center Detachment	
	Only: NAVSWC DET WHITE OAK, ATTN: TECH LIB	1
C34C	Naval Support Activity Detachment	1
C58J	Air Maintenanace Training Group Detachment	
	Only: NAMTRAGRUDET PENDLETON	8
C80D	Aviation Logistic Center Detachment EUR and Repair and Rework Activity	1
FA6	Air Station LANT	
	Only: NAS CECIL FIELD, ATTN: AVIA PHYS TRNG UT	1
FB7	Air Station PAC	
	Only: NAS MIRAMAR, ATTN: CODE 4004; NAS NORTH ISLAND, ATTN: CODE 19630	1
	Only: NAS FALLON, ATTN: AIMD/QA CTPL	2
FB42	Navy Office	2
FF5	Safety Center	4
FF18	Tactical Support Activity	4
FF44	War College	2
FF63	Strike Warfare Center	2
FH3	Hospital	
	Only: NAVHOSP CHERRY POINT NC, ATTN: CODE 361B; NAVHOSP CHERRY POINT NC, ATTN: AERO PHYS TR BR; NAVHOSP CORPUS CHRISTI TX, ATTN: AVIA PHYS TRG UT	1
FH18	Aerospace Medical Institute	
	Only: NAVAEROMEDINST, ATTN: QA; NAVAEROMEDINST, ATTN: AVIA PHYS DEPT C-9	1
	Only: NAVAEROMEDINST, ATTN: NAPTP ATMM	2
FH31	Medical Clinic	

U.S. Navy Distribution (continued)

OV-10D SLEP NATOPS FLIGHT MANUAL

		Only: NAVMEDCLINIC NORFOLK VA, ATTN: CD56-APTD; NAVMEDCLINIC NORFOLK VA, ATTN: CODE 56 BLDG S-33	1
FKA1A	Air Systems Command		
		Only: COMNAVAIRSYSCOM, ATTN: AIR 511; COMNAVAIRSYSCOM, ATTN: AIR 5363; COMNAVAIRSYSCOM, ATTN: AIR 530A; COMNAVAIRSYSCOM, ATTN: PMA-276 OV-10 PGM; COMNAVAIRSYSCOM, ATTN: AIR 500L TECH LIB	1
FKM9	Supply Center		
		Only: NSC NORFOLK, ATTN: CODE 12.2; NSC SAN DIEGO	1
FKM22	Publications and Forms Center		1
FKP4B	Explosive Ordnance Disposal Technology Center		1
FKQ6A	Air Development Center		
		Only: NAVAIRDEVCEN, ATTN: CODE 015M; NAVAIRDEVCEN, ATTN: CODE 602415; NAVAIRDEVCEN, ATTN: 60132 MR RENT	1
FKQ6H	Weapons Center		1
FKR1B	Aviation Depot		
		Only: NAVAVNDEPOT NORFOLK VA, ATTN: 62420 BLDG V-88	1
		Only: NAVAVNDEPOT NORTH ISLAND CA, ATTN: CODE 68510; NAVAVNDEPOT PENSACOLA FL, ATTN: CODE 56720	2
		Only: NAVAVNDEPOT CHERRY POINT NC, ATTN: TECH LIB 35520	20
FKR3A	Air Engineering Center		
		Only: NAVAIRENGCEN, ATTN: CODE 91122; NAVAIRENGCEN, ATTN: CODE 91232A; NAVAIRENGCEN, ATTN: CODE 1114 TECH DATA	1
FKR3C	Air Test Center		
		Only: NAVAIRTESTCEN, ATTN: SY80; NAVAIRTESTCEN, ATTN: SABOTL; NAVAIRTESTCEN, ATTN: TID BLDG 405	1
		Only: NAVAIRTESTCEN, ATTN: SCH ACADEMICS TP 04; NAVAIRTESTCEN, ATTN: STRK A/C DIR MNT BR QA	3
FKR3E	Weapons Evaluation Facility		1
FKR4A	Pacific Missile Test Center		
		Only: PACMISTESTCEN, ATTN: CODE 2061 TECH LIB; PACMISTESTCEN, ATTN: TECH LIB 1018 BLDG 36	3
FKR5	Avionics Center		2

U.S. Navy Distribution (continued)

OV-10D SLEP NATOPS FLIGHT MANUAL

FKR7C	Air Technical Services Facility	
	Only: NAVAIRTECHSERVFAC, ATTN: CODE 22-13	1
	Only: NAVAIRTECHSERVFAC, ATTN: CODE 3222	2
FKR7E	Aviation Depot Operations Center	1
FR3	Air Station COMNAVRESFOR	
	Only: NAS ATLANTA, ATTN: AIMD TECH LIB	2
FT35	Amphibious School	
	Only: NAVPHIBSCOL LITTLE CREEK, ATTN: CODE 22	1
FT91	Training Squadron	
	Only: TRARON TWO ONE	2
MISC	Miscellaneous Addresses	
	Only: EAST/WEST INDS INC, ATTN: P. MARTINO; EXEC RESOURCE ASSOC., INC.; MOOD, ATTN: CPL-A; QED SYSTEMS	1
	Only: JANA INC	2
	Only: USAF 0504, ATTN: MAQL	3
NAT	NATOPS Distribution Addressees	
	Only: AFPLANT REP	35
V5	Marine Corps Air Station	
	Only: MCAS EL TORO, ATTN: CODE 1KC141 TECH PUBS; MCAS EL TORO, ATTN: AEROSPACE PHYS TRN UT	1
V11	Marine Corps Institute	
	Only: MCI, ATTN: WU-2; MCI, ATTN: AVIATION SECTION	1
V22	4th Marine Aircraft Unit	
	Only: MAG FOUR SIX DET C, ATTN: QA TPL	100

OV-10D SLEP

CONTENTS

Page No.

Page No.

Page No.

Page No.

Page No.

Page No.

Page No.

CHAPTER 14 — IN-FLIGHT EMERGENCIES

Page No.

Page No.

Page No.

Page No.

Page No.

CHAPTER 30—DESCENT DATA

CHAPTER 31—LANDING DATA

CHAPTER 32—MISSION PLANNING

LIST OF ILLUSTRATIONS

Page No.

CHAPTER 17—ALL-WEATHER OPERATION

CHAPTER 19—ELECTRONIC EQUIPMENT

CHAPTER 21—ARMAMENT

Page No.

CHAPTER 22 — AVIONICS

CHAPTER 24 — NATOPS EVALUATION PROGRAM

CHAPTER 25 — STANDARD DATA

CHAPTER 26 — TAKE-OFF DATA

Page No.

Page No.

CHAPTER 31 — LANDING DATA

CHAPTER 32 — MISSION PLANNING

FOLDOUTS

RECORD OF CHANGES

Change No. and Date of Change	Date of Entry	Page Count Verified by (Signature)

NA-86-0043-361

INTERIM CHANGE SUMMARY

The following Interim Changes have been canceled or previously incorporated in this manual:

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE

The following Interim Changes have been incorporated in this Change Revision:

INTERIM CHANGE NUMBER	REMARKS/PURPOSE
1	Parachute Emergency Release Handle and Shoulder Harness
2	Ejection Handle
3	Advance Change Conference Items

Interim Changes Outstanding - To be maintained by the custodian of this manual:

INTERIM CHANGE NUMBER	ORIGINATOR/DATE (or DATE/TIME GROUP)	PAGES AFFECTED	REMARKS/PURPOSE

NA-86-0043-362

SUMMARY OF APPLICABLE TECHNICAL DIRECTIVES

Information relating to the following recent technical directives has been incorporated in this manual

CHANGE NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION

Information relating to the following recent technical directives will be incorporated in a future change

CHANGE NUMBER	DESCRIPTION	VISUAL IDENTIFICATION

NA-86-0043-363

PREFACE

SCOPE

The NATOPS Flight Manual (A1-O10DA-NFM-000) is issued by the authority of the Chief of Naval Operations and under the direction of Commander, Naval Air Systems Command in conjunction with the Naval Air Training and Operating Procedures Standardization (NATOPS) Program. This manual contains information on all aircraft systems, performance data, and operating procedures required for safe and effective operations. However, it is not a substitute for sound judgment. Compound emergencies, available facilities, adverse weather or terrain, or considerations affecting the lives and property of others may require modification of the procedures contained herein. Read this manual from cover to cover. It's your responsibility to have a complete knowledge of its contents.

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

A1-O10DA-NFM-500 (NATOPS Pilot's Pocket Checklist)
A1-O10DA-NFM-700 (NATOPS Functional Checkflight Checklist)
CV NATOPS
LPH/LHA NATOPS
LSO NATOPS

HOW TO GET COPIES
AUTOMATIC DISTRIBUTION

To receive future changes and revisions to this manual or any other NAVAIR aeronautical publication automatically, a unit must be established on an automatic distribution list maintained by the Naval Air Technical Services Facility (NATSF). To become established on the list or to change existing NAVAIR publication requirements, a unit must submit the appropriate tables from NAVAIR 00-25 DRT-1 (Naval Aeronautic Publications Automatic Distribution Requirements Tables) to NATSF, 700 Robbins Ave., Philadelphia, Pa. 19111, listing this manual and all other NAVAIR publications required. For additional instructions refer to NAVAIRINST 5605.4 series and Introduction to Navy Stocklist of Publications and Forms NAVSUP Publication 2002 (S/N 0535-LP-004-0001).

UPDATING THE MANUAL

To ensure that the manual contains the latest procedures and information, NATOPS review conferences are held in accordance with OPNAVINST 3710.7 series.

CHANGE RECOMMENDATIONS

Recommended changes to this manual or other NATOPS publications may be submitted by anyone in accordance with OPNAVINST 3710.7 series.

Routine change recommendations are submitted directly to the Model Manager on OPNAV Form 3500-22 shown on the next page. The address of the Model Manager of this aircraft is:

Commander Officer
VMO-2, MAG-39, 3d MAW, FMFPAC
MCAS Camp Pendleton, California 92055-6093
ATTN: NATOPS Model Manager

Change recommendations of an URGENT nature (safety of flight, etc) should be submitted directly to the NATOPS Advisory Group Member in the chain of command by priority message.

NATOPS/TACTICAL CHANGE RECOMMENDATION
OPNAV FORM 3500/22 (5-69) 0107-722-2002

DATE

TO BE FILLED IN BY ORIGINATOR AND FORWARDED TO MODEL MANAGER

FROM (originator)	Unit
TO (Model Manager)	Unit

Complete Name of Manual/Checklist	Revision Date	Change Date	Section/Chapter	Page	Paragraph

Recommendation (be specific)

☐ CHECK IF CONTINUED ON BACK

Justification

Signature	Rank	Title

Address of Unit or Command

TO BE FILLED IN BY MODEL MANAGER *(Return to Originator)*

FROM	DATE
TO	

REFERENCE
(a) Your Change Recommendation Dated ____________

☐ Your change recommendation dated __________ is acknowledged. It will be held for action of the review conference planned for ______________________ to be held at ____________________.

☐ Your change recommendation is reclassified URGENT and forwarded for approval to ______________ ____________________ by my DTG ______________________.

/S/ ______________________________ MODEL MANAGER. | ______________________________ AIRCRAFT

NA-86-0043-364

YOUR RESPONSIBILITY

NATOPS Flight Manuals are kept current through an active manual change program. Any corrections, additions, or constructive suggestions for improvement of its content should be submitted by routine or urgent change recommendations, as appropriate, at once.

NATOPS FLIGHT MANUAL INTERIM CHANGES

Flight Manual Interim Changes are changes or corrections to the NATOPS Flight Manuals promulgated by CNO or NAVAIRSYSCOM. Interim Changes are issued either as printed pages, or as a naval message. The Interim Change Summary page is provided as a record of all interim changes. Upon receipt of a change or revision, the custodian of the manual should check the Interim Change Summary to ascertain that all outstanding interim changes have been either incorporated or canceled; those not incorporated by the revision or change shall be recorded in the outstanding section and entered in the manual.

CHANGE SYMBOLS

Revised text is indicated by a black vertical line in either margin of the page, adjacent to the affected text, like the one printed next to this paragraph. The change symbol identifies the addition of either new information, a changed procedure, the correction of an error, or a rephrasing of the previous material.

WARNINGS, CAUTIONS, AND NOTES

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

WARNING

An operating procedure, practice, or condition, etc, which may result in injury or death, if not carefully observed or followed.

CAUTION

An operating procedure, practice, or condition, etc, which may result in damage to equipment, if not carefully observed or followed.

NOTE

An operating procedure, practice, or condition, etc, which is essential to emphasize.

WORDING

The concept of word usage and intended meaning which has been adhered to in preparing this Manual is as follows:

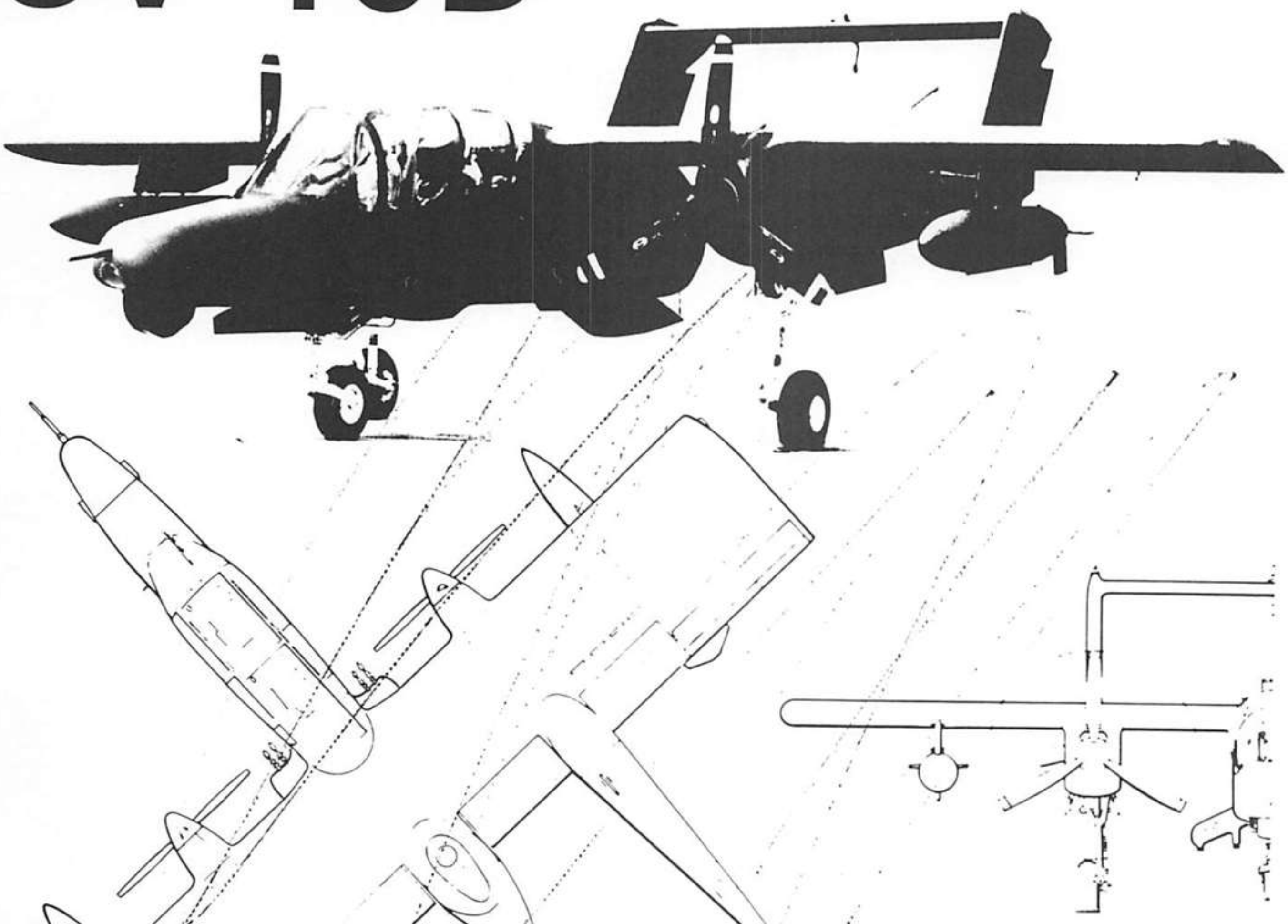
"Shall" has been used only when application of a procedure is mandatory.

"Should" has been used only when application of a procedure is recommended.

"May" and "need not" have been used only when application of a procedure is optional.

"Will" has been used only to indicate futurity, never to indicate any degree of requirement for application of a procedure.

OV-10D



NA-86-0043-82A

PART I

The Aircraft

CHAPTER 1

Description

1.1 THE AIRCRAFT

The Rockwell International OV-10D is a twin-turboprop, Night Observation System (NOS) aircraft designed for day and night tactical operations. Main identification features include a shoulder-mounted, straight wing; a large, glass enclosed cockpit; extended nose section mounting the FLIR/LRD sensor turret; aerodynamic spitter plates on the nose wheel door, twin tail booms; and swept vertical stabilizers with a high-set horizontal stabilizer. The cockpit section contains a second flight crew station (observer's) with message drop capability. The cockpit section is partially armor plated to provide protection from small arms penetration. Two canted sponsons are mounted on the lower fuselage, providing four external store stations and housing for four 7.62mm guns with integral ammunition supply. Additional weapons or a single external fuel tank may be installed at a centerline store station under the fuselage. An external store station under each wing provides capability for carrying pylon-mounted armament or auxiliary fuel tanks. See Figures 1-1 through 1-7.

1.2 DIMENSIONS

Overall static dimensions of the aircraft are as follows:

Span	40 feet
Height	15.1 feet
Length	44.08 feet
Tread Width	14.83 feet

See Figure 1-7 for additional aircraft dimensions.

1.3 GROSS WEIGHT

Clean aircraft take-off gross weight with sponsons, ballast, center-line pylon, full usable internal fuel (JP-5) and a crew of two is approximately 11,601 pounds. When wing pylons and full wing and centerline (Aero 1C, packed) external fuel tanks (JP-5) are installed, the take-off gross weight is increased to 14,426 pounds. For additional weight data, refer to Part XI, Chapter 25. For detailed weight data, refer to the Weight and Balance Data Manual (NAVAIR 01-1B-50).

1.4 MISSIONS

The aircraft may be configured for Night Observation Surveillance (NOS), strike-reconnaissance, forward air control, cargo and paratroop transport missions.

The AN/AAS-37, Infrared Laser Detecting-Ranging Set provides the OV-10D aircraft with a night and day battlefield surveillance, a primary mission of target acquisition and a secondary mission of target designation for high performance attack aircraft carrying laser-guided weapons.

1.4.1 Strike, Strike-Reconnaissance, or TAC(A). For a strike, strike-recon, or tactical air coordination (airborne) mission, external armament, integral guns, and communications equipment provide the capabilities required.

1.4.2 Night Observation Surveillance (NOS). For Night Observation Surveillance, the aircraft configuration includes a FLIR/LRD sensor turret and pilot's and observer's cockpit controls and indicators for operation of the FLIR/LRD system. Sponsons, centerline store station, and wing pylons (when installed) provide additional capabilities to carry auxiliary fuel tanks or other external stores required for mission accomplishment.

1.4.3 Cargo and Paratroop Transport. Refer to Cargo and Paratroop Transport Provisions, Chapter 2 in this part.

1.5 AIRCRAFT ARRANGEMENT

See Figure 1-1 for general arrangement.

See Figures 1-2, 1-3, 1-4, and 1-5 for pilot's cockpit arrangement.

See Figure 1-6 for observer's cockpit arrangement.

See Figure 1-7 for principal dimensions.

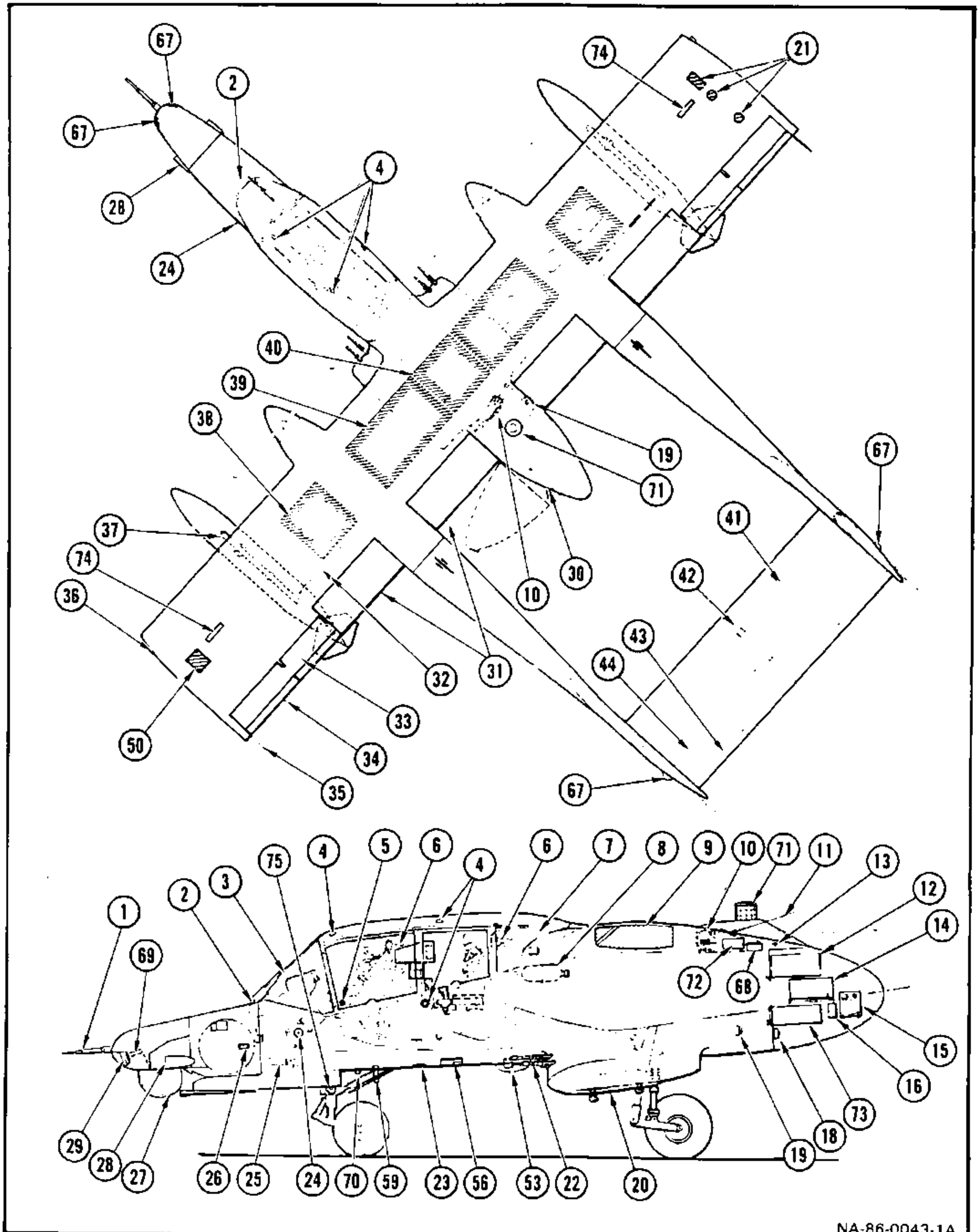


Figure 1-1. General Arrangement (Sheet 1 of 4)

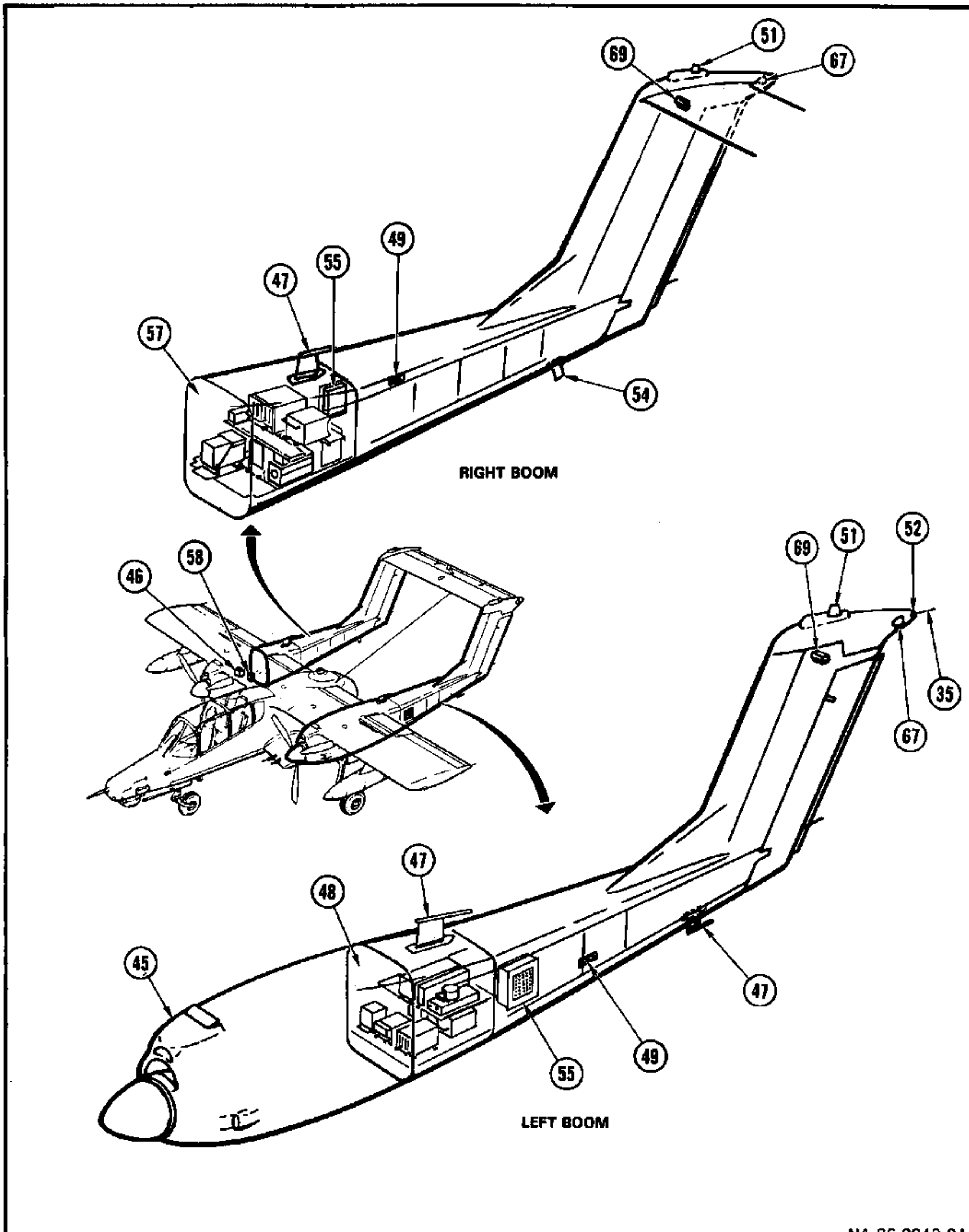


Figure 1-1. General Arrangement (Sheet 2 of 4)

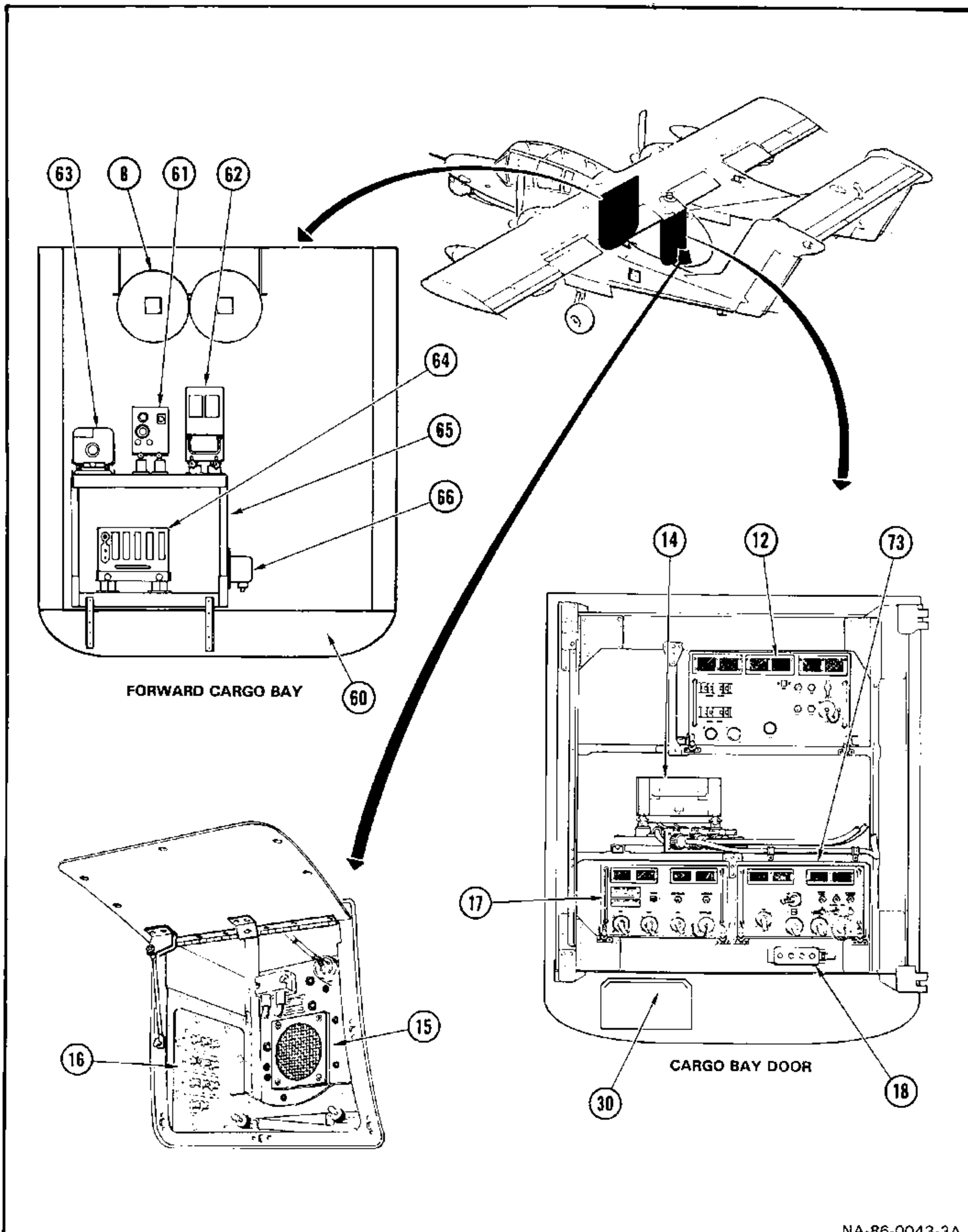
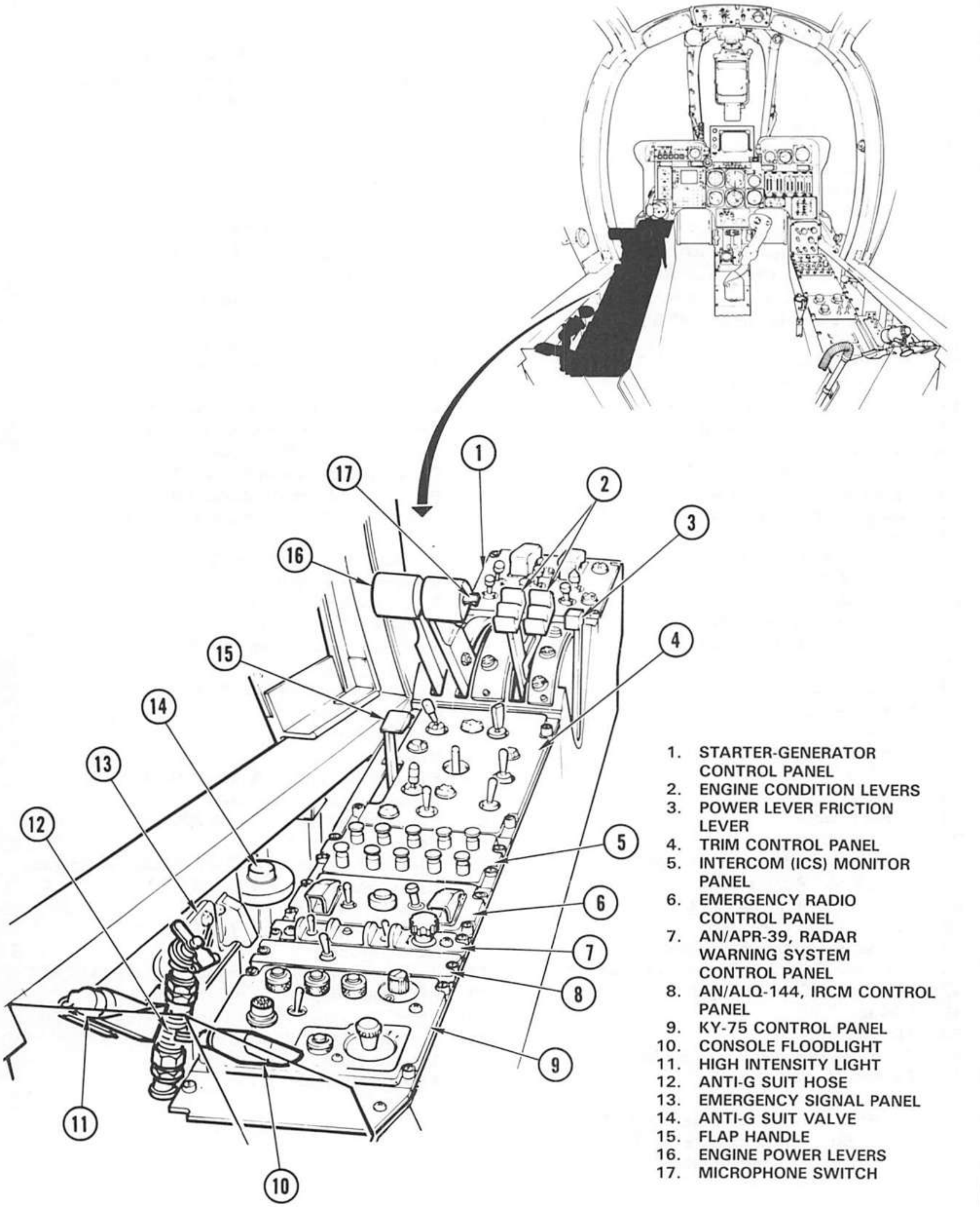


Figure 1-1. General Arrangement (Sheet 3 of 4)

1. Pitot-Static Tube
2. Ram Air Inlet
3. Windshield Wiper
4. Cockpit Air Vent
5. OAT Indicator
6. LW-3B Ejection Seat
7. Electrical Equipment Bay
8. Oxygen Supply Bottles
9. Fuel Cell
10. Hydraulic Power System
11. HF Radio Antenna, AN/ARC-199
12. Video Tracking Computer, AN/AAS-37
13. Underwater Acoustic Locator Beacon
14. Mission Video Recorder, RD-548/AXQ
15. Inverter No. 3
16. FLIR/LRD/AVT
    Circuit Breaker Panel
17. Servomechanism Control, AN/AAS-37
18. BIT Fault Indicator Panel
19. External Electrical
    Power Receptacle (Right Side)
20. Sponsons, Left and Right
21. Radar Altimeter System, AN/APN-171(V)
22. M60C 7.62 mm Guns (4)
23. Message Drop Door
24. Angle-of-Attack Probe
25. Brake Master Cylinder
26. Formation Lights (Both Sides)
27. FLIR/LRD Turret, AN/AAS-37
28. Air Scoop
29. Landing/Taxi Light
30. Cargo Bay Door
31. Flaps
    (Inboard/Outboard Sections)
32. Spoilers
33. Aileron
34. Aileron Tab
35. Static Discharger
36. Position Light (Both Wing Tips)
37. Wing Pylon/Auxiliary Tank
38. Outboard Wing Fuel Tank
39. Inboard Wing Fuel Tank
40. Center-Feed Wing Fuel Tank
41. Magnetic Compass Transmitter, AN/ASN-75
42. Upper Anti-Collision Light
43. Elevator Tab
44. Elevator
45. T-76G-420 Engine (-421 Right)
46. Battery (1–Each Boom)
47. VHF/UHF Antenna (3)
    Left Boom Top Antenna–Radio 2
    Left Boom Bottom Antenna–Radio 1
    Right Boom Top Antenna–Radio 3
48. Electronic Equipment Bay (Left)
    VHF/UHF, AN/ARC-182 Radio Set No. 1
    VHF/UHF, AN/ARC-182 Radio Set No. 2
    Switching Unit, AN/ARC-182
    KY 1 (KY-58) Processor
    BSIU 3
    TACAN, AN/ARN-118(V)
    Gyro/Power Supply
    Compass Compensator
    UHF-ADF Set, AN/ARA-50
49. Formation Light (Both Booms)
50. Doppler Receiver-Transmitter Antenna
51. TACAN Antenna, AN/ARN-118(V),
    (Left Side)
    IFF, AN/APX-100(V), Antenna (Right Side)
52. Tail Position Light (Left Only)
53. Lower Anti-Collision Light
54. IFF-SIF, AN/APX-100(V), Antenna
55. AN/ALE-39 Dispenser Module (2)
56. UHF-ADF, AN/ARA-50, Antenna
57. Electronic Equipment Bay (Right)
    Kit-1A TSEC Crypto Computer
    VHF/UHF, AN/ARC-182 Radio Set No. 3
    BSIU 2
    Inverters, No. 1 and No. 2
    IFF-SIF Transponder
    KY 2 (KY-58) Processor
58. AN/ALE-39 Programmer
59. VHF Homing Antenna (Not Used)
60. Foward Cargo Bay
61. HF Radio Set, AN/ARC-199
62. KY-75 Processor
63. Gyro, MD-1
64. BSIU 1
65. Forward Cargo Bay Avionics Rack
66. Accelerometer, ABU-13A
67. Radar Signal Detector, AN/APR-39,
    Spiral Antenna (4)
68. Radar Signal Detector, AN/APR-39, Comparator
69. Radar Signal Detector, AN/APR-39,
    Dual Receiver (3)
70. Radar Signal Detector, AN/APR-39,
    Blade Antenna
71. IR Countermeasures Transmitter, AN/ALQ-144
72. HF Radio Coupler, AN/ARC-199
73. Video Converter Power Supply, AN/AAS-37
74. Formation Light (Both Wings,
    Top and Bottom)
75. Approach Lights

NA-86-0043-83A

Figure 1-1. General Arrangement (Sheet 4 of 4)



1. STARTER-GENERATOR CONTROL PANEL
2. ENGINE CONDITION LEVERS
3. POWER LEVER FRICTION LEVER
4. TRIM CONTROL PANEL
5. INTERCOM (ICS) MONITOR PANEL
6. EMERGENCY RADIO CONTROL PANEL
7. AN/APR-39, RADAR WARNING SYSTEM CONTROL PANEL
8. AN/ALQ-144, IRCM CONTROL PANEL
9. KY-75 CONTROL PANEL
10. CONSOLE FLOODLIGHT
11. HIGH INTENSITY LIGHT
12. ANTI-G SUIT HOSE
13. EMERGENCY SIGNAL PANEL
14. ANTI-G SUIT VALVE
15. FLAP HANDLE
16. ENGINE POWER LEVERS
17. MICROPHONE SWITCH

NA-86-0043-4B

Figure 1-2. Pilot's Left Console

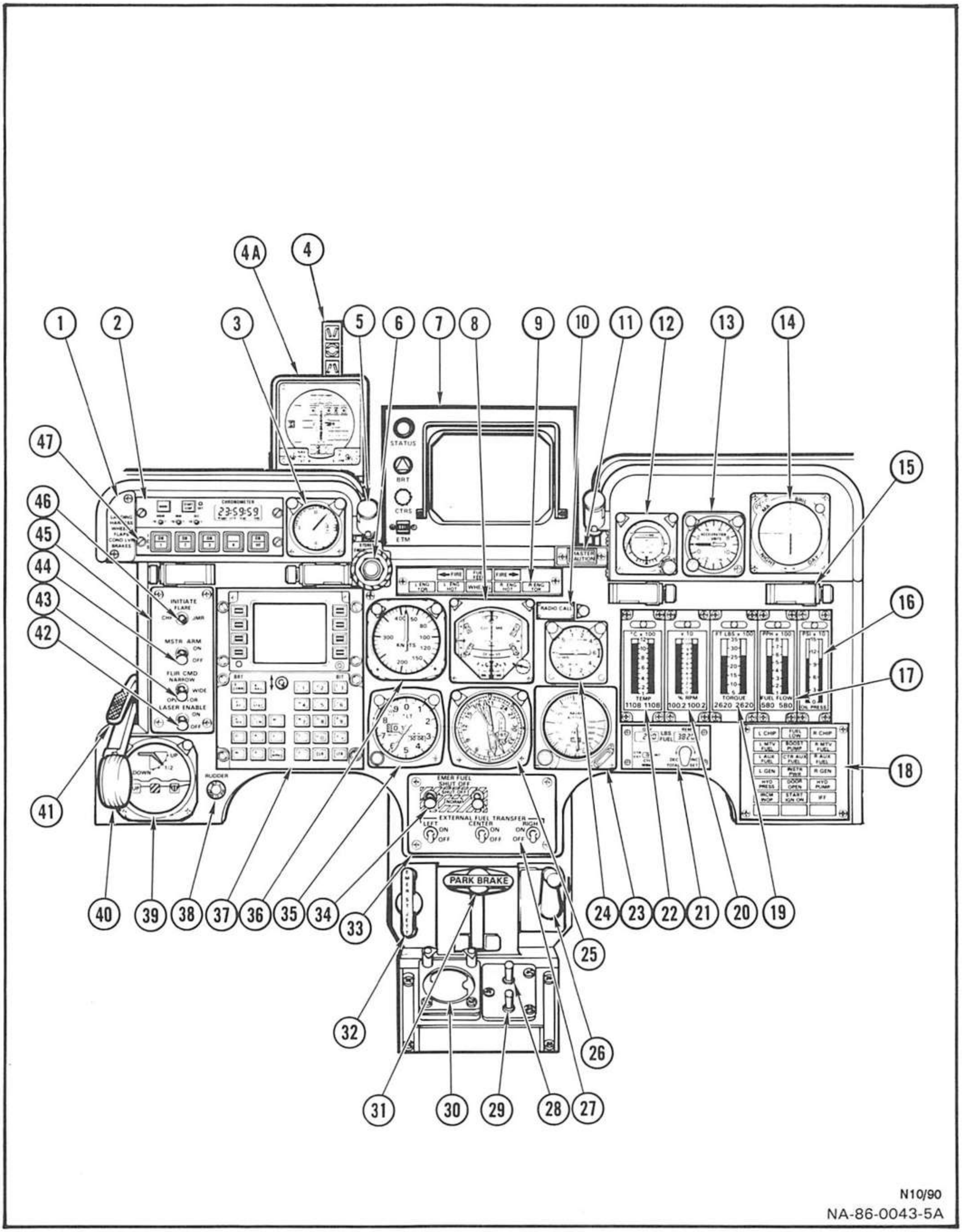


Figure 1-3.   Pilot's Instrument Panel (Sheet 1 of 2)

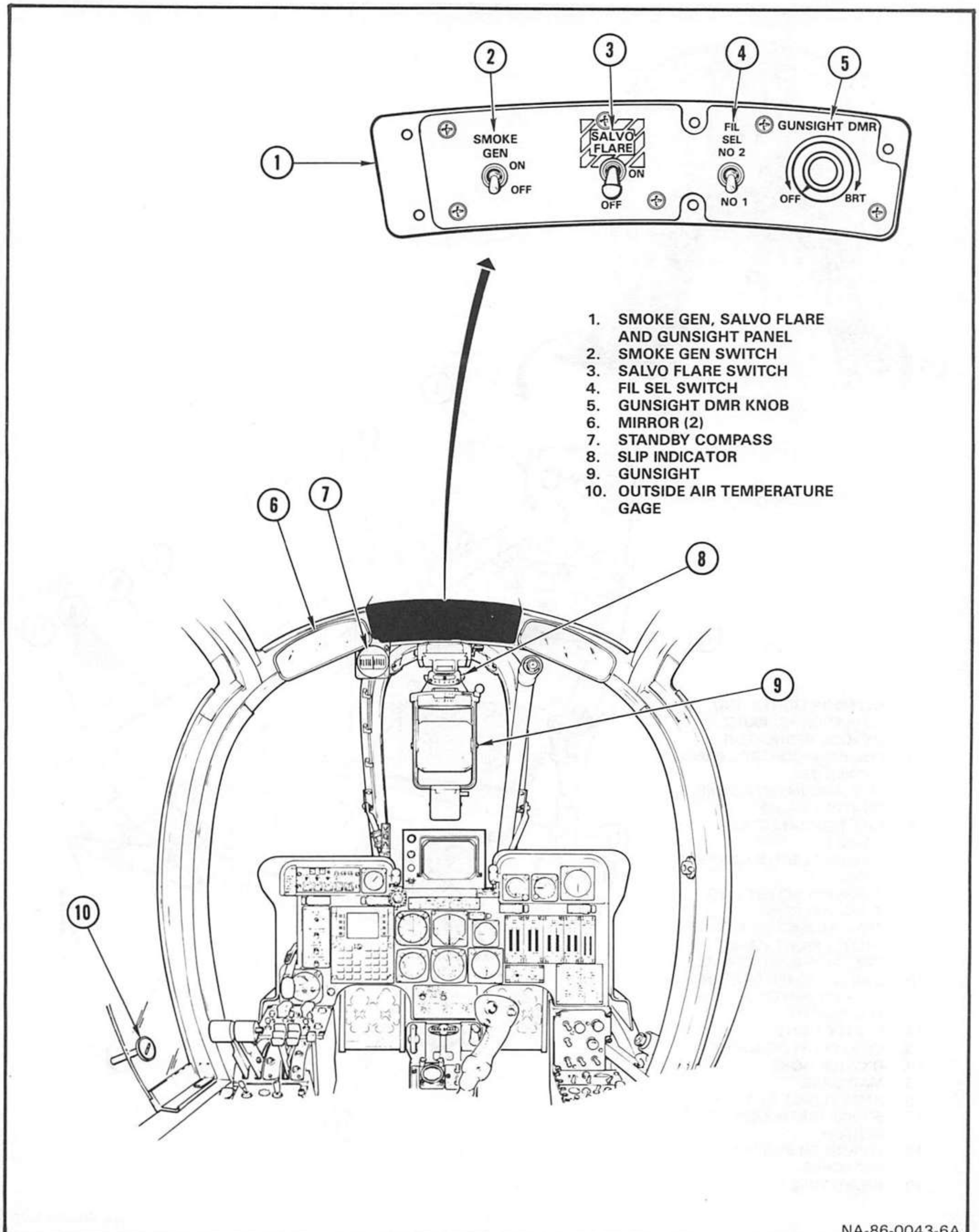
1. LANDING Checklist Panel
2. Chronometer
3. Angle-of-Attack Indicator
4. Approach Indexer

4A. Multipurpose Indicator, ID 2440/APN

5. Instrument Panel Floodlight (2)
6. Stores Emergency Release Button
7. Pilot's FLIR Display
8. Remote Attitude Indicator, ARU-50/A
9. Pilot's Caution/Warning Light Panel
10. RADIO CALL Panel
11. MASTER CAUTION Light
12. Standby Gyro
13. Accelerometer
14. Radar Warning Signal Indicator, AN/APR-39
15. Instrument Panel Floodlight (4)
16. OIL PRESS Instrument
17. FUEL FLOW Instrument
18. Pilot's Caution Light Panel
19. TORQUE Instrument
20. %RPM Instrument
21. Fuel Panel
22. TEMP Instrument
23. Radar Altimeter Indicator, AN/APN-171(V)
24. Vertical Velocity Indicator
25. Bearing-Distance-
    Heading Indicator (BDHI)
26. Pedal Adjust Crank
27. EXTERNAL FUEL TRANSFER Switches
28. LT TEST Switch
29. ATTD GYRO Switch
30. Voltammeter Indicator
31. PARK BRAKE
32. EMER ST JETT Handle
33. Fuel Shutoff and Transfer Panel
34. EMER FUEL SHUT OFF Switches
35. Barometric Altimeter
36. Airspeed Indicator
37. CMS Control Display Unit No. 1
38. RUDDER Neutral Light
39. Wheels and Flaps
    Position Indicator
40. Landing Gear Handle
41. Gear Handle Release Lever
42. LASER ENABLE Switch
43. FLIR CMD Switch
44. MSTR ARM Switch
45. FLIR/Weapons Control Panel
46. INITIATE FLARE Switch
47. Intercom (ICS) Selector Panel

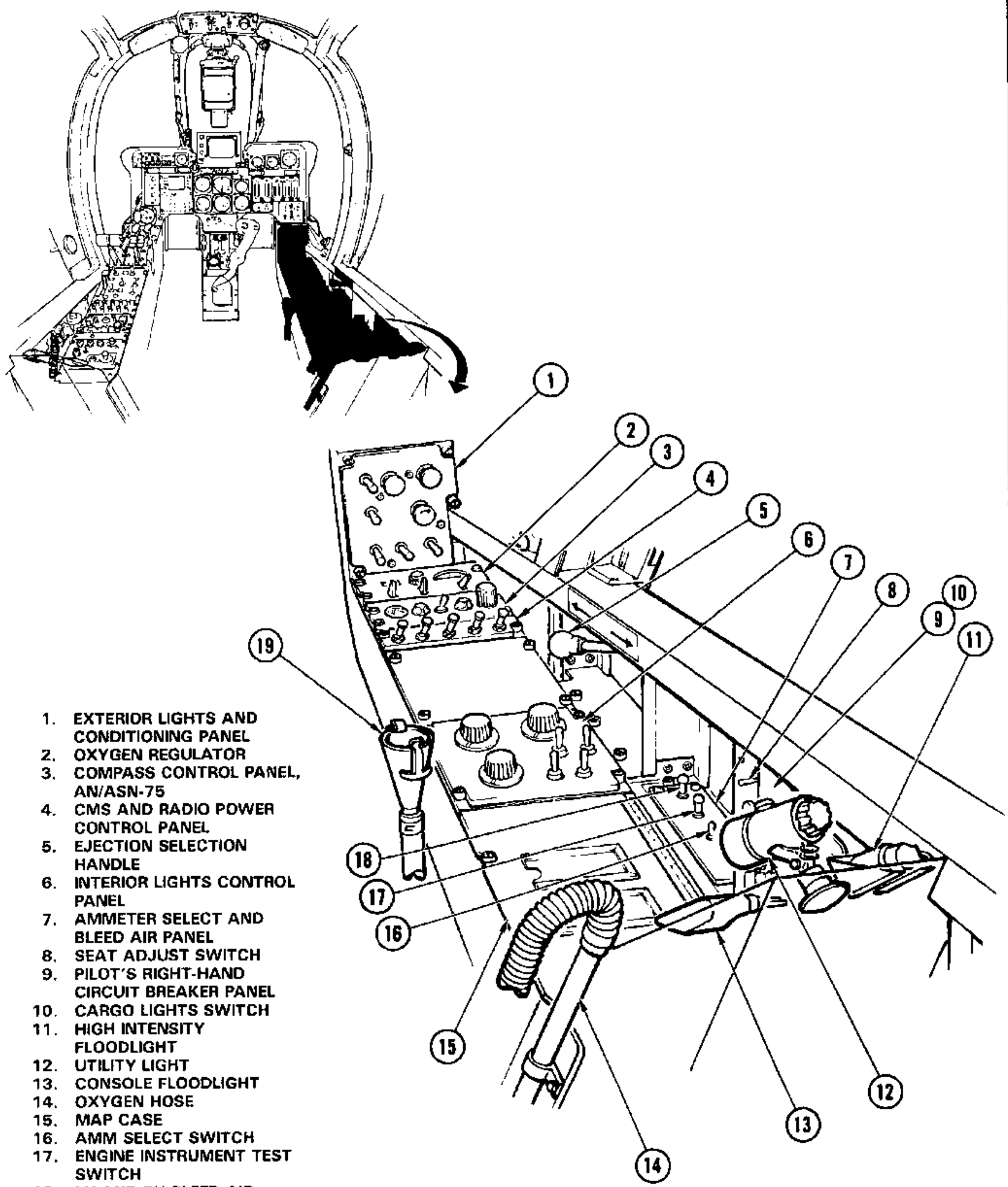
N10/90
NA-86-0043-84A

Figure 1-3. Pilot's Instrument Panel (Sheet 2 of 2)



1. SMOKE GEN, SALVO FLARE AND GUNSIGHT PANEL
2. SMOKE GEN SWITCH
3. SALVO FLARE SWITCH
4. FIL SEL SWITCH
5. GUNSIGHT DMR KNOB
6. MIRROR (2)
7. STANDBY COMPASS
8. SLIP INDICATOR
9. GUNSIGHT
10. OUTSIDE AIR TEMPERATURE GAGE

Figure 1-4. Pilot's Upper Cockpit



1. EXTERIOR LIGHTS AND CONDITIONING PANEL
2. OXYGEN REGULATOR
3. COMPASS CONTROL PANEL, AN/ASN-75
4. CMS AND RADIO POWER CONTROL PANEL
5. EJECTION SELECTION HANDLE
6. INTERIOR LIGHTS CONTROL PANEL
7. AMMETER SELECT AND BLEED AIR PANEL
8. SEAT ADJUST SWITCH
9. PILOT'S RIGHT-HAND CIRCUIT BREAKER PANEL
10. CARGO LIGHTS SWITCH
11. HIGH INTENSITY FLOODLIGHT
12. UTILITY LIGHT
13. CONSOLE FLOODLIGHT
14. OXYGEN HOSE
15. MAP CASE
16. AMM SELECT SWITCH
17. ENGINE INSTRUMENT TEST SWITCH
18. LH AND RH BLEED AIR SWITCHES
19. RELIEF TUBE

NA-86-0043-7B

Figure 1-5. Pilot's Right Console

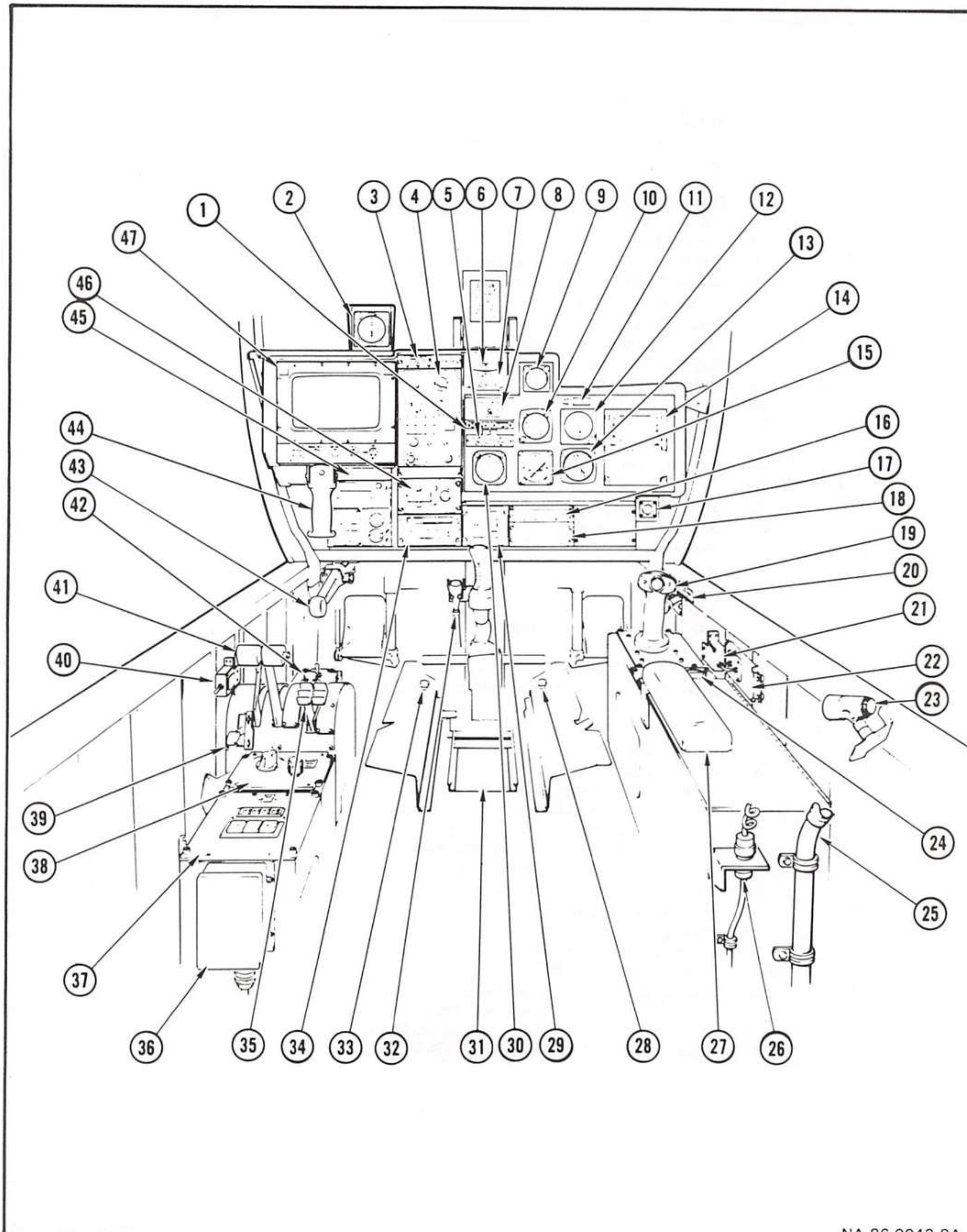


Figure 1-6. Observer's Cockpit (Sheet 1 of 2)

1. MASTER CAUTION Light
2. Radar Warning Signal Indicator, AN/APR-39
3. Chronometer
4. FLIR Control Panel, AN/AAS-37
5. Observer's Caution/Warning Light Panel
6. Slip Indicator
7. LDG CHECK LIST
8. AN/ALE-39 Countermeasures Initiate Panel
9. Vertical Velocity Indicator
10. Barometric Altimeter
11. RADIO CALL Panel
12. Radar Altimeter Indicator
13. Bearing-Distance-Heading Indicator
14. CMS Control Display Unit No. 2
15. MB-1 Gyro Horizon Indicator
16. Intercom (ICS) Selector Panel
17. Instrument Panel Disconnect
18. Intercom (ICS) Monitor Panel
19. Target Tracking Sight Control, AN/AAS-37
20. Ejection Selection Handle
21. Seat Adjust Switch
22. No. 3 Inverter Control Panel
23. Utility Light
24. Oxygen Regulator
25. Oxygen Hose Connection
26. Intercom (ICS) Disconnect
27. Map Case
28. Radio Xmit Switch
29. Video Recorder and Emergency IFF Panel
30. Airspeed Indicator
31. Message Drop Door
32. Relief Tube
33. ICS Talk Switch
34. Laser Control Panel, AN/AAS-37
35. Engine Condition Levers
36. TIT/Low-Altitude Warning Aural Tone Generator
37. LRD Code Generator Panel, AN/AAS-37
38. RTC Control Panel, AN/AAS-37
39. Flap Lever
40. Elevator Trim Switch
41. Power Control Levers
42. Lights Dim/Test Panel
43. Landing Gear Handle
44. Fire Control Grip, AN/AAS-37
45. Doppler Navigation Computer Display Unit, AN/APN-233
46. Video Tracking Control Panel, AN/AAS-37
47. Observer's FLIR Display, AN/AAS-37

NA-86-0043-85A

Figure 1-6. Observer's Cockpit (Sheet 2 of 2)

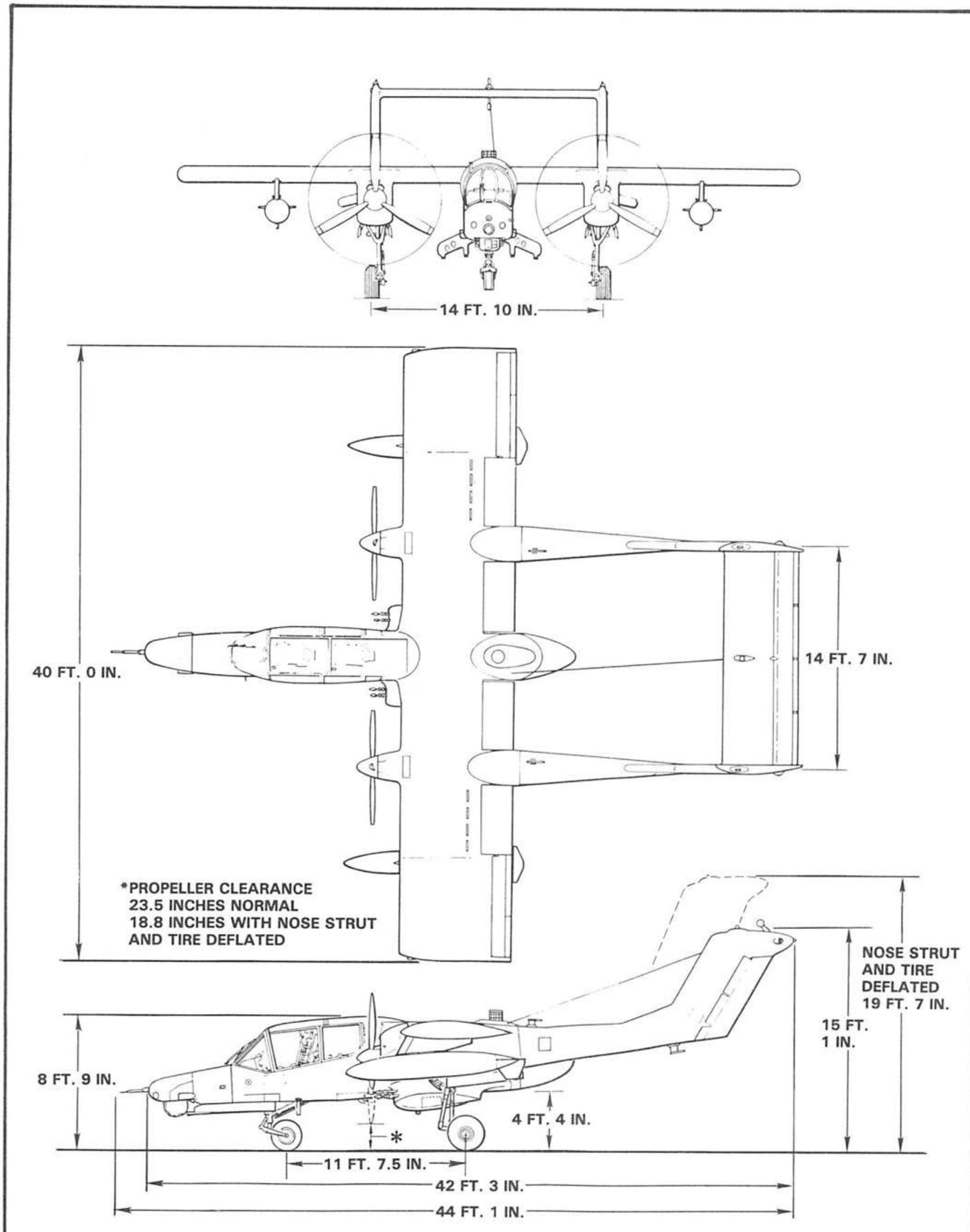


Figure 1-7. Principal Dimensions

CHAPTER 2

Systems

2.1 POWER PLANTS

The aircraft is powered by two Garrett-AiResearch T76-G-420 (left) and -G-421 (right) fixed-shaft turboprop engines, rated 1040 shaft horsepower. The major engine components consist of the reduction gearbox, a two-stage centrifugal compressor, a three stage axial turbine surrounded by an annular combustion chamber and the accessory section. See Figures 2-1 and 2-2. The engine is attached to a tubular truss, with three vibration isolation mounts, which is attached to the nacelle in four places.

2.2 ENGINE EXHAUST SYSTEM

IR suppression exhaust stacks are provided on all aircraft. The IR suppression system wraparound deflectors produce incremental exhaust gas pressure (EGT) losses; however, aircraft propulsion performance degradation is less than 2 percent.

2.3 ENGINE FUEL SYSTEMS

Fuel is supplied to the engines from the wing center/feed tank in which a submerged boost pump is installed. Fuel at low pressure is then directed to the combination low/high pressure fuel pump which supplies fuel at high pressure to the fuel control units. the fuel control units provide engine overspeed protection through an automatic flow limiting feature of the overspeed governor which is set at 103.8% to 104.3% rpm. An underspeed governor on each engine sets minimum propeller rpm for selected flight conditions. To provide for cold temperature and high altitude engine starting, a fuel enrichment system provides supplemental starting fuel which bypasses the fuel control and fuel shutoff valve and is fed directly into the engine.

2.3.1 Fuel Enrichment Kit. The fuel enrichment kit consists of a fuel enrichment solenoid, a temperature sensing switch, and electrical inputs from the engine speed sensing switch (see Figure FO-1). The fuel enrichment kit provides supplemental fuel during engine ground starts when exhaust gas temperature (EGT) is less than 450 (±50) °C and rpm is between 10% and 50%. During the ground start sequence, this supplemental fuel will be provided automatically by the engine speed sensing switch at 10% rpm by powering the fuel enrichment solenoid valve to the open position. (Ignition also occurs at 10 percent.) This fuel is provided to the engine independently of the position of the condition lever since it bypasses the engine fuel shutoff valve. Holding the IGNITION AND UNFEATHERING switch in the CRANK position will interrupt the fuel flow. Should the temperature sensing switch fail to cut off fuel enrichment during a ground start at 450 (±50) °C, it will be automatically terminated at approximately 50% rpm by the engine speed sensing switch. Shutting the engine down during a ground start when the engine has not reached 50% rpm will require moving the condition lever to FUEL SHUTOFF and repositioning the START switch to ABORT; otherwise, the fuel enrichment system will continue to supply the engine with fuel and it will continue to run at approximately 20% rpm and 400 °C to 500 °C EGT. During engine air starts, positioning the AIR START switch to ON provides immediate, direct power to the fuel enrichment solenoid valve, at any rpm, when the exhaust gas temperature is less than 450 (±50) °C. With ignition and fuel present, the engine will run even if the condition lever is in the FUEL SHUTOFF position.

NOTE

> Failure of the engine temperature sensing switch to cut off start fuel at 450 (±50) °C may prevent a successful airstart attempt by inducing high EGTs prior to reaching 10% rpm, since both ignition and start fuel are available immediately upon actuation of the AIR START switch.

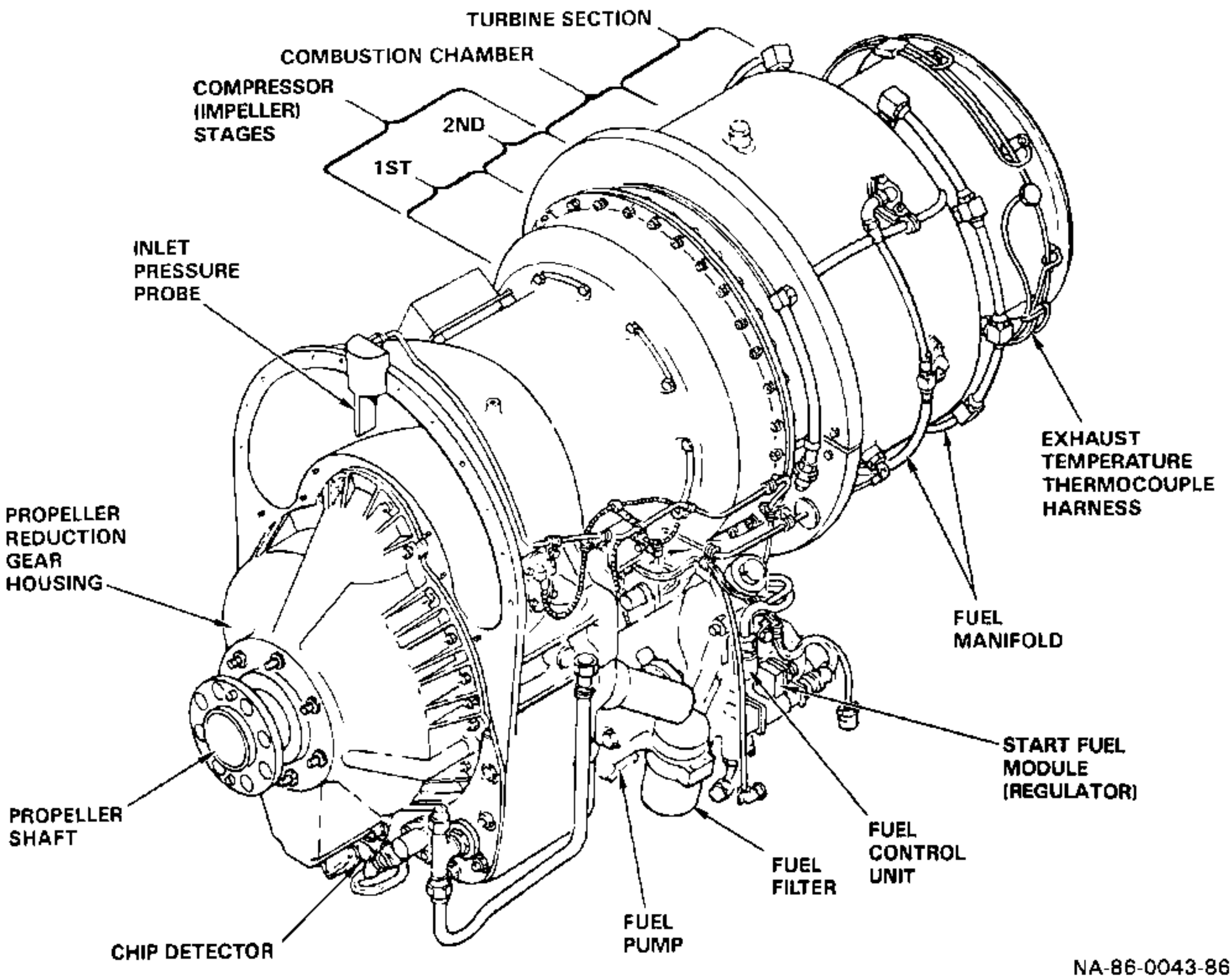


Figure 2-1. T-76 Engine

2.4 ENGINE IGNITION SYSTEM

Each independent engine ignition system consists of an ignition unit and a single ignition plug mounted in the engine combustion chamber. For ground starts, the system is energized automatically by the engine speed sensing switch as the rpm passes 10%. Ignition operation is cut out automatically by the engine speed sensing switch as rpm passes 50%, discontinuing the start cycle. The ignition system is energized both on the ground and airborne whenever the AIR START switch is moved to ON. To discontinue the ignition cycle, this switch must be moved to the AUTO position. Ignition system operation can be verified by the pilot's START IGNITION ON light.

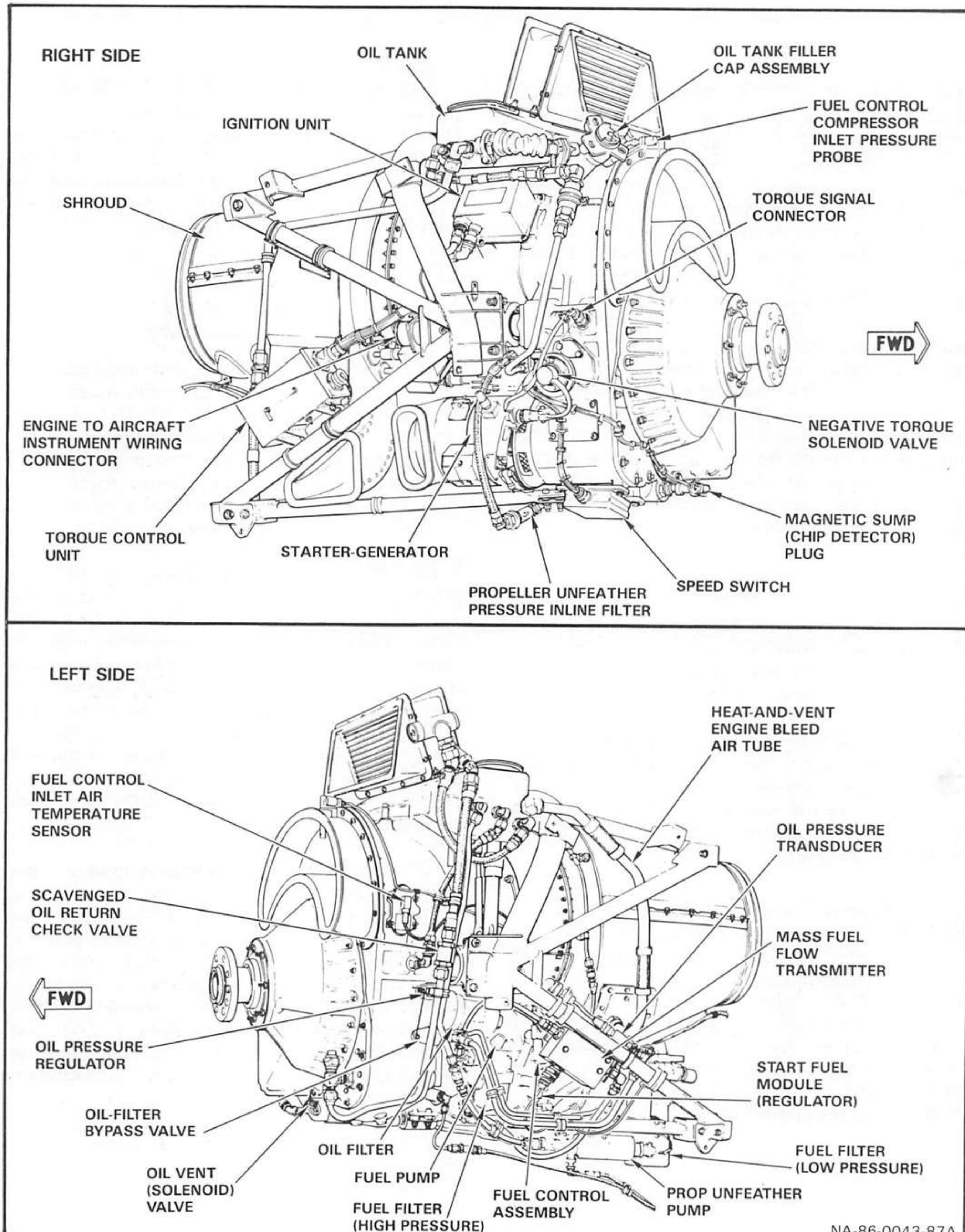


Figure 2-2. Engine–External View

2.4.1 Ignition and Unfeathering (AIR START) Switches. The AIR START (IGNITION & UNFEATHER) switches (Figure 2-6) are located on the pilot's starter-generator control panel. These switches are covered with red guards labeled AIR START and have ON, AUTO, and CRANK positions. In AUTO (guards down), the ignition systems are armed for ground starts and controlled by the engine speed sensing switches. With the main dc bus energized, the ON position activates the propeller unfeathering pump (below 50% rpm), provides continuous ignition system operation, furnishes supplemental fuel by means of the fuel enrichment kit, and trips the generator. The ON position is used for air starting the engine; the switch must be returned to the AUTO position after the start to remove power from the ignition system and the fuel enrichment solenoid, and to allow the generator to reset automatically.

NOTE

When the AIR START switch is placed in the ON position, the TEMP instrument indicates EGT below 50% rpm and TIT above 50% rpm.

With the BATTERY switch ON or external dc power applied, holding either switch in CRANK activates the corresponding unfeathering pump, and interrupts the fuel enrichment and igniters to the applicable engine. Refer to ENGINE OPERATION, in this Part.

2.4.2 Starter Switches. The L START and R START switches (Figure 2-6) are located on the pilot's starter-generator control panel. These three-position lever-lock-type switches are marked START, RUN, and ABORT, and require positive, lift-to-unlock action to select the START position. With the BATTERY switch ON (with or without external dc power applied), holding the desired switch momentarily in START initiates engine starter operation through a holding relay. The ABORT position deenergizes the automatic ignition circuit, disengages the starter, and cuts off fuel enrichment flow. During flight, the ground start system is not functional since electrical power is removed from the ground start switches by the landing gear safety relay when the aircraft is airborne.

WARNING

If the START switch is energized and the engine fails to crank, move the START switch to ABORT to deenergize the automatic ignition circuit prior to attempting any further corrective action. Failure to do so may cause inadvertent engine start if the circuit is later completed.

2.4.3 Start Ignition ON Caution Light. The START IGN ON caution light is installed on the pilot's caution light panel. See Figure 2-17. This yellow light is illuminated whenever an engine is started as in a normal ground start (one engine at a time) or when either or both engines are started on the air start system. The START IGN ON caution light should extinguish at 50% rpm during a normal ground start, and when the AIR START switches are moved to AUTO following air start. This light receives 28-VDC power from the main bus.

2.4.4 Anti-Flameout Continuous Ignition Feature. When icing conditions are inadvertently encountered, continuous ignition may be applied to the engines to avoid engine flameout due to ice or water ingestion. When engine rpm is greater than 50% the propeller unfeather pumps will be inhibited, when the AIR START switches (Figure 2-6) are placed to ON. The engine TEMP instrument will display turbine inlet temperature (TIT) when continuous ignition is selected.

2.5 ENGINE OIL SYSTEM

An independent, dry sump oil system is provided for each engine. These systems provide both engine lubrication and propeller control system supply. Total oil system capacity is 2.25 gallons with a flow rate of 4 to 7 gallons per minute. Oil is stored in a 1.5-gallon tank on each engine, 1.25 gallons of which are usable. At ground idle (65% rpm), minimum oil pressure is 48 psi. Above 91% rpm, oil pressure is regulated at 105 (± 15) psi by the return of excess oil from the engine-driven pump back to the inlet side of the oil pump. For limits at all rpm, refer to OIL PRESSURE LIMITS, Chapter 4, in this Part. Each system includes an air-oil cooler and oil cooler door system to maintain oil temperature at approximately 190 °F (87.7 °C). The air-oil cooler incorporates a thermostatic valve and a pressure relief valve to direct scavenge oil to the cooler core or directly to the oil tank. The air-oil cooler doors, located on the wing leading edge above each nacelle, open when the landing gear extend to ensure airflow through the air-oil cooler during ground operations. Both engine accessory gearcases are equipped with a magnetic drain plug which attracts any ferrous particles present in the lower area of the sump. The plugs provide the electrical ground for operations of the engine chip warning lights. To reduce the load on the starter-generators during start, both engines are incorporated with an engine oil vent solenoid valve. This valve opens upon start and provides ambient air to the three oil pumps, reducing loads on the pumps. The valve closes at 50% rpm and true oil pressure is not available on start until after 50% rpm.

2.5.1 Engine Chip Caution Lights. The L CHIP and R CHIP caution lights (Figure 2-17) are located on the pilot's caution light panel. Collection of sufficient ferrous particles on either engine accessory case chip detector will cause the associated caution light to illuminate. The 28-VDC primary bus provides electrical power for light operation.

2.6 PROPELLERS

Each engine drives an 8.5-foot, three-blade, fully reversible aluminum spar, fiberglass-covered propeller. At Military-rated engine rpm (41,730), the propellers rotate at 2000 rpm. To reduce torque effect, the left propeller rotates clockwise and the right propeller rotates counterclockwise. Normal operation of the propeller is achieved by the propeller control system using high-pressure oil to hold the propeller blades at the required position to maintain rpm. The propeller control systems use engine oil boosted in pressure by the propeller governors. In the event of complete control oil pressure loss, the propeller will automatically be driven to a near-feathered position by the force applied against the propeller blade pitch control piston by a stack of compression washers. The propeller control systems incorporate dump (feather) valves which allow the pilot to manually select feathering as required.

2.7 TURBINE INLET TEMPERATURE SYSTEM

The turbine inlet temperature system consists of the engine thermocouple harness, a dc powered resistor, an ac powered temperature computer for each engine, and the dc powered temperature (TEMP) indicators.

During engine starts (at less than 50 percent), the TEMP indicators display exhaust gas temperature (EGT). At engine speeds above minimum generator cut-in rpm (50% to 53%), the turbine inlet temperature (TIT) system provides simplified engine temperature in the form of computed turbine inlet temperature (TIT). As the known temperature differential between exhaust gas temperature and TIT changes with operation conditions, the computed output varies as a function of the ratio of compressor discharge pressure to turbine discharge pressure. The final product is a computed temperature indication which accounts for airspeed, altitude, and outside air temperature variations. Operation of the overtemperature warning lights and audible warning tone is a direct function of the TEMP indicators. These lights and tone allow pilot attention to be directed outside the cockpit when operationally required. By adjusting the power levers to prevent actuation of the overtemperature warning system, the pilot is assured that engine temperature limits are not being exceeded. If electrical power failure to a TEMP indicator occurs during engine start or in flight, vertical scale liquid crystal diode (LCD), and digital readout shall return to a reading less than 100 °C and the overtemperature warning system is inoperative.

2.7.1 Overtemperature Warning. Two red ENG HOT (L, R) warning lights are installed on the pilot's caution/warning light panel and two repeater ENG HOT (L, R) warning lights are located on the observer's caution/warning light panel (Figures 2-17 and 2-18). The warning lights are controlled by a circuit within the TEMP indicators. When the respective TEMP indicator reaches 1125 (+4/−0) °C, the internal circuit will cause the warning light to illuminate. A command signal from the pilot's TEMP indicator(s) is sent to TIT/low altitude warning aural tone generator initiating a 4.5 second, alternating 700 and 1300 Hz tone with a 6 Hz repetition rate in the headsets of both crewmembers. Illumination of warning lights and initiation of the tone occurs at less than the maximum allowable temperature limit to call attention to the indicators. Should engine overtemperature be encountered, retarding of the affected engine power lever will extinguish the light and stop the tone when TIT drops 6 °C below the temperature at which the light was illuminated. Electrical power for the warning lights and the indicator overtemperature switch circuit is 28 VDC provided by the main dc bus.

2.8 ENGINE AND PROPELLER INSTRUMENTS

The following instruments; TEMP, % RPM, TORQUE, FUEL FLOW, and OIL PRESS, located on the pilot's instrument panel are used to display engine and propeller operating information (Figure 2-3). Each instrument contains a left and right engine indicator with a color-coded vertical range scale. The indicators permit monitoring of engine and propeller performance by viewing the rising and falling white liquid crystal diode (LCD) levels displayed adjacent to the scale. Below each scale (with the exception of the OIL PRESS instrument) a precise digital readout is provided to display the numeric equivalent of the vertical scale display. The engine and propeller instruments, FUEL panel digital readouts, engine OVERTEMP and OVERTORQUE warning systems and lights are tested with the ENG INSTR TEST switch.

2.8.1 Engine Instrument Test (ENG INST TEST) Switch. The engine and propeller instruments and FUEL panel are tested with the ENG INSTR TEST switch (Figure 2-3). The switch is a spring-loaded, two-position switch (TEST and NORM) located on the pilot's right console. Instrument testing may be performed when external, battery, or aircraft electrical power is available. The switch is spring-loaded to the NORM position. When selected and held to the TEST position, the instruments and FUEL panel digital segments will display an "8" and instrument LCDs will form a horizontal line (Figure 2-3). Release of the switch from TEST to NORM will initiate and test the overtemperature and overtorque system electrical circuits, associated warning/caution lights, and aural warning tone.

2.8.1.1 TEST Position (Engine Instrument Test). When selected to the TEST position, the switch provides a ground that enables test signals to be displayed on the engine TEMP, % RPM, TORQUE, FUEL FLOW, and OIL PRESS instruments on the pilot's instrument panel. The instruments will display white LCD levels in the normal operating range (green scale) of approximately the same height forming a horizontal line. Digital readouts below engine instruments (except OIL PRESS) will indicate a digital 8, testing each digit segment. The switch will also test digit segments (8s) of the digital readouts on the FUEL panel.

TEST INDICATIONS (FIGURE 2-3).

ENGINE INSTRUMENT	VERTICAL SCALE INDICATION	DIGITAL READOUT
TEMP	800 (°C × 100)	888
% RPM	70 (× 10)	88.8
TORQUE	2300 (FT-LBS × 100)	8888
FUEL FLOW	520 (PPH × 100)	888
OIL PRESS	100 (PSI × 10)	—
FUEL PANEL		
QTY	—	8888
REM	—	8888

2.8.1.2 TEST to NORM Position (Overtemperature and Overtorque Test). Upon release of the ENG INSTR TEST switch from TEST to NORM, both vertical scales of the TEMP instrument will rise and indicate 1125 (+4/−0) °C testing the overtemperature sensing system. This action closes each TEMP indicator's internal overtemperature switch causing the L and R ENG HOT

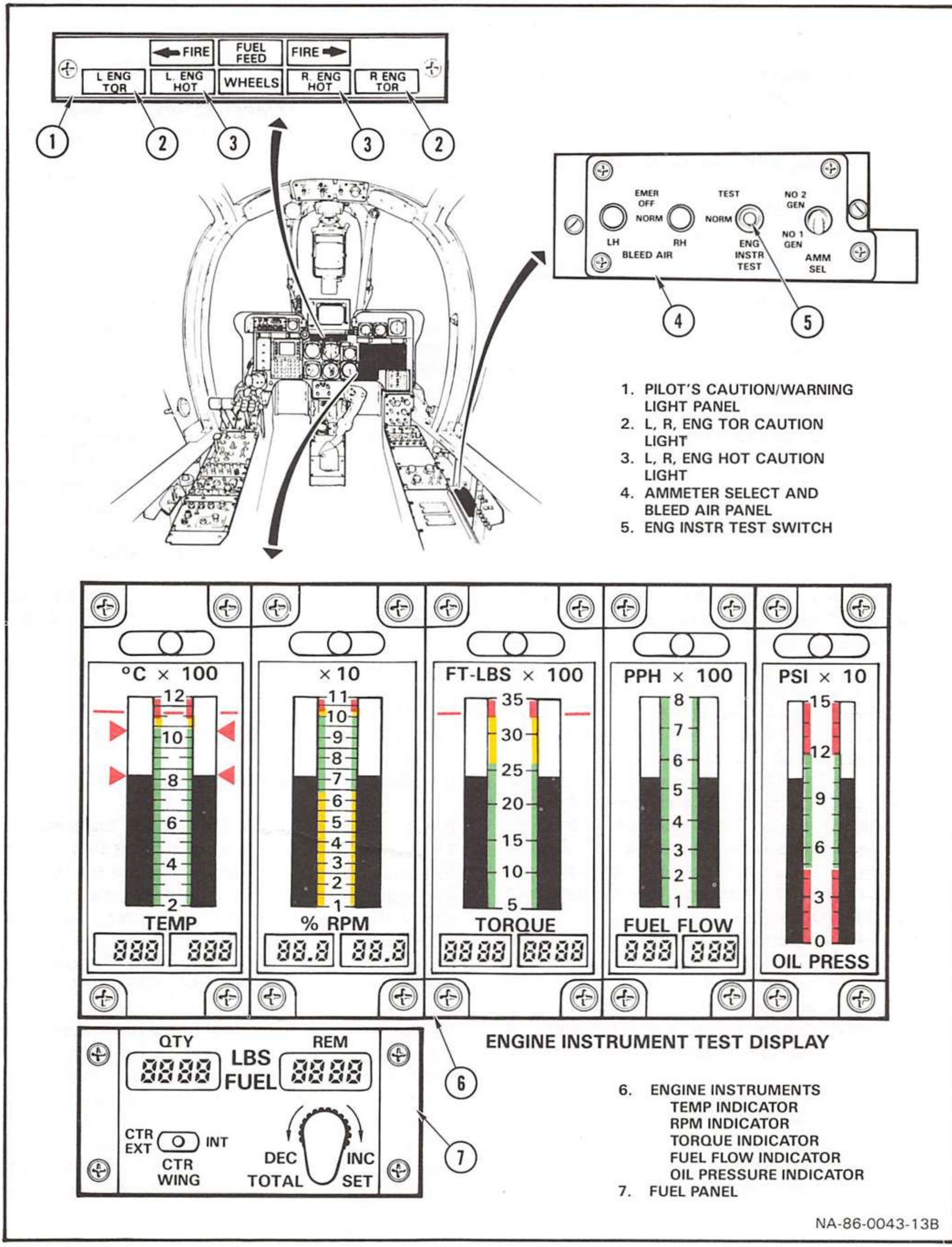


Figure 2-3. Engine Instrument Test Display

caution lights, located on the pilot's and observer's caution/warning light panels, to come ON and then go OFF initiating an aural warning tone in each crewmembers headset for 2 seconds. Each TEMP indicator's corresponding digital readout will also indicate 1125 (+4/−0) °C during this portion of the test. Following the momentary rise in engine temperature displayed on the indicators, each TEMP indicator vertical scale and digital readout will display less than 100 °C or return to normal engine TEMP indications. Simultaneously, both TORQUE instrument indicators will rise and display 3320 ft-lbs on the vertical scales and 3300 (±20) foot-pounds on the digital display. On the pilot's caution/warning light panel, the L and R ENG TOR caution lights come ON and then go OFF. After two seconds the display will return to normal torque indications or return to the bottom of the scale.

2.8.2 Engine Temperature (TEMP) Instrument. The TEMP instrument installed on the pilot's instrument panel, consists of two temperature indicators for the left and right engine, (Figure 2-3). The indicators display engine temperature in EGT (exhaust gas temperature) or TIT (turbine inlet temperature) depending on engine rpm. During ground starts (below 50% rpm or generator cut-in speed) the indicator will reflect EGT. At 50% rpm and with the instrument power switch (Figure 2-6) positioned to INV NO. 1 or INV NO. 2, the system switches from EGT to TIT. Above 50% rpm with the AIR START switch (Figure 2-6) placed to the ON position, the indicator will indicate TIT. Engine temperature input is provided by engine-mounted thermocouples and the battery bus provides 28-VDC electrical power to the indicator. The vertical scale for each indicator is calibrated from 200° to 1200 °C, a red line index at 1129 °C and two red tic indexers (815° and 1040 °C) are marked on the indicator face. Below each scale is a digital readout capable of indicating the engine temperature from 100° to 1200 °C. Each indicator contains an overtemperature switch that will illuminate a warning light (L or R ENG HOT) on the pilot's and observer's caution/warning panel (Figures 2-17 and 2-18) and initiate an aural warning tone in both crewmembers headsets.

TEMP INSTRUMENT RANGE

RANGE	TEMPERATURE (°C × 100)	VERTICAL SCALE
NORMAL	100° to 1040°	GREEN
CAUTION	1040° to 1100°	YELLOW
DANGER	1100° to 1200°	RED

2.8.3 % RPM Instrument. The % rpm instrument consists of two indicators that provide a display of rpm for the left and right engine respectively. Indicator power (28 VDC) is provided by the battery bus. Engine rpm is reflected in percent of military-rated rpm for both engines by way of a linear scale from 10 to 110 percent and below each scale is a corresponding digital readout that displays rpm from zero to 110 percent. The indicator receives input from two engine-mounted tach generators (Figure 2-3).

% RPM INSTRUMENT RANGE

RANGE	RPM (× 10)	VERTICAL SCALE
CAUTION (LOW)	10% to 64%	YELLOW
NORMAL	64% to 100%	GREEN
CAUTION (HIGH)	100% to 104%	YELLOW
DANGER	104% to 110%	RED

2.8.4 Engine Torque (TORQUE) Instrument. The TORQUE instrument consists of two indicators that provide a display of torque for the left and right engine (Figure 2-3). Instrument power (28 VDC) is provided by the battery bus. The TORQUE instrument, located on the pilot's instrument panel, displays engine torque on a vertical scale linear from 500 to 3500 FT-LBS. A red line index of 3348 ft-lbs is located on the indicator faceplate. Below each vertical scale is a digital readout that reflects engine torque up to 3990 FT-LBS with the last character on the digital display being a fixed zero. Torque sensing system inputs to the indicator are two dc current values proportional to the torque of each engine. Each indicator contains an overtorque sensing switch (28 VDC) that will initiate the respective (L or R) ENG TOR caution light.

TORQUE INSTRUMENT RANGE

RANGE	TORQUE (FT-LBS × 100)	VERTICAL SCALE
NORMAL	500 to 2600	GREEN
CAUTION	2600 to 3260	YELLOW
DANGER	3260 to 3500	RED

2.8.4.1 Overtorque Warning. Two yellow ENG TOR (L, R) caution lights are installed on the pilot's caution/warning light panel (Figure 2-17). The caution lights are controlled by a circuit within the TORQUE indicators. When the respective TORQUE indicator reaches 3282 to 3318 FT-LBS torque, the internal circuit causes the caution light to illuminate. Should overtorque be encountered, retarding the affected engine power lever(s) will extinguish the light(s) when torque has been decreased by approximately 37 FT-LBS.

2.8.5 Engine Fuel Flow (FUEL FLOW) Instrument. The fuel flow instrument, located on the pilot's instrument panel, consists of two indicators that display fuel flow rate for each engine (Figure 2-3). Instrument power is 28 VDC provided by the battery bus. Fuel flow rate for both engines is displayed on a linear scale from 100 to 800 pounds per hour (pph). Below each scale is a corresponding digital readout that displays fuel flow from 100 to 800 pph with the last digit being a fixed zero. Fuel flow below 100 pph will not be displayed. During normal operation the instrument receives input from two independent mass fuel flow rate transmitters, one mounted on each engine.

FUEL FLOW INSTRUMENT RANGE

RANGE	FUEL FLOW (PPH × 100)	VERTICAL SCALE
NORMAL	100 to 800	GREEN

2.8.6 Engine Oil Pressure (OIL PRESS) Instrument. The oil pressure instrument , located on the pilot's instrument panel, consists of two indicators that provide a display of oil pressure for each engine (Figure 2-3). The oil pressure instrument displays oil pressure from 0 to 150 pounds per square inch (psi) on a linear scale. Indicator power (28 VDC) is provided by the battery bus. During normal operation, the indicator receives input from two engine-mounted, dc powered, oil pressure transmitters. During engine starts the indicator provides 10 VDC to the transmitters for excitation.

OIL PRESSURE INSTRUMENT RANGE

RANGE	PRESSURE (PSI × 10)	VERTICAL SCALE
DANGER (LOW)	000 to 47.5	RED
NORMAL	47.5 to 120	GREEN
DANGER (HIGH)	120 to 150	RED

2.9 ENGINE OPERATION

Air is drawn through an inlet above the propeller hub, compressed by a two-stage centrifugal compressor (impeller), mixed with fuel, and ignited within a reverse-flow annular combustor. The resultant expanded gases drive a three-stage turbine. The compressor and turbine sections rotate on a common shaft where power is extracted to drive the propeller reduction gears. The reduction gears convert the high speed, low torque of the turbine to the lower speeds and higher torques necessary to drive the propeller and the components that control engine operation. Military power (100% rpm) is achieved at 41,730 rpm of the compressor-turbine shaft (propeller shaft rotation 2000 rpm). The engine fuel control units schedule fuel flow through inputs of the power lever position, compressor inlet pressure and temperature, compressor discharge pressure, and engine rpm. Engine rpm and propeller blade angle are scheduled through condition and power levers by an independent power management control system.

2.9.1 Power Management Control System (PMCS). The PMCS simplifies power/thrust management by automatic control and correlation of all functions of the engine and the propeller into a single-point input to the cockpit power lever. A separate power lever and a condition lever are provided for each engine/propeller. The PMCS provides both governing-type control mode and a Beta-type control mode. The system automatically transitions from one mode to the other as flight conditions and power lever positions dictate.

2.9.2 Power Levers. The power levers are located on the left console quadrants (Figures 1-2 and 1-6). The quadrants are marked at FULL REVERSE, GROUND START, GROUND IDLE, FLIGHT IDLE, and MILITARY positions. The power levers are linked to the engine fuel control units and the propeller governor units through the power management control systems. The primary functions of the power levers are to control engine fuel flow and propeller speed (rpm) setting, and to select reverse thrust. Selection of FULL REVERSE drives the propeller blades against the reverse pitch stops to obtain maximum reverse thrust, and also automatically provides the required fuel flow for reverse thrust conditions. The GROUND START position of the power levers approximates the area of minimum torque. Placement at the FLIGHT IDLE mark provides in-flight minimum fuel flow and torque, depending on airspeed. Reverse thrust is obtained by retarding the power levers into the reverse thrust range. Inadvertent in-flight selection of reverse thrust is prevented by a solenoid-operated gate in the pilot's power quadrant at the FLIGHT IDLE position. The gate is automatically retracted with the weight of the aircraft on the left main landing gear through the action of the ground safety switch. In the event of malfunction, the gate can be bypassed by lifting the power levers approximately 1/4 inch and then going to the reverse thrust position.

CAUTION

The power levers shall not be retarded aft of the "gate" in flight.

2.9.3 Condition Levers. The condition levers are located on the left console quadrants (Figures 1-2 and 1-6), inboard of the power levers. The quadrants are marked TO/LAND, NORMAL FLIGHT, FUEL SHUTOFF, and FEATHER & FUEL SHUTOFF. The condition levers are linked to the engine fuel shutoff valve, and the propeller feather valve through the power management system. The primary function of the condition levers is to permit selection of any engine power setting at high propeller rpm for rapid thrust transients at all power lever settings, to initiate or shut off fuel flow to the engines (FUEL SHUTOFF), and to manually feather the propellers and shut off fuel to the engines (FEATHER & FUEL SHUTOFF).

WARNING

Placing a condition lever in NORMAL FLIGHT position when the engine is not running will cause the fuel trapped under pressure between the engine-driven fuel pump and the fuel shutoff valve to be injected directly into the combustion chamber. A fire is highly probable if the engine is hot.

2.9.4 Friction Lever. Operating friction of the pilot's and observer's power levers may be adjusted through a friction lever on the pilot's quadrant in the front cockpit only (Figure 1-2). Operating friction of the engine condition levers is ground-adjusted.

2.9.5 Governing Control Mode. In the governing mode, the engine shaft horsepower output and speed (rpm) are variables selected and set by the pilot. Fuel flow to the engine is selected by manipulation of the engine fuel control input through the cockpit power lever to set the power delivered to the propeller. Simultaneously through the PMCS, the operating speed (rpm) of the system is established by a speed set input signal to the propeller control. The propeller governor automatically provides propeller blade angle pitch control to maintain the selected speed (rpm) so that the power delivered by the engine is equal to that absorbed by the propeller. During normal flight operations, governing-type speed control is provided.

2.9.5.1 Propeller Governor. The propeller governor regulates and controls the operating speed (rpm) of the engine-propeller combination by hydraulic modulation of the propeller blade angle, as required to absorb the power output of the engine at the selected set speed. The propeller governor incorporates an internal set of spring-balanced flyweights which are mechanically coupled to the engine-propeller shaft through appropriate gearing and directly senses the operating rpm. A pilot valve, actuated by the flyweights, controls the flow (volume) of oil to and from the propeller to control blade angle. The pilot valve acts to port oil to the propeller (which decreases blade angle) in the event of insufficient rpm, and to port oil away from the propeller (which increases blade angle) in the event of excessive rpm. The propeller governor provides an isochronous speed control characteristic (rpm control is independent and does not vary with load). Basic speed set to the propeller governor is derived from the power lever, and except as overridden by the condition lever input, sets the operation rpm from a minimum governing speed of 70% to a maximum of 101%.

2.9.5.2 Underspeed Governor (USG). The underspeed governor (USG) is physically an integral component of the engine fuel control. The purpose of the USG is to provide supplementary fuel flow to that fuel flow scheduled and provided by the fuel control main fuel metering valve if this latter fuel flow is insufficient to permit attainment of the USG set engine speed. This device, combined with the Beta valve, permits achievement of reverse thrust and Beta-type control mode operation. Basic speed set to the USG is derived from the power lever, and except as overridden by the condition lever input, sets the minimum operating rpm. To prevent control interaction, USG set rpm (65% to 66%) must always be below the propeller governor set rpm (70% to 71%).

2.9.5.3 Overspeed Governor (OSG). The purpose of the overspeed governor is to limit the maximum rpm within safe limits in the event of propeller governor or underspeed governor speed control failure or malfunction. The overspeed governor is physically an integral component of the engine fuel control, and acts to limit/reduce fuel flow in accordance with a speed (rpm) input. OSG action takes precedence over all other fuel inputs to the engine. The engine OSG provides a speed-droop characteristic and nominally is set to provide a limiting rpm of 104% when the propeller blades are locked and positioned on the shutdown pitch stop (minimum torque—zero airspeed).

2.9.5.4 Beta Valve. The Beta valve schedules the minimum blade angle to which the propeller governor may drive the propeller. In the Beta mode, this valve is positioned by the power lever and hydraulically controls the propeller blade angle.

2.9.5.5 Beta Control Mode. In the Beta mode of control, propeller blade angle is set by the power lever and the fuel control underspeed governor automatically adjusts the fuel flow and power output of the engine to maintain the selected rpm at the selected blade angle. The PMCS simultaneously coordinates these functions as selected through movement of the power lever to maintain the engine speed desired. During Beta mode of control, the propeller governor speed set is rescheduled to a high level to eliminate its interaction with the underspeed governor on the engine.

2.9.6 Negative Torque Sensing Operation. In the event of flame-out or sudden power loss, the airflow will attempt to turn the propeller and thus drive the engine (negative torque). This high drag condition is undesirable. The negative torque sensing (NTS) system in the T76 engine will automatically sense negative torque and will act to drive the propeller toward high pitch (feather), resulting in a low drag (only slightly higher than in feather), no-thrust condition with the engine windmilling. When the negative torque condition no longer exists, the NTS system will return control of the propeller to the normal propeller control system. At any time during this sequence, the pilot may elect to feather the propeller with the condition lever. The NTS system removes the urgency from the feathering procedure. If an engine failure occurs, the pilot has time to identify the malfunctioning engine and take appropriate action. Although this low-drag operation will continue as long as oil pressure is available, the propeller of the failed engine should be feathered as soon as practical.

2.9.7 Engine Conditions. For graphic presentation of engine operation under various conditions, see Figure 2-4.

2.9.8 Engine Starts. Engine starts may be performed by the pilot only, and can be achieved using battery power only or battery and external

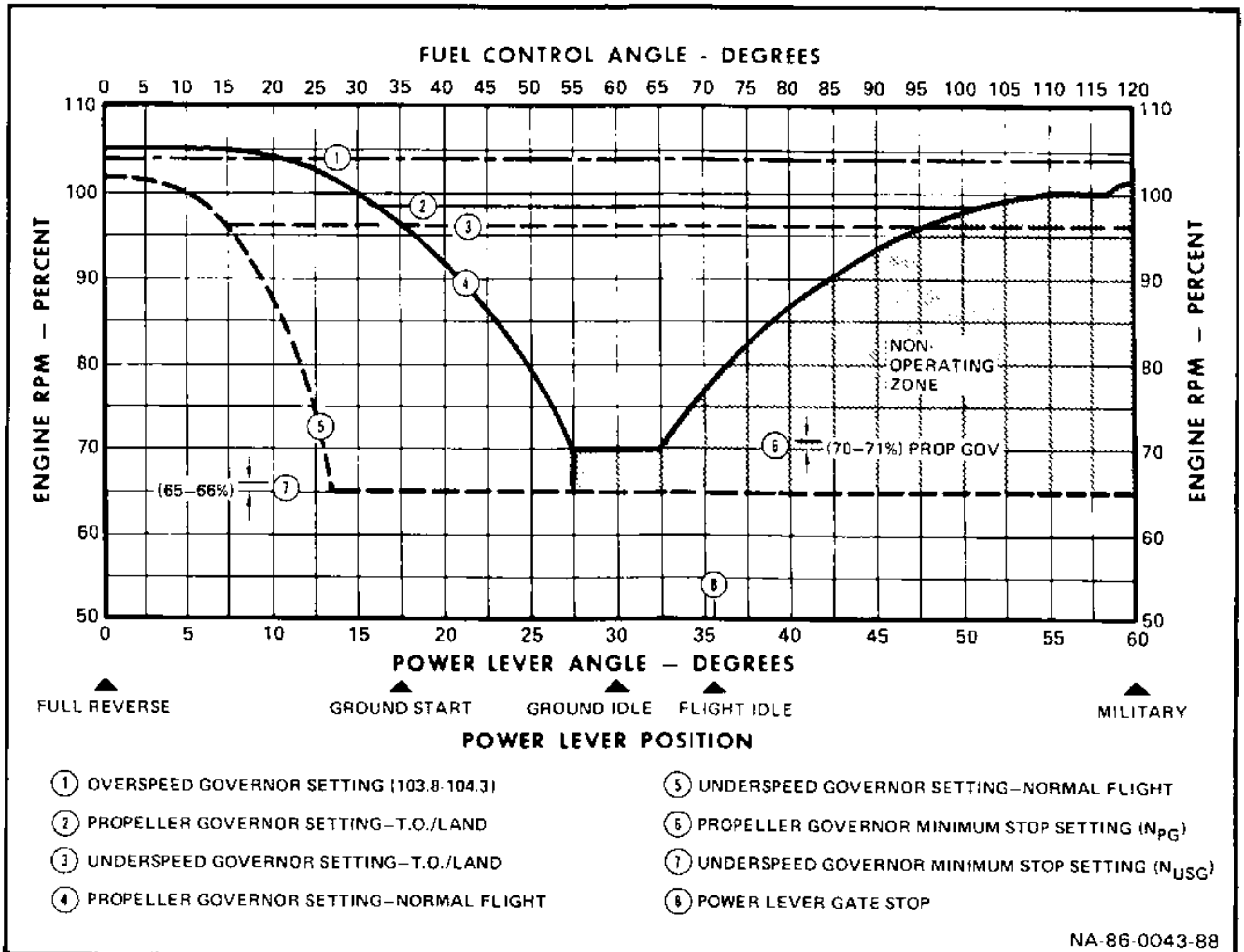


Figure 2-4. Engine Speed Control

dc electrical power. During battery starts of the first engine, all buses except the main and battery buses are disconnected from the system when the START switch is moved to the START position and remain disconnected until generator cut-in speed of approximately 50 percent is reached. If the propellers were feathered on the preceding shutdown, they shall be unfeathered and set in flat pitch, one at a time, prior to start to avoid hot or hanging starts. To accomplish unfeathering, the power levers are set in the reverse thrust range and the AIR START switches are held in CRANK until the propeller blades reach the full reverse position. Subsequently advancing the power levers into the positive thrust region releases unfeather pump oil pressure in the propeller dome, allowing the feathering mechanism to drive the blades toward feather position, engaging the flat pitch locks. For normal starts, the desired condition lever is positioned at FUEL SHUTOFF, the corresponding power lever is set at GROUND IDLE, the corresponding starter switch is held momentarily in START, and the condition lever is moved to NORMAL FLIGHT. The resulting sequence of engine cranking, light-off, and acceleration is automatic. Light-off (EGT rise) normally occurs between 10% and 12% rpm. The START IGN ON light should illuminate when either engine start switch is held in START, and go out at 52% rpm for both battery-powered and externally powered starts. The START IGN ON light should illuminate when either AIR START switch is moved to ON and go out when the switch is returned to AUTO position.

CAUTION

Should the electrical external power unit fail on initiating engine start, overtemperature could occur. With BATTERY switch ON and engine START switch held momentarily in START, the engine selected will be motored by the starter if the external unit plug is extracted from the receptacle. To prevent undesired engine rotation, hold the applicable START switch in ABORT and/or move the BATTERY switch to OFF in the event of a bog-down failure of the external power unit. (Procedure outlined in Part V.)

2.9.9 Ground Operation. Prior to taxi, the propellers must be unlocked by retarding the power levers into the reverse thrust range momentarily until propeller unlocking action is detected. Unlocking action is confirmed by aircraft reaction to reverse thrust as the blades leave flat pitch and an rpm of 65% minimum to 71% maximum when the power lever is returned to GROUND IDLE. A slight rise in torque indication may be noted during unlocking. Taxiing may be accomplished in either the TO/LAND or NORMAL FLIGHT position of the condition levers. Selection of NORMAL FLIGHT results in reduced propeller rpm, reduced thrust, and lower noise level.

NOTE

When the engines are to be operated for any length of time prior to take-off, the pilot may elect to place the condition levers to NORMAL FLIGHT and the power levers to GROUND START positions to provide lower fuel consumption, minimum thrust (essentially zero thrust), and the lowest noise level.

2.9.10 Take-off. With the condition lever in either the NORMAL FLIGHT or TO/LAND position, when the power lever is advanced to MILITARY, maximum thrust is attained. The propeller governor is set at approximately 100 percent (increasing to 101 percent in the last 2 to 3 degrees of travel for use during propeller synchronization) and the propeller governor schedules blade angle as required to maintain rpm, absorb power, and develop thrust. Propeller rpm is essentially constant in the TO/LAND condition. Changes in airspeed and power setting do not result in sound level variations.

2.9.11 Flight in Take-Off and Land (TO/LAND). As the power lever is retarded from MILITARY, the propeller governor is reset to 99% and the power lever schedules fuel to the engine. The propeller governor schedules blade angle as required by power and airspeed. At low airspeeds and power, the desired blade angle may be below the minimum blade angle schedule. Since the propeller governor may not schedule below this minimum, the propeller load is too great for the power available and rpm begins to drop. The rpm lowers to the USG set point of 96% and then the USG adds fuel to maintain rpm. Thus, as the aircraft slows further, power is increased. This is known as Beta mode operation.

2.9.12 Flight in NORMAL FLIGHT. As the power lever is retarded from MILITARY, the propeller governor is reset to the appropriate rpm for the power desired, down to a minimum of 70%. Transition to Beta mode at 65 percent occurs below normal flight speeds and thus should not be observed in flight. It should be noted that during power changes along the portion of the schedule where both rpm and fuel flow vary, the propeller governor will correct rpm first, then absorb the increased power. Thus an increase in power lever will result in a momentary decrease in thrust until rpm reaches the new value; this condition is reversed when retarding the power levers.

2.9.13 Landing in TO/LAND. In TO/LAND, the aircraft transitions to Beta mode at FLIGHT IDLE during deceleration. As the aircraft slows following touchdown, if the power lever is not retarded below the gate, positive thrust will be maintained and the landing roll will be increased. When the left main gear ground safety switch is closed, the gate stops are retracted and the power lever can be retarded to the GROUND START position or below. This action reduces the blade angle and the USG then adds fuel, providing propeller drag (reverse thrust) instead of forward or positive thrust. The rpm remains at the USG setting. For limitations on use of reverse thrust, refer to REVERSE THRUST LIMITS, Chapter 4, in this Part.

2.9.14 Reverse Power. As the power lever is retarded below GROUND START increasing negative blade angle, the USG begins to add fuel to support the propeller load. When full reverse is reached, the USG has been reset to a high rpm to provide more power in reverse. To avoid interference between the propeller governor and USG, the propeller governor is reset in reverse to 105% rpm so that it always senses underspeed and attempts to decrease blade angle, holding it on the reverse schedule. The maximum power (fuel flow) available from the engine due to underspeed governor action varies with engine rpm. Typically, reducing engine speed from 100% to 90% rpm reduces maximum power available by 300 shaft horsepower; an additional 10 shaft horsepower per percent rpm is lost below 90% rpm. Movement of the power levers below GROUND IDLE changes both the speed set of the underspeed governor and propeller blade angle. Due to the relative difference in the transient response of the engine speed/torque characteristics and propeller blade pitch control dynamics, under certain conditions, such as condition lever in NORMAL FLIGHT, it is possible to obtain a full reverse blade angle on the propeller without obtaining sufficient engine power and rpm to support this demand. Also at higher landing speeds, full reverse may require more propeller power than is available from the engine. Under these conditions, an engine bog-down is precipitated and immediate advancement of the power lever to the GROUND START position is required to move the propeller blade pitch to a position requiring less engine power. An engine bog-down is usually typified by a rapid decrease in engine rpm and an equally rapid rise in TIT. If this condition is not immediately arrested, severe temperature damage to the engine will occur. To preclude engine bog-down, landings should not be made when the condition lever is positioned to NORMAL FLIGHT. The NORMAL FLIGHT position permits the power lever to schedule engine rpm as low as 65% rpm during reverse thrust operation, which will not support power demands during rapid transient acceleration to full reverse thrust conditions. With the condition levers in TO/LAND, engine rpm is never scheduled less than 94% so that engine-propeller power balance is maintained.

2.9.15 Engine Shutdown–Normal (Flat Pitch). For operational convenience (turnaround flights), engines are normally shut down with the propeller blades locked at flat pitch. To achieve shutdown in flat pitch, the power levers are adjusted to obtain minimum available indicated torque until TIT stabilizes. For shutdown, the condition levers are pulled to the FUEL SHUTOFF position, immediately followed by retarding the power levers to FULL REVERSE and holding until engine rotation stops. Advancing the power levers to GROUND IDLE will drive the blades from full reverse toward feather, engaging the flat pitch locks.

2.9.16 Engine Shutdown–Feathered. As required, the engines may be shut down with the propellers feathered. To obtain feathering on shutdown, adjust power lever position to obtain minimum torque and pull the condition levers full aft to FEATHER & FUEL SHUTOFF. Subsequent start procedure must then include unfeathering. Refer to ENGINE STARTS, in this Part.

CAUTION

Failure of engine to stop running when the condition levers are placed in FUEL SHUTOFF may indicate a broken or disconnected fuel control linkage or shutoff valve. Positioning the power lever to FULL REVERSE or the condition lever to FEATHER and FUEL SHUTOFF under these circumstances may result in engine OVERTEMP/FIRE. When linkage failure occurs, shut down the engine using the EMER FUEL SHUT OFF switch.

2.10 AIRCRAFT FUEL SUPPLY SYSTEM

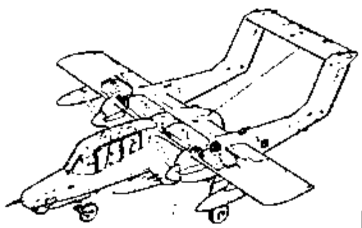
Internal fuel is carried in five self-sealing, unpressurized wing tanks: two inboard, two outboard, and center (see Figure FO-1). The center wing tank includes a sump portion, which acts as an engine feed tank. All wing tanks are bladder-type cells, backed with cellular plastic foam, and filled with foam baffling material. The center tank receives all fuel from the inboard and outboard tanks. The engine feed portion of the center wing tank has limited inverted flight capability and receives all fuel before it is distributed to the engines. Wing and center tank fuel is transferred by gravity and ejector-type transfer pumps which are operated by motive flow returned from the low-pressure port of the two-stage engine-driven fuel pumps. Fuel from the feed tank is supplied by a submerged boost pump to the engine fuel lines. In the event of boost pump failure, feed tank fuel is available to the engine-driven fuel pumps by gravity flow. Should wing or center tank ejector pump action fail, fuel will continue to flow into the feed tank by gravity. Refueling is accomplished manually through five filler points on top of the wing. For a schematic of the fuel system, see Figure FO-1. For fuel quantity, see Figure 2-5.

2.10.1 External Fuel Tanks. External fuel may be carried in a single 150-gallon auxiliary fuel tank, which may be installed at the centerline fuselage station and/or two 100-gallon auxiliary fuel tanks which can be installed on the wing pylons. Each wing pylon contains an electrical fuel transfer pump to transfer fuel from the 100-gallon auxiliary tanks to the outboard wing tanks. Fuel is transferred from the centerline tank to the feed portion of the center wing tank by an electrically driven transfer pump in the external fuel transfer line. There are two versions of the 150-gallon external fuel tank which can be carried: the Aero 1C and the FPU-3/A. Special procedures must be used for filling the Aero 1C to 150 gallons of fuel. The aircraft must be elevated approximately 4 degrees nose up (to level the tank), or the tank will accept only 122 gallons. The FPU-3/A tank has an aft gravity filler cap in the aft section of the tank. The aircraft does not have to be elevated to fill the tank with 150 gallons of fuel.

2.11 FUEL SYSTEM CONTROLS AND INDICATORS

2.11.1 Condition Levers. Normal turn-on and shutoff of engine fuel flow are controlled through the condition levers. Advancing these levers from FUEL SHUTOFF to NORMAL FLIGHT during ground starts allows the main fuel shutoff valve on the respective engine to open when 10% rpm is reached. Retarding these levers to FUEL SHUTOFF or FEATHER & FUEL SHUTOFF closes the main fuel shutoff valves.

2.11.2 Fuel Panel. Total fuel quantity and total fuel remaining (in pounds) is displayed on the fuel panel by two digital readouts, located on the pilot's instrument panel (Figure 2-3). Indicator power is 28 VDC provided by the battery. The face of the panel has a three-position switch for selection of the fuel quantity to be displayed. The switch may be positioned to center wing fuel (CTR WING), total internal fuel (INT), or centerline external fuel (CTR EXT). On the panel a knob (TOTAL SET) is used to preset (increase



BASED ON: ESTIMATED DATA JP-4 = 6.5 LBS/GAL
DATA AS OF: 1 OCTOBER 1976 JP-5 = 6.8 LBS/GAL

(1) TANK PACKED (NOSE RAISED 4 DEGREES)

(2) TANK REFUELED IN NORMAL ATTITUDE

	TANK CAPACITY				USABLE		
	GALLONS	LITERS	JP-4 POUNDS	JP-5 POUNDS	GALLONS	JP-4 POUNDS	JP-5 POUNDS
WING OUTBOARD (2)	75.2	285.0	489.5	511.4	72.4	470.6	492.3
WING INBOARD (2)	133.6	506.2	868.4	908.6	129.7	843.0	882.0
CENTER	37.6	142.5	244.4	255.5	36.5	237.0	248.0
TOTAL INTERNAL	246.4	933.7	1602.3	1675.5	238.6	1550.6	1622.3
INTERNAL TOTAL	246.4	933.7	1602.3	1675.5	238.6	1550.6	1622.3
WING AUXILIARY (2)	192.0	727.7	1248.0	1305.6	180.0	1170.0	1224.0
TOTAL	438.4	1661.4	2850.3	2981.1	418.6	2720.6	2846.3
INTERNAL TOTAL	246.4	933.7	1602.3	1675.5	238.6	1550.6	1622.3
CENTERLINE TANK (1) (FPU-3/A) OR (AERO 1C)	150.0	568.0	975.0	1020.0	150.0	975.0	1020.0
TOTAL	396.4	1501.7	2577.3	2695.5	388.6	2525.6	2642.3
INTERNAL TOTAL	246.4	933.7	1602.3	1675.5	238.6	1550.6	1622.3
CENTERLINE TANK (2) (AERO 1C)	122.0	462.0	793.0	829.6	122.0	793.0	829.6
TOTAL	368.4	1395.7	2395.3	2505.1	360.6	2343.6	2451.9

NA-86-0043-89A

Figure 2-5. Fuel Quantity Data

or decrease) the initial fuel load in the fuel remaining readout. Fuel system inputs are provided by two engine-mounted fuel flow rate transmitters for the fuel remaining readout and fuel tank mounted probes for the fuel quantity readout. Both portions of the indicator are tested with the ENG INSTR TEST switch mounted on the pilot's right console. Associated with the fuel quantity system installed is an indication error which is the result of both system design and calibration inaccuracy. The built-in error must always be considered when determining the actual maximum and minimum amount of fuel remaining in the aircraft. The system design tolerance is 3 percent of the total indication of the fuel quantity indicator. Normal total fuel indication is 1900 pounds. Calibration inaccuracy is 6 percent of the fuel quantity indication. Combining these tolerances results in the total fuel quantity indication error allowable. Maximum allowable error is ±154 pounds. In order to compute the maximum indication error, it must be remembered that it is a combination of two system tolerances. As an example: What is the maximum indication error for a fuel quantity readout reading of 1620 pounds?

- System design error = 1900 pounds × 3 percent = ±57 pounds
- Calibration tolerance = 1620 pounds × 6 percent = ±97 pounds
- Maximum indication error = ±154 pounds

What is the actual maximum and minimum amount of fuel remaining in the aircraft with 1200 pounds indicated?

- System design error = ±57 pounds
- Calibration tolerance = 1200 pounds × 6 percent = ±72 pounds
- Maximum indication error = ±129 pounds
- Maximum actual fuel = 1329 pounds
- Minimum actual fuel = 1071 pounds

2.11.2.1 Fuel Quantity Readout. The fuel quantity readout (FUEL QTY) is capable of displaying three selectable fuel weight quantities (in pounds) on a four-digit display with the fourth digit being a fixed zero (Figure 2-3). The indicator input is provided by seven capacitive-type probes mounted in the outboard, inboard and center wingtanks, and the center line external tank. Below the readout is a three-position switch for selection of the fuel quantity to be displayed. Switch operation to the INT position provides a readout of the total aircraft internal fuel (LH and RH inboard and outboard wing tanks and forward and aft center wing tank). Similar movement to the CTR EXT position displays external centerline tank fuel. Returning the switch to the center CTR WING position will display the center wing tank quantity (forward and aft).

2.11.2.2 Fuel Remaining Readout. The fuel remaining readout (FUEL REM) displays the total aircraft fuel weight (in pounds) on a four-digit display with the fourth digit a fixed zero (Figure 2-3). A knob on the face of the indicator allows the pilot to decrease or increase the display in order to preset the initial fuel load. The fuel remaining display is determined by input from two engine-mounted fuel flow transmitters. The input signal varies from 80 to 800 pounds per hour causing the digital display to count down from the initial preset value providing a continuous readout of fuel remaining.

2.11.3 Fuel Level Window Assembly. Each 100-gallon wing drop tank has a fuel level window assembly installed at a high point on each side of the nose cone, providing a means of verifying a full auxiliary fuel tank. The window assembly provides a high visual contrast between wet and dry conditions. The window assembly reflects incident light when the tank is less than full. When the auxiliary fuel tank is full, the window assembly reflects no light and appears as a dark black color.

2.11.4 EXTERNAL FUEL TRANSFER Switches. The EXTERNAL FUEL TRANSFER switches, located on the pilot's instrument panel, provide control for the left, right, and center auxiliary fuel transfer pumps. The auxiliary fuel transfer pumps are powered by the primary dc bus and are turned ON and OFF by moving the LEFT, CENTER, RIGHT switches as applicable (Figure 1-3).

Depending on engine fuel flow, the rate of transfer from the external tanks (720 to 750 pounds per hour each) may be sufficient to fill the center wing tank. When this occurs, fuel will enter the inboard wing tanks through the intertank vent lines. The outboard wing tanks will then be filled by the same method when the inboard wing tanks are full. External transfer switches should be turned OFF before the internal tanks are full, or after all fuel is transferred.

The individual auxiliary transfer pumps will shut off automatically (illuminating the respective AUX FUEL caution light) when fuel flow has stopped for 10 seconds. Automatic transfer flow interruption (flow rate less than 1 gallon per minute) can be caused by low engine demand, full internal tanks or by a steep nose-down attitude uncovering the auxiliary tank fuel pickup for more than 10 seconds.

NOTE

> If auxiliary fuel transfer has been interrupted for 10 seconds or more, (auxiliary tanks not empty) turn the External Fuel Transfer switch(es) to OFF and wait 60 seconds to allow the pump to re-prime before attempting to regain fuel transfer by cycling the transfer switch to ON.

Two automatic fuel float shutoff switches, located inside the left and right outboard wing fuel tanks, prevent excessive overboard fuel venting (Figure FO-1). When either one or both fuel float shutoff switch(es) close (indicating outboard wing fuel tanks are full) all selected auxiliary transfer pumps will automatically shutoff, in addition, those transfer pumps not selected will not energize if selected. Transfer operation will resume when normal fuel consumption causes the switch(es) to open, energizing the external fuel transfer pumps. During this condition AUX FUEL caution lights will not illuminate.

2.11.5 Fuel Emergency Shut Off Switches. The EMER FUEL SHUT OFF switches (Figure 1-3) are located lower center of the pilot's instrument panel. These switches are powered by the main dc bus and operate fuel shutoff valves installed on the outer bulkhead of each inboard wing fuel tank. See Figure FO-1. The shutoff valve for the applicable engine is closed by moving the appropriate switch to the SHUT OFF position. The valves will remain in the last position selected when electrical power is removed.

NOTE

The applicable engine will continue to operate up to a maximum of 1 minute after the emergency fuel shutoff valve is closed.

2.11.6 FUEL LOW Caution Lights. The FUEL LOW caution lights on the pilot's caution light panel (Figure 2-17) and on the observer's caution/warning light panel (Figure 2-18) illuminate whenever center tank fuel quantity falls below approximately 220 (± 15) pounds. The FUEL LOW caution system operates from a float switch which is independent of the fuel quantity indicating system and the FUEL FEED warning system. The FUEL LOW caution lights should illuminate when the LT TST switch is held in WRN LT position.

WARNING

Do NOT maneuver aircraft into steep bank angles or pitch attitudes if fuel level in center tank indicates less than full. Possible ingestion of air into fuel feed lines and subsequent engine flameout may result.

2.11.7 FUEL FEED Warning Lights. The FUEL FEED warning lights on the pilot's (Figure 2-17) and observer's (Figure 2-18) caution/warning light panels illuminate whenever fuel level in the feed portion of the center wing tank is reduced from full to approximately 50 pounds or less (approximately 5 minutes of flight). The FUEL FEED warning system operates from a float switch which is independent of the fuel quantity indicating system and the FUEL LOW caution system. The FUEL FEED warning lights should illuminate when the lights LT TST switch is held in WRN LT.

WARNING

In the event of FUEL FEED warning light illumination, maintain a nose-high attitude to ensure adequate fuel supply to the engines.

2.11.8 BOOST PUMP Caution Light. The center wing tank fuel boost pump is an electrically operated pump located in the feed portion of the center wing tank. The pump will begin to function on the ground when one or both generators are on the line except during the start cycle of either engine. Airborne, this pump will remain on at all times. The boost pump caution light (Figure 2-17) is installed on the pilot's caution light panel. This light will illuminate when the wing boost pump output pressure drops to 4 (± 1) psi, electrical power is lost, or the pump becomes inoperative. This caution light will also illuminate when the lights LT TST switch is held in WRN LT.

2.11.9 Motive Fuel Flow (MTV FUEL) Caution Lights. The L MTV FUEL and R MTV FUEL caution lights (Figure 2-17) are installed on the pilot's caution light panel. These lights illuminate when motive flow output fuel pressure from the respective engine fuel boost pump low pressure connection decreases from normal to 4 (± 1) psi. The lights illuminate when the lights LT TST switch is held in WRN LT.

2.11.10 Auxiliary Fuel (AUX FUEL) Caution Lights. The L AUX FUEL, CTR AUX FUEL, and R AUX FUEL caution lights (Figure 2-17) are installed on the pilot's caution light panel. These lights illuminate when the respective external fuel tank transfer flow rate is less than 1.0 gpm. The lights illuminate when the lights LT TST switch is held in the WRN LT position.

2.12 ELECTRICAL POWER SYSTEM

The normal electrical power system consists of two dc generators and three dc to ac static inverters. Emergency dc power is supplied by two nickel-cadmium storage batteries. For block schematics of ac and dc electrical power distribution, see Figure FO-2.

2.13 DC ELECTRICAL POWER SYSTEM

2.13.1 Starter-Generators. Above approximately 50% engine rpm, each engine starter-generator functions as an independent generator, supplying up to 400 amperes of 30-VDC power to the dc buses. Proper generator output is 28.0 ($\pm$0.8) volts. During normal operation, generator output is paralleled, providing a total load capacity of 760 amperes. Single-generator operation is capable of supplying sufficient power required for all electrical loads.

NOTE

Left and right amperage will match if GCUs are paralleled correctly. If an amp split occurs, monitor closely for increasing split or split in excess of 20 amps. Should this happen, secure the battery. If the amp split remains, it is an indication of incorrectly paralleled GCUs. Turn the battery back on and monitor closely for the flight. If upon securing the battery the amp split goes away, suspect thermal runaway. Leave battery secured, and land as soon as practical.

2.13.2 Generator Switches. The L GEN and R GEN switches (Figure 2-6) are located on the pilot's engine starter-generator control panel. These lift-to-unlock switches have RESET, NORM, and TRIP positions, spring-loaded to NORM. When engine rpm passes approximately 50% during battery start with the GEN switch in NORM, generator output is automatically supplied. The RESET position is used to attempt to restore generator operation. Placing the switches to TRIP disconnects generator output from the electrical system, illuminating the generator-out caution lights. The generator reset function is delayed during air starts until the AIR START switch is returned to AUTO.

2.13.3 Voltammeter. The voltammeter (Figure 1-3) is located on the center pedestal. The voltmeter indicates primary dc voltage provided from batteries, generators, or external start power. The ammeter indicates system load as selected by the AMM SEL switch. Steady-state ammeter readings above 200 may indicate an excessive load (defective equipment) and action should be taken to isolate the defective equipment.

2.13.4 Ammeter Select Switch. The ammeter select (AMM SEL) switch (Figure 1-5) is located on the pilot's right console. Either generator system may be checked, individually, by reading the NO. 1 GEN or selecting and reading the NO. 2 GEN position.

2.13.5 Generator-Out (GEN) Caution Lights. The L GEN and R GEN caution lights are located on the pilot's caution light panel (Figure 2-17). With the primary dc bus energized (battery or external power), these lights are on whenever the respective generator is disconnected from the electrical system. When starting on battery power only, the respective generator-out caution lights should extinguish during engine start as rpm passes approximately 50%. When external power is used during an engine start, the generator-out caution lights will not extinguish until external power plug is disconnected.

2.13.6 Batteries. Two 24-volt, 30-ampere-hour, air-cooled, nickel-cadmium batteries are installed for engine starting and emergency electrical power. A solution of potassium hydroxide and distilled water is used as the electrolyte. Fully charged batteries are capable of providing sufficient power for three unsuccessful engine ground start attempts and a fourth (successful) start without recharge. The batteries can be charged with generator power when the BATTERY switch is positioned to ON or EMERG. The batteries cannot be charged by external dc power. The amperage used when charging the batteries, not the specific gravity reading, determines the battery state of charge.

NOTE

Twenty minutes flying time with both generators operating should assure two fully charged batteries. Assuming fully charged batteries with both generators failed in flight, and the battery selected to EMERG, emergency power for the battery, main, primary and secondary dc buses is available. With INV NO. 1 selected with the INST PWR switch during these conditions, the primary ac and instrument buses will also be available. VHF/UHF radios may be ON and transmitting 1 minute out of each 5-minute period.

2.13.7 Battery Switch. The ON position of the BATTERY switch located on the pilot's starter-generator panel (Figure 2-6), connects the battery bus to the main dc bus. In event of a dual-generator failure in flight, the EMERG position will recover secondary dc bus power.

2.13.8 Main DC Bus. The main 28-VDC bus is the central distribution point for all sources of dc power, which enables use of a single external power source for both utility power and engine starts.

2.13.9 Battery Bus. The battery bus provides power to emergency equipment and is powered by the batteries at all times regardless of BATTERY switch position. With both generators off, the battery bus can power all buses except the armament and monitor buses by positioning the BATTERY switch to EMERG; with the switch in the ON position, the secondary dc bus will not be powered. During either engine battery start, all buses except the main and battery buses deenergize to assure sufficient power for starting and to prevent battery overload.

2.13.10 Primary DC Bus. The primary dc bus provides power to all normal mission dc powered equipment and provides control of the secondary dc bus, No. 1 monitor dc bus, armament dc bus, and the ac buses. The primary dc bus receives battery, generator, or external dc power from the main bus. In the absence of aircraft generator or external dc power, the primary bus may be energized by moving the BATTERY switch to ON or EMERG. During the start of either engine, and until the generator is energized, the primary bus is disconnected from the main bus.

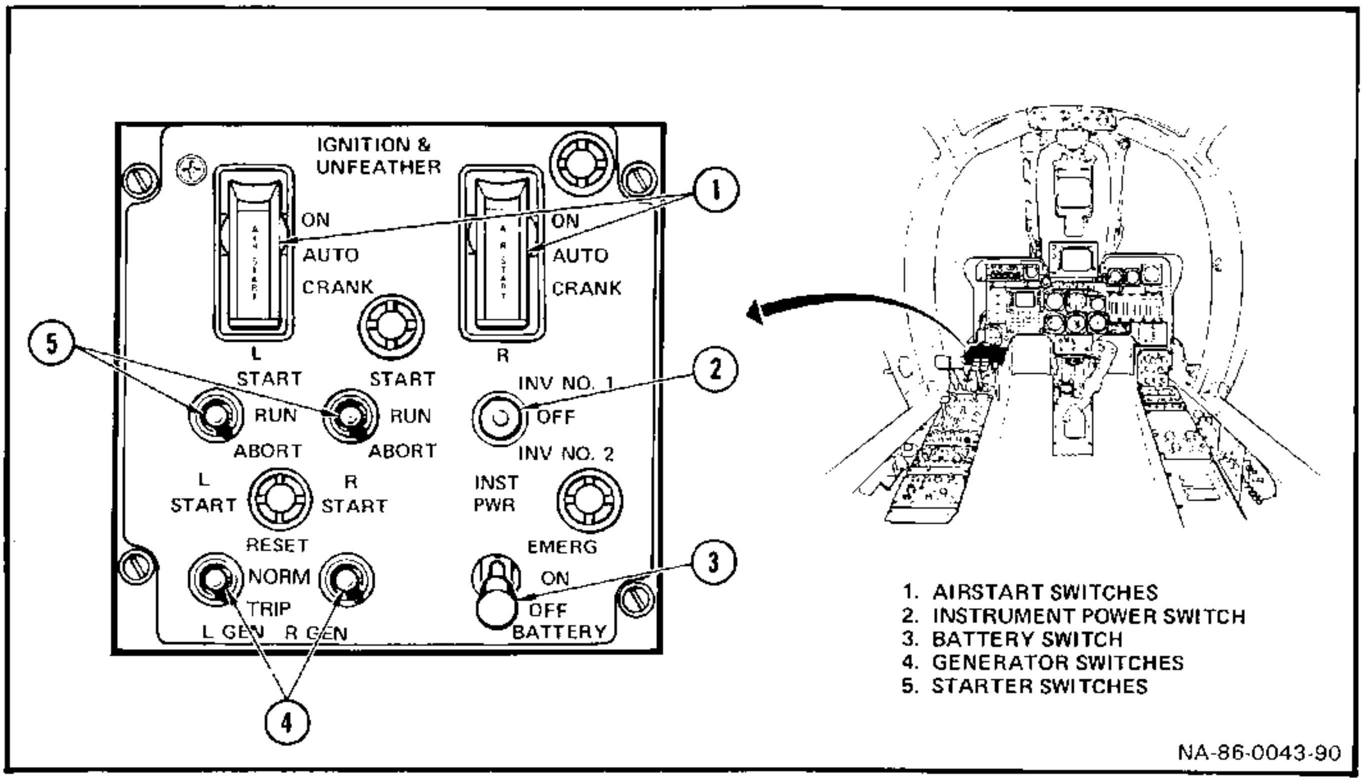


Figure 2-6. Starter-Generator Control Panel

2.13.11 Secondary DC Bus. The secondary dc bus provides power to lighting and communications equipment and receives power from the main bus. In the event of failure of both generators in flight, secondary bus power may be provided by the aircraft batteries through the main bus by moving the BATTERY switch to EMERG or placing the landing gear handle down.

2.13.12 Monitor DC Bus. The No. 1 monitor dc bus provides power to items considered nonessential and receives power from the main bus, providing at least one generator is operating or external dc power is applied.

2.13.13 Armament DC Bus. The armament dc bus receives power from the main dc bus, providing the monitor dc bus is energized, and the pilot's MASTER ARM switch is ON, and the landing gear handle is up. When the gear handle is down, the armament bus may be energized by moving the MASTER ARM switch to ON and holding the ARMT SAFETY DISABLE switch (left main gear well) momentarily in the DISABLE position. Subsequent armament ground safety operation is restored by moving the MASTER ARM switch to OFF, or deenergizing all electrical power.

2.13.14 DC Circuit Breakers. Push-pull-type circuit breakers (Figure 2-7), function to protect the dc power system by disengaging automatically whenever an overloaded or short circuit exists. Should a circuit breaker pop out, it can be reset by manually pushing in on the circuit breaker. A dc circuit can also be opened manually by pulling out on the respective circuit breaker for that line.

2.14 AC ELECTRICAL POWER SYSTEM

Electrical power (115-VAC, 400-cycle, three phase) is provided to aircraft systems by two 1000-volt-ampere dc to ac static inverters. A third 2500-volt-ampere dc to ac static inverter provides ac power to FLIR/LRD system components. This inverter is controlled by the NO. 3 INV control switch on the right side of the observer's cockpit.

2.14.1 No. 1 and No. 2 Inverters. No. 1 and No. 2 inverter control is provided by the instrument power (INST PWR) switch located on the pilot's starter-generator control panel. When INV NO. 1 is selected, the No. 1 inverter, powered by the primary dc bus, will energize and supply power to the primary ac bus and the instrument ac bus (by way of the instrument transformer). Both inverters are located in the right boom electronics bay. The No. 2 inverter, powered by the No. 1 monitor dc bus, will also energize and supply power to the No. 2 monitor ac bus. The OFF position of the INST PWR switch turns both No. 1 and No. 2 inverters OFF. When the INV NO. 2 position is selected, No. 2 inverter energizes and supplies power to the primary ac bus and the instrument ac bus. No. 2 monitor ac bus will not be available when INV NO. 2 is selected.

2.14.2 No. 3 Inverter. The No. 3 inverter, located in the cargo bay FLIR compartment, is powered by the No. 1 monitor dc bus and supplies the FLIR/LRD components with ac power. The inverter is protected by a circuit breaker and controlled by the NO. 3 INV CONTROL ON/OFF switch located on the right side of the observer cockpit. When selected ON, power is provided to the video tracker, FLIR system, FLIR heater, compartment fan, and the ABU-13 accelerometer.

2.14.3 Instrument Power Caution Light. The INST PWR caution light is located on the pilot's caution light panel on the pilot's instrument panel (Figure 2-17). This light illuminates in the event of failure of primary ac bus power. Should INV NO. 1 be selected and No. 1 inverter fail, the light may be extinguished and electrical loads transferred by selecting INV NO. 2; however, No. 2 monitor ac bus will be lost. Should the No. 2 inverter fail, the light will illuminate, but it will not be possible to recover the primary and instrument ac buses.

2.14.4 AC Fuses and Circuit Breakers. The aircraft ac electrical power supply system is protected by fuses, which are mounted on a panel located in the right boom. The FLIR/LRD ac electrical power supply system is protected by circuit breakers located in the cargo bay door.

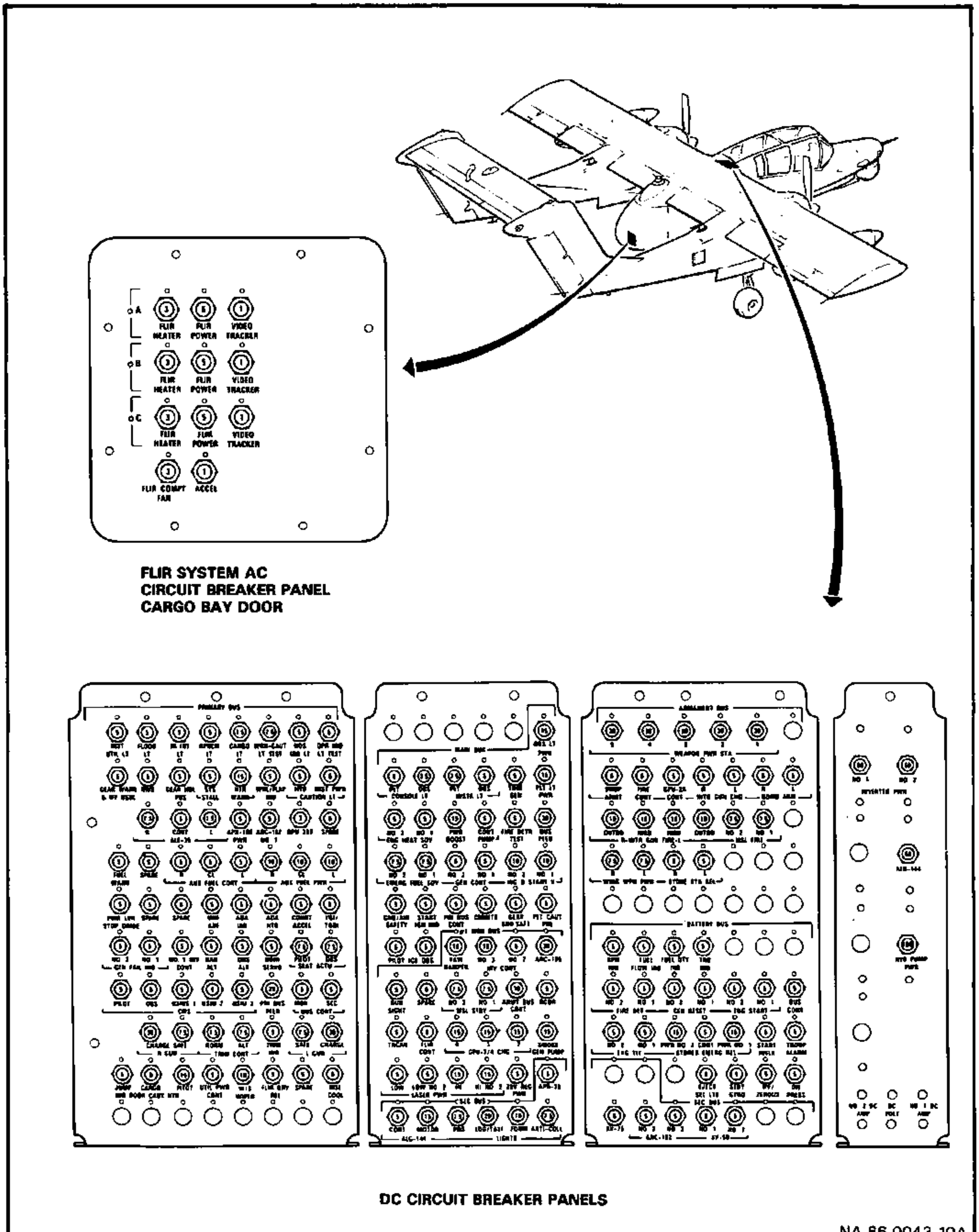


Figure 2-7. Circuit Breaker and Fuse Panels (Sheet 1 of 2)

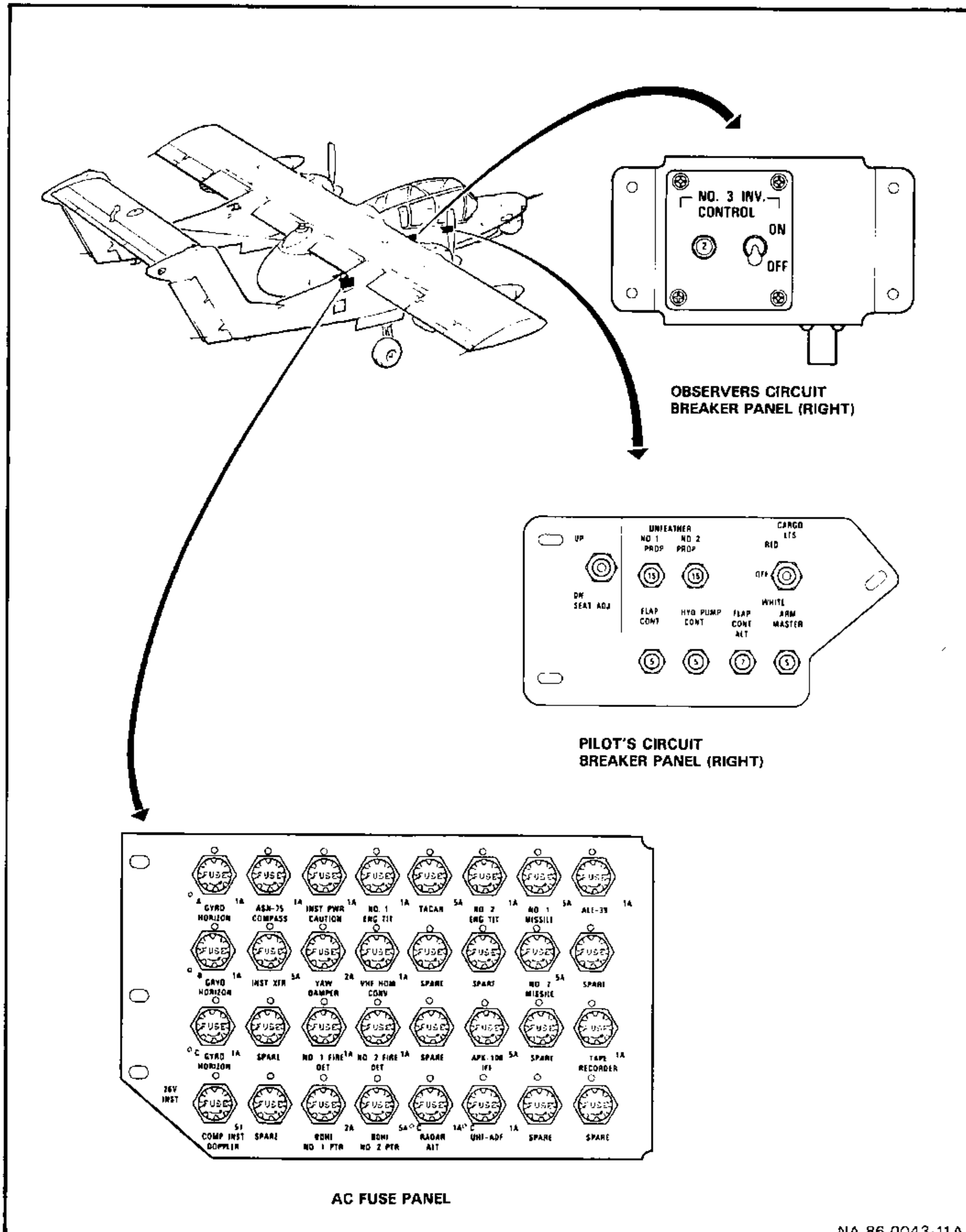


Figure 2-7. Circuit Breaker and Fuse Panels (Sheet 2 of 2)

2.14.5 Primary AC Bus. The primary (three-phase) ac bus is normally powered by the No. 1 inverter when the INST PWR switch is in the INV NO. 1 position. Should the No. 1 inverter fail, the No. 2 inverter will restore primary ac bus power by selecting INV NO. 2 position.

2.14.6 Instrument AC Bus. The instrument ac bus receives primary ac bus power through an instrument transformer, supplying 26-VAC power for navigation instruments.

2.14.7 No. 2 Monitor AC Bus. The No. 2 monitor ac bus provides nonessential instrument power and receives power from No. 2 inverter only with the INST PWR switch selected to INV NO. 1. If the INST PWR switch is positioned to INV NO. 2, the NO. 2 monitor bus powered equipment will be deenergized until the switch is repositioned to the INV NO. 1 position. In the event of failure of the No. 2 monitor ac bus with INV NO. 1 selected (failure of No. 2 inverter) all systems on this bus will be lost and will not be recoverable.

NOTE

In the event of failure of both generators, No. 2 monitor ac bus power is not recoverable.

2.15 EXTERNAL POWER

External dc power may be applied for engine starts or for energizing the dc system for maintenance purposes. The external power access is located on the right side of the fuselage, forward of the cargo door. The rectangular receptacle accommodates the oval external power plug for both start and utility dc power. The external power receptacle incorporates a switch which prevents the batteries from powering the main bus when the external power plug is inserted. Engine start cannot be accomplished with external power only. Batteries are required to energize the start relays. For acceptable start and service electrical power units, refer to AIRCRAFT SERVICING, Chapter 3, in this Part.

2.16 INTER-AIRCRAFT STARTING POWER

The external power receptacle may be used as a 28-VDC power output. With an engine running and UTILITY PWR SELECT switch (in the external power receptacle access) positioned to PWR OUT, a jumper cable may be used to supply power to another aircraft. The UTILITY PWR SELECT switch must be in NORM (guard closed) position at all other times.

2.17 LIGHTING SYSTEM

The interior lighting system includes; instrument panel lighting, instrument lighting, console lighting, utility lights and floodlighting for both cockpits controlled by the interior lights control panel, located in the pilot's cockpit, and the light dim/test panel in the observer's cockpit. Two variable output lighting power supplies, located in the forward cargo bay, provide 28-VDC and 5-VDC lighting power. Cargo bay lighting is controlled from the cargo bay and the pilot's cockpit. Exterior lighting includes the position lights, anti-collision lights, a landing/taxi light, and formation lights (Figure 2-9). For lighting control location see Figure 2-8.

2.17.1 Interior Lights. The pilot's and observer's cockpits are equipped with the following interior lighting equipment:

PILOT'S COCKPIT

- Instrument integral lights (red)
- Console edge lights (red)
- Console and instrument floodlights (red or white)
- High-intensity lights (white)
- Standby compass light (red)
- Utility light (red or white)

OBSERVER'S COCKPIT

- Instrument integral lights (red)
- Console edge lights (red)
- Utility light (red or white)

2.17.2 Cargo Bay Lights. Two dome-type cargo bay lights are installed on the right side of the cargo bay. A third dome-type cargo bay light is installed in the ceiling at the aft end of the cargo bay and is used during maintenance of the FLIR/LRD system. These lights provide red or white illumination of the cargo bay interior or cargo bay door as selected.

2.18 INTERIOR LIGHTS CONTROL (PILOT'S COCKPIT)

The pilot's cockpit lighting controls are on the interior lights control panel located on the pilot's right console (Figure 2-8).

2.18.1 FLOODLIGHTS Switch. Console and instrument panel floodlight intensity switch selection is available (OFF, BRT, or DIM) by rotating the CONSOLES knob from OFF (Figure 2-8). Red or white floodlighting is available by rotating the end cap on the instrument panel floodlights until the lens on the floodlight displays the desired color. Electrical power is 28 VDC supplied by primary dc bus.

2.18.2 High-Intensity (HIGH INTEN) Lights Switch. The high-intensity (thunderstorm) lights are controlled through the HIGH INTENSITY switch (Figure 2-8) on the interior lights control panel.

2.18.3 INSTRUMENTS Lights Knob. The pilot's integral instrument lighting is powered by 28 VDC and 5 VDC (variable) supplied from a dc power supply energized by the main dc bus. Intensity may be adjusted as desired through the INSTRUMENTS knob on the interior lights control panel (Figure 2-8). With the INSTRUMENTS knob rotated from OFF, potential brightness of caution lights on the pilot's caution light panel is reduced to a dim setting. Intensity of the pilot's optical sight inclinometer post light and the standby compass are controlled by the INSTRUMENTS knob when the STBY COMPASS switch is selected ON. When the doppler navigation computer display unit (DOP NAV CDU) is installed in the pilot's right console, the INSTRUMENTS knob will control the intensity of the CDU panel edge lighting. The doppler navigation system (DNS) multipurpose indicator 28-VDC panel edge lighting intensity is adjustable with the INSTRUMENTS knob regardless of CDU installation location.

2.18.4 CONSOLES Lights Knob. Intensity of the pilot's 28-VDC (main dc bus) panel edge lighting is adjusted by the CONSOLES knob on the interior lights control panel (Figure 2-8). When the DOP NAV CDU is installed on the pilot's right console, the CONSOLES knob will control the intensity of the digital display portion of the CDU.

2.18.5 Flight Instrument (FLT INSTR) Light Knob. The pilot's flight instrument lighting is powered by 28 VDC from the main dc bus. Brightness of the primary flight instruments including the standby gyro, radio call panel, accelerometer, radar altimeter, vertical velocity indicator, bearing-distance-heading indicator (BDHI), barometric altimeter, airspeed indicator, remote attitude indicator, and angle-of-attack indicator, may be adjusted through the FLT INSTR knob on the interior lights control panel (Figure 2-8).

2.18.6 INDEXER Lights Switch. With the pilot's INSTRUMENTS knob rotated from OFF, brightness of the approach indexer lights may be selected to either DIM or medium (MDM) through the INDEXER switch (Figure 2-8) on the interior lights control panel. The approach indexer will only illuminate when landing gear handle is DOWN and weight-off-wheels conditions exist. With the INSTRUMENTS knob in the OFF position, bright indexer lighting is selected.

2.18.7 Standby Compass (STBY CMPS) Light Switch. Interior lighting of the standby compass and the optical sight inclinometer post light are controlled through the ON and OFF positions of the STBY CMPS switch (Figure 2-8) on the pilot's interior lights control panel. Intensity of these lights is adjusted with the INSTRUMENTS knob.

2.18.8 Cargo Bay Lights (CARGO LTS) Switch. The CARGO LTS switch (Figure 2-8) is located on the pilot's circuit breaker panel aft of the right console. The CARGO LTS switch provides OFF, RED, or WHITE selection. A cargo bay maintenance light switch is located on the left-hand side of the cargo bay. The maintenance light switch provides OFF, RED, or WHITE selection. The light is automatically turned off when the cargo bay door is closed.

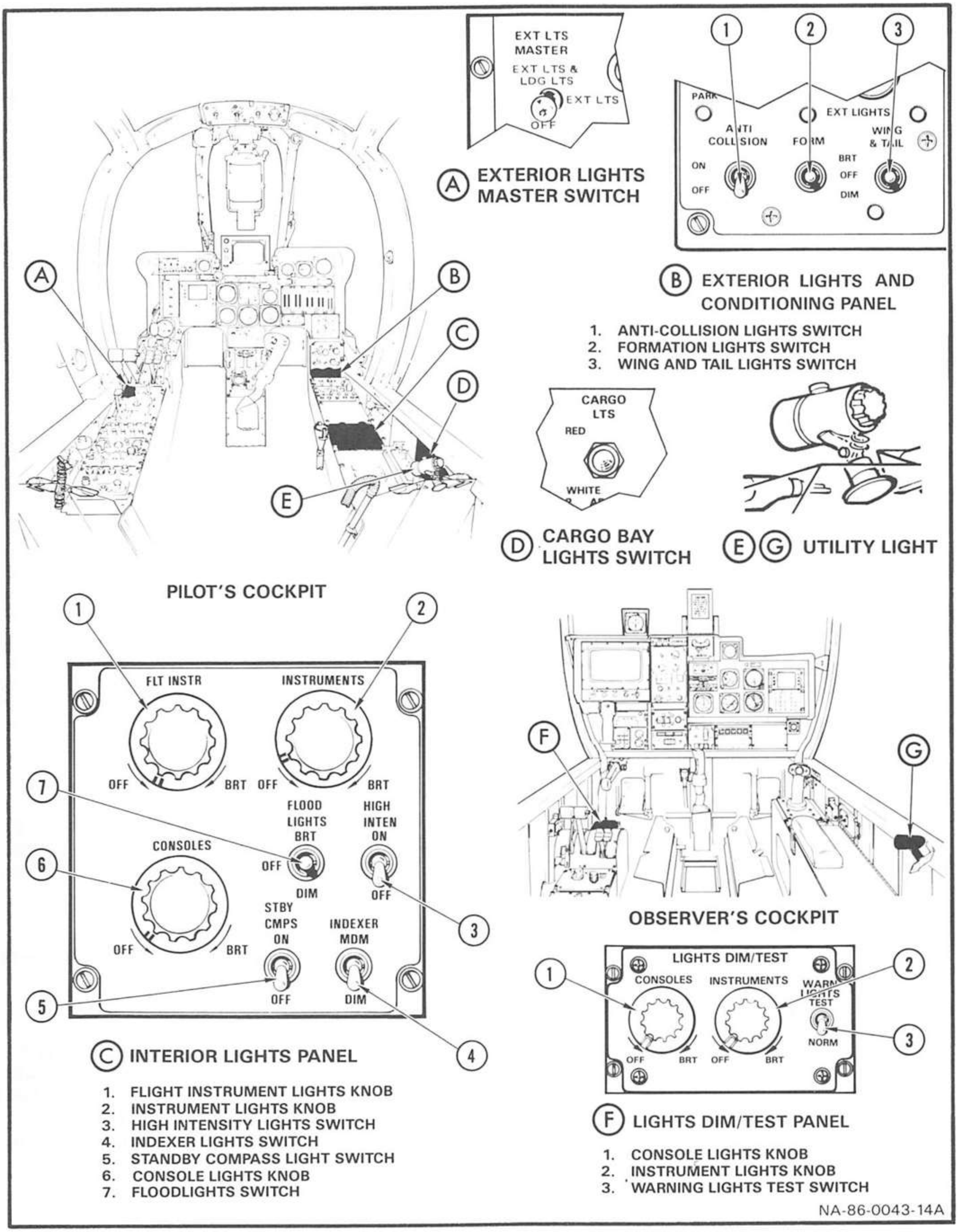
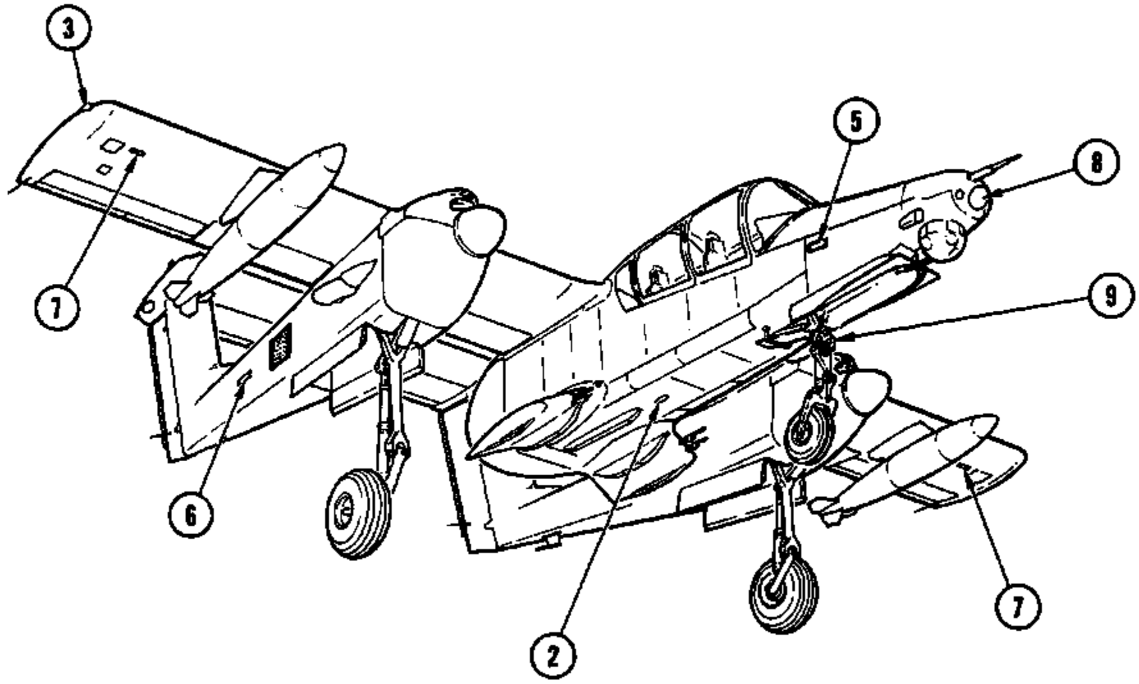
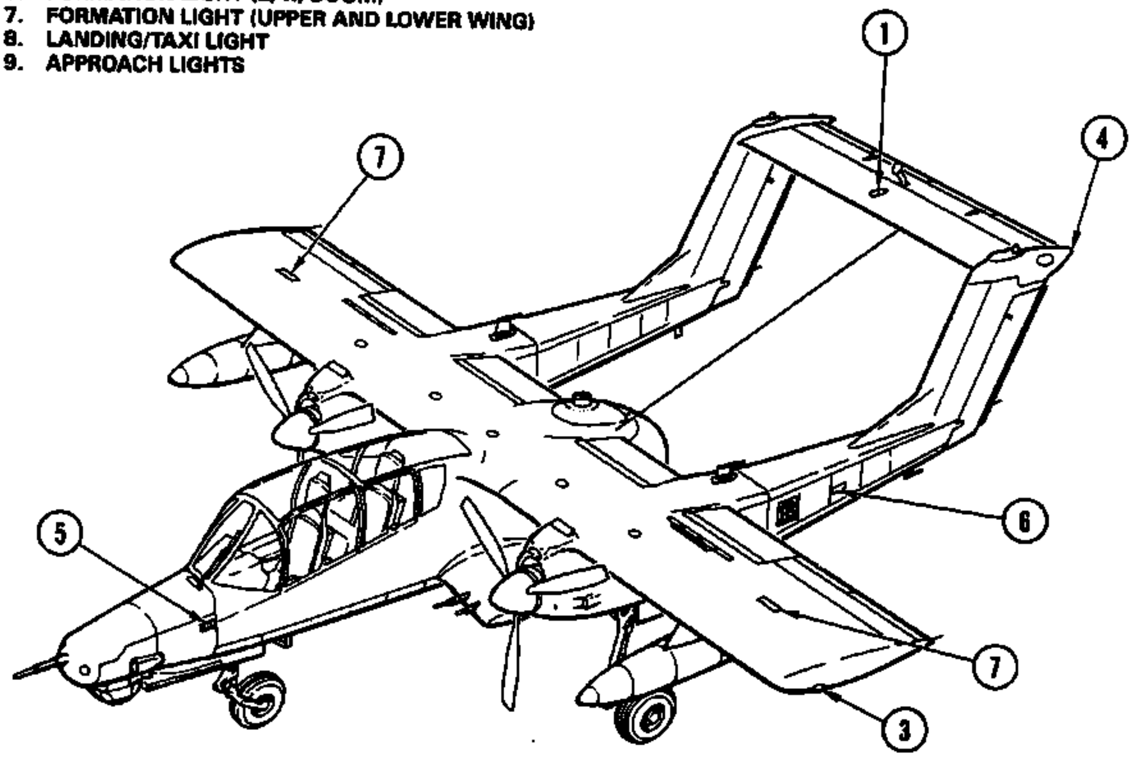


Figure 2-8. Lighting Controls



1. ANTI COLLISION LIGHT (UPPER)
2. ANTI COLLISION LIGHT (LOWER)
3. POSITION LIGHT (L, R, WING TIP)
4. POSITION LIGHT (L TAIL ONLY)
5. FORMATION LIGHT (L, R, FORWARD FUSELAGE)
6. FORMATION LIGHT (L, R, BOOM)
7. FORMATION LIGHT (UPPER AND LOWER WING)
8. LANDING/TAXI LIGHT
9. APPROACH LIGHTS



NA-86-0043-17A

Figure 2-9. Exterior Lights

2.18.9 Utility Light. A removable utility light is located on the right side of the pilot's cockpit (Figure 2-8). Electrical power for the light is provided by the 28-VDC primary bus. A rheostat on the end of the light is used for ON, OFF, and intensity control. The light may be adjusted for red or white light by turning the lens filter.

2.19 INTERIOR LIGHTS CONTROL (OBSERVER'S COCKPIT)

Control of lighting in the observer's cockpit is provided by the light dim/test panel, located on the observer's left console (Figure 2-8).

2.19.1 INSTRUMENTS Knob. The INSTRUMENTS knob on the observer's lights dim/test control panel provides 28 VDC (variable) from the main dc bus and controls the intensity of the observer's flight instruments and radio call panel (Figure 2-8).

2.19.2 CONSOLES Knob. The observer's console lighting is powered by 28 VDC and 5 VDC (variable) supplied from a dc power supply on the main dc bus. Brightness of the observer's cockpit panel edge lighting may be adjusted as desired with the CONSOLES knob on the observer's light dim/test control panel. With the knob rotated from OFF, potential brightness of all warning lights is reduced to a dim setting (Figure 2-8).

2.19.3 Utility Light. A removable utility light is located on the right side of the observer's cockpit. Electrical power for the light is provided by the 28-VDC primary bus. A rheostat on the end of the light is used for ON, OFF, and intensity control. The light may be adjusted for red or white light by turning the lens filter (Figure 2-8).

2.20 EXTERIOR LIGHTS

Aircraft exterior lighting consists of wing and tail position lights, formation lights, anti-collision lights, and a fixed-landing and taxi light (Figure 2-9).

2.21 EXTERIOR LIGHTS CONTROL

2.21.1 Exterior Lights Master Switch. The EXT LTS MASTER switch (Figure 2-8), a three-position lever-lock switch is located on the pilot's flap and trim control panel on the left console. Exterior lighting, as selected through individual exterior lights switches, is energized through the EXT LTS and EXT LTS & LDG LTS positions of the EXT LTS MASTER switch. The switch is detented in the EXT LTS & LDG LTS position, requiring it to be lifted in order to select or turn off the landing light.

2.21.2 Wing and Tail Lights Switch. The WING & TAIL lights switch, located on the pilot's exterior lights control panel (Figure 2-8), provides BRT, DIM, and OFF selection of wing and tail position light illumination.

2.21.3 Anti-Collision Lights Switch. Operation of the anti-collision lights is controlled through the ON and OFF positions of the pilot's ANTI-COLLISION lights switch (Figure 2-8) on the exterior lights control panel.

2.21.4 Formation Lights Switch. The FORM lights switch (Figure 2-8), located on the pilot's exterior lights control panel, provides BRT, DIM, and OFF selection of formation light illumination.

2.22 HYDRAULIC POWER SYSTEM

Hydraulic power at 1500 to 1550 psi is supplied by a closed-center, intermittent duty system. The hydraulic power package, including the reservoir and electrically operated hydraulic pump, is installed above the cargo bay aft of the wing. A clear plastic sight gage is mounted on the side of the reservoir. Full level lines are marked on the sight and may be used in checking fluid level. Hydraulic fluid level can also be checked through external access door on upper aft fuselage by checking fill pipe level. Hydraulic power is supplied to operate the landing gear normal extension and retraction, wing flap normal extension and retraction, and nose wheel steering systems. The brake system obtains hydraulic fluid for operation from the hydraulic system reservoir. During nonduty periods, the hydraulic pump is turned off, leaving slowly reducing residual pressure in the lines last pressurized. The hydraulic system does not provide sufficient flow to allow simultaneous, full-rate operation of the landing gear, and flap extend-retract functions. If both are selected in rapid order, both will operate at a reduced rate. For a schematic of the hydraulic power system, see Figure FO-3.

CAUTION

The hydraulic pump is not continuous duty, it requires a 3-minute rest after the following operations: 5 minutes of nose wheel steering, or three flap cycles, or three landing gear cycles, or any combination thereof.

2.22.1 Hydraulic System Caution Lights. The hydraulic system caution lights are located on the pilot's caution light panel (Figure 2-17).

2.22.1.1 Hydraulic Pump (HYD PUMP) Caution Light. A yellow HYD PUMP light (Figure 2-17) will come ON if hydraulic pump operation is not detected during flap, landing gear, or nose gear steering demands.

2.22.1.2 Hydraulic Pressure (HYD PRESS) Caution Light. A yellow HYD PRESS caution light (Figure 2-17) is installed on the pilot's caution light panel and illuminates in the event hydraulic system pressure fails to build up to more than at least 200 psi on demand (gear, flap, or nose wheel steering operation). The nose wheel steering button may be used to operate the hydraulic pump at any time, providing operation in the event of failure of the pump to provide pressure through normal control circuits.

CAUTION

If it is suspected that the hydraulic pump is running continuously, pulling the hydraulic circuit breaker in the front cockpit will preclude pump overheating and possible system failure.

2.23 FLIGHT CONTROL SYSTEMS

The elevator, aileron/spoiler, and rudder systems are reversible, balanced-mechanical systems operated by cables, rods, and bellcranks. Primary in-flight movement of the ailerons and elevator is achieved by the aerodynamic action of spring, and gear-operated boost tabs. Control force trim is achieved by electrically operated trim bungees which move the flight control systems to no-load positions as required. For flight control characteristics, refer to Part IV, Chapter 11, and see Figure FO-4.

2.23.1 Longitudinal System. The longitudinal system consists of a horizontal stabilizer and a tab-boosted, mechanically damped, overbalanced elevator. The tab system consists of four trailing edge segments extending the entire span of the elevator. In flight, the spring (outboard) tabs are driven by the control stick in the direction opposing desired elevator movement, displacing the elevator by aerodynamic reaction until spring tab stops are contacted. The geared tab (inboard) segments are driven directly by the elevator to the same limits as the spring tabs. Movements of the control stick beyond the tab stops, either nose up or nose down, physically drive the elevator in the desired direction. Pitch trim is achieved through the action of a trim actuator/torsion bar assembly which adjusts the no-load position of the system (including the control stick) as required.

2.23.2 Directional System. The directional system consists of twin vertical stabilizers, twin rudders, and an electromechanical yaw damper system. The rudders are not tab-boosted, and are displaced by direct mechanical action through the rudder pedals. Rudder trim is provided by an electrical actuator/bungee assembly which displaces the control linkage, adjusting the directional system to no-load position as required.

2.23.2.1 Yaw Damper. The yaw damper system supplies a control torque to the rudders proportional to aircraft yaw rate and oscillation frequency and in the opposite direction of the yaw motion. The system, powered by the monitored dc bus, contains three major components—the yaw rate gyro, yaw damper amplifier, and servo actuator. The yaw rate gyro signal is fed to a differential rate dc amplifier through a capacitor to drive a pair of magnetic clutch coils in the actuator. The actuator transmits torque through an integral gearbox to a bellcrank coupled to the directional control system. Pilot control of the system is obtained through a three-position (ON, OFF, TEST) toggle switch. The TEST position is selected for ground checkout only and bypasses the ground safety relay contacts. The pilot can override yaw damper action by exerting approximately 100 pounds force on the rudder pedals. When the aircraft is on the ground (struts compressed), the yaw damper is automatically disengaged.

2.23.3 Lateral System. The lateral system consists of spring- and gear-tab boosted ailerons, augmented by spoilers. Operation of the outboard (spring) tabs is similar to that of the elevator spring tabs, in that in-flight control stick initial movement displaces the tabs, driving the ailerons by aerodynamic reaction until spring tab stops are contacted. Further lateral movement of the control stick then drives the ailerons directly.

2.23.3.1 Spoiler. Four fan-shaped, upward rotating, axially hinged spoiler plates are installed in each wing. Movement of the ailerons displaces mechanical linkage to rotate upward from the down-going wing, creating additional rolling reaction due to lift loss. The spoilers are positioned with their leading edges 10 degrees below the wing upper mold line with the ailerons neutral. At full stick lateral travel, the spoilers are displaced approximately 86 degrees. Delayed operation, due to the submerged neutral spoiler position, prevents projection at neutral trim and allows aileron trim operation without causing spoiler deflection.

2.24 FLIGHT CONTROLS AND INDICATORS

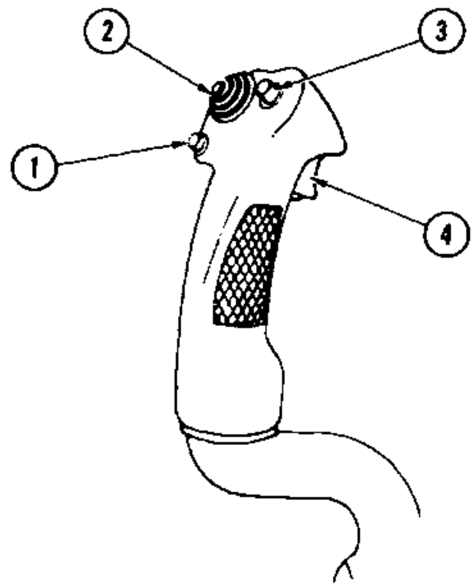
2.24.1 Control Sticks and Rudder Pedals. A pedestal-type, pivot-mounted control stick and rudder/wheel brake control pedals are installed in the pilot's cockpit. The pilot's stick grip (Figure 2-10) contains a conventional roll/pitch trim switch, as well as a nose wheel steering button, bomb release button, and a gun/missile trigger switch. A control stick and rudder/brake pedals are installed in the rear cockpit area. The observer's control stick grip does not incorporate armament or trim controls and the rear cockpit rudder pedals are not adjustable.

2.24.2 Pedal Adjust Crank. A rudder pedal adjust crank (Figure 1-3) is installed on the center pedestal in the pilot's cockpit. This fold-away crank allows pedal adjustment through a 9-inch range.

2.24.3 TRIM SELECT Switch. The TRIM SELECT switch (Figure 2-11) is located on the pilot's trim control panel. In the NORM position, aileron, elevator, and rudder trim is powered by the primary dc bus and controlled through the pilot's stick grip trim and normal rudder trim control system. The observer's elevator trim switch is also operational when the pilot has NORM selected. The ALT position provides an alternate source of primary dc bus power and trim is controlled through use of the alternate elevator and aileron trim and alternate rudder trim switches.

2.24.4 Aileron and Elevator Trim Switches. The normal aileron and elevator (roll and pitch) trim switch (Figure 2-10) is located on the pilot's control stick grip. The ALT ELEV & AIL TRIM switch (Figure 2-11) is located on the pilot's trim control panel.

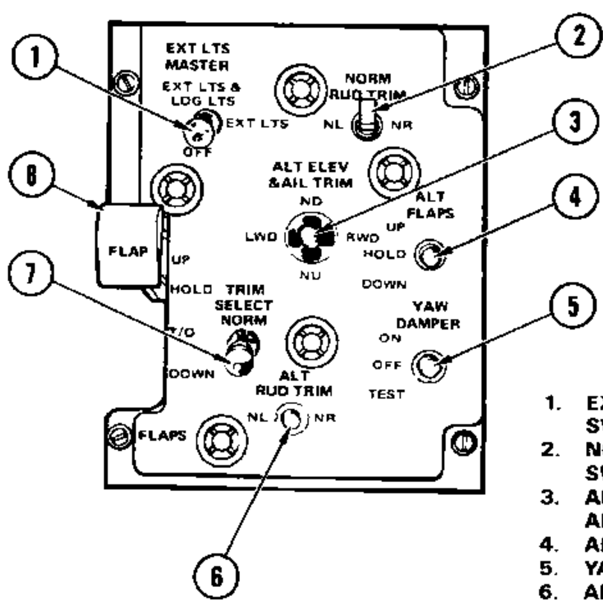
2.24.4.1 Observer Elevator Trim Switch. The observer trim switch, located on the left side of the observer's cockpit (Figure 2-6), provides the observer with the ability to control elevator trim when the pilot has NORM trim selected on the trim control panel. If the pilot has selected ALT trim, the switch has no effect.



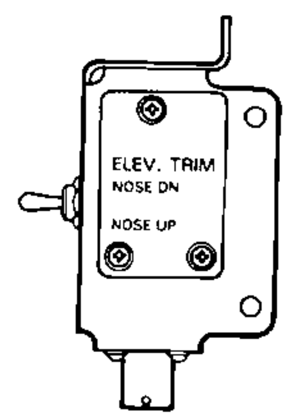
1. DROP (BOMB RELEASE) BUTTON
2. PITCH-AND-ROLL TRIM SWITCH
3. NOSE WHEEL STEER BUTTON
4. FIRE TRIGGER SWITCH

NA-86-0043-91

Figure 2-10. Pilot's Stick Grip



OBSERVER'S ELEVATOR TRIM SWITCH



1. EXTERIOR LIGHTS MASTER SWITCH
2. NORMAL RUDDER TRIM SWITCH
3. ALTERNATE ELEVATOR AND AILERON TRIM SWITCH
4. ALTERNATE FLAPS SWITCH
5. YAW DAMPER SWITCH
6. ALTERNATE RUDDER TRIM SWITCH
7. TRIM SELECT SWITCH
8. FLAPS HANDLE

NA-86-0043-92

Figure 2-11. Flap-Trim Panel and Observer's Elevator Trim Switch

2.24.5 Rudder Trim Switches. The NORM RUD TRIM and ALT RUD TRIM switches (Figure 2-11) are located on the pilot's trim control panel.

2.24.6 YAW DAMPER Switch. The YAW DAMPER switch (Figure 2-11) is located on the pilot's trim control panel. The switch has OFF, ON, and TEST positions. In OFF, the yaw damper clutch is disengaged. The momentary TEST position overrides the damper ground safety function, permitting damper system operational testing on the ground. When the aircraft is airborne, selection of ON allows the yaw damper to operate normally.

2.24.7 Rudder Trim Neutral Light. A rudder trim neutral light (Figure 1-3) is installed on the pilot's instrument panel. The green, press-to-test light, powered by the primary dc bus, is on when yaw trim is set at the neutral (take-off) position. Brightness of the rudder trim neutral light is controlled by adjusting the lens opening. Rotating the lens clockwise or counterclockwise will dim or brighten the light, respectively.

2.24.8 Control Surface Trim Position Indicating System. The cockpit management system (CMS) and control display unit (CDU) provide a display of elevator position and aileron and rudder neutral position to the pilot and observer. To display the Trim page proceed as follows and see Figure 2-12.

1. Ensure CMS ready for operation–Refer to COCKPIT MANAGEMENT SYSTEM; Part VII, Chapter 19.

2. Press IDX key–Index page displayed.

3. Press TRIM (LS6)–Trim page displayed.

4. To exit, press RTN (LS8)–Index page displayed.

NOTE

The Trim page may also be accessed from the Take-Off Checklist page. Refer to Part VII, Chapter 19, COCKPIT MANAGEMENT SYSTEM.

2.24.8.1 Trim Page Description. The Trim page displays the elevator position scale on the information line from −2 units nose down to +2 units nose up and includes takeoff (T) and neutral (0) positions (takeoff position is −0.5 units). An arrow on the elevator bargraph indicates present position of the elevator in 0.25 unit increments. The arrow will point down when the elevator is less than zero units and up when more than zero units, an up/down arrow will be displayed when the elevator is neutral. Elevator position is also indicated numerically from −2.5 to +3.5 units on data line four. Rudder and aileron trim indicators are located at the top of the display on data line one and are depicted as up/down arrows when in a neutral position. When rudder and ailerons are not neutral, no arrows will be displayed.

2.25 WING FLAPS

A four-section, slotted wing flap system is installed. One section is located inboard and one section outboard of the tail boom on each wing. Normal extension and retraction are provided by hydraulic system power through a separate mechanical jackscrew for the flaps on each wing. Control of boundary layer airflow is provided by slot doors on the lower wing surfaces which extend mechanically with the flaps. An electrically powered alternate flap system is provided for extend-retract control in the event of hydraulic system failure or normal flap control circuit failure.

2.26 FLAP CONTROLS AND INDICATOR

2.26.1 Flap Handles. A FLAP handle (Figure 2-11) is located on the left console in the pilot's cockpit, and on the left side of the rear cockpit (Figure 1-6). Power is supplied from the primary dc bus. Repositioning the flap handle completes a circuit to move the flap selector valve and starts operation of the hydraulic pump. The circuit is broken and all power is removed from the hydraulic pump when the flaps reach the desired position. The flaps may

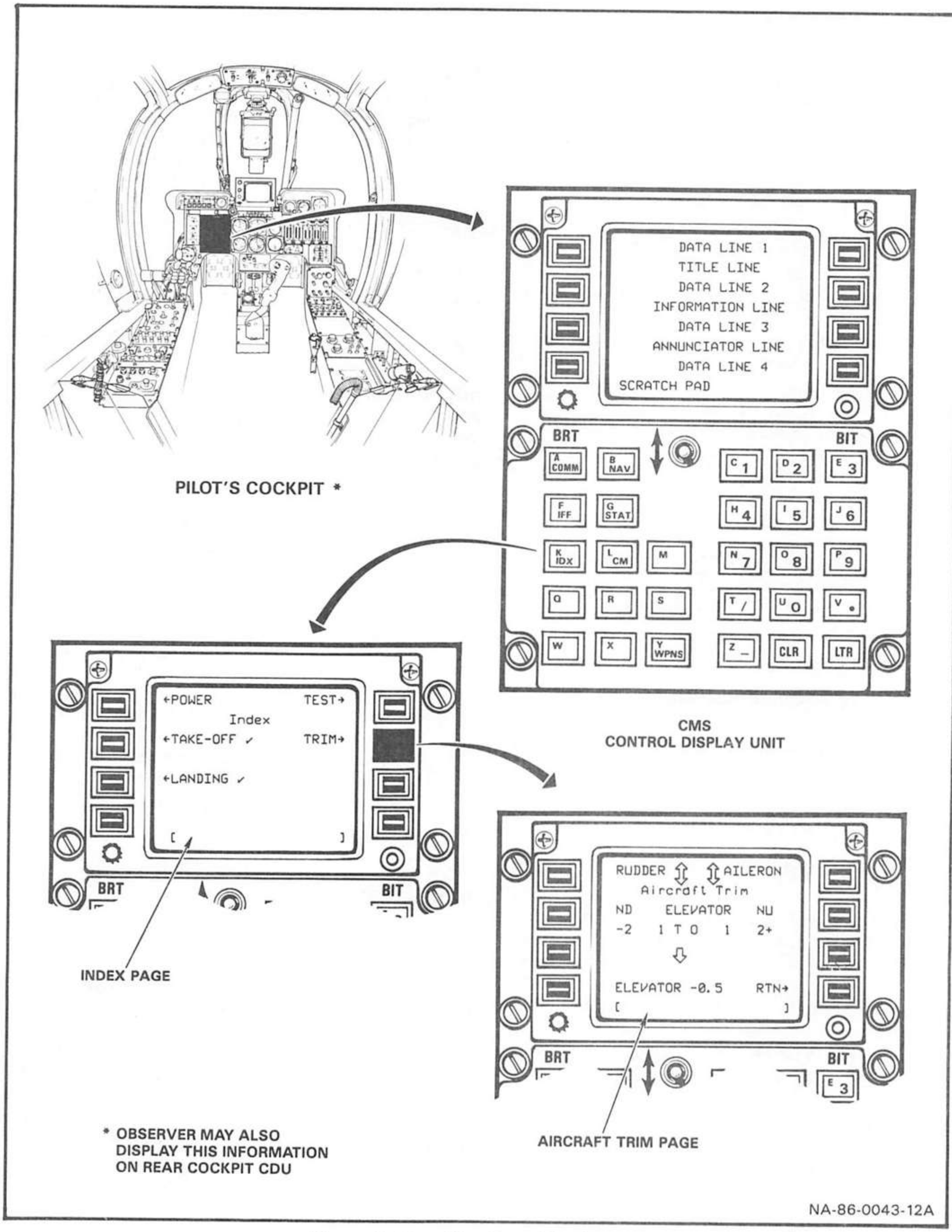


Figure 2-12. Trim Page Display

be operated through a 40-degree range, or stopped at any intermediate position by selecting UP, T/O (20 degrees), HOLD, or DOWN as desired. The flaps may be fully extended or retracted without airload in approximately 8 seconds.

2.26.2 Alternate Flaps Switch. The ALT FLAPS switch (Figure 2-11) is located on the pilot's trim control panel. Power is supplied from the primary dc bus. The switch has UP, HOLD, and DOWN positions and is spring-loaded from UP to HOLD. The alternate flaps switch may be used to obtain flap extension and retraction as desired in the event of failure of normal flap hydraulic power or electrical control. Full extension during alternate flap operation may require up to 1 minute.

NOTE

Ensure the FLAP handle is in HOLD when using the ALT FLAPS switch to prevent inadvertent retraction or extension.

2.26.3 Flap Position Indicator. The flap position indicator (Figure 1-3) is an integral part of the landing gear position indicator on the pilot's instrument panel. Flap position indications at UP, 1/4, 1/2, 3/4, and DOWN are provided.

2.27 LANDING GEAR

Folding drag-link, trailing-arm, tricycle landing gear is installed. Gear retraction is hydraulically powered, with the mains retracting upward and aft, and the nose gear retracting forward. The landing gear control system consists of the landing gear handles, mechanical linkage to the extend-retract control valve, the hydraulic power system, and position and warning indicators. The landing gear well doors remain open when the gear is extended and are closed mechanically by the gear on retraction. Normal retraction requires approximately 10 seconds; extension requires approximately 7 seconds.

2.27.1 Landing Gear Emergency Extension. Emergency extension is accomplished by gravity, assisted by the spring bungees on the main landing gear. In the event of hydraulic failure or normal extension circuit failure, normal gear extension procedures will extend the gear at speeds below approximately 120 knots. Emergency retraction is not provided.

2.27.2 Ground Safety Switch. The ground safety switch is located on the left main landing gear strut. When the landing gear is compressed (on the ground), the ground safety switch deactivates the following systems, approach lights, angle-of-attack heater, pitot heater, yaw damper, stall warning system, emergency stores jettison, and activates nose wheel steering and power lever gate override system.

WARNING

If the ground safety switch is misaligned, the functions of the ground safety switch might be reversed.

NOTE

The nose gear-up and locked switch operates the nose gear-up and locked relay on the miscellaneous electrical systems panel. This relay prevents laser firing if the nose gear is not up and locked.

2.28 LANDING GEAR CONTROLS AND INDICATORS

2.28.1 Landing Gear Handles. A landing gear handle (Figure 1-3) is installed in the pilot's cockpit. An observer's gear handle (Figure 1-6) is installed as part of the observer's cockpit package. The pilot's handle is equipped with a release lever (Figure 1-3) which must be depressed to unlock the handle for upward movement. Movement of the handle to the up position selects the retract condition of the landing gear control valve, turns on the hydraulic system pump, and hydraulically retracts the landing gear downlocks. Selection of the down position moves the landing gear control valve to extend condition and mechanically retracts the landing gear uplocks. The rear cockpit landing gear handle can be used to extend the landing gear only, and does not incorporate a handle release lever or gear unsafe warning light.

NOTE

A landing gear safety relay deactivates the hydraulic system pump power relay if the landing gear handle is placed in the up position while the aircraft is on the ground to prevent inadvertent retraction of the landing gear.

2.28.2 Landing Gear Unsafe Light. The pilot's landing gear handle incorporates a gear unsafe light. This red light is illuminated whenever the landing gear is not locked in the position demanded by the gear handle.

2.28.3 Landing Gear Position Indicator. The landing gear position indicator (Figure 1-3) is located on the pilot's instrument panel, integral with the flap position indicator. Landing gear position is reflected by a separate solenoid-operated window-indicator for each gear. Landing gear UP, DN, and intermediate (barber pole) positions are indicated. With primary dc power removed, the barber-pole indication is displayed.

2.28.4 WHEELS Warning Light. A WHEELS warning light is located on the pilot's caution/warning light panel (Figure 2-17) and on the observer's instrument caution/warning light panel (Figure 2-18). With primary dc bus power available, these red warning lights flash whenever any landing gear is not locked down, either engine condition lever is at TO/LAND, and (1) both power levers are retarded more than halfway from MILITARY to FLIGHT IDLE, or (2) the flaps are extended to 30 degrees or more.

CAUTION

During single-engine operations, place failed engine power lever in the FLIGHT IDLE position, or operate the power levers simultaneously to ensure WHEELS warning light capability.

2.29 WHEEL BRAKES

Manually operated, hydraulically independent wheel brakes are installed. Pressure applied at the rudder pedals in either cockpit operates a separate brake master cylinder for each wheel. The brakes include integral parking brake provisions, utilizing pedal pressure by a valve mechanism which traps pressure generated in the master cylinders.

2.29.1 Parking Brake Handle. The PARK BRAKE handle (Figure 1-3) is installed on the pilot's center pedestal. Brakes are set for parking by applying pedal pressure as desired, then pulling the handle out and releasing pedal pressure. The parking brakes are released by applying sufficient pedal pressure to exceed the level of trapped pressure.

2.30 NOSE WHEEL STEERING

Nose wheel steering is available up to 55 degrees left or right of center, through a hydraulically operated nose wheel steer-damper system. Nose wheel steering is less effective to the left than to the right. With the weight of the aircraft on the landing gear, hydraulic system pressure is ported through a steering control valve to the steer-damper unit as long as the nose wheel steering button is held depressed.

2.30.1 Nose Wheel Steering Button. The nose wheel STEER button (Figure 2-10) is located on the face of the pilot's stick grip. Operation of the nose wheel steering system requires that the weight of the aircraft be on the landing gear and the button be depressed and held.

2.31 INSTRUMENTS

2.31.1 Pitot-Static System. Ram-air pressure and static air pressure are sensed by a pitot-static tube located on the nose. The altimeter, airspeed indicator, vertical velocity indicator, and ejection seat speed-altitude sensor are operated by the pitot-static system. Selective pitot tube electrical heating is provided for flight in visible moisture or during flight at freezing temperatures.

2.31.1.1 Airspeed Indication. A 40- to 400-knot airspeed indicator (Figure 1-3) is installed on the pilot's instrument panel. An identical airspeed indicator (Figure 1-6) is installed on the observer's instrument panel.

2.31.1.2 Altimeters, AAU-21/A and AAU-24/A. An AAU-21/A counter drum pointer altimeter (Figure 1-3) is installed on the pilot's instrument panel. An AAU-24/A altimeter (Figure 1-6) is installed on the rear cockpit observer's instrument panel. The AAU-21/A is a barometrically operated counter drum pointer altimeter that incorporates a servo-driven encoder which provides an altitude signal to the aircraft transponder for transmission to a ground station when Mode C of the transponder is operating. The single sweep hand and digital counter drum of the instrument are mechanically linked through a gear train in an evacuated bellows, plus the hand being linked to an electrical servomotor. The face of the instrument is marked from 0 to 9 (× 100) feet with graduated increments for each 50 feet. A counter window, adjacent to the sweep hand, contains three digital drums which rotate to indicate altitude in thousands and hundreds of feet. At altitudes below 10,000 feet, a barber pole appears in place of the left digit. Another window in the upper left of the instrument face indicates coder ON, coder OFF modes of operation, and a window in the lower right of the face indicates barometric pressure. A knob on the lower left front of the instrument case permits manual correction of the instrument for barometric pressure variations from the standard gradient. The AAU-24/A, located in the aft cockpit, is identical to the AAU-21/A except it has no servo-driven encoder incorporated and no mode window on the face.

2.31.1.3 Vertical Velocity Indicator. A vertical velocity indicator (Figures 1-3 and 1-6) is installed on the pilot's and observer's instrument panel. These indicators are calibrated from 0 to 6000 feet per minute.

2.31.1.4 PITOT HEAT Switches. The PITOT HEAT switch (Figure 2-23) on the pilot's exterior lights and conditioning panel allows selection of electrical heat element operation in the pitot-static tube and the stall warning transducer when the aircraft is airborne.

2.31.2 Accelerometer. A standard, three-pointer accelerometer (Figure 1-3) is installed on the instrument panel in the pilot's cockpit. The instrument incorporates a reset button which may be depressed to return the positive and negative acceleration recording pointers to 1 "g" as desired. An ABU-13A accelerometer is installed in the cargo bay to supply acceleration information to the FLIR/LRD system.

2.31.3 Vertical Gyro Indicating System. The aircraft is equipped with an ARU-50/A remote attitude indicator located on the pilot's instrument panel. An ARU-42/A-2 standby gyro is also provided and located on the pilot's upper right instrument panel for emergency reference. An MB-1 attitude indicator is located on the instrument panel in the observer's cockpit. Both the ARU-50/A and MB-1 attitude indicators require primary ac bus power and will operate with either inverter selected. An electrical power failure will cause an OFF flag to be displayed on the face of either indicator. An MD-1 pitch and roll displacement gyroscope is installed in the cargo bay. Pitch and roll information from the MD-1 is supplied to the ARU-50/A, the FLIR/LRD system, and the doppler navigation system.

2.31.3.1 Remote Attitude Indicator, ARU-50/A. The pilot's remote attitude indicator, located on the pilot's instrument panel, provides a constant visual indication of the simultaneous pitch-and-roll attitude of the aircraft relative to the earth's surface (Figure 2-13). The primary ac bus supplies 115 VAC for indicator power. An MD-1 roll-and-pitch displacement gyro, located in the forward cargo bay, senses displacement and supplies reference signals for pitch and roll.

A pitch trim knob allows the attitude sphere horizon line to be adjusted to desired pitch-axis presentation relative to a miniature aircraft. A turn-and-slip indicator is integral to the indicator and is located below the sphere. The glide slope, localizer, and auxiliary attitude source functions are not used. When 28-VDC power is applied to the aircraft the GS, LOC, AUX alarm flags will disappear from the indicator face. The vertical (localizer) bar will move to the right out of sight and the horizontal (glide slope) bar will move to the top of the indicator disappearing from view. The attitude warning flag (OFF) is in view when (1) loss of 115-VAC indicator power occurs (2) failure of roll and/or pitch displays to track attitude input signals within ± 6 degrees or (3) loss of attitude data from the MD-1 reference source. The indicator receives power when the INST PWR switch on the starter-generator control panel is moved to INV NO. 1 or INV NO. 2 position. The OFF flag will disappear after 1 minute. Two minutes later the slip indicator ball and the turn index should be centered. The horizon line should be zero (± 1 degree). The pitch trim knob index arrow should be aligned with the indicator index. When rotating the pitch trim knob fully clockwise, the display should reflect a dive of 15 degrees (± 5 degrees). After returning the knob to the indexed position, rotate the control fully counterclockwise. The indicator should display a climb of 7.5 degrees (± 2 degrees). When the FAST ERECT switch is selected on the pilot's center pedestal the OFF flag will appear and the gyro fast erects.

2.31.3.2 Attitude Indicator, MB-1. The MB-1 attitude indicator, located on the observer's instrument panel, incorporates a pitch angle readout within a range of 5 to 80 degrees of climb or dive (Figure 2-13). The MB-1 permits 360-degree aircraft rotation about the pitch and bank axes (roll and yaw) without tumbling. Maximum up and down travel of the horizon bar is 27 degrees. Beyond these limits, further rotation of the sphere reveals CLIMB and DIVE markings, each immediately followed by a bullseye which marks the area around 90 degrees of pitch. As the aircraft approaches vertical, the indicator sphere rotates 180 degrees counterclockwise in a climb, clockwise in a dive. Maneuvering may cause considerable pitch precession. If in-flight caging is required, ensure the aircraft is in straight and level flight before pulling and releasing the caging knob.

2.31.3.3 Standby Gyro, ARU-42/A-2. The standby gyro is located on the pilot's instrument panel and is powered by 28-volts dc from the battery bus (Figure 2-13). The indicator provides a back-up source of pitch and roll information if electrical power is lost or the primary attitude indicator (ARU-50/A) is determined to be unreliable. In the event that electrical power is lost to the standby gyro indicator, the OFF flag will appear on the indicator face. The gyro will coast however and provide pitch and roll attitude information. The information displayed will not change by more than ± 6 degrees for up to 9 minutes after power is lost.

2.31.3.3.1 Standby Gyro Caging. To check and cage the standby gyro proceed as follows:

1. Assure aircraft is in a wings-level attitude.

2. Apply 28 VDC to aircraft.

3. Pull caging knob out and turn to the extreme clockwise position–Leave knob in the extended position, OFF flag will appear.

4. Allow 3.5 minutes for warm-up.

5. Uncage gyro by returning knob to original position–OFF flag shall disappear.

6. Set pitch and trim knob to align index marks–Horizon line indicates 0 (± 1) degrees bank.

7. Rotate the pitch trim knob fully clockwise–The indicator should display a 5-degree climb.

8. Rotate the pitch trim knob fully counterclockwise–The indicator should display a 5-degree dive.

NOTE

The final settling point of the sphere after uncaging the gyro depends on the aircraft pitch and roll attitude and setting of the pitch trim knob.

2.31.3.4 Attitude Gyro Erect Switch. The attitude gyro erect switch (Figure 2-13) is located on the pilot's center pedestal with NORM and FAST ERECT positions. This two-position toggle switch is spring-loaded to the NORM position and allows selection of the fast erect mode of MD-1 vertical gyro erection. The fast erect mode of erection is selected by holding the switch in the FAST ERECT position. During operation of the fast erect cycle, the OFF flag will appear in the face of the ARU-50/A indicator.

2.31.4 Compass System, AN/ASN-75. Refer to Compass System, AN/ASN-75, Part VII, Chapter 19.

2.31.5 Radar Altimeter, AN/APN-171(V). Refer to Radar Altimeter, Part VII, Chapter 19.

2.31.6 Angle-of-Attack System. The angle-of-attack system consists of a relative airstream probe mounted on the left side of the forward fuselage, an angle-of-attack transmitter, the angle-of-attack indicator, an approach indexer, and approach lights. Angle of attack is indicated from 0 to 30 units by the angle-of-attack indicator. On speed indication for landing approach is indicated by the approach indexer and approach lights.

WARNING

The angle-of-attack system shall not be used as a primary reference.

2.31.6.1 Angle-of-Attack Indicator. The angle-of-attack indicator (Figure 1-3), mounted on the pilot's instrument panel, displays aircraft local angle of attack as sensed by the relative airstream probe. This indicator is operated by primary dc power and is operative whenever primary power is available (external power connected, battery on, or either generator operating). The face of the indicator is adjusted to place the nominal approach angle of attack in units under an index at the 3-o'clock position. An OFF flag, located near the center of the indicator, appears in the event of failure. In the event of failure or when not powered, the indicator pointer rests at zero. A system of cam-operated switches within the indicator operates the approach indexer and approach lights.

2.31.6.2 Approach Indexer. The red-lighted approach indexer (Figure 1-3) is located above the pilot's instrument panel as a visual aid in determining the optimum landing approach airspeed. No control action is required from the pilot to utilize the approach lights and approach indexer systems. The indexer and approach lights function only when the landing gear is locked down and aircraft weight is not on the landing gear.

2.31.6.3 Approach Lights. The approach lights, installed on the nose gear strut, aid in determining aircraft landing approach airspeed (Figure 2-9). These lights signify fast (red), on-speed (amber), and slow (green) approach speeds. The approach lights system is automatic and is controlled by the angle-of-attack indicator. Refer to ANGLE-OF-ATTACK INDICATOR, in this chapter. The approach lights are dimmed for night operations by placing the EXT LTS MASTER switch to EXT LTS or EXT LTS & LDG LTS. The approach lights are extinguished when the weight of the aircraft compresses the landing gear struts.

2.31.6.4 Approach Lights Test Switch. Ground test of the approach lights may be accomplished through an approach lights test switch in the nose gear well.

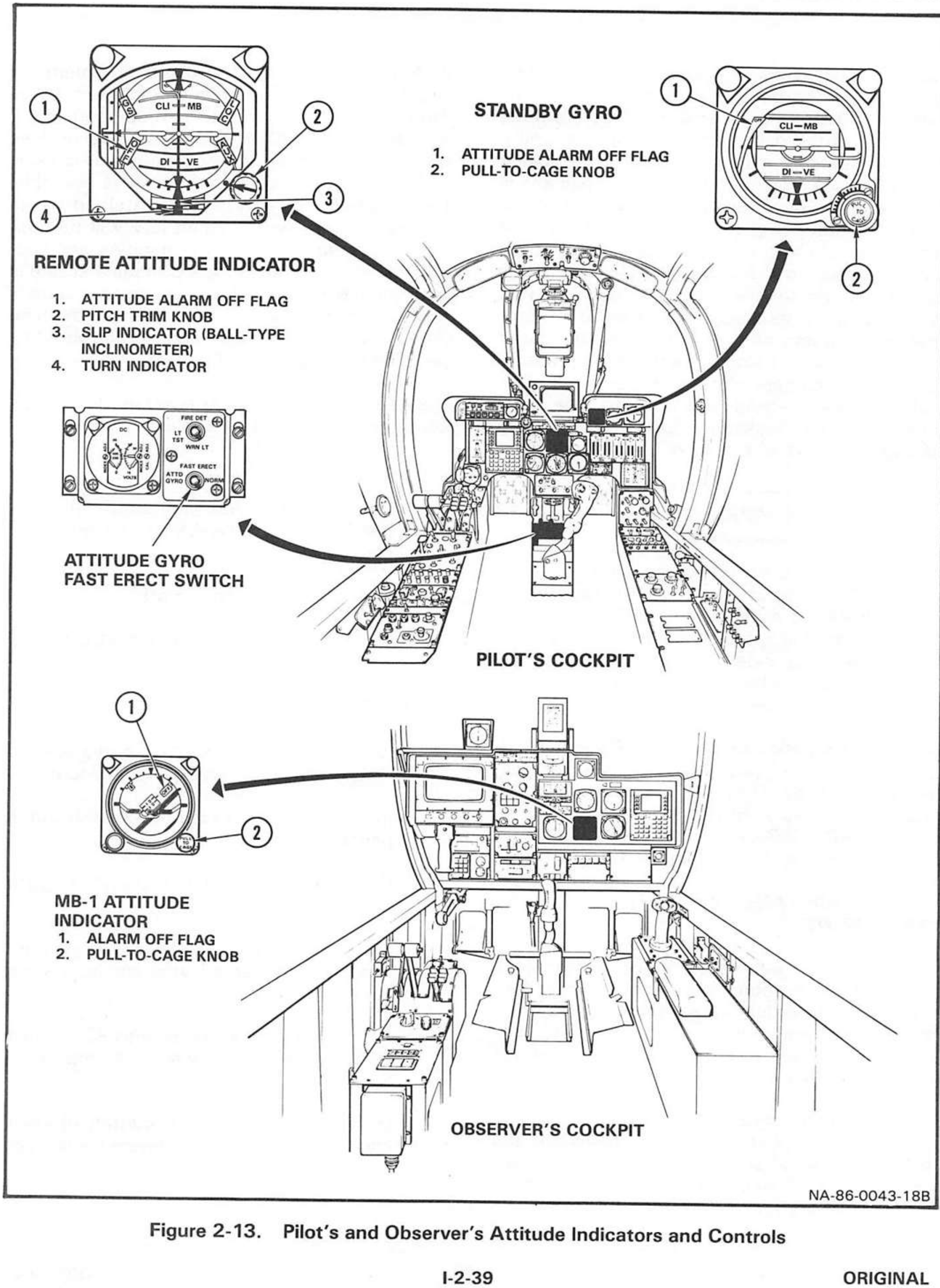


Figure 2-13. Pilot's and Observer's Attitude Indicators and Controls

2.31.7 Stall Warning System. A stall warning system is incorporated, consisting of a lift detector-transducer and heating element installed on the right wing, an amplifier, and a motor-operated pedal shaker. The pedal shaker system is powered by the primary dc bus and is disabled from operating with the weight of the aircraft depressing the landing gear ground safety switches. Stall warning system operation is not related to the angle-of-attack indicating system (indicator and indexer), but operates when wing lift generated decreases to approximately 6 grams at the transducer. Indicated angle of attack at stall warning may vary from 22 to 30 units, depending on gross weight, flap setting, power setting, and "g" load. The pedal shaker may be checked for operation by holding the lights LT TST switch in WRN LTS position.

WARNING

Depending on power and aircraft configuration, the rudder pedal shaker is activated 1 to 7 knots above stall speed during normal 1-g stalls. Dependent on rate of entry, the pedal shaker may not activate prior to accelerated stall.

2.31.8 Navigation Instruments. Radio navigation displays in the pilot's and observer's cockpit are provided by ID-663D/U bearing-distance-heading indicators (BDHI). For a description of the UHF-ADF, TACAN and compass functions of these indicators, refer to Part VII, Chapter 19.

2.32 MISCELLANEOUS FLIGHT INSTRUMENTS

Non-system dedicated flight instruments include two chronometers, a cockpit management system, a doppler navigation system, an outside air temperature indicator, a standby compass, and a bearing-distance-heading-indicator (BDHI).

2.32.1 Chronometer. Two chronometers, one located on the pilot's instrument panel and the other on the observer's instrument panel, receive 28-VDC electrical power from the main dc bus (Figure 2-14). The digital chromometer has four modes of operation; Greenwich Mean Time (GMT), local time (LT), an up-count (UC), and down-count (DC) mode. The display does not need to be reset if electrical power is interrupted. When no electrical power is available, the timekeeping feature is maintained by an internal battery which when low will be indicated by a dot between the minutes and seconds displays. When in the DC mode and zero is reached, a beeping, 1950-Hz alarm tone sounds for 5 seconds in the pilot's headset and the time display flashes. The tone may be interrupted by pressing the START/STOP button.

2.32.1.1 Chronometer Operation. To set the chronometer proceed as follows:

NOTE

Synchronize chronometer start with GMT reference (WWV HF broadcast).

1. Apply 28 VDC to aircraft.
2. On ICS monitor panel, set VOL control to mid-range.
3. To Set GMT:

(a) Press MODE switch and position index to GMT–Observe second count.

(b) Press the recessed SET switch with a pencil.

(c) Set hours with HOURS toggle switch.

(d) Set minutes with MIN toggle switch–The chronometer will stop and hold while setting minutes.

(e) Set correct seconds with SEC toggle switch–The chronometer will stop while seconds are set.

(f) Press START/STOP switch to start chronometer when GMT reference and set time agree.

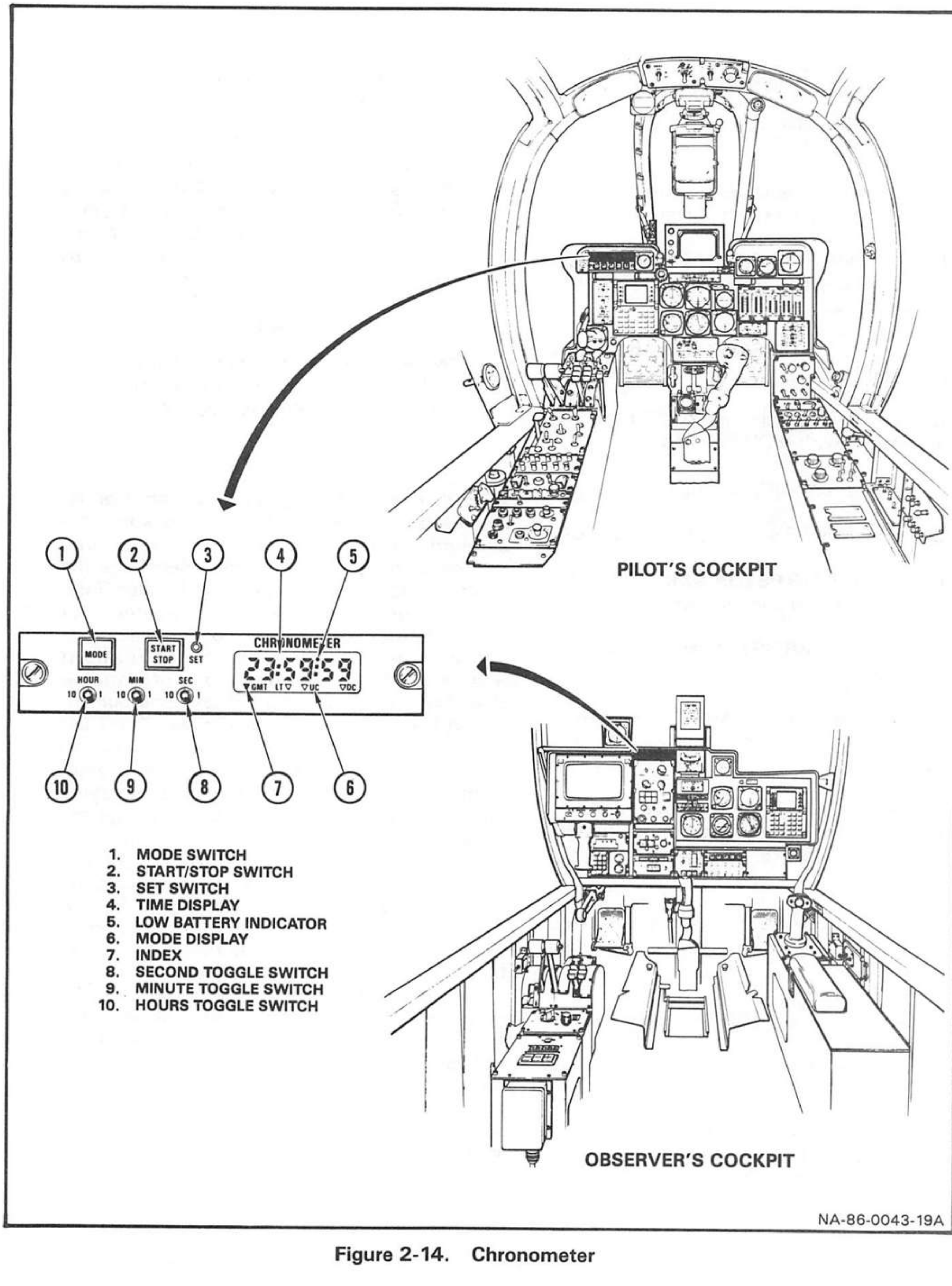


Figure 2-14. Chronometer

4. To set local time (LT):

(a) Press MODE switch until index is positioned to LT.

(b) Press recessed SET switch with a pencil–Only hours will be displayed.

(c) Set correct hours with HOURS toggle switch–Minutes and seconds should remain the same as GMT.

(d) Press START/STOP switch to exit SET mode.

(e) Recheck local and GMT time for agreement with MODE switch.

5. Set up-count (UC) function:

(a) Press MODE switch until index to UC.

(b) Press START/STOP switch–Counter will reset to zero and start up count.

(c) Press START/STOP switch to stop and hold count.

(d) Pressing the START/STOP switch again will reset to zero and start another count.

(e) Press MODE switch four times to sequence the annuniciator repositioning the index back to UC–Ensure that up count has continued.

(f) Press START/STOP switch two times–The count should hold and then reset to zero.

6. Set down-count (DC) function:

(a) Press MODE switch and position index over DC.

(b) Reset time to zero with HOURS, MIN, SEC, toggles if required.

(c) Set desired down-count time with HOURS, MIN, SEC, toggles.

(d) Press START/STOP switch to start countdown–When count reaches zero, the display will flash at a 2-Hz rate and a tone will be heard on the ICOM system in the pilot's headset. Both alarms will stop in 5 seconds or may be terminated by pressing START/STOP switch.

NOTE

When countdown reaches zero it will start to count up until the START/STOP switch is pressed.

2.32.2 Cockpit Management System Control Display Units (CMS-CDUs). Two cockpit management system control display units, one located on the pilot's instrument panel and the other on the observer's, provide the crew integrated control and display management of weapons, countermeasures, communications, navigation, identification equipment (Figure 2-15). In addition, take-off/landing checklists, trim indication displays and built-in-test (BIT) functions are available. The CDU screen displays data received from associated systems or data entered from the keyboard. Eight line select (LS) keys are used to initiate functions selected, insert data, or change the display to the page indicated. The function select keys, COMM, NAV, IFF, STAT, CM, WPNS, and IDX allow the crew to call up and display the associated data on the CDU screen display. Alphanumeric keys allow the selection of either letters or numbers (selectable from the LTR key) for entry into a scratch pad displayed at the bottom of the screen. The scratch pad can be cleared with the clear (CLR) key. A slew switch is provided to permit up (backward) or down (forward) display of pages or activation of other functions. Power for the CMS system is 28 VDC provided by the primary dc bus. For further description and operation refer to COCKPIT MANAGEMENT SYSTEM, Part VII, Chapter 19.

1. LINE SELECTOR (LS) KEYS 1, 2, 3, 4 (TOP TO BOTTOM)
2. CRT DISPLAY
3. LINE SELECT (LS) KEYS 5, 6, 7, 8 (TOP TO BOTTOM)
4. BUILT-IN-TEST (BIT) INDICATOR
5. ALPHANUMERIC KEYS
6. SPECIAL FUNCTION KEY (LETTER KEY)
7. SPECIAL FUNCTION KEY (CLEAR KEY)
8. FUNCTION SELECT KEYS
9. SLEW SWITCH
10. CRT BRIGHTNESS (BRT) CONTROL

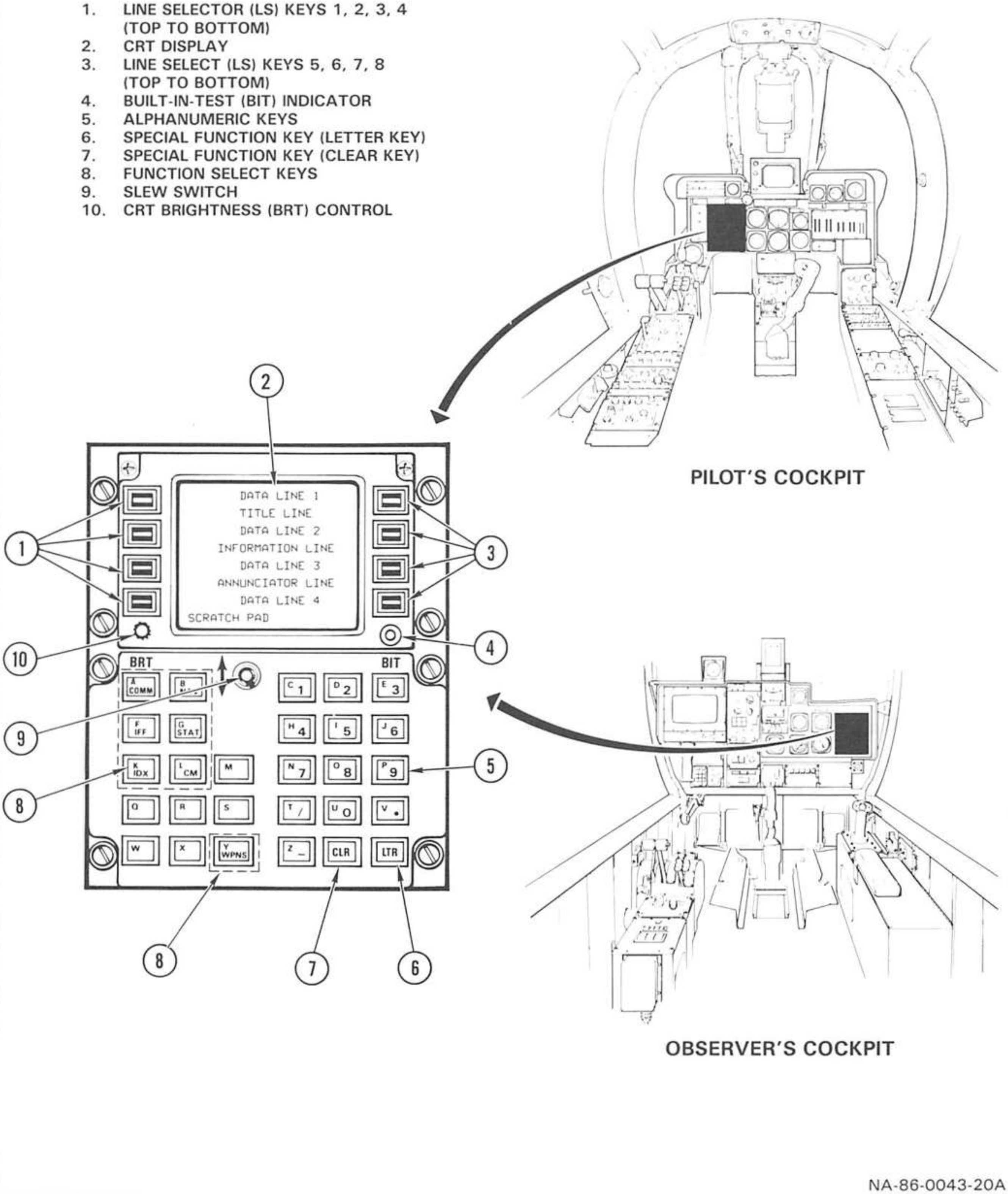


Figure 2-15. Cockpit Management System Control Display Unit

2.32.3 Doppler Navigation Computer Display Unit (DOP NAV CDU). The aircraft is equipped with a doppler navigation computer display unit (DOP NAV CDU) installed on the observer's instrument panel. Provisions for moving and installing the CDU in the pilot's right console allow the CDU to be used for solo flight (Figure 2-16). Navigation information computed by the CDU is also displayed in the pilot's cockpit on a multipurpose indicator (MPI) located on the left-hand instrument panel shroud. The CDU and MPI are provided 28-VDC power by the primary dc bus. Five doppler dead reckoning modes of operation are available: OFF, TEST, LAND, AIR DATA (AD), and SEA. The CDU receives a serial/digital input signal from the doppler receiver-transmitter antenna (RTA), located in the left wing tip, consisting of magnetic heading from the compass system, pitch and roll from the vertical gyro indicating system, and doppler ground velocity from the doppler receiver-transmitter antenna. Aircraft position is determined by converting, correcting, and resolving the received digital information into aircraft velocity and heading signals. The composite signal is then time-compared with operator-designated checkpoint locations, target locations, and initial location to give incremental changes in position, heading, and velocity. In addition, the CDU calculates range, bearing, and estimated time to checkpoints and provides distance-off-course (DOC) data and present position information. Present position is displayed in either latitude/longitude or Universal Transverse Mercator coordinates. For operation, refer to Doppler Navigation System, Part VII, Chapter 19.

2.32.4 Outside Air Temperature Indicator. An outside air temperature indicating thermometer (Figure 1-4) is installed in the glass panel of the pilot's left-hand canopy door. This indicator is calibrated from $-70°$ to $40\ °C$.

2.32.5 Standby Magnetic Compass. A standby magnetic compass is installed on the upper left portion of the windshield bow in the pilot's cockpit (Figure 1-4). A compass correction card is installed on the pilot's right console.

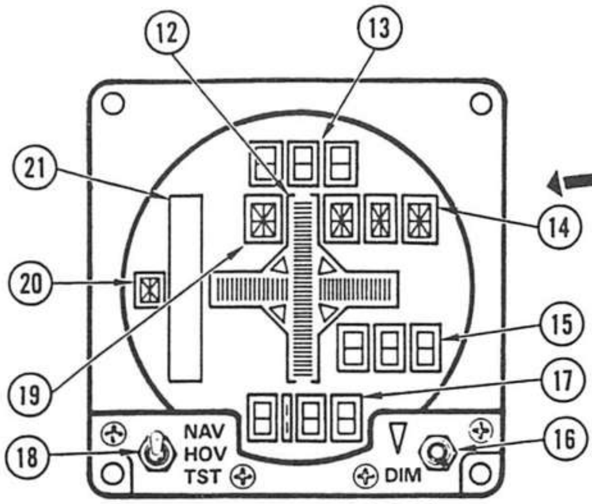
2.32.6 Turn-and-Slip Indicator. A 2-minute turn-and-slip indicator is an integral part of the pilot's remote attitude indicator (ARU-50/A) on the pilot's instrument panel (Figure 2-13). The turn indicator is a rate instrument that utilizes a dc signal provided by a turn-rate gyro located in the forward cargo bay. When the indexer is off center, it indicates that the aircraft is turning in the direction shown by the indexer. The slip indicator is a ball-type inclinometer that indicates bank angle of ± 5 degrees (± 2 degrees). When the ball is centered, the aircraft is flying level. Additional slip indicators (ball-type inclinometers) are provided as an integral part of the weapons delivery optical sight (Figure 1-4) and on the observer's instrument panel (Figure 1-6).

2.32.7 Bearing-Distance-Heading Indicator (BDHI). Refer to TACAN, AN/ARN-118, Part VII, Chapter 19.

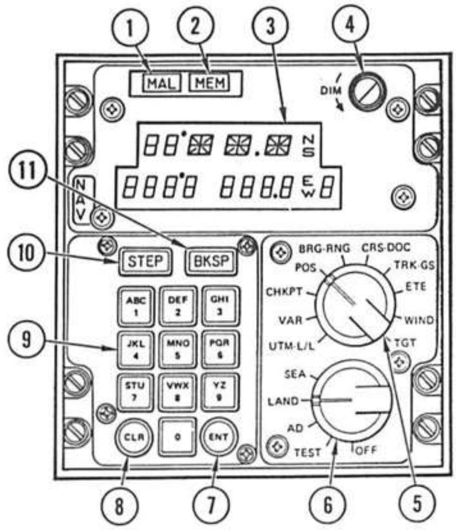
2.33 WARNING, CAUTION, AND ADVISORY LIGHTS

The warning, caution, and advisory lights system consists of the pilot's caution light panel, the pilot's and observer's caution/warning light panels, the pilot's and observer's master caution light system, and pilot's and observer's caution/warning lights test systems. See Figures 2-17 and 2-18 for caution and warning lights locations, descriptions, conditions that will cause illumination and corrective action.

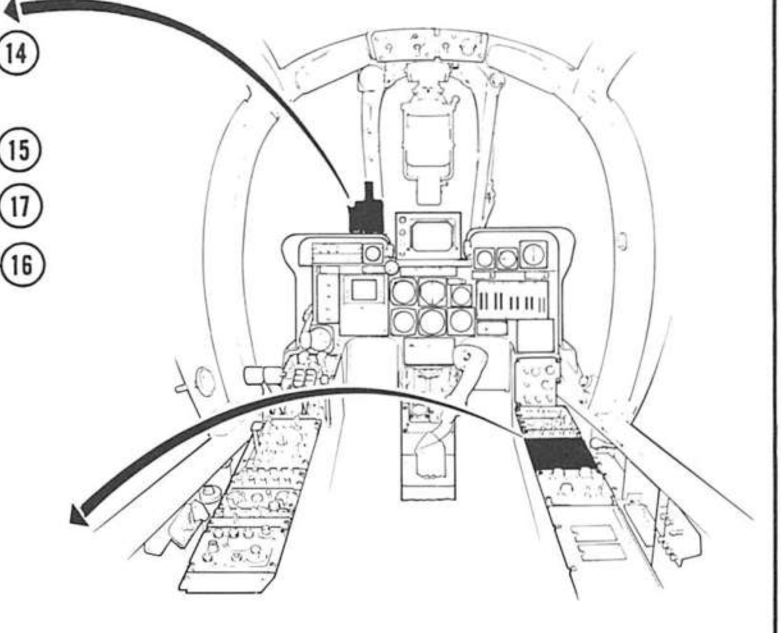
2.33.1 Pilot's Caution Light Panel. The pilot's caution light panel, located on the pilot's instrument panel, alerts the pilot to conditions that may affect safe operation of the aircraft (Figure 2-17). Electrical power (28-VDC) for the caution lights is provided by the main dc bus. Eighteen aviation yellow caution lights provide the pilot with indications of engine, fuel, electrical, hydraulic, avionic, and cargo bay door system status. When illuminated, the individual caution lights come on steady and will cause the pilot's and observer's master caution light to come on flashing. Intensity of the caution lights may be bright or dim depending on the position of the INSTRUMENTS knob, located on the pilot's interior lights dimming control panel. Rotating the knob from OFF will cause potential brightness of any illuminated caution lights to be dim. Lights on this panel are tested by placing the LT TST switch, located on the pilot's pedestal, to WRN LT position.



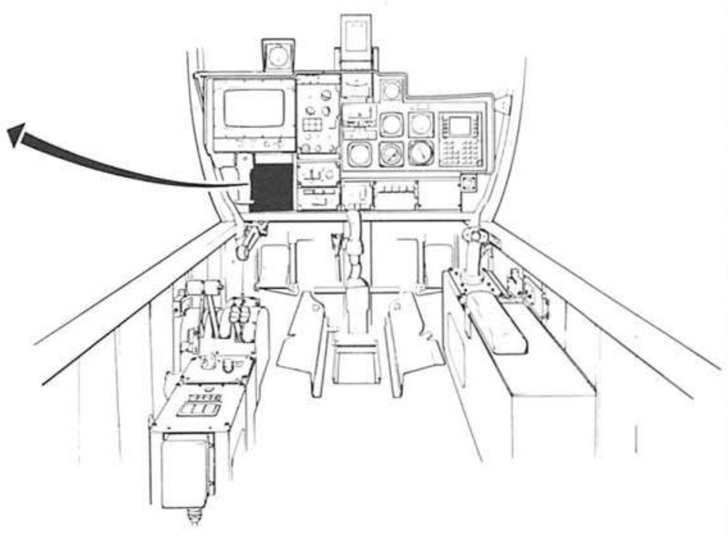
PILOT'S MULTIPURPOSE INDICATOR, ID-2440/APN



COMPUTER DISPLAY UNIT, CP-1600/APN-233



PILOT'S COCKPIT
*ALTERNATE INSTALLATION



OBSERVER'S COCKPIT

1. MALFUNCTION INDICATOR
2. MEMORY INDICATOR
3. ALPHANUMERIC DISPLAY
4. ALPHANUMERIC DISPLAY DIMMING CONTROL
5. FUNCTION/DISPLAY SELECTOR SWITCH
6. MODE SELECTOR SWITCH
7. CLEAR KEY
8. ENTER KEY
9. ALPHANUMERIC KEYBOARD
10. STEP KEY
11. BKSP (BACKSTEP) KEY
12. X-Y/BULLSEYE GRAPHIC DISPLAY
13. COMMAND HEADING DISPLAY
14. GROUNDSPEED/STATUS/RIGHT TURN DISPLAY
15. RANGE DISPLAY
16. DIM SWITCH
17. ESTIMATED TIME ENROUTE DISPLAY
18. NAV/HOV/TST SWITCH
19. LEFT TURN ARROW DISPLAY
20. VERTICAL VELOCITY BAR
21. VERTICAL VELOCITY CENTER SYMBOL

N10/90
NA-86-0043-21B

Figure 2-16. Doppler Navigation System Computer Display Unit

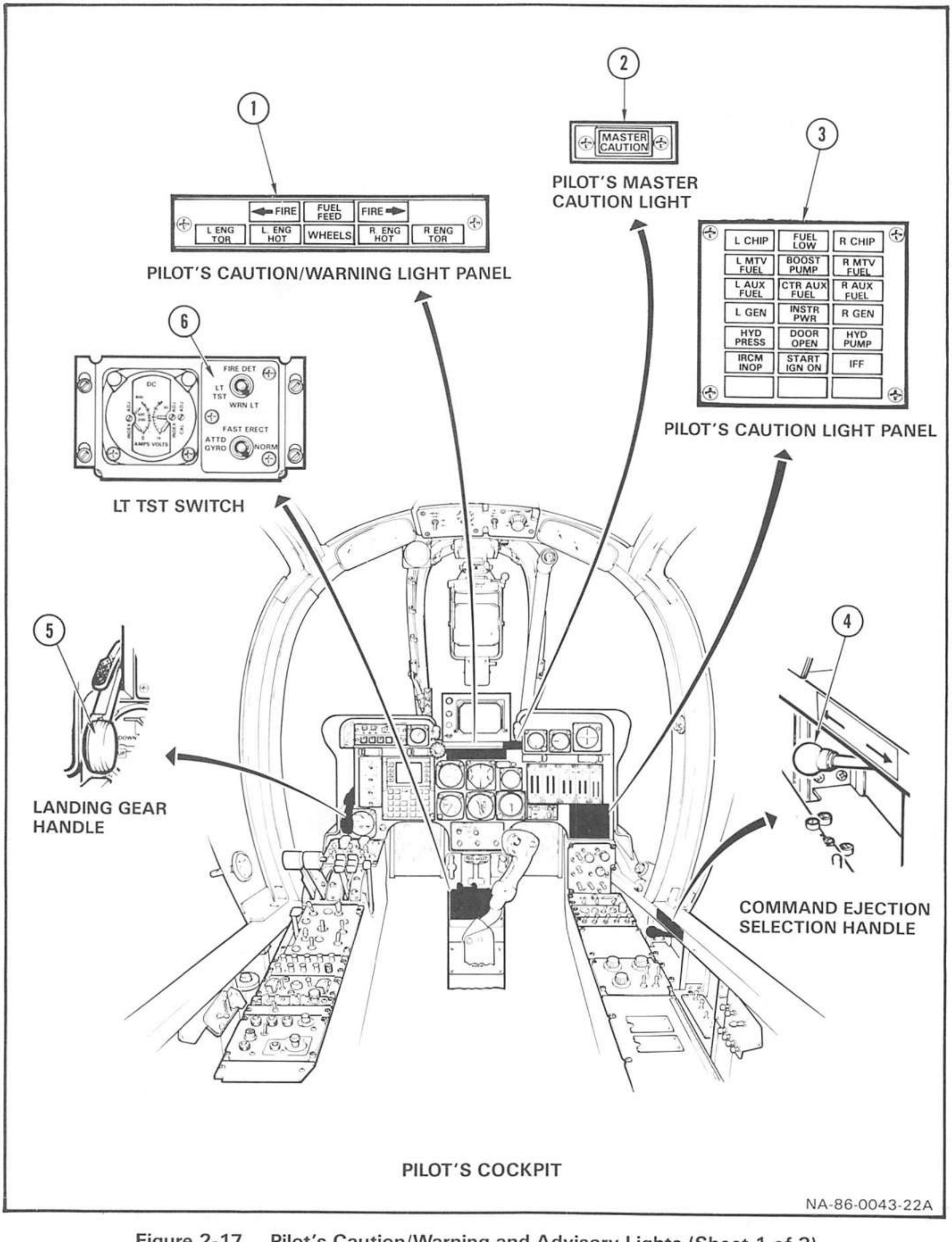


Figure 2-17. Pilot's Caution/Warning and Advisory Lights (Sheet 1 of 3)

LIGHT	COLOR	CONDITION	CORRECTIVE ACTION
1. PILOT'S CAUTION/ WARNING LIGHT PANEL			
L ENG TOR R ENG TOR	YELLOW	ENGINE TORQUE ABOVE 3282 POUND—FEET	RETARD POWER UNTIL TORQUE IS WITHIN LIMITS
L ENG HOT (O) R ENG HOT (O)	RED	ENGINE TURBINE INLET TEMPERATURE ABOVE 1125 (+4/−0) C°	REDUCE POWER UNTIL TIT IS WITHIN LIMITS
WHEELS (O)	RED (FLAS-HING)	ANY GEAR NOT EXTENDED AND LOCKED. EITHER CONDITION LEVER AT T.O./LAND AND: 1. POWER LEVERS RETARDED, OR 2. FLAPS 30 DEGREES OR MORE	ADVISORY
L FIRE (O) R FIRE (O)	RED	OVERHEAT OR FIRE IN NACELLE	EXECUTE EMERGENCY PROCEDURE
FUEL FEED (O)	RED	LESS THAN 50 POUNDS OF FUEL IN FEED TANK	EXECUTE EMERGENCY PROCEDURE
2. MASTER CAUTION LIGHT (O)	YELLOW (FLAS-HING)	CAUTION LIGHT ILLUMINATED ON PILOT'S CAUTION LIGHT PANEL	ACKNOWLEDGE CAUTION LIGHT AND PUSH TO RESET
3. PILOT'S CAUTION LIGHT PANEL			
L CHIP R CHIP	YELLOW	IRON-METALLIC PARTICLES ON CHIP DETECTOR	EXECUTE EMERGENCY PROCEDURE
FUEL LOW (O)	YELLOW	LESS THAN 220 (± 15) POUNDS FUEL REMAINING IN CENTER TANK	EXECUTE EMERGENCY PROCEDURE
L MTV FUEL R MTV FUEL	YELLOW	FUEL TRANSFER PRESSURE (MOTIVE FLOW OUTPUT) LOW	EXECUTE EMERGENCY PROCEDURE
BOOST PUMP	YELLOW	LOSS OF BOOST PUMP PRESSURE	EXECUTE EMERGENCY PROCEDURE
L AUX FUEL CTR AUX FUEL R AUX FUEL	YELLOW	NO AUXILIARY FUEL TRANSFER	EXECUTE EMERGENCY PROCEDURE
L GEN R GEN	YELLOW	GENERATOR OFF LINE	EXECUTE EMERGENCY PROCEDURE

(O) = ALSO INSTALLED IN OBSERVER'S COCKPIT

NA-86-0043-93A

Figure 2-17. Pilot's Caution/Warning and Advisory Lights (Sheet 2 of 3)

LIGHT	COLOR	CONDITION	CORRECTIVE ACTION
INSTR PWR	YELLOW	PRIMARY AC BUS POWER FAILURE	EXECUTE EMERGENCY PROCEDURE
HYD PRESS	YELLOW	LESS THAN 200 PSI ON DEMAND	ADVISORY
HYD PUMP	YELLOW	HYDRAULIC PUMP NOT OPERATING ON DEMAND	EXECUTE EMERGENCY PROCEDURE
DOOR OPEN	YELLOW	CARGO BAY DOOR NOT CLOSED AND LATCHED	ENSURE DOOR CLOSED AND LATCHED PRIOR TO TAXI
IRCM INOP	YELLOW	COOL DOWN CYCLE IN PROGRESS OR BIT FAULT DETECTED	ADVISORY
START IGN ON	YELLOW	EITHER ENGINE STARTER OR IGNITION OPERATING	ADVISORY
IFF	YELLOW	MODE 4 INTERROGATIONS RECEIVED BUT REPLIES NOT GENERATED OR MODE 4 IS ZEROED	ADVISORY
4. EJECTION SELECTION HANDLE (0)	RED	SELECTION HANDLE NOT FULLY ENGAGED OR MALFUNCTION IN MECHANICAL LINKAGE	RECHECK HANDLE
5. PILOT'S GEAR HANDLE	RED	GEAR NOT LOCKED IN SELECTED POSITION	RECHECK GEAR

6. LT TEST SWITCH POSITION	RESULT
WRN LT	TESTS PILOT'S CAUTION AND WARNING LIGHTS, APPROACH INDEXER LIGHTS, EJECTION SELECTION SYSTEM, ACTIVATES STALL WARNING TEST (PEDAL SHAKER).
FIRE DET	TESTS ENGINE FIRE DETECTION SYSTEM AND FIRE WARNING LIGHTS.

NA-86-0043-94A

Figure 2-17. Pilot's Caution/Warning and Advisory Lights (Sheet 3 of 3)

2.33.2 Pilot's Caution/Warning Light Panel. The pilot's caution/warning light panel, located on the pilot's instrument panel, alerts the pilot of conditions or malfunctions, that require an immediate response (Figure 2-17). Electrical power (28-VDC) or ground for these lights is provided by engine, fuel, and landing gear detecting/sensing systems. Six aviation red warning lights are located on this panel (L/R ENG HOT, WHEELS, L/R FIRE, FUEL FEED) and two aviation yellow caution lights (L/R ENG TOR). The caution and warning lights on this panel will not activate the master caution light system. Potential brightness of caution and warning lights may be bright or dim depending on the position of the INSTRUMENTS knob with exception of the WHEELS warning light which illuminates bright and flashing. Rotating the knob from OFF will cause any warning or caution light to be dim. Lights on this panel are tested by placing the LT TST switch to the WRN LT position.

2.33.3 Observer's Caution/Warning Light Panel. The observer's caution/warning light panel, located on the observer's instrument panel, alerts the observer to caution and warning lights illuminated in the pilot's cockpit (Figure 2-18). The various caution and warning lights located on this panel are FUEL LOW, L/R FIRE, FUEL FEED, L/R ENG HOT, and WHEELS. These lights operate simultaneously with lights located on the pilot's caution/warning light panel and the pilot's caution light panel. Potential brightness of these lights may be bright or dim depending on the position of the CONSOLES knob, located on the observer's light/dimming control panel. Rotating the knob from OFF will cause the warning and caution lights to be dim with exception of the WHEELS warning light. When illuminated, six warning lights on this panel are aviation red and one caution light (FUEL LOW) is aviation yellow. Testing is performed by placing the WARN LIGHTS switch, located on the observer's LIGHTS DIM/TEST panel, to the TEST position.

2.33.3.1 PILOTS FLIR Advisory Light. An aviation green advisory light, located adjacent to the observer's caution/warning light panel advises the observer that the pilot has control of the FLIR system (Figure 2-10). The light will be illuminated when the pilot has positioned the FLIR CMD switch to the WIDE or NARROW position on the FLIR/WEAPONS control panel (Figure 1-3).

2.33.4 Master Caution Light System. The master caution light system consists of two (aviation yellow) MASTER CAUTION lights located on the pilot's and observer's instrument panel. The observer's MASTER CAUTION light functions as a repeater of the pilot's light. Electrical power (28 VDC) for the system is provided by the main dc bus. The master caution light system provides a visual alert to the pilot to check 18 caution lights located on the pilot's caution light panel. When a caution light is illuminated, both MASTER CAUTION lights will come ON and flash at 2 to 5 cycles per second. After acknowledging the illuminated caution light, the MASTER CAUTION lights must be reset to arm the master caution light system for subsequent caution light illumination. This is accomplished by pressing the MASTER CAUTION light on the pilot's instrument panel and releasing. The observer's light does not have the capability to reset the system. The MASTER CAUTION lights will then go OFF and any caution light that cannot be extinguished by corrective action will remain ON.

2.33.5 Caution and Warning Lights Test (Pilot's Cockpit). When the LT TST switch, located on the voltammeter panel on the pilot's pedestal, is placed in the WRN LT position test voltages are provided to various caution/warning lights and systems. When the test is initiated, the pilot's caution light panel, caution/warning light panel, MASTER CAUTION light, landing gear handle, ejection selection handle light and approach indexer will illuminate (Figure 2-17).

2.33.6 Caution and Warning Lights Test (Observer's Cockpit). The WARN LIGHTS switch, located on the lights dim/test panel on the observer's left console, provides a test voltage to caution, warning, and advisory lights and the ejection selection system when placed in the TEST position. When positioned to TEST, the observer's caution and warning light panel, MASTER CAUTION light, PILOTS FLIR advisory light, and various FLIR/LRD advisory lights will come ON. In addition, the ejection selection handle light will illuminate (Figure 2-18).

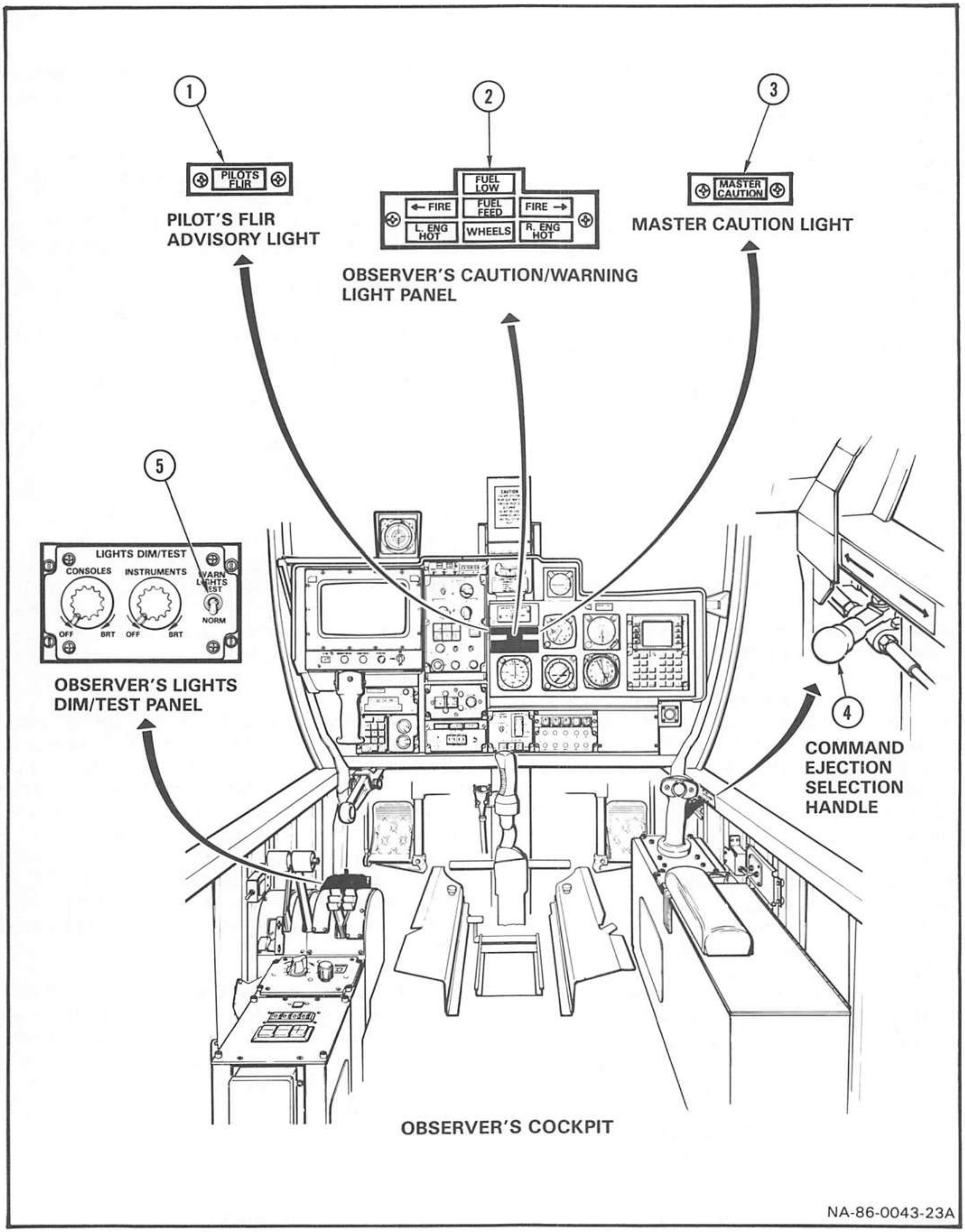


Figure 2-18. Observer's Caution/Warning and Advisory Lights (Sheet 1 of 2)

LIGHT	COLOR	CONDITION	CORRECTIVE ACTION
1. PILOT'S FLIR	GREEN	PILOT HAS COMMAND OF FLIR SYSTEM	ADVISORY
2. OBSERVER'S CAUTION/ WARNING LIGHT PANEL			
L ENG HOT (P) R ENG HOT (P)	RED	ENGINE TURBINE INLET TEMPERATURE ABOVE 1125 (+4/−0) C°	REDUCE POWER UNTIL TIT IS WITHIN LIMITS
WHEELS (P)	RED (FLASHING)	ANY GEAR NOT EXTENDED AND LOCKED. EITHER CONDITION LEVER AT T.O./LAND AND: 1. POWER LEVERS RETARDED, OR 2. FLAPS 30 DEGREES OR MORE	ADVISORY
L FIRE (P) R FIRE (P)	RED	OVERHEAT OR FIRE IN NACELLE	EXECUTE EMERGENCY PROCEDURE
FUEL FEED (P)	RED	LESS THAN 50 POUNDS OF FUEL IN FEED TANK	EXECUTE EMERGENCY PROCEDURE
FUEL LOW (P)	YELLOW	LESS THAN 220 (±15) POUNDS FUEL REMAINING IN CENTER TANK	EXECUTE EMERGENCY PROCEDURE
3. MASTER CAUTION LIGHT (P)	YELLOW (FLASHING)	CAUTION LIGHT ILLUMINATED ON PILOT'S CAUTION LIGHT PANEL	ADVISORY
4. EJECTION SELECTION HANDLE (P)	RED	SELECTION HANDLE NOT FULLY ENGAGED OR MALFUN-CTION IN MECHANICAL LINKAGE	RECHECK LEVER

5. WARN LIGHTS SWITCH

POSITION	RESULT
TEST	TESTS OBSERVER'S CAUTION AND WARNING LIGHTS, MASTER CAUTION LIGHT, PILOT'S FLIR LIGHT, FLIR/LRD ADVISORY LIGHTS, AND EJECTION SELECTION HANDLE LIGHT.

(P) = ALSO INSTALLED IN PILOT'S COCKPIT

NA-86-0043-95A

Figure 2-18. Observer's Caution/Warning and Advisory Lights (Sheet 2 of 2)

2.34 NACELLE FIRE WARNING SYSTEM

The nacelle fire warning system for each engine consists of an independent fire detector control assembly in each boom, a continuous-sensing element routed around each engine compartment, the nacelle FIRE warning lights, and a system test switch. The fire warning system normally operates on 115-VAC power but automatically operates on 28-VDC power in the event of ac power failure. As engine compartment temperature rises, the resistance of the sensing element lowers and is monitored by the control assembly. This signal energizes a relay to illuminate the FIRE warning lights.

2.34.1 Nacelle Fire Warning Lights. Two nacelle fire warning lights are located on the pilot's (Figure 2-17) and observer's caution/warning light panels (Figure 2-18). When illuminated, these lights point toward the engine compartment in which overheat or fire is detected. The entire fire warning system may be tested by holding the lights test (LT TST) switch in the FIRE DET position. AC (primary) electrical power is provided by the 115-VAC, 400-cycle primary bus and dc (secondary) electrical power is taken from the dc battery bus.

2.34.2 Fire Detection Test. The LT TST switch on the pilot's center pedestal panel (Figure 2-17) is used to provide and operational test of the nacelle fire detection and warning system. With primary dc bus power available, holding the switch in FIRE DET, tests the continuity of the nacelle fire detection and warning light system.

2.35 INGRESS/EGRESS SYSTEMS

The ingress/egress system is comprised of the pilot and observer cockpit enclosure, including the canopy, canopy doors and handles, all steps and handholds, and ejection seats.

2.35.1 Cockpit Enclosure. The unpressurized cockpit section is enclosed by a three-piece windshield and a six-piece canopy. Entrance or exit from the cockpits is accomplished through two upward swinging doors on both sides of the enclosure. All four doors are equipped with over-center latch handles. The top panels are penetrated by the seats in the event of ejection.

2.35.2 Canopy Doors. The right-hand canopy doors are normally used for entrance and exit of the flight crew (Figure 2-19). These doors are equipped with bungees which act to hold the doors in the fully open position. The pilot's doors are equipped with hold-open rods which may be used during ground operation. The left door rod holds the door approximately one-half open; the right door rod holds the door full open. These rods are secured with lever-released positive lock devices. After release and before closing the doors, the rods may be stowed in spring clip retainers on the door frames.

CAUTION

Do not use the canopy door bungees or rod as handholds for cockpit entry.

2.35.2.1 Canopy Door Handles. All four doors are locked closed or unlocked by latch handles installed at the door bottom frames (Figure 2-19). The doors are unlocked from inside by grasping the handle and rotating upward (aft) approximately 120 degrees, or until the locking overcenter linkage is operated. The door is then free to raise vertically the right side doors being raised by holding bungees. Locking operation is the reverse, with the handle being rotated forward (and overcenter) with the door fully down. Proper locking of each canopy door necessitates that both forward and aft latch pins be engaged and the handle in the full forward position. A lock bar installation on the aft latch of each canopy door prevents the latch handle from being placed in the locked position if the aft canopy latch lockpin is misaligned with the door lockpin hold-down fitting.

CAUTION

Before take-off, visually check the canopy door locking pins fully seated with the latch handles fully seated in the locked position.

2.35.3 Steps and Handholds. A folding step-ladder is provided on the right side of the fuselage and additional spring-loaded step/-handholds are provided for use in entering the cockpit or mounting the wing for refueling purposes (Figure 2-19).

2.35.4 Ejection Seats. The aircraft is equipped with LW-3B ejection seats and a command ejection selection system that provides the pilot or observer with the capability of ejecting both occupants (Figure 2-20). This seat provides safe recovery under nearly all speed-altitude conditions. Once initiated, the entire ejection

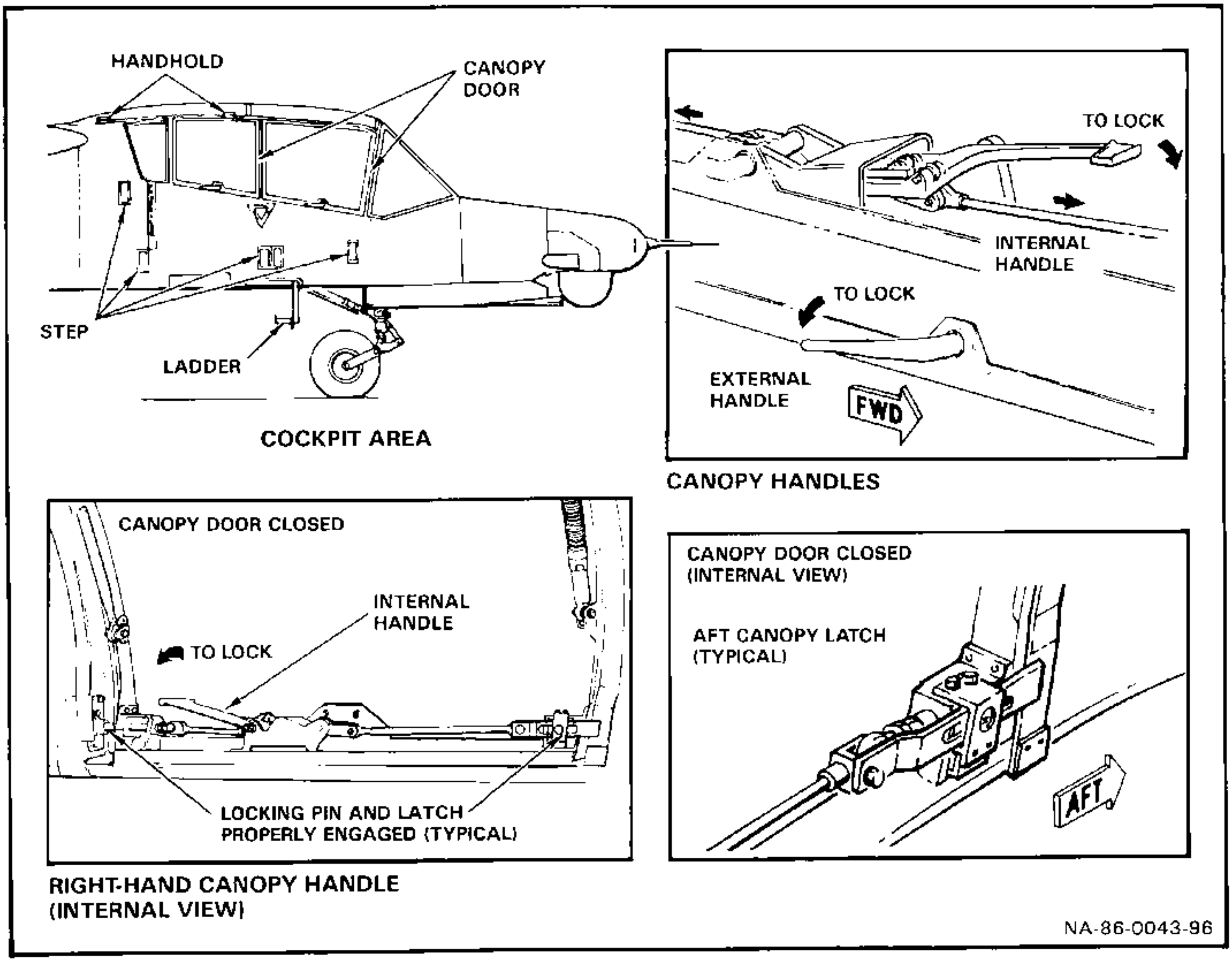
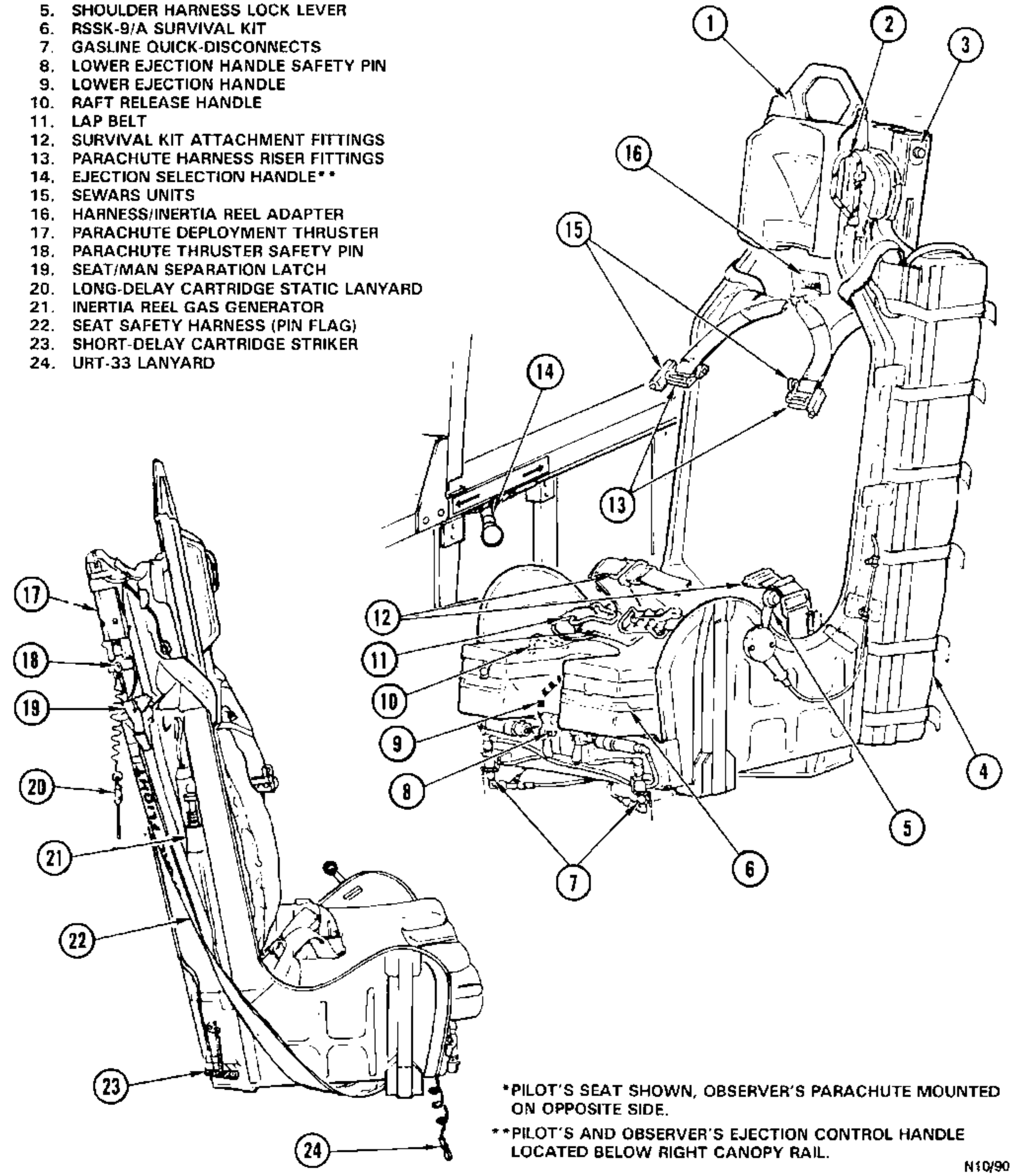


Figure 2-19. Entry and Exit

1. CANOPY BREAKER
2. PARACHUTE EMERGENCY RELEASE HANDLE
3. CATAPULT ATTACHMENT BOLT
4. RECOVERY PARACHUTE*
5. SHOULDER HARNESS LOCK LEVER
6. RSSK-9/A SURVIVAL KIT
7. GASLINE QUICK-DISCONNECTS
8. LOWER EJECTION HANDLE SAFETY PIN
9. LOWER EJECTION HANDLE
10. RAFT RELEASE HANDLE
11. LAP BELT
12. SURVIVAL KIT ATTACHMENT FITTINGS
13. PARACHUTE HARNESS RISER FITTINGS
14. EJECTION SELECTION HANDLE**
15. SEWARS UNITS
16. HARNESS/INERTIA REEL ADAPTER
17. PARACHUTE DEPLOYMENT THRUSTER
18. PARACHUTE THRUSTER SAFETY PIN
19. SEAT/MAN SEPARATION LATCH
20. LONG-DELAY CARTRIDGE STATIC LANYARD
21. INERTIA REEL GAS GENERATOR
22. SEAT SAFETY HARNESS (PIN FLAG)
23. SHORT-DELAY CARTRIDGE STRIKER
24. URT-33 LANYARD



*PILOT'S SEAT SHOWN, OBSERVER'S PARACHUTE MOUNTED ON OPPOSITE SIDE.

**PILOT'S AND OBSERVER'S EJECTION CONTROL HANDLE LOCATED BELOW RIGHT CANOPY RAIL.

N10/90
NA-86-0043-24B

Figure 2-20. Ejection Seat

sequence is automatic. After the seat penetrates the top canopy panel and clears the aircraft, the recovery parachute is deployed by a ballistically operated thruster which forces the pilot chute canopy into the airstream. Forced deployment of the personnel parachute provides extremely rapid canopy inflation and low-altitude/low-speed recovery capability. The seats are interconnected and the ejection sequence controlled by positioning the ejection selection handles to either the forward or aft positions. The handles are located on the right side of the pilot and observer cockpits below the canopy rail. The handles are mechanically connected by a common cable so the desired ejection sequence can be selected by either crewmember.

When the ejection selection handle is placed forward position (FWD COCKPIT BOTH EJECT/ AFT COCKPIT AFT ONLY EJECT), pilot initiated ejection will cause the observer to be ejected first followed by the pilot. If the observer initiates ejection with the handle forward, only he will be ejected and the pilot will remain. When the ejection selection handle is placed in the aft position (FWD/AFT COCKPIT BOTH EJECT), initiation of ejection by either crewmember will result in both crewmembers being ejected (the observer will be ejected first followed by the pilot). Ejection initiated by the pilot or observer will eject the aft seat after a 0.4-second delay of catapult initiators, which allows harness retraction to position occupant in the seat. The system sequencing further delays the front seat ejection by 0.5 second to allow separation between front and aft cockpit. The total elapsed time for front seat ejection is 0.9 second. The 0.9 second delay operates on front seat ejection even if the aft seat is ejected separately or is removed. Two parachute risers, located on the ejection seat back, are each equipped with a sea water (SEAWARS) activated parachute release/ sensor unit. The release/sensor units provide automatic release of the parachute canopy and connecting risers after landing in sea water following ejection as a back-up release system for manual primary release system. No high-altitude oxygen supply is provided.

WARNING

- Alternate escape (overside bail-out) is NOT POSSIBLE due to the design and mounting of the recovery parachute, which is an integral part of the seat. The advantage of forced chute deployment and the reliability of dual systems outweigh the lack of an alternate bail-out capability.
- A red warning light is located in the knob of each ejection selection handle. When illuminated, it indicates that the handle is not in the full FWD or full AFT position or that a malfunction exists in the linkage, switch adjustment, or selector valve.

2.35.4.1 Recovery Parachute. A 28-foot, flat canopy parachute is mounted in an elongated pack behind the seat back. The parachute canopy is forcibly deployed by a ballistic thruster (Figure 2-20) which expels a 1-pound slug. The slug is tied to a lanyard, which is connected to the apex of the pilot chute. Deployment thruster operation, seat acceleration, and pilot chute action combine to provide rapid parachute deployment. The recovery parachute on the pilot's seat is mounted on the left side, and the observer's on the right side of the seat back. The effective offset in ejected mass center of gravity provides lateral separation of the two seats in the event of pilot-initiated dual ejection.

2.35.4.2 Speed/Altitude Sensor. ACC 469 removed the arming key from the speed/altitude sensor (Figure 2-21). The plunger remains in the extended position, allowing contact with a striker (item 23, Figure 2-20) on the seat and firing the parachute deployment thruster short-delay cartridge (0.125 second). Should this cartridge fail to fire, the parachute deployment thruster long-delay cartridge (2.0 seconds) will be fired by a static lanyard (item 20, Figure 2-20) attached to the bulkhead.

WARNING

The parachute deploys immediately as the seat clears the cockpit and will inflate rapidly at high flight speeds. Ejection above 235 KIAS may result in high opening shock which may cause structural damage to the main parachute.

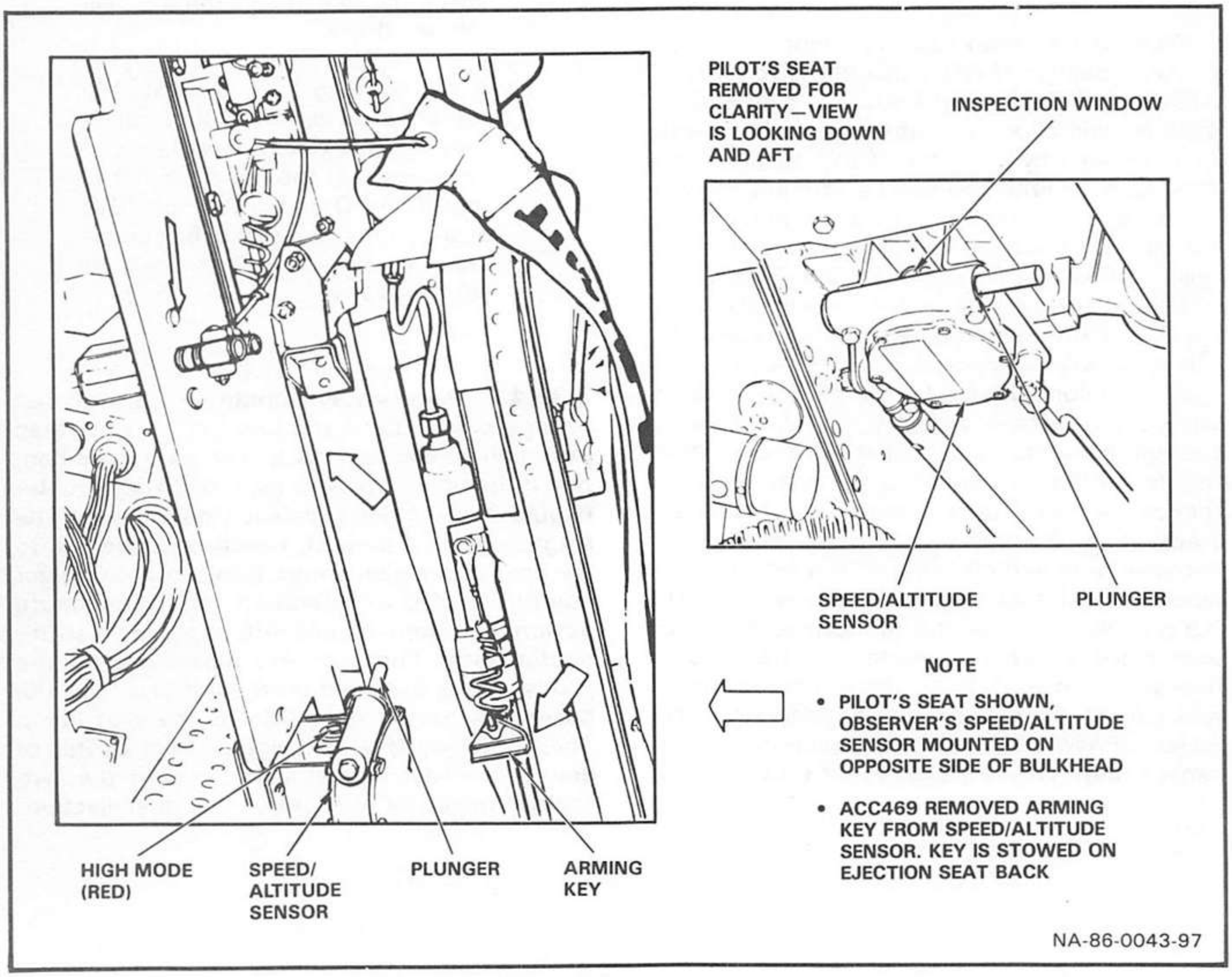


Figure 2-21. Speed/Altitude Sensor

2.35.4.3 Parachute Harness and Lap Belt. The MA-2P integrated harness garment is used. Koch fittings are used to secure the parachute risers, located on the ejection seat back, to the harness garment. Sea water activated parachute release/sensor units (SEWARS) are attached to the parachute riser koch fittings to provide a backup means for canopy release when the fittings are immersed in sea water. When the SEWARS sensor comes in contact with sea water, a circuit is completed to fire the electronically activated explosive device (EED). The EED cartridge fires and compresses a plunger in the plug assembly, releasing the pin and sleeve from the riser attach (koch) fitting releasing the riser from the restraint harness. Fittings at the lower attach points are used with rocket-jet fasteners to secure the survival kit straps to the harness (Figure 2-20). Seat/man retention is provided by a standard lap belt.

WARNING

The ejection seat and the RSSK-9A survival kit are equipped with all necessary padding and cushioning materials. Do not add any seat or back pad devices, as such material may disturb seat/man center of gravity enough to cause severe tumbling and injury on ejection.

2.35.4.4 Inertia Reel. A ballistically operated inertia reel provides crewmember retention in an upright position during maneuvering, deceleration, and ejection. The reel may be manually locked and unlocked during normal use by the shoulder harness lock lever. The reel mechanism is attached to the upper portion of the parachute harness by a strap which, when in the unlocked condition of the reel allows the crewmember to lean forward as desired. When locked by the handle or a 2- to 3-g deceleration, the reel prevents any further play-out. On ejection, the inertia reel ballistic device is actuated, winding in the strap and restraining the crewmember in the retracted position in the seat.

2.35.4.5 Raft Release Handles. The raft release handle (Figure 2-20) is mounted on the right side of the survival kit. For operation of the kit deployment handle, refer to Part V, Chapter 16.

2.35.4.6 Automatic Emergency IFF. Ejection departure of the pilot's seat closes a switch which activates the emergency mode of IFF-SIF operation for emergency radar tracking purposes. When the ejection switch is open (seat installed), manual or CMS-CDU selection of the emergency mode is required. Ejection emergency IFF operation overrides all previously selected IFF modes except OFF and automatically selects the proper SIF code for emergency operation and IFF interrogation.

2.36 EJECTION SEAT CONTROLS

Seat controls include seat adjust switches, the lower ejection handle, shoulder harness lock levers, parachute emergency release handle, seat safety harness, and the ejection selection handles.

2.36.1 SEAT ADJUST Switches. A SEAT ADJUST switch is located above the right console (Figure 1-3) in the pilot's cockpit and on the right side of the observer's cockpit (Figure 1-6). The seats may be adjusted through a 5-inch vertical range.

2.36.2 Lower Ejection Handle. Lower ejection handle (Figure 2-20) is mounted on the seat bucket between the crewmember's legs. Ejection is initiated by pulling the handle upward approximately 2 inches, which fires a set of dual initiators. A lower ejection handle safety pin (Figure 2-20) is provided for insertion when the aircraft is on the ground.

2.36.3 Shoulder Harness Lock Lever. The shoulder harness lock lever (Figure 2-20) is mounted on the left side of the seat. Moving the lever to LOCKED (forward) prevents the crewmember from leaning forward by locking the inertia reel. The reel may be unlocked by leaning back to remove tension from the reel and moving the lever aft to UNLOCK. If the reel is locked automatically, it may be unlocked by cycling the lever.

2.36.4 Parachute Emergency Release Handle. The parachute emergency release handle (Figure 2-20) is located on the left side of the seat headrest. Should the parachute deployment thruster fail to fire, chute deployment and seat separation may be initiated by pulling this handle. Pulling the handle fully down fires a ballistic cutter which severs the lanyard between the chute canopy and the thruster slug. A spring-loaded lever holds the parachute emergency release handle in place until the ejection seat has left the aircraft. This prevents inadvertent operation of the parachute emergency handle. Separate action also opens the parachute pack through a cable-operated rip cord. Deployment of the parachute then accomplishes the seat/man separation sequence.

2.36.5 Seat Safety Harness. Two safety pins are installed on the seat when not occupied for flight (Figure 2-20). One pin secures the lower ejection handle and the other safeties the parachute deployment thruster on the aft right side of the pilot's seat and the aft left side on the observer's seat. These pins are connected by a seat safety harness red streamer, which should be stowed after the crewmember is strapped in. The observer's seat is provided with a survival kit/seat cushion harness which retains the kit in place when the seat is unoccupied.

CAUTION

The observer's seat lap belt does not provide sufficient survival kit restraint and the seat cushion harness must be used during solo flight.

2.36.6 Ejection Selection Handles. The ejection selection handles, located in each cockpit below the right canopy rail, allow either crewmember to initiate the normal dual ejection sequence by pulling his lower ejection handle. Normal sequencing is aft seat followed by the forward seat. Ejection from either cockpit is through the canopy.

2.36.6.1 Pilot Initiated Ejection. To initiate the dual ejection sequence the pilot must place his ejection selection handle to the FWD COCKPIT BOTH EJECT (FWD) position. The pilot would then pull his lower ejection handle to start the dual ejection sequence. With the ejection selection handles in the FWD position, the observer may also eject independently by pulling his lower ejection handle without affecting the pilot. With the ejection selection handle left in the FWD position (after the observer has ejected) the pilot can then eject as required.

2.36.6.2 Observer Initiated Ejection. The observer must set his ejection selection handle to the FWD/AFT BOTH EJECT (AFT) position. He would then pull his lower ejection handle to start the dual ejection sequence. Independent observer ejection is not available when the control lever is in the AFT position.

2.37 EJECTION SEAT OPERATION

During all ejections, the recovery parachute is deployed immediately as the seat clears the cockpit. The parachute deployment thruster partially deploys the parachute canopy and the pilot chute continues inflation and deployment action. Deployment of the chute automatically provides seat/man separation. Force on the risers from the inflating parachute separates the seat back from the seat bucket sufficiently to operate an overcenter device which releases the riser attach fitting from the inertia reel adapter fitting, freeing the upper riser adapter to leave the seat with the parachute risers. The same action also releases the lap belt as end fittings. As the drag on the inflating parachute decelerates the crewmember, the released seat assembly is carried upward and ahead, providing positive seat/man separation. (Refer to Part V, Chapter 16).

WARNING

If a parachute deployment does not occur immediately following ejection, pull the parachute emergency release handle.

ALTITUDE VS DIVE ANGLE

NOTE:
TERRAIN CLEARANCE REQUIRED IS MEASURED TO THE POINT OF INITIATION

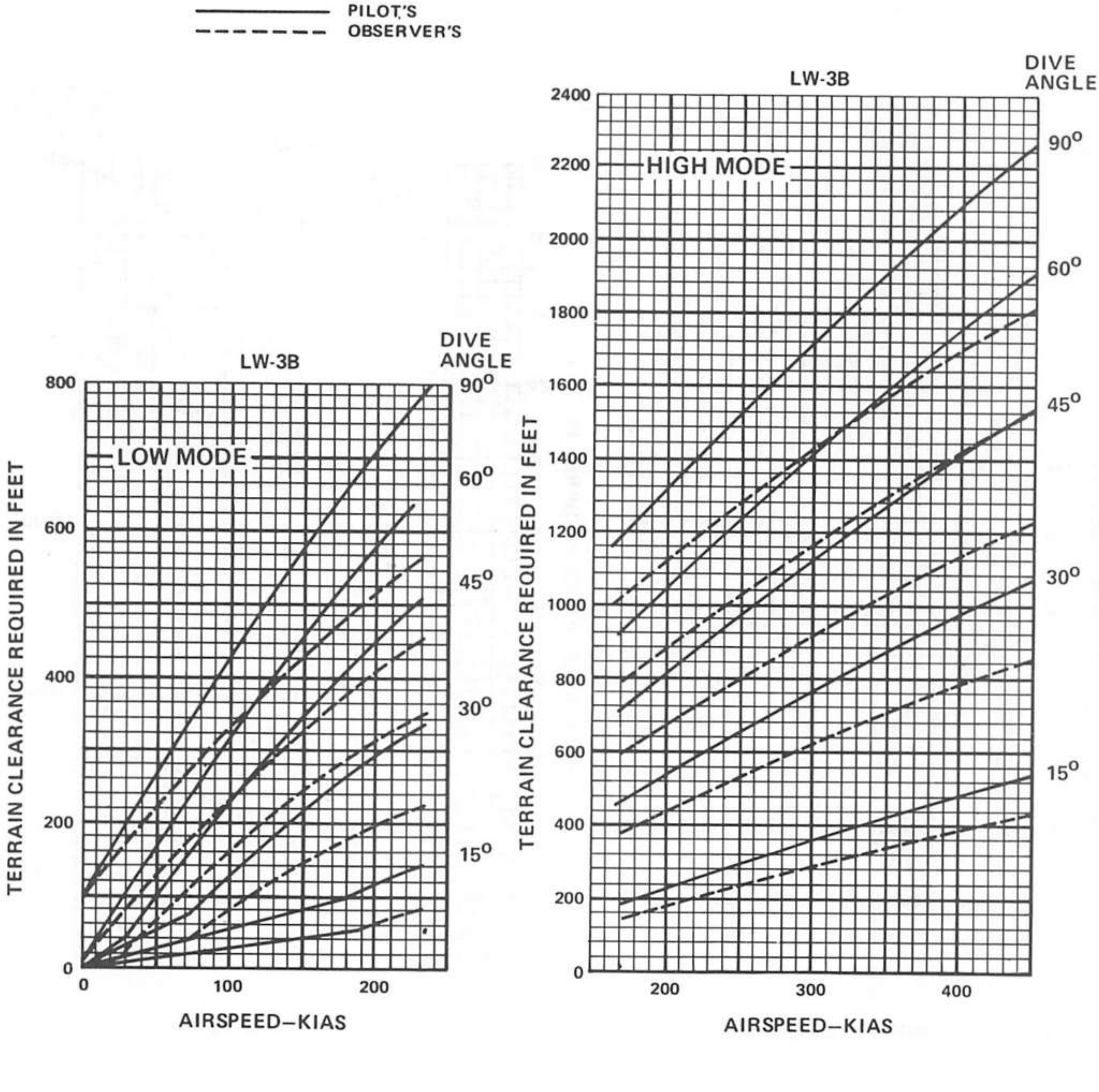


Figure 2-22. Recovery Capability, Dive Angle (Sheet 1 of 3)

SINK RATE

ALTITUDE VS SINK RATE

NOTE :

TERRAIN CLEARANCE REQUIRED IS MEASURED TO THE POINT OF INITIATION

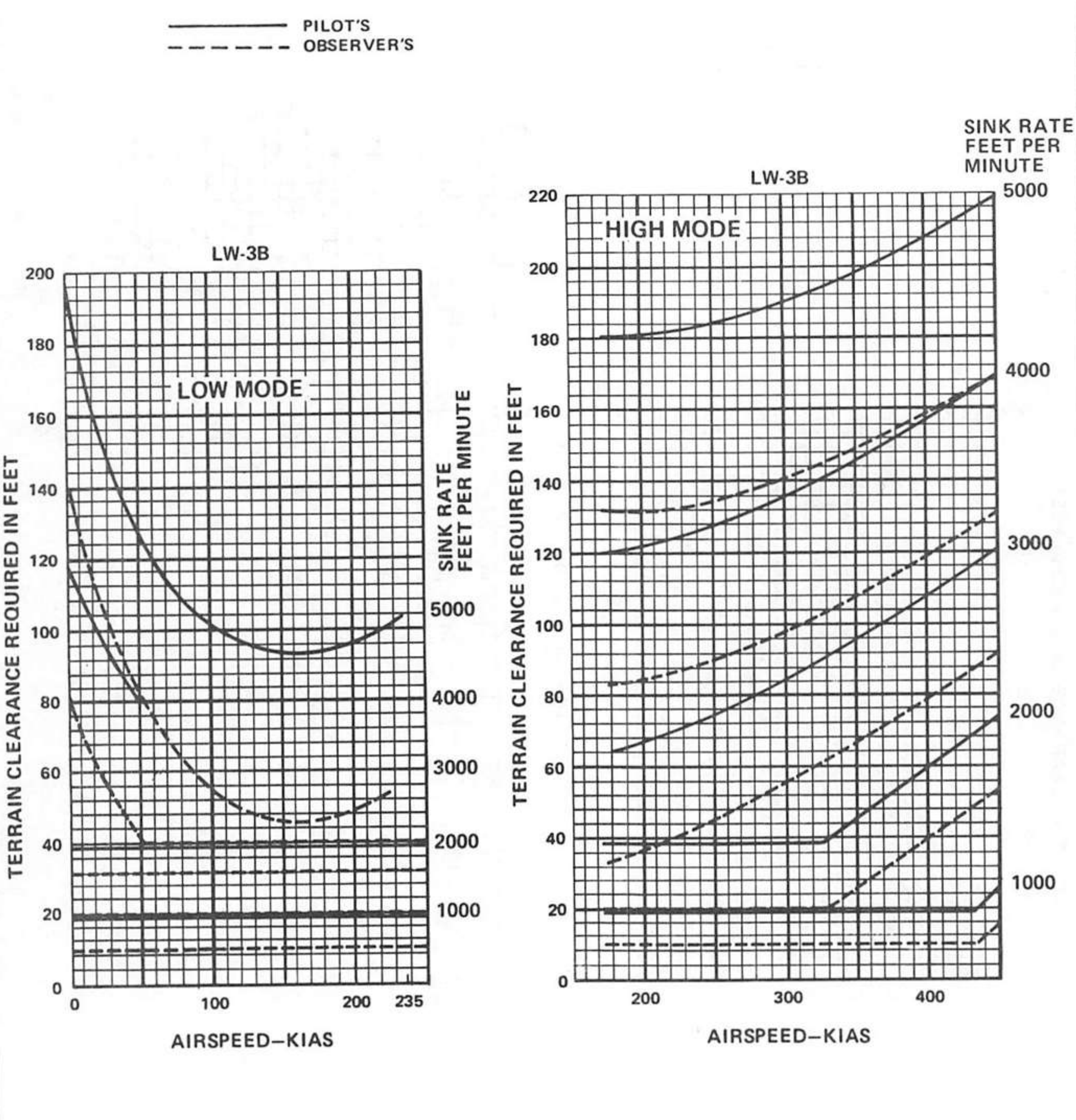


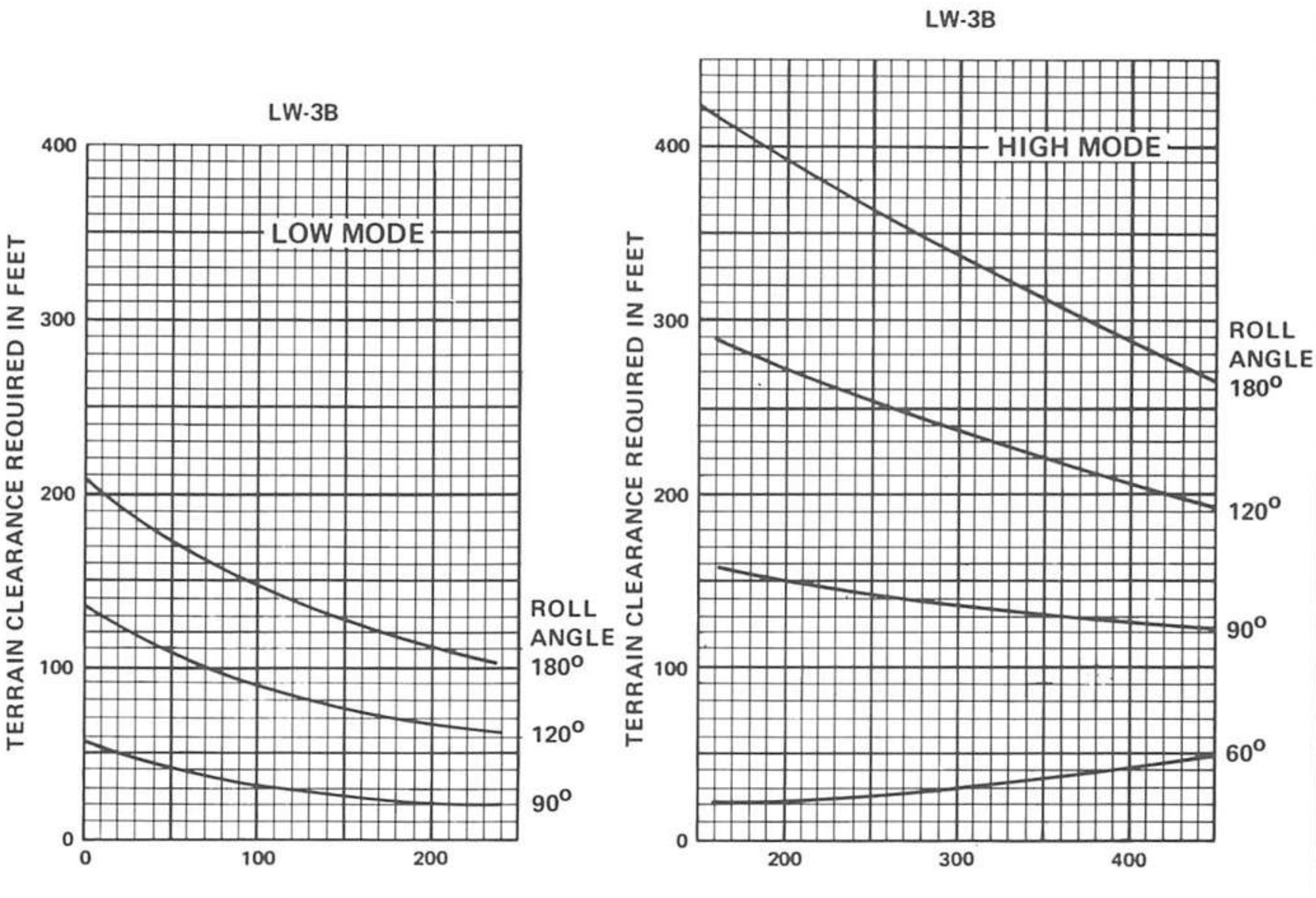
Figure 2-22. Recovery Capability, Sink Rate (Sheet 2 of 3)

ROLL ANGLE

ALTITUDE VS ROLL ANGLE

NOTE:

1. TERRAIN CLEARANCE REQUIRED IS MEASURED TO THE POINT OF INITIATION
2. CURVES ARE FOR BOTH THE PILOT AND OBSERVER



NA-86-0043-100

Figure 2-22. Recovery Capability, Roll Angle (Sheet 3 of 3)

2.37.1 Recovery Capability. Figure 2-22 shows the recovery capability of the LW-3B escape system in terms of required terrain clearance at initiation of ejection for successful recovery from various aircraft flight conditions. Altitudes shown are absolute minimums at which the system will consistently provide recovery capability. The recovery charts show initiation requirements for both pilot and observer.

To illustrate the use of the charts, assume the seat system is in the low mode, aircraft velocity is 200 KIAS and a dive angle of 90 degrees exists. For both crewmembers to be safely recovered, the pilot must initiate the system above 710 feet. The observer could initiate his escape system above 520 feet and safely recover. To depict the influence of sink rate, ground level recovery for both crewmembers at 200 KIAS is possible with zero sink rate. However, with the system in low mode, aircraft velocity 200 KIAS, and sink rate of 5000 feet per minute, the pilot must initiate ejection above 96 feet for successful recovery.

2.38 ENVIRONMENTAL CONTROL SYSTEMS

2.38.1 Heating, Ventilation, and Defrost Systems. Hot air from the engine compressors is used in combination with ram air to provide controlled temperature air for cockpit heat and to provide defrost air. Engine compressor bleed air is routed to an air mixing chamber forward of the pilot's instrument panel, and directly to anti-G valves on the left side of both cockpits. Mixing chamber air, controlled to desired temperature, is directed into the pilot's cockpit through the windshield defrost duct and footwarmer, and into the observer's cockpit by jet pump action through an air distribution tube, and through an aft footwarmer below the observer's instrument panel. For a system block schematic, see Figure 2-23.

2.38.2 Heat, Vent, and Defrost Controls. Various heating, ventilation, and defrosting controls are located in the front and rear cockpits. For detailed descriptions of the controls, see the following paragraphs.

2.38.2.1 BLEED AIR Switches. The BLEED AIR switches (Figure 2-23) on the pilot's right console are marked LH and RH (left and right engines), with NORM and EMER OFF positions. These switches are used to close pressure-operated engine bleed air valves which open normally on engine start, and close normally as pressure drops following engine shutdown. The switches are normally left in NORM but may be positioned to EMER OFF as desired or in the event of wing battle damage.

2.38.2.2 Temperature Knob. The TEMP knob (Figure 2-23) on the pilot's exterior lights, and conditioning panel mechanically controls a shut-off valve in the compressor air line leading to the air mixing chamber. Pulling the TEMP knob outward increases heat input to the chamber.

NOTE

> Selection of full heat (TEMP knob full out) results in a reduction of available engine torque by approximately 150 pound-feet per engine at Military power at sea level on a Standard Day.

2.38.2.3 RAM AIR Knob. The RAM AIR knob (Figure 2-23) mechanically operates a valve which controls the flow of ram air into the top of the air mixing chamber. Pulling the RAM AIR knob outward increases ram-air flow through the foot-warmers and defrost air tubes. Turning the RAM AIR knob to the right locks the knob and ram-air door at the desired position.

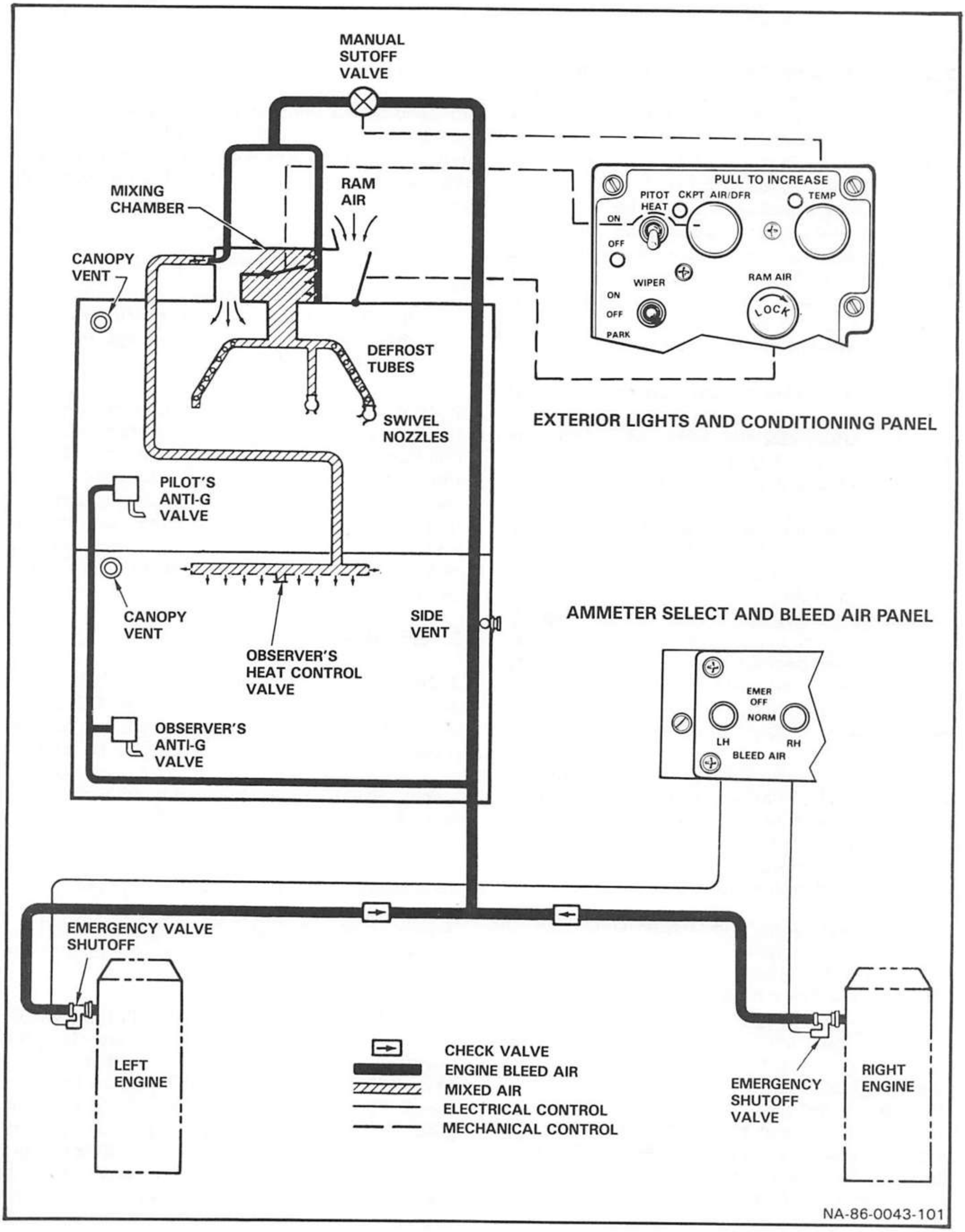


Figure 2-23. Heat-Vent-Defrost System

2.38.2.4 Cockpit Air/Defrost Knob. The CKPT AIR/DFR knob (Figure 2-23) on the pilot's exterior lights, and conditioning panel mechanically controls a diverter valve in the mixing chamber outlet duct. Pulling the knob outward decreases the amount of air directed to the windshield defrost ducts and diverts air to the cockpit. A certain amount of air bleeds through the defrost ducts under these conditions. With the knob pushed full forward, maximum air is supplied to the defrost ducts. The pilot's defrost tube is equipped with swivel nozzles which allow control of airflow direction as desired.

2.38.2.5 Observer's Heat Control Valve. Aft cockpit footwarmer tube airflow may be controlled by a foot-operated slide valve. Airflow is increased by moving the valve to the left, or closed off by moving the valve to the right.

2.38.2.6 Canopy Vents. An adjustable ventilation valve (Figure 1-1) is installed in the left forward corner of the canopy center panel above each crewmember's seat. Pushing the valve body upward allows air to flow into the cockpit. Airflow direction may be adjusted by turning the valve body as desired. Pulling the valve body downward shuts off airflow. By turning the valve body to the rear, the ram inlet may be used as an air ventilation outlet.

2.38.2.7 Observer's Side Air Ventilation Valve. A swivel-ball air valve (Figure 1-1) is installed on the right side of the observer's cockpit area. This valve is pushed outward to open and pulled inward to close. The swivel provides control of air direction as desired.

2.38.3 Heat, Vent, and Defrost Operation. To obtain warm airflow for cold weather operation, pull the RAM AIR knob out and lock as desired, then pull the TEMP knob out as required to provide sufficient heat at desired volume. Pulling the TEMP knob only, with the RAM AIR knob in, may result in insufficient airflow for comfort, even though air temperature is sufficiently high. By opening the ram-air valve, additional airflow is generated through jet pump action of the heat input diffuser in the mixing chamber. To obtain footwarmer flow, push the CKPT AIR/DFR knob in as desired. To obtain ventilation for hot weather operation, ensure the TEMP knob is pushed completely in, pull the RAM AIR knob out, and adjust the canopy ventilators and side ventilation valve as desired. To obtain maximum defrost, pull the RAM AIR and TEMP knobs as required, and push the CKPT AIR/DFR knob full in.

CAUTION

Pulling the TEMP knob full out with the RAM AIR knob pushed full in may result in overheat damage to the windshield panels.

2.38.4 Oxygen System. A diluter-demand, regulated, gaseous oxygen system may be installed. The oxygen regulators are installed on the pilot's right console and on the right side of the observer's cockpit. Oxygen supply is stored in two 514-cubic inch bottles, which are installed on the cargo bay ceiling behind the observer's cockpit. For oxygen duration data, see Figure 2-24.

2.38.5 Oxygen System Controls

2.38.5.1 Oxygen Regulator. A CRU-44/A diluter-demand regulator panel (Figure 2-25) is installed on the pilot's right console and on the right side of the rear cockpit as part of the observer's cockpit package. These regulators automatically supply the proper mixture of air and oxygen at all altitudes.

2.38.5.1.1 Supply Lever. The oxygen supply lever must be positioned to ON to provide oxygen pressure in the regulator. The OFF position does not affect system pressure indication, which is reflected by the pressure indicator on the regulator panel.

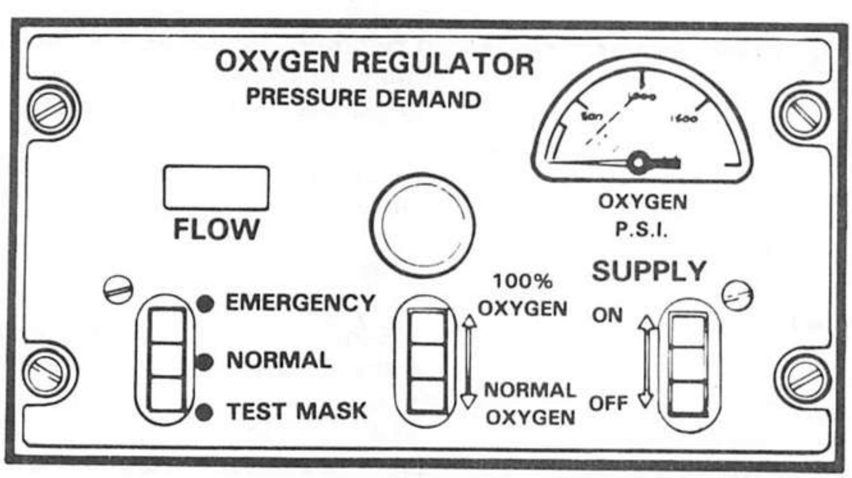
2.38.5.1.2 Diluter Lever. The diluter lever is used to select normal regulator diluter-demand operation (NORMAL OXYGEN) or undiluted pure oxygen (100 percent OXYGEN). The diluter lever should be placed at 100 percent OXYGEN for all ground operations and for other phases of flight as desired. Operation in 100% OXYGEN position reduces the available oxygen duration. The 100% OXYGEN Position should also be used any time smoke or fumes are detected in the cockpit.

TWO CREW MEMBERS
DOUBLE VALUES FOR SINGLE CREW MEMBER

ALTITUDE (FEET)	GAGE PRESSURE - PSI 1800	1500	1200	900	600	300	BELOW 300
NORMAL OXYGEN							
25,000	5.4	4.5	3.6	2.7	1.8	0.9	DESCEND BELOW 10,000 FEET
20,000	6.1	5.1	4.1	3.0	2.0	1.0	
15,000	7.4	6.2	5.0	3.7	2.5	1.2	
10,000	9.9	8.2	7.4	4.9	3.7	1.8	
100% OXYGEN							
25,000	4.3	3.6	2.8	2.1	1.4	0.7	DESCEND BELOW 10,000 FEET
20,000	3.3	2.7	2.2	1.6	1.1	0.5	
15,000	2.6	2.2	1.7	1.3	0.8	0.4	
10,000	2.1	1.7	1.4	1.0	0.7	0.3	

NA-86-0043-102

Figure 2-24. Oxygen Duration (Hours)



NA-86-0043-103

Figure 2-25. Oxygen Regulator

2.38.5.1.3 Oxygen Pressure Indicator. The oxygen pressure (OXYGEN P.S.I) indicator on the regulator panel indicates the total pressure remaining in the oxygen supply bottles. The indicator should be checked prior to flight to assure sufficient oxygen service to complete the planned mission. The indicator should also be checked periodically in flight to guard against inadvertent use of 100% OXYGEN, or a leak in the system.

2.38.5.1.4 Emergency Lever. The emergency lever is used to select NORMAL operation (spring-loaded to return from TEST MASK), to select EMERGENCY flow pressure, or to check oxygen mask fit and system flow (TEST MASK position).

2.38.5.1.5 Flow Indicator. The flow indicator should blink white on each inhalation, returning to black on exhalation, reflecting proper passage of air or oxygen through the regulator. Though this indicator does not reflect proper oxygen ratio or flow, lack of positive indication should be interpreted as a regulator malfunction. With the emergency lever in TEST MASK or EMERGENCY, the indicator remains in white condition.

2.38.6 Oxygen System Check. The following preflight check should be performed on all flights with the oxygen system installed:

1. Oxygen pressure indicator–MINIMUM FOR FLIGHT (Full = 1800 psi).

2. Aircraft and mask hoses–CHECK CONDITION AND FITTINGS.

3. SUPPLY lever–OFF.

4. Attempt to obtain oxygen.

NOTE

It should not be possible to obtain oxygen with the supply lever OFF.

5. SUPPLY lever–ON.

6. Diluter lever–100% OXYGEN.
Perform blow-back check to ensure regulator diaphragm continuity.

NOTE

Little or no resistance to blow-back check indicates a faulty regulator diaphragm.

7. Mask-hose connections–SECURE.

8. Diluter lever–NORMAL OXYGEN OR 100% OXYGEN, as desired.

9. Mask–SECURE AND TIGHT.

10. Emergency lever–TEST MASK (hold and check for leaks).

2.38.7 Oxygen System Normal Operation. During flight with the oxygen system installed, check the system as follows:

1. Diluter lever–NORMAL OXYGEN.

2. Flow indicator–CHECK PERIODICALLY FOR NORMAL INDICATIONS.

3. OXYGEN P.S.I. indicator–CHECK PERIODICALLY FOR NORMAL DEPLETION.

2.38.8 Oxygen System Emergency Operation. If symptoms of hypoxia occur, or with smoke or fumes in the cockpit, set the diluter lever to 100% OXYGEN. If necessary, set emergency lever to EMERGENCY. After the emergency is over, return the emergency lever to NORMAL, as supply will be rapidly depleted.

2.39 ANTI-G SUIT SYSTEM

Engine compressor bleed air is directed to an anti-G suit valve (Figure 1-2) in the pilot's cockpit and on the left side of the observer's cockpit. During maneuvering flight, air pressure regulated to between 1.5 and 2.0 psi per "g" (over and above 1.0 "g") is directed into the crewmember's anti-G suits. A manual valve override button is provided on top of each valve, which is used to check anti-G system operation.

2.40 WINDSHIELD WIPER

An electrically operated windshield wiper is installed for use in rain removal from the windshield forward panel. The wiper system is designed to operate normally at a maximum speed of 200 KIAS.

2.40.1 WIPER Control Switch. The WIPER control switch (Figure 2-23) is located on the pilot's exterior lights and conditioning panel. A switch provides OFF-ON-PARK selections. On selection of OFF, the wiper blade stops in place. The PARK position moves the blade to the right side of the windshield.

CAUTION

The windshield wiper shall not be operated on dry glass.

2.41 CARGO AND PARATROOP TRANSPORT PROVISIONS

The cargo compartment, excluding the interior of the cargo door, measures 30 inches wide, 39 inches high, and 90 inches long with the cargo barrier package installed, providing approximately 61 cubic feet of usable volume on 19 square feet of flooring. The package is composed of a forward cargo barrier, fiberglass side panels, basic flooring, and required restraint straps and hinged tie-down rings. Care must be taken when loading the cargo bay to ensure that aircraft cg locations remain within prescribed limits. The cargo floor is capable of supporting a maximum of 200 pounds per square foot, or a maximum of 2633 pounds total cargo weight (Figure 2-26).

2.41.1 Cargo Door. A manually operated cargo door is installed. The door is hinged on the port side and swings open 180 degrees, providing unlimited access to the cargo compartment entrance. The cargo door handle is mounted on the right side of the fuselage (inside and outside), forward of the entrance. To unlock, rotate the handle down to the UNLOCK position. To lock, once the door is fully closed, firmly rotate the handle to LOCK position (aligned with the fuselage).

NOTE

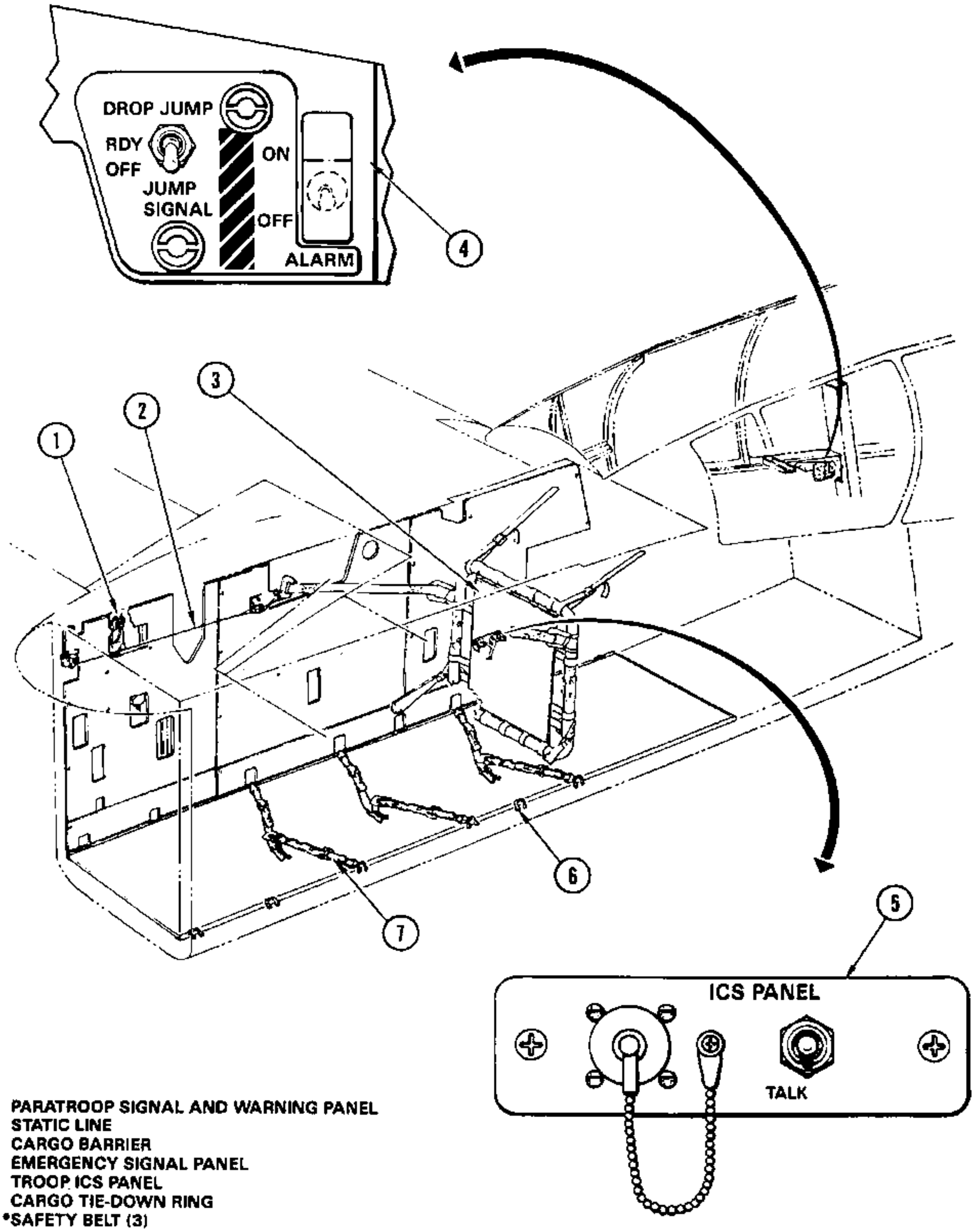
Paratroop and cargo drop missions requires cargo door removal and cargo bay stowage of electrical cables. The FLIR/LRD system and mission recorder system will be disabled during open cargo bay flight operations.

2.41.1.1 Cargo Door Hold-Open Rod. A telescoping hold-open rod is installed in the apex of the cargo door cone. This rod may be used to secure the door to receiving rings on the left boom (90 degrees open). To lock the door in an open position, depress the release button adjacent to the stowed rod and pull the rod to the length desired. The rod and its door retainer lock into the ring, securing the door in position. To release the rod, depress the locking collar at the base of the retainer and push the rod fully into the stowage tube in the cargo bay door.

NOTE

A nylon cord bungee restricts door travel to approximately 108 degrees to prevent damage to cargo bay door components and wiring in the event of wind gusts.

2.41.2 Paratroop Transport Configuration. The paratroop transport configuration consists of the basic cargo flooring and barrier, three safety belts, a troop ICS panel, a parachute static line installation, side panel covers, and a troop signal and warning system (Figure 2-26).



1. PARATROOP SIGNAL AND WARNING PANEL
2. STATIC LINE
3. CARGO BARRIER
4. EMERGENCY SIGNAL PANEL
5. TROOP ICS PANEL
6. CARGO TIE-DOWN RING
7. *SAFETY BELT (3)

*SAFETY BELTS INSTALLED AS REQUIRED FOR CARGO CONFIGURATION

Figure 2-26. Cargo and Paratroop Transport Equipment

2.41.2.1 Emergency Alarm. A troop warning alarm (horn) is located in the upper aft left corner of the cargo compartment. The alarm is operated by the pilot's ALARM switch (Figure 2-26) located on the emergency signal panel above the left console. The emergency alarm operates off the battery bus and therefore will function any time a charged battery is installed.

2.41.2.2 Cargo Troop Signal Lights. A green DROP/JUMP light and an amber READY light are installed on the paratroop signal and warning panel, located in the upper aft left cargo bay. These press-to-test, signal lights are operated by the pilot's signal switch on the emergency signal panel above the left console. The RDY position is used to alert paratroops or cargo master to prepare for mission execution. The DROP/JUMP position is used to signal execution of troop jump or cargo drop (Figure 2-26).

2.41.2.3 Troop ICS Panel. An intercom disconnect panel is located on the forward right side of the cargo compartment for headset and microphone connection (Figure 2-26). ICS communication is available at all times with primary dc electrical power available, providing the observer's intercom (ICS) monitor panel has the INT button pulled UP and set to mid-range. A push-to-talk microphone switch or the TALK button on the troop ICS panel may be used for transmitting on the ICS system.

2.42 EMERGENCY EQUIPMENT

2.42.1 First Aid Kit. A first aid kit is installed in the observer's cockpit on the upper left side of the instrument panel.

2.42.2 Survival Kit. An RSSK-9A rigid survival kit (Figure 2-20) is installed in each ejection seat. The delivered kit contains standard PK-2 survival equipment. A personnel locator beacon which can be set for automatic or manual operation is also installed in the survival kit.

2.43 MISCELLANEOUS EQUIPMENT

2.43.1 Underwater Acoustic Locator System. A battery-powered, water-activated (fresh or sea), acoustic locator beacon is installed in the upper, aft cargo bay. When activated, the beacon will transmit a one pulse-per-second acoustic signal at 37.5 kHz for 30 days from the water surface down to 20,000 feet. Search operations for aircraft which have crashed in the water are conducted by utilizing a portable receiver equipped with a directional hydrophone to detect the acoustic locator beacon signal. The locator beacon can be detected at a range of 2000 to 4000 yards depending on sea state and ambient noise (Figure 1-1).

NOTE

Inadvertent exposure of the beacon water switch to any source of water such as rain, salt spray, melting ice, or snow will initiate locator beacon electronic emission.

2.43.2 Armor Plating. Crew protection from shrapnel and small arms fire is provided by one-half inch thick armor plating in both cockpits. Plating is located in the pilot's seat back, flooring, and side console areas. The observer is protected by plating in the cockpit floor and consoles.

2.43.3 Map and Data Cases. A map and publications case is provided on the pilot's right console (Figure 1-2). A map stowage case is installed on the right console of the observer's cockpit (Figure 1-6).

2.43.4 Message Drop Door. A foot-operated, spring-loaded message drop door system is installed in the aft cockpit. The door and foot pedal are located on the cockpit floor forward of the observer's control stick (Figure 2-27). The system is operated by depressing the pedal lever forward with the left foot, which simultaneously opens the inner and outer doors. An overcenter mechanism overrides the spring-closing feature, holding the doors open with the pedal depressed full forward.

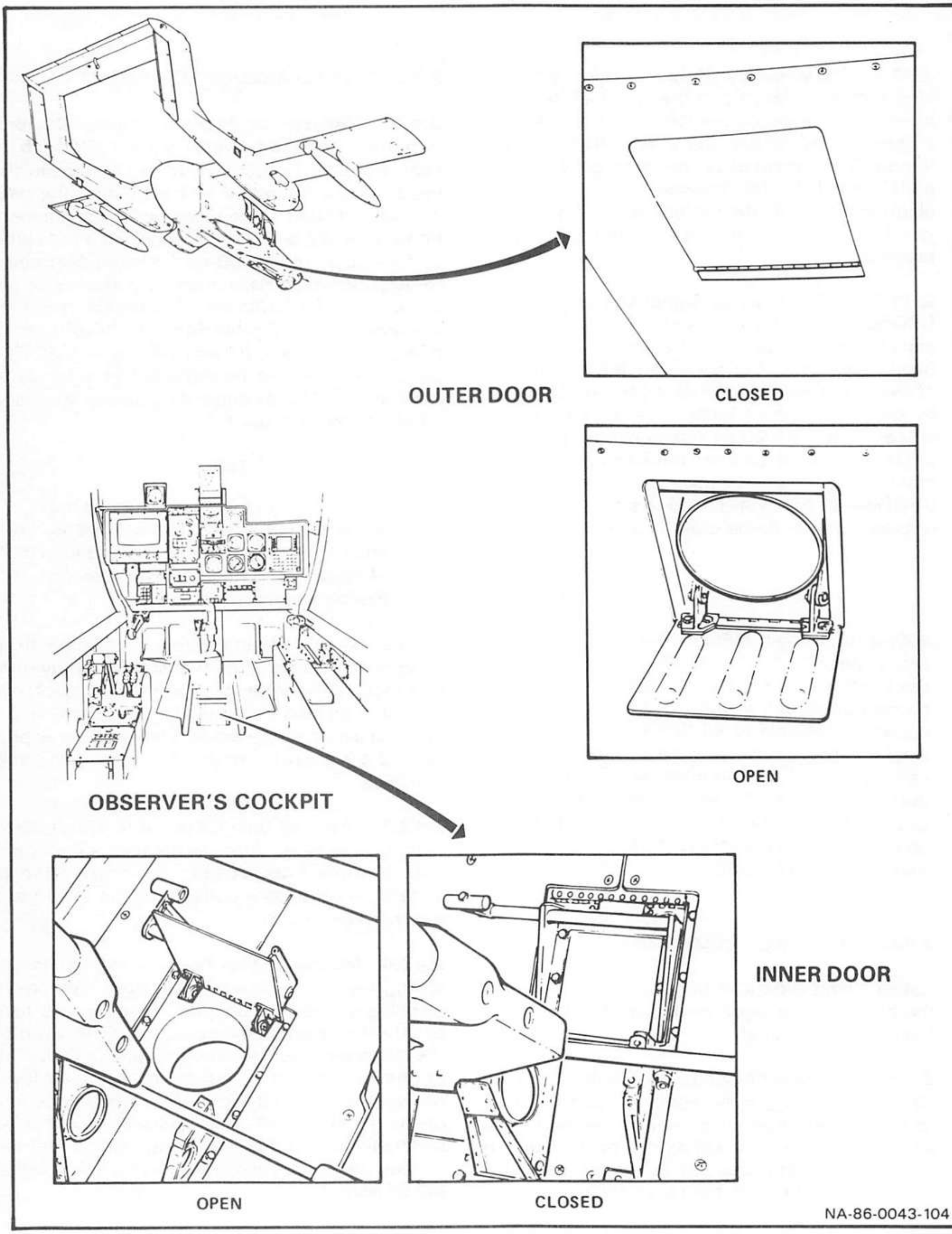


Figure 2-27. Message Drop Installation

2.43.5 Smoke Generating System. A smoke generating system is incorporated so the aircraft may be more easily identified by airborne or ground personnel. The system consists of an oil tank, pressure pump, nozzle, necessary lines, and a cockpit control switch and circuit breaker. Components of the system are located in the left wheel well and in the pilot's upper cockpit. The smoke generating system utilizes fog oil (MIL-F-12070) and has a capacity of approximately 2.3 gallons. When smoke is desired, placing the SMOKE GEN switch (Figure 1-4) to ON will cause oil to be pumped under pressure through a nozzle into the exhaust duct of the left engine. This atomized oil vaporizes in the exhaust gases, leaving a heavy smoke trail.

2.43.5.1 Smoke Generating System Oil Tank. A smoke generating system oil tank is mounted on the inboard side of the left wheel well. Capacity is approximately 2.3 gallons and the filler access cap is located on top of the tank. The wheel well installation includes a pump mounted on the bottom of the tank.

2.43.5.2 Smoke Generating System Control Switch. The smoke generating system control switch (SMOKE GEN) is located on smoke generator, salvo flare and gunsight dimmer panel (Figure 1-4) in the pilot's cockpit. The switch has ON and OFF positions and is powered from the monitored 28-VDC bus. The circuit breaker for the system is located on the dc circuit-breaker panel behind the observer's headrest.

2.43.6 Relief Tubes. A relief tube is installed on the right side of the pilot's cockpit (Figure 1-5) and in the aft cockpit (Figure 1-6).

2.43.7 Rearview Mirrors. Two rearview mirrors are installed on the pilot's windshield bow (Figure 1-4). A rearview mirror is installed in the observer's compartment for view of circuit breaker panel.

2.43.8 Landing Checklists. Common landing checklist placards are located on the pilot's and observer's instrument panels (Figures 1-3 and 1-6). In addition, the cockpit management system provides a common take-off checklist page for both crewmembers and a separate landing checklist page for the pilot and observer. For CMS display access and description refer to Part VII, Chapter 19.

CHAPTER 3

Service and Handling

3.1 SERVICING DATA

3.1.1 Aircraft Servicing. For servicing locations, see Figure 3-1.

3.1.2 Material Specifications

MATERIALS	MILITARY SPECIFICATIONS	FLIP CODES	NATO CODES
Fuel			
Primary	MIL-T-5624	J5	F-44
Alternate	MIL-T-5624	J4	F-40
Alternate	MIL-T-83133	J8	F-34
Alternate	ASTM (Civil Jet A-1)	TA1	F-34
Alternate	ASTM (Civil Jet B)		F-40
Emergency	MIL-G-5572	A+	F-22
Hydraulic Fluid	MIL-H-83282	None	None
Oil			
Engine	MIL-L-23699	None	O-156
Smoke Generator System	MIL-F-12070	None	None
Oxygen Gaseous	MIL-O-27210	LPOX	None
Nitrogen	MIL-N-6011, Grade A	None	None

3.2 EXTERNAL POWER

The aircraft electrical system is designed to permit normal engine starts with battery power; however, when tactically feasible, engine starts may be made using external electrical starting power. Starting units should be capable of providing 28-VDC power at a minimum of 300 amperes for utility power and 1000 amperes for starting power with a maximum of 1250 amperes.

CAUTION

- If external power unit fails when initiating start, overtemperature could occur. Proceed as outlined in Part V.
- Use of higher rated units may cause damage to the starter-generator, which do not contain current limiters.

Usable electrical power units are as follows:

USN UNITS	USAF UNITS
NC-5*	C-26 (1200 amp)
NC-7*	C-26 (1000 amp)*
NC-8A (with 1100-amp/ 28-VDC adapter)*	MD-3*
NC-10A-1†	
NC-12A	
60G20S (Navy-Hobart)*	
JEX-EX (Hobart Commercial)*	

† Switch must be in the 1100 AMP position for start.

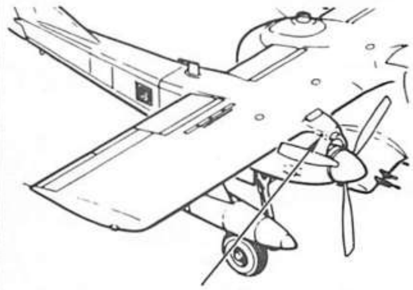
NOTE

* The OV-10D aircraft is configured to require only one cable and will use only the oval plug cable from a two-cable cart.

3.3 REFUELING

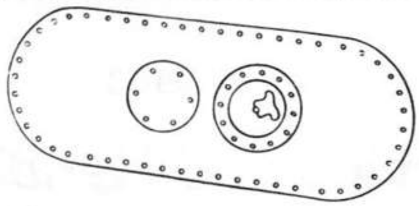
Refueling is accomplished manually through tank filler receptacles. To refuel the aircraft, proceed as follows:

1. If used, ensure fuel truck properly grounded.
2. Ensure aircraft properly grounded.



Ⓐ OIL SYSTEMS

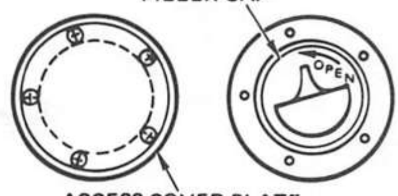
EACH TANK-1.5 GALLONS



Ⓑ REFUELING (GRAVITY FILL)

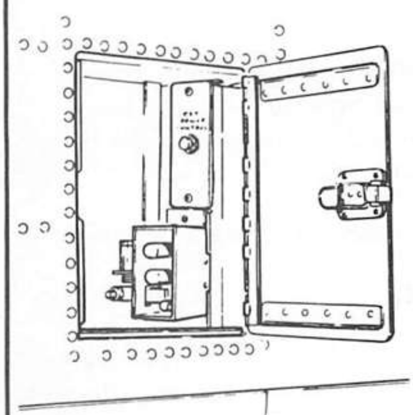
TYPICAL FILLER CAP

TANK	CAPACITY (GALLONS)
CTR WING TANK	37.6
LH OUTBD WING TANK	37.6
RH OUTBD WING TANK	37.6
LH INBD WING TANK	66.8
RH INBD WING TANK	66.8
TOTAL INTERNAL	246.4
DROP TANKS (2)	192.0
(TOTAL)	438.4
C/L TANK (FPU-3/A)	150.0
(TOTAL)	396.4

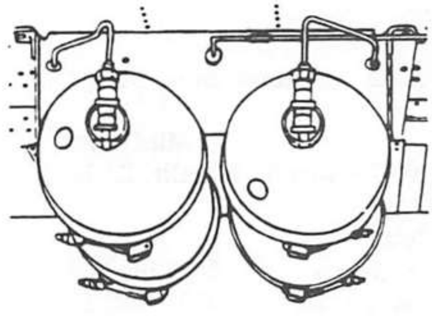


Ⓒ HYDRAULIC SYSTEM

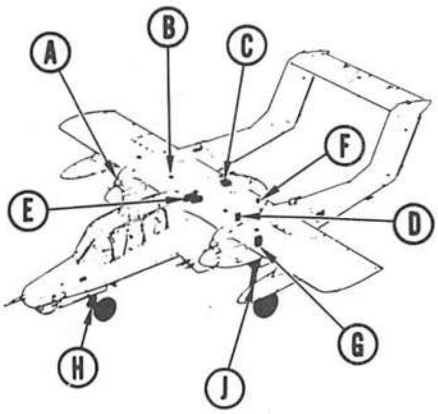
SYSTEM (COMPLETE)–1.5 GALLONS
RESERVOIR–0.6 GALLON

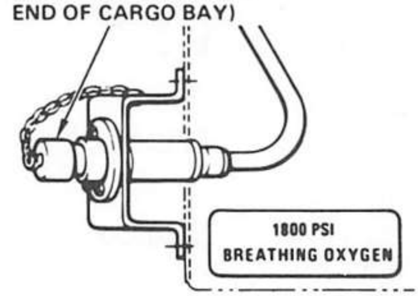


Ⓓ EXTERNAL ELECTRICAL POWER RECEPTACLE

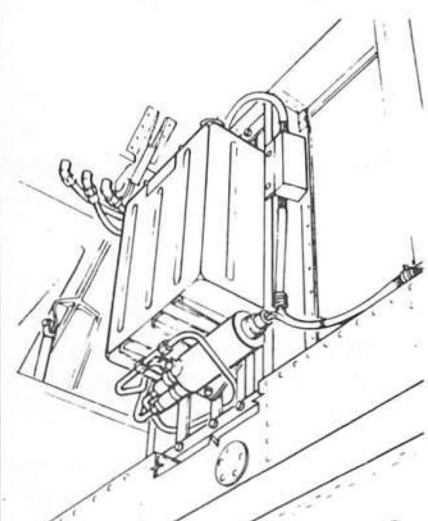


Ⓔ OXYGEN BOTTLES



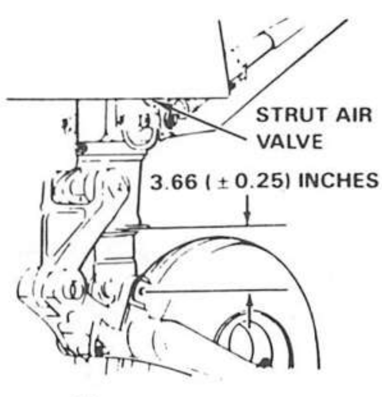


Ⓕ OXYGEN 1800 (± 50) PSI



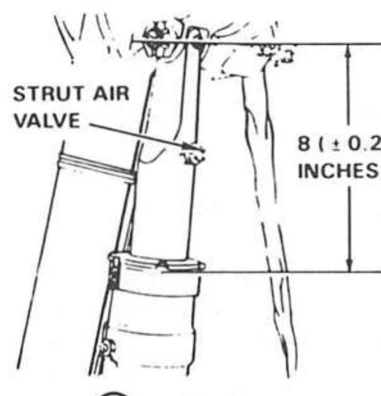
Ⓖ SMOKE GENERATOR OIL TANK

(2.3 GALLONS)



Ⓗ NOSE GEAR

TIRE PRESSURE 80 PSIG



Ⓙ MAIN GEAR

TIRE PRESSURE 65 PSIG

NA-86-0043-105

Figure 3-1. Servicing

3. Ensure fuel vent outlets open.

4. Check wing tank drains closed (lower surface of wings).

5. Check remote water drain closed (valve in cargo bay).

6. Check all electrical equipment off.

7. Fill each auxiliary tank as applicable and replace filler cap.

NOTE

Unless special procedures are followed to elevate the nose of the aircraft to about 4 degrees nose-up, the Aero 1C external fuel tank will accept a maximum of only 122 gallons of fuel.

8. Fill center wing tank to bottom of standpipe and replace filler cap.

9. Fill left and right inboard wing tanks to bottom of standpipes and replace filler cap.

10. Fill outboard wing tanks to bottom of standpipes and replace filler caps.

3.3.1 Primary, Alternate, and Emergency Fuels. Operational primary fuel is JP-5. Alternate fuels are JP-4 and JP-8. When neither the primary nor alternate fuels are available, emergency fuel is Aviation Gasoline, 115/145 Octane (MIL-G-5572).

3.3.2 Fuel Control. To ensure proper engine operation, the specific gravity setting of the fuel control should be reset whenever the type of fuel is changed (Figure 3-2).

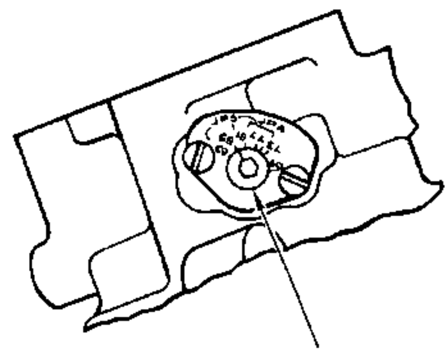
3.4 SYSTEMS SERVICING

3.4.1 Oil Systems. Use MIL-L-23699 turbine oil.

1. Unlock and lift oil filler on cowling.

2. Fill to full mark on filler neck.

3. Reseat filler, turn cap 45 degrees aft, and lock by depressing lock lever. Check cap fully seated and locked.



Fuel Used	Specific Gravity Setting
MIL-T-5624, JP-5	0.83
MIL-T-83133, JP-8	0.81
MIL-T-5624, JP-4	0.77
Grade 115/145	0.71

NA-86-0043-106

Figure 3-2. Fuel Control

4. Repeat for opposite engine.

NOTE

When a propeller is cranked out of feather after engine shutdown, the oil reservoir will indicate approximately 2 quarts low. The oil used by the unfeathering pump is not returned to the reservoir until the engine is motored for at least 10 seconds or started. If serviced prior to starting, the excess oil will vent overboard.

3.4.2 Hydraulic System. Use MIL-H-83282 hydraulic fluid. To service, proceed as follows:

1. Open HYD PUMP CONT circuit breaker.

2. Open external hydraulic reservoir access door on upper aft portion of fuselage top deck.

3. Remove filler and vent cap.

4. Fill reservoir.

NOTE

Reservoir is full when fluid is up to middle of fill pipe (even with machined land at middle of filler pipe).

5. Replace filler cap and hydraulic reservoir fuselage access door.

6. Close HYD PUMP CONT circuit breaker.

3.4.3 Oxygen System. Use MIL-O-27210 high-pressure breathing oxygen. To service the oxygen system, refer to Maintenance Instructions—Oxygen Equipment (NAVAIR 03-50-1) and proceed as follows:

1. Open cargo door.

WARNING

Ensure that filler valve and surrounding area are free of contamination. Oils, grease, and solvents may burn or explode spontaneously when contacted by oxygen under pressure.

NOTE

Oxygen fill receptacle is located on left hand aft end of cargo bay.

2. Remove filler cap.

WARNING

If system has been depleted of oxygen or dropped below 50 psi for a period of 2 hours or more, the entire system must be purged. Refer to Environmental Systems Manual (A1-O10DA-410-000).

3. Connect gaseous oxygen supply (MIL-O-27210) to bottle filler valve. Charge bottle to correct pressure compensated for ambient air temperature.

WARNING

Rapid filling of oxygen cylinder creates severe internal heat, which may result in explosion or fire.

Fill the oxygen bottle in stages as follows, allowing not less than 3 minutes for each filling stage and 2 minutes for cooling between stages.

Stage 1—Fill to 500 psi
Stage 2—Fill to 1000 psi
Stage 3—Fill to 1500 psi
Stage 4—Fill to 1800 psi

NOTE

Oxygen bottles should be charged with a pressure of 1800 plus or minus 50 psi at ambient temperature of 70 °F (21 °C). For every 10 °F plus or minus, charging pressure will vary approximately 25 to 50 psi, plus or minus, respectively.

4. Remove oxygen supply and install filler cap.

5. Close and lock cargo bay door.

3.4.4 Tires. Tires are normally inflated with dry air. Dry nitrogen (MIL-N-6011) may be used if an adequate source is available. Tire specifications and pressures are as follows:

TIRE	SIZE	PRESSURE
Nose	7.50 × 10, Type III	80 psig
Mains	29 × 11, Type III	65 psig

3.4.5 Struts. Struts are serviced with dry nitrogen (MIL-N-6011). Strut servicing may be accomplished using dry air only if an adequate dry nitrogen source is not available.

NOTE

If struts are serviced with air, reservicing should be accomplished when a source of dry nitrogen is available.

Service landing gear struts as follows:

1. Remove air valve dust cap, connect pressure source and loosen hex nut one-quarter turn.

2. Inflate strut to specified dimension and tighten hex nut; remove pressure source and install dust cap.

3. Ensure accuracy by rocking aircraft to settle struts and remeasuring.

Nose gear (strut flange to fork nut) = 3.66 (± 1/4) inches.
Main gear (oleo flange to connector nut) = 8.00 (± 1/4) inches.

3.4.6 Batteries. For servicing and maintenance of nickel-cadmium batteries, refer to Servicing and Maintenance Instructions, Naval Aircraft Batteries (NAVAIR 17-15BAD-1).

CAUTION

No maintenance of batteries should be performed on the flight line or with the batteries installed in the aircraft. Batteries requiring maintenance must be removed and serviced by a shop which specializes in nickel-cadmium battery maintenance.

NOTE

An external power source should always be applied to the aircraft when electrical power is required for trouble shooting or other maintenance functions. This is necessary to conserve battery power for its intended use, supplying an alternate source of power in an emergency or for starting engines.

3.4.7 Smoke Generator Oil Tank. To fill smoke generator oil tank, proceed as follows:

1. Gain access to left wheel well.

2. Remove filler cap.

3. Fill tank (2.3-gallon capacity) with fog oil (MIL-F-12070).

4. Install filler cap by turning clockwise.

5. Position cap lever down to lock cap.

3.5 ICE REMOVAL

To de-ice parked aircraft, refer to Anti-icing, De-icing, and Defrosting of Parked Aircraft Manual (NAVWEPS 01-1A-520).

3.6 JACK/MOOR PADS

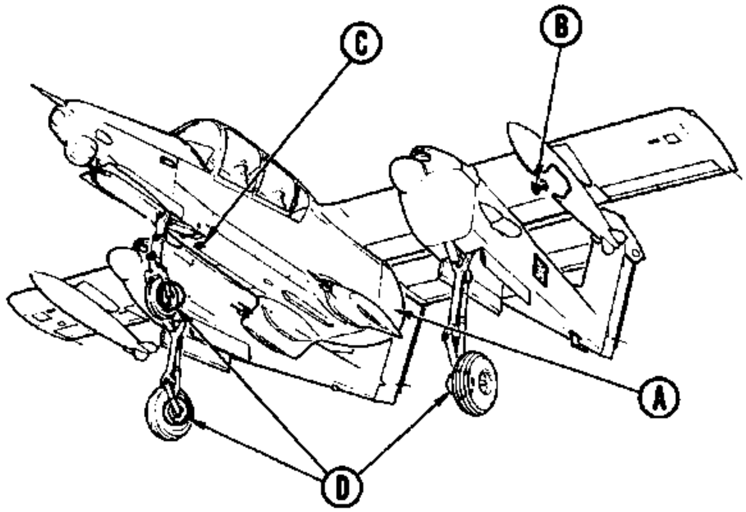
Jack/moor pads are normally carried in each aircraft in a canvas bag attached to the cargo door. For jacking or mooring, these pads are attached to the wing outboard of the engines and underneath the fuselage at a point marked MOOR/JACK (Figure 3-3).

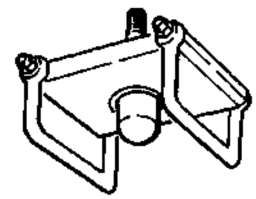
3.7 TOWING AIRCRAFT

Refer to General Aircraft Information Manual (A1-O10DA-GAI-000, WP 008 00) for aircraft towing procedures.

3.8 TIE DOWN/SECURING AIRCRAFT

Refer to General/Aircraft Information Manual (A1-O10DA-GAI-000, WP 008 00) for aircraft tie-down and securing information.





E13710 JACK PAD

Ⓐ JACK PAD STOWAGE (CANVAS BAG ATTACHED TO LOWER CARGO DOOR).

Ⓑ WING JACK PAD INSTALL POINT (ONE ON LOWER SURFACE OF EACH WING).
REQUIRES HYDRAULIC TRIPOD (10-TON), TYPE B-6 JACK

Ⓒ FORWARD FUSELAGE JACK PAD INSTALL POINT
REQUIRES HYDRAULIC TRIPOD (5-TON), TYPE B-5 JACK

Ⓓ AXLE JACKING POINTS
REQUIRE 5-TON AXLE JACK

NA-86-0043-107

Figure 3-3. Jack/Moor Pads

CHAPTER 4

Operating Limitations

4.1 INTRODUCTION

This part presents operating limitations applicable to military aircrews. Only those stores and operating limitations listed in Figure 4-5 and Figure 25-1 are authorized to be carried and released or fired to the limits shown.

4.2 ENGINE OPERATING LIMITATIONS

4.2.1 Starter-Generator Duty Cycle. The engine starter-generators are limited to four consecutive cranking/motoring cycles of 15 seconds maximum duration each to engine light-off, with the following cooling periods between start attempts:

1. One-minute cooling period prior to second attempt
2. Two-minute cooling period prior to third attempt
3. Ten-minute cooling period prior to fourth attempt

A 60-minute cooling period is required prior to a repeat of the starter-generator duty cycle or damage may result to the starter-generator.

4.2.2 Ignition System. The ignition system is continuous duty, with no limitations.

4.2.3 Unfeathering Pump Limits. The unfeathering pump is limited to 1 minute ON, 5 minutes OFF, 1 minute ON, and 60 minutes OFF.

4.2.4 Military Power. Military power is defined as the maximum power available which does not exceed the limits of 101% rpm and either 1035 °C to 1108 °C TIT or 2626 to 3282 pounds torque. Operation at military power is restricted to a maximum of 30 minutes.

NOTE

Maximum engine temperature and torque should be verified at the 115- to 117-degree position of the power levers. Maximum take-off thrust will be obtained at the FULL FORWARD (120-degrees) position of the levers.

4.2.5 Normal Power. Normal power is defined as that combined rpm/torque/engine temperature setting which is not time-limited. Normal power is the same as maximum continuous power, and is reached at a maximum torque setting of 2625 foot-pounds and/or 1034 °C TIT with rpm less than 101%.

4.2.6 RPM Limits. Engine rpm limits are shown in Figure 4-2, RPM is NOT time limited up to 101%. Operation between 101 and 103 percent is limited to 1 minute regardless of torque setting. Operation between 103 and 105 percent for 5 seconds is acceptable on ground run-up with the propellers on the start locks to allow for overspeed governor check. If 105 percent is exceeded in flight, reduce torque to minimum practical and land as soon as practicable. An inspection of power plant and fuel systems must be accomplished if any of these limits are exceeded.

4.2.7 Engine Turbine Inlet Temperature Limits. The rpm, temperature, and duration of any engine overtemperature operation shall be recorded so that the prescribed engine inspection can be performed. Engine turbine inlet temperature (TIT) limits are shown in Figure 4-2. The turbine inlet temperature limits for the engines are established as follows:

4.2.7.1 Normal Power Operation–1034 °C. The engines may be operated at 1034 °C or less with no time limitations.

4.2.7.2 Military Power Operation–1108 °C. Engine operation between 1035° and 1108 °C shall be limited to 30 minutes per 2 hours of engine operation. Operation at these temperatures should be limited to those times where maximum or near maximum power is required to accomplish mission requirements. By minimizing operation at this temperature, turbine component life will be maximized. During engine rigging and trimming operation this temperature shall never be exceeded. A yellow index on the TEMP instrument indicators will aid the pilot in keeping within this limit.

				ENGINES: T76G-420/-421 FUEL: JP-4 (MIL-T-5624) JP-5 (MIL-T-5624)
OPERATION	TURBINE INLET TEMP (°C)	RPM (%)	TORQUE (LB-FT)	TIME LIMIT
STARTING PEAK	1040	—	—	1 SECOND
(LESS THAN 50% RPM)	815 (EGT)			
TRANSIENTS	1109–1129	101–103	—	1 MINUTE
		—	3283-3348	45 SECONDS
		103–105	—	5 SECONDS
MILITARY POWER (INTERMEDIATE)	1035–1108	101.0	2626–3282	30 MINUTES
NORMAL POWER (MAXIMUM CONTINUOUS)	1034	101.0	2625	
FULL REVERSE	1120–1129	101.0	2301–2640	5 SECONDS
	999	100.0–100.5	2300	

NA-86-0043-108

Figure 4-1. Engine Limits

4.2.7.3 Transient Operating Conditions–1129 °C. Engine operation between 1109° and 1129 °C is allowed for transient conditions only. Operating time at these temperatures shall be limited to periods of 1 minute or less. During periods of maximum power operation there may be times when the turbine inlet temperature exceeds 1108 °C. This can be expected during maximum power climbouts, sideslips, and maneuvering. No pilot action is required during these transient conditions so long as 1129 °C is not exceeded and the duration of the event is less than 1 minute. A red warning index on the TEMP instrument indicators, a red warning light, and turbine inlet temperature (TIT) aural warning tone will alert the pilot to the fact that the 1129 °C limit has been approached. The red light and warning tone will be activated in the range of 1125° to 1129 °C. When the warning is activated the TIT must be immediately brought back to the yellow caution index or below.

NOTE

If for some reason (aircraft emergency, combat tactics) these limits are exceeded, the pilot must report the overtemperature event to maintenance personnel for determination if the engine is suitable for further use.

4.2.8 Torque Limits. Engine torque limits are shown in Figure 4-1. Torque is not time-limited up to 2625 foot-pounds. Operation between 2626 and 3282 foot-pounds is limited to 30 minutes duration. Operation between 3283 and 3348 foot-pounds is limited to 45 seconds for acceleration transients. If 3348 foot-pounds is exceeded on the ground for any duration, shut down the engine. If 3348 foot-pounds is exceeded in flight, reduce torque to minimum practical and land as soon as practicable. For reverse thrust operation, transient peaks to 2640 foot-pounds are permissible for 5 seconds. Reverse thrust torque settings up to 2300 foot-pounds are not time-limited.

NOTE

Maximum allowable torque indicator difference between engines is 200 foot-pounds during flight or ground operation (prior to commencing take-off).

4.2.9 Oil Pressure Limits

WARNING

If oil pressure is below minimum at GROUND IDLE with propellers on the start locks, take-off is not recommended, due to possible engine failure. Engine inspection should be accomplished prior to further operations.

Oil pressure limits are shown in Figure 4-2. Minimum acceptable oil pressure is 48 psi. Maximum pressure limit is 120 psi. Minimum operating oil pressure depends on rpm setting as follows:

RPM (%)	MINIMUM OIL PRESSURE (PSI)
65 (Idle)	48
70	56
75	64
80	72
85	80
88	85
91–101	90

4.3 HYDRAULIC SYSTEM OPERATION LIMITS

A 3-minute cooling period is required after 5 minutes of continuous nose wheel steering, or three continuous flap cycles, or three continuous landing gear cycles, or a combination thereof.

4.4 REVERSE THRUST LIMITS

Use of reverse thrust is prohibited in flight. For static ground operations, reverse thrust is limited to 1 minute.

CAUTION

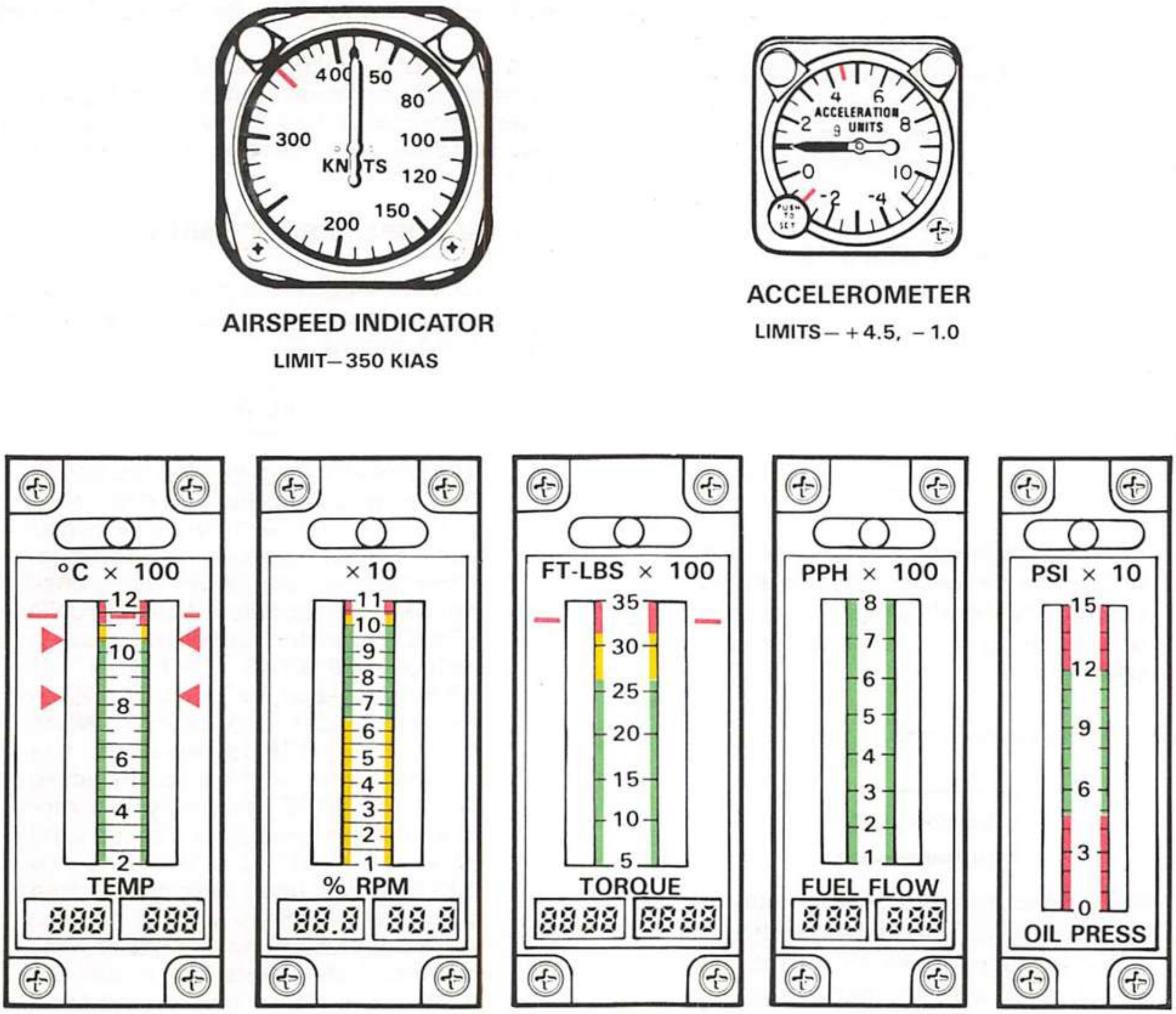
The pilot shall ensure that the condition levers are in the TO/LAND position for all landings except simulated single-engine landings. After landing, the power levers shall not be retarded below the GROUND START position until airspeed is below 100 KIAS (OAT 100 °F/37.8 °C or less), or 75 KIAS (OAT in excess of 100 °F/37.8 °C). When FULL REVERSE is required, the power levers will be retarded to FULL REVERSE, smoothly but rapidly; do not modulate thrust until FULL REVERSE (100.0% to 100.5%) has been obtained. If rpm decreases to 94% during reverse thrust operation, power levers shall be immediately advanced to prevent further rpm decay and engine overtemperature.

4.5 AIRSPEED LIMITS

4.5.1 Maximum Allowable Airspeed. For operating flight limits, see Figure 4-3. The maximum allowable airspeed limit with or without external stores and FLIR turret is 350 KIAS.

4.5.2 Landing Gear Limit Speed. Maximum speed for operation with the landing gear extended, extending, or retracting (in transit) is 158 KIAS.

4.5.3 Flap Limit Speeds. Maximum speed for flap extension and flap limit to T/O setting (20 degrees) is 158 KIAS. Maximum speed for flap extension and flap limit to DN (40 degrees) is 130 KIAS.



TEMP INDICATORS	% RPM INDICATORS	TORQUE INDICATORS	FUEL FLOW INDICATORS	OIL PRESS INDICATORS
	103–105% 5 SECONDS 101–103% 1 MINUTE 101% OR LESS NO LIMIT	0-2625 NO LIMIT 2626–3282 30 MINUTES 3283–3348 45 SECONDS REVERSE THRUST TORQUE LIMITS 0–2300 NO LIMIT 2301–2640 5 SECONDS	100–800 PPH (NORMAL RANGE)	48 PSI (MINIMUM-IDLE RPM) 48–120 PSI (NORMAL RANGE) 120 PSI (MAXIMUM)

TIT	
1040°C (815°C EGT)	ENGINE START PEAK (1-SECOND LIMIT)
1034°C OR LOWER	NORMAL POWER (NO TIME LIMIT)
1108°C	MILITARY POWER LIMIT (30 MINUTES)
1129°C	ACCELERATION TRANSIENT LIMIT (1 MINUTE)

NA-86-0043-26B

Figure 4-2. Engine Instrument Markings

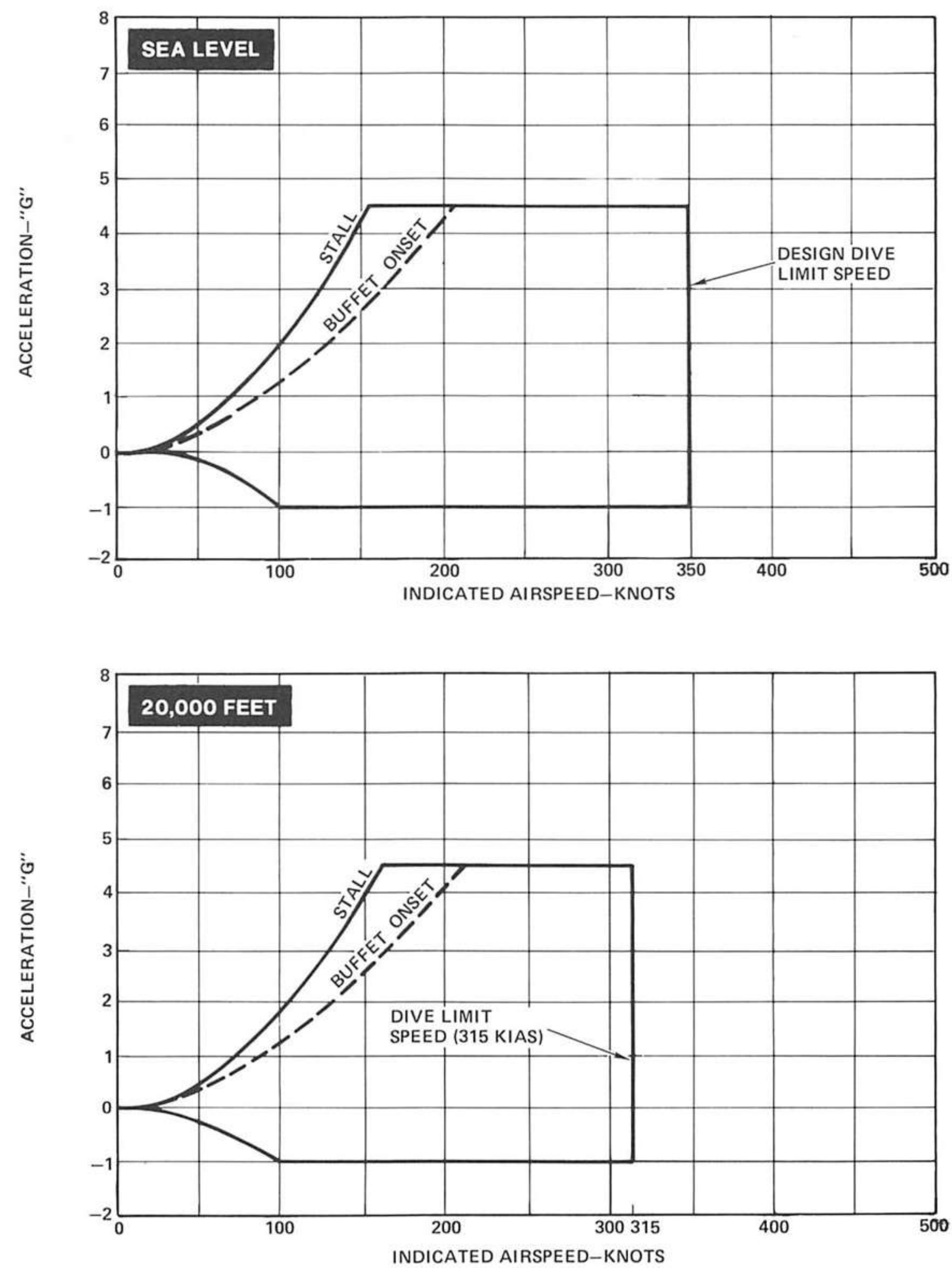


Figure 4-3. V–N Diagram

4.5.4 Minimum Speeds–Normal Operation

- Take-Off—Refer to Part XI, Chapter 26.
- Landing—Refer to Part XI, Chapter 31.

4.5.5 Minimum Speeds—STOL Operations. STOL operations must be planned with care and accuracy. For minimum speeds, refer to Part XI, Chapters 26 and 31.

4.5.6 Crosswind Component. The crosswind component limit is 20 knots at 90 degrees for take-off and landing (Figure 25-10).

4.5.7 Cargo Bay Door Removed Speed. Flights with cargo bay door and rack removed are limited to 300 KIAS or less.

4.6 ACCELERATION LIMITS

For aircraft design acceleration limits, see Figure 4-4. (Limits with stores, which in many cases are more restrictive, are shown in Figure 4-5 and Figure 25-1 in Part XI.) Symmetrical "g" limits (auxiliary fuel tanks on or off) are minus 1.0 to plus 4.5 "g's" at gross weights up to 13,142 pounds. At higher gross weights, the load factor decreases linearly to 4.0 "g's" maximum. Rolling pull-out "g" limits are 0 to 3.6 "g's." With flaps down (20 degrees only) and at 158 KIAS or less, the acceleration limits are minus 1.0 "g" to maximum attainable.

4.7 EXTERNAL STORE LIMITS

Maximum airspeed for jettisoning centerline or wing pylon auxiliary fuel tanks is 150 KIAS; jettison is restricted to level flight at + 1.0 "g," full or empty. For external fuel tank limitations, see Figure 4-5. For all other authorized external stores limitations, see Figure 25-1 and the current NWP 55-6-OV10A/D (OV-10A/D Tactical Manual).

4.8 INSTRUMENT MARKINGS

Instrument markings are presented in Figure 4-2. Careful attention should be given to these markings, as the limits and parameters shown are not necessarily repeated in this or other sections of the manual.

4.9 PROHIBITED MANEUVERS

The following maneuvers are prohibited:

1. Intentional spins.

2. Abrupt lateral control deflections, greater than one-half stick input and bank angle changes of greater than 90 degrees, at airspeeds greater than the maximum attainable in level flight.

3. Power settings less than the gate stop in flight.

4. Landings on other than smooth, hard paved surfaces.

5. Flight at zero or negative "g" in excess of 10 seconds.

6. Aerobatics with less than full center wing tank.

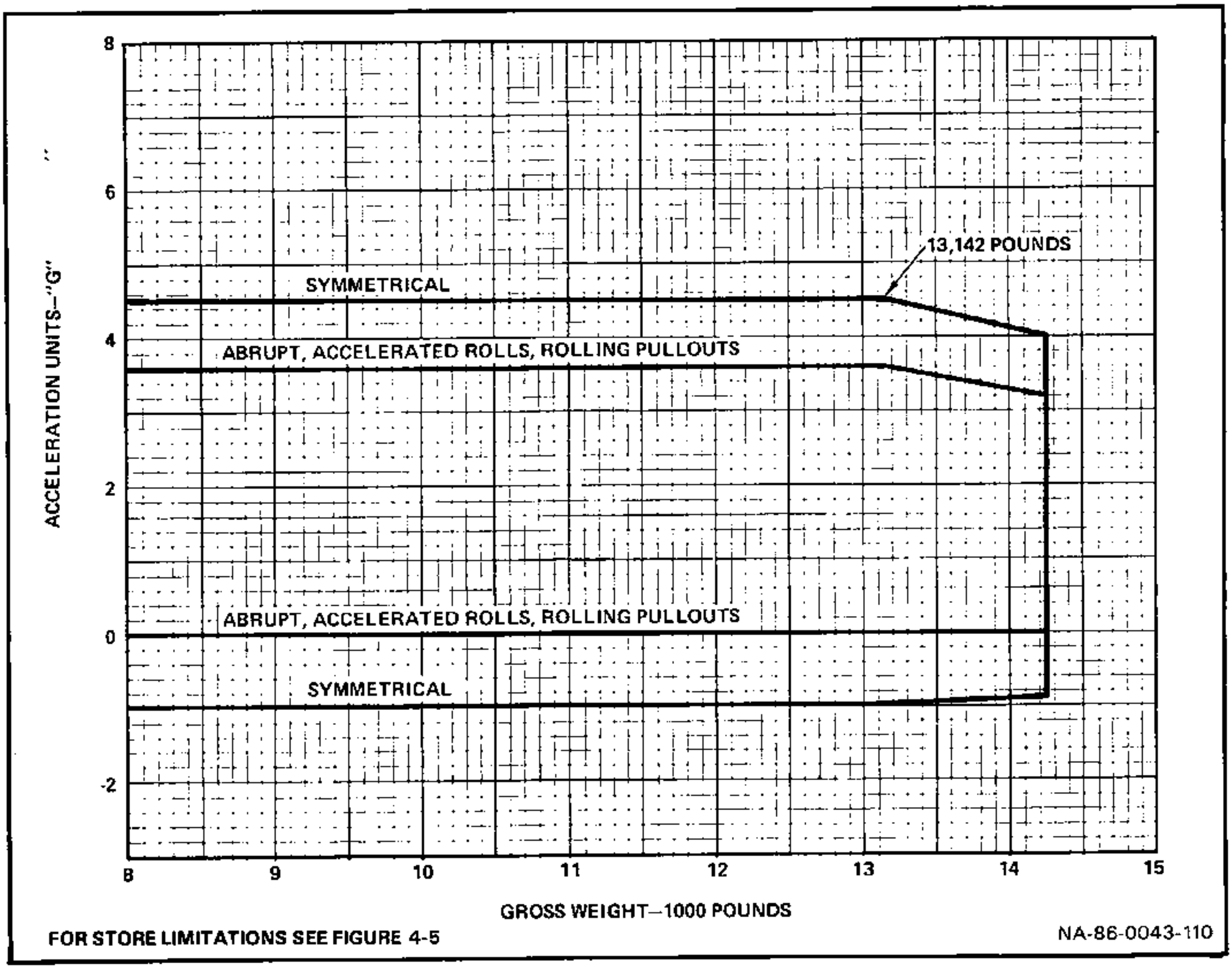


Figure 4-4. Aircraft "G" Limits

4.10 LANDING SINK RATES

Maximum landing sink rates with wings level at gross weights under 12,694 pounds are as follows:

1. Smooth, hard paved surfaces: Landing at 840 fpm or less is authorized.

2. Landings with full or partially full wing tanks at sink speeds in excess or 10 fps are prohibited.

(a) External wing drop tanks must be empty for carrier landings.

STORE	LINE NUMBER	STATION LOADING							MAX AIR-SPEED		ACCELERATION "G"		REMARKS	WEIGHT (LB)		DRAG		
		L WING	1	2	3	4	5	R WING	CARRIAGE	JETTISON	CARRIAGE	JETTISON		FULL	EMPTY	SINGLE	ADJACENT	MULTIPLE
FPU-3/A OR AERO 1C 150 GALLON					×				350	150	0.0 to + 5.5	+ 1.0 (full or empty)	See note.	1155	135	14.0		24.0
USAF 230-GALLON TANK					×				350	150	SYM 0.0 to + 5.5 UNSYM 0.0 to + 4.5	+ 1.0 (full or empty)	See note. No rough field operations authorized with 230-gallon tank.	1812	248	26.8		40.1
EXTERNAL FUEL TANKS P/N 8478 16100-1 100 GALLON		×						×	350	150	− 1.0 to + 4.5	+ 1.0 (full or empty)	See note.	1536	232	27.0		

NOTE

- INSTALLATION AND CARRIAGE OF AERO 1C, FPU-3A, OR USAF 230-GALLON EXTERNAL FUEL TANK REQUIRES THE AERO 1A ADAPTER WITH THE AERO 65A RACK.
- STORES ARE SUSPENDED FROM AERO 65A1 OR 65A1/B1 RACK UNLESS OTHERWISE SPECIFIED.

N10/90
NA-86-0043-111A

Figure 4-5. External Stores Limitations

4.11 CENTER-OF-GRAVITY LIMITS

For all usable aircraft configurations, center of gravity must be restricted to a range between 19.0% and 28.5% mean aerodynamic chord (MAC). For factors controlling center-of-gravity and loading limits, refer to the Weight and Balance Data Manual (NAVAIR 01-1B-50).

NOTE

Removal of FLIR/LRD equipment from the aircraft will cause CG shift. Weight and balance of the aircraft, using the Weight and Balance Data Manual (NAVAIR 01-1B-50), shall be determined any time that FLIR/LRD or subcomponents are removed. The FLIR/LRD closeout cover, P/N 8692-311031, shall be installed for flight operations with the FLIR/LRD turret removed.

4.12 WEIGHT LIMITS

Weight limits under various conditions are as follows:

1. Smooth hard paved surfaces:

(a) Maximum weight for take-off is 15,000 pounds.

(b) Maximum weight for normal landing with minimum rate of descent is 13,000 pounds.

2. Maximum external stores loading is 3600 pounds for stations 1 through 5, not to exceed individual station limits (1200 pounds centerline and 600 pounds each sponson station). Maximum wing pylon loading is 750 pounds for each station.

PART II

Indoctrination

CHAPTER 5

Indoctrination

5.1 INTRODUCTION

This section establishes minimum requirements for training, initial qualification, and currency in specified areas. The operational information considered necessary to ensure safe and efficient operation, when used in conjunction with the Naval Warfare Publications series, is provided in subsequent sections. Procedures for requesting waivers from the provisions of this section are contained in OPNAVINST 3510.3 (current revision). Training requirements, checkout procedures, evaluation procedures, and weather minimum for ferry squadrons are governed by OPNAVINST 3710.6 (current revision).

5.2 GROUND TRAINING

Ground training should be continuous throughout the career of OV-10D aircrew personnel. The overall syllabus will vary according to local conditions, facilities, directions from higher authority, and the unit commanders estimation of squadron readiness. However, there are certain specific requirements which shall be met to ensure that the aircrew and aerial observers are properly indoctrinated and briefed prior to flight.

5.2.1 Requirements. Ground training and other related requirements for all aircrew personnel and aerial observers prior to familiarization flights are as follows:

1. Current medical clearance.

2. Aviation physiological training as set forth in OPNAVINST 3710.7 (current revision).

3. NAMO Pilot Familiarization course (if available) or equivalent lectures by other qualified personnel.

4. Lectures from qualified personnel on the following subjects:

   (a) Flight characteristics and operating limitations.

   (b) Use of safety and survival equipment and related procedures.

   (c) Aircraft preflight, ground handling, hand signals, and normal flight procedures.

   (d) Emergency procedures.

   (e) Past aircraft mishaps as an aid in preventing future mishaps of like nature.

   (f) Local course rules, flying area, instrument procedures, and SAR facilities.

5. Satisfactory completion of open-book NATOPS and emergency procedures examinations.

6. Supervised cockpit check.

7. Supervised engine start (pilot only).

8. Closed-book NATOPS examination prior to solo (pilot).

5.2.2 Subjects. The following subjects should be included in the normal ground training syllabus, depending upon the squadron mission and qualifications of the pilot or aerial observer.

5.2.2.1 Mission Training

1. Map reading

2. Visual recon/observation

3. FAC/TAC(A) procedures

4. Artillery spot/naval gunfire spotting

5. Close-air support procedures

6. Ordnance, theory, and delivery procedures

7. Aviation ordnance and weapons loading

8. Pertinent publications in the NWP and NWIP series

9. Night Observation Surveillance (NOS)

5.2.2.2 **Instrument Training**

1. Instrument flight procedures.

5.2.2.3 **Flight Safety**

1. MIR/hazard reports.

2. Aircraft emergencies.

3. Laser safety.

4. Oral or written review of emergency procedures should be required after any lay-off from flying in excess of 2 weeks.

5.2.2.4 **Intelligence**

1. Mission planning materials

2. Orders of battle

3. Recognition

4. Escape and evasion

5. Authentication procedures

5.2.2.5 **Survival**

1. Physiological and medical aspects

2. First aid

3. Survival on land or sea

4. Pilot rescue techniques

5.3 FLIGHT QUALIFICATIONS

The flight syllabus as set forth in the current Training and Readiness Manual or OPNAVINST will be used for initial pilot checkout. Command prerogative should be exercised to waive certain flights where pilot qualification in similar type aircraft and/or mission warrants. Minimum requirements for qualification and currency for each phase of flight are as follows:

5.3.1 **Familiarization**

1. Completion of the ground training requirements is required prior to flight.

2. Fam flights will be conducted.

3. Initial checkout flights will consist of a minimum of 5 hours. If NATOPS current in the OV-10A initial checkout flights will consist of a minimum of 3 hours.

5.3.2 Instruments. Minimum requirements prior to actual instrument flight are as follows:

1. Ten hours in OV-10A/D aircraft in the last 6 months.

2. At least one OV-10A/D flight in the last 30 days.

3. Valid instrument rating.

4. Demonstration of instrument proficiency in model.

5.3.3 Night Flying. Minimum requirements prior to night flights are as follows:

1. Valid instrument rating.

2. Ten hours in OV-10A/D aircraft within the last 3 months.

5.3.4 Currency Requirements. Currency requirements are to be in accordance with OPNAVINST 3710.7 series.

5.3.5 Mission and Weapons Training. Prerequisites for mission and weapon training are as follows:

1. Completion of appropriate ground training as set forth in this section.

2. Minimum of 10 hours in the OV-10A/D aircraft.

Minimum requirements prior to night mission and weapon training are as follows:

1. Same as night flying missions, plus 25 hours in the OV-10A/D aircraft and 10 hours in the last 30 days.

2. Day proficiency in type mission or delivery in the OV-10A/D aircraft.

3. Familiarity with operating area/target and procedures.

5.3.6 Cross-Country Flight. Minimum requirements prior to cross-country flight are as follows:

1. Valid instrument rating.

2. Fifteen hours in OV-10A/D aircraft to include 3.0 hours instrument time and 1.5 hours of night time.

3. Familiarity with aircraft servicing.

5.4 FLIGHT CREW DESIGNATIONS, QUALIFICATIONS, AND REQUIREMENTS

5.4.1 Functional Check Pilot (FCP). A functional check pilot must be a pilot qualified in model (PQM) and have a minimum of 100 hours in the OV-10A/D and be designated in writing by the commanding officer for full or partial systems functional check flights.

5.4.2 Pilot Qualified in Model (PQM). A pilot qualified in model must have satisfactorily completed a NATOPS evaluation.

5.5 PERSONAL FLYING EQUIPMENT

The personal flying equipment in OPNAVINST 3710.7 series shall be carried or worn by all personnel on every flight.

PART III

Normal Procedures

CHAPTER 6

Flight Preparation

6.1 INTRODUCTION

Briefings will be conducted using a prepared briefing guide and the appropriate mission card. The briefing shall cover those items pertinent to the specific mission assigned. Any format which is complete, concise, and orderly, and which can be readily used by the Flight Leader as a briefing guide is suitable. Each pilot should record all data necessary to successively assume the lead and complete the assigned mission. This, however, does not relieve the Flight Leader of the responsibility for all pilots in the operation and conduct of the flight.

6.2 MISSION PLANNING

6.2.1. General. Mission planning is concerned with two requirements. The first is for pilots to calculate normal and emergency aircraft operating capabilities concurrent with existing ambient conditions and mission requirements prior to each flight. The second requirement is preparation of planning documents for future missions and is normally prepared from weather summaries and predicted weather and geographic studies in the area to be considered.

6.2.2 Planning

1. For performance data applicable to mission planning, refer to Part XI, Chapters 25 through 32.

2. For aircraft engine operating limits and weight and balance data, refer to Part I, Chapter 4. For loading information, refer to the Weight and Balance Data Manual (NAVAIR 01-1B-40).

3. For weapons delivery, refer to the appropriate NWP/NWIPS and Part I, Chapter 4, Part VIII, and Part XI, Chapter 25.

6.3 BRIEFING/DEBRIEFING

6.3.1. Briefing Guide. The briefing guide will include the following items, when applicable.

6.3.1.1 General

1. Aircraft, call signs, event numbers.

2. Aircraft configuration, fuel load, gross weight.

3. Night brief.

6.3.1.2 Weather (Current and Forecast)

1. Local, en route, operating area, destination.

2. Alternate/diverts.

6.3.1.3 Ground

1. Walk, start time.

2. Radio checks.

3. Taxi route, hazards.

4. Succession to lead.

5. Loading/arming procedures.

6. Aircrew coordination.

6.3.1.4 Take-off

1. Take-off data.

2. Take-off time, clearance.

3. Departure route, climb, rendezvous.

   (a) Formation flight characteristics (dissimilar weights/configurations).

4. Aircrew coordination.

6.3.1.5 En Route/Mission (See TACMAN Brief if Applicable)

1. Mission plan, primary/secondary.
2. Controlling agencies.
3. Route, ingress, egress, DD-175.
4. Operating/restricted areas.
5. Range/target/en route times.
6. Intelligence/authentication/E and E.
7. Bingo, low fuel.
8. Tactical formation.
9. Weapon delivery:
   - (a) Mil setting.
   - (b) Altitude, patterns.
   - (c) Switchology.
   - (d) "G" versus weight.
   - (e) Safety, minimum altitude, duds.
10. Aircrew coordination.

6.3.1.6 Recovery

1. VFR/IFR/hung ordnance.
2. Recovery data:
   - (a) Landing weight, distance.
   - (b) Minimum single-engine speeds.
   - (c) Formation flight characteristics (dissimilar weights/configurations).
3. Dearming.
4. Aircrew coordination.

6.3.1.7 Communications

1. Agencies/frequencies.
2. IFF-SIF.
3. Flight discipline/radio procedures.
4. Hand-arm and light signals, HEFOE.
5. Aircrew coordination.

6.3.1.8. Emergencies

1. Ground.
2. Aborts (ground, takeoff, in-flight).
3. System failures.
4. Lost communications, NAVAID.
5. Ejection, SAR.
6. Lost sight/inadvertent IFR/midair/birdstrike.
7. Misfire/hangfire/ordnance jettison area.
8. Aircrew coordination.

6.3.2. Debriefing. Each flight shall be followed with a thorough debriefing by the Flight Leader as soon as practicable. All phases of the flight shall be covered, paying particular attention to those areas where difficulties were encountered and to the effectiveness of any tactics employed or weapons expended. To derive maximum benefit, constructive criticism and suggested improvements as to doctrine, tactics, and techniques should be given and received with the frankness, purpose, and spirit of improving the proficiency of the unit, as well as that of the individual pilot.

CHAPTER 7

Shore-Based Procedures

7.1 FLIGHT RESTRICTIONS

For aircraft and engine operating limits, refer to Part I, Chapter 4.

7.2 FLIGHT PLANNING

For performance data applicable to mission planning, refer to Part XI, Chapters 25 through 32.

7.3 WEIGHT AND BALANCE

For weight and balance limits, refer to WEIGHT LIMITS, Part I, Chapter 4. For loading information, refer to the Weight and Balance Data Manual (NAVAIR 01-1B-50).

7.4 PREFLIGHT CHECKS

NOTE

Procedures in this section are coded as follows:

(O)–Applicable to observer.

(P,O.)–Applicable to both crewmembers.

Unmarked–Applicable to pilot only.

7.4.1 Interior Inspection—Front Cockpit

1. Ejection seat safety pins—INSTALLED.
2. BATTERY—OFF.
3. Landing gear handle—DOWN AND LATCHED.
4. MASTER ARM switch—OFF.
5. LASER ENABLE—OFF.
6. Gust lock—REMOVED.
7. All electrical equipment—OFF.
8. BATTERY switch—ON.
   (a) Check voltage.
   (b) Power lever gates retracted.
   (c) Ejection selection handle light—OFF.
   (d) Gear indication (down and locked).
9. Fuel quantity—CHECK.
10. BATTERY switch—OFF.

7.4.2 Interior Inspection—Rear Cockpit

1. Ejection seat safety pins—INSTALLED.
2. NO. 3 INV switch—OFF.
3. FLIR mode switch—OFF.
4. VIDEO power switch—ON.
5. All electrical equipment—OFF.
6. LASER ARM switch—OFF.

7.4.3 Exterior Inspection

1. Chocks—AS REQUIRED.
2. Right propeller and hub—CHECK.
3. Right engine—ROTATES FREELY.
   (a) Rotate propeller in normal direction of rotation by hand to determine if engine rotates freely.

(b) If any resistance to rotation is found, rotate propeller one blade width past the point of maximum resistance.

(c) Allow engine to cool for a minimum of 5 minutes.

(d) Repeat until engine rotates freely. A start shall not be attempted until engine rotates freely.

CAUTION

If engine has been shut down for 5 minutes to 2 hours following a run of any duration and any resistance to engine rotation is found, engine damage may occur.

4. Right engine intake—CLEAR.

5. Right engine and cowling—CHECK.

6. Right engine oil cap—SECURED.

7. Right engine exhaust stack—CHECK.

8. Right wing pylon/drop tank—CHECK.

9. Right wing and control surfaces—CHECK.

10. Stall warning sensor—CHECK.

11. Right main landing gear door and brake/wheel assembly—CHECK.

12. Right battery cover—SECURED.

13. Right avionics bay cover—SECURED.

14. Right sponson access doors—SECURED.

15. External stores—CHECK.

16. Utility power selector switch—NORMAL.

17. Cargo bay for loose cables and equipment—SECURED.

18. Mission recorder tape loaded—CHECK (as required by mission).

19. BIT fault indicator panel (four indicators reset)—CHECK.

20. Cargo bay door mounted equipment toggle circuit breakers—ON.

21. Cargo bay door—CLOSED AND LOCKED.

22. Right boom structural integrity—CHECK.

23. Visual inspection of tail and horizontal stabilizer—CHECK.

24. Left boom for structural integrity—CHECK.

25. Left sponson access doors—SECURED.

26. External stores—CHECK.

27. Left avionics bay cover—SECURED.

28. Left battery cover—SECURED.

29. Left main landing gear door and brake/wheel assembly—CHECK.

30. Ground safety switch—CHECK CONDITION AND PROPERLY POSITIONED.

31. Left wing pylon/drop tank—CHECK.

32. Left engine exhaust stack—CHECK.

33. Left wing control surfaces—CHECK.

34. Left engine and cowling—CHECK.

35. Left engine intake—CHECK.

36. Left engine oil cap—CHECK.

37. Left propeller and hub—CHECK.

38. Left engine—ROTATES FREELY.

(a) Rotate propeller in normal direction of rotation by hand to determine if engine rotates freely.

(b) If any resistance to rotation is found, rotate propeller one blade width past the point of maximum resistance.

(c) Allow engine to cool for a minimum of 5 minutes.

(d) Repeat until engine rotates freely. A start shall not be attempted until engine rotates freely.

CAUTION

If engine has been shut down for 5 minutes to 2 hours following a run of any duration and any resistance to engine rotation is found, engine damage may occur.

39. Nose wheel strut wheel assembly—CHECK.

40. Nose wheel steering/shimmy damper—CHECK.

41. Angle-of-attack probe—COVER REMOVED.

42. Approach lights—CHECK.

43. Nose wheel doors—CHECK.

44. Ground test protective covers removed from FLIR turret—CHECK.

45. FLIR and LRD windows for cleanliness—CHECK.

46. FLIR turret in stowed position—CHECK.

47. LASER safety plug not installed (unless required for mission)—CHECK.

48. FLIR GIMBLE DRIVE DSBL switch—NORM.

49. Nose turret access door secured—CHECK.

50. Landing light—CHECK.

51. Pitot tube—COVER REMOVED.

52. Fuel caps—SECURED.

53. IRCM transmitter—COVER REMOVED.

54. IRCM transmitter windows for cleanliness—CHECK.

55. Hydraulic reservoir access door secured—CHECK.

56. Circuit breaker panel—CHECK.

57. EMERG IFF switch—NORMAL (P,O).

58. Aft cockpit—SECURED. Seat cushion harness installed (SOLO).

59. Cockpit enclosure—CHECK CONDITION.

7.4.4 Ejection Seat Inspection (P,O). See Figure 7-1.

1. Lower ejection handle safety pin and parachute thruster safety pin—INSTALLED.

2. Ejection selection handle—AS DESIRED.

3. Emergency radio beacon lanyard—SECURED (to deck).

4. IFF seat sensing switch roller—CHECK FOR PROPER CONTACT (P).

5. Seat quick-disconnects—CHECK FOR INTEGRITY.

6. Speed sensor lines—SECURED (to deck).

7. Speed/Altitude sensor—arming key secured to back of seat. Plunger extended 1 to 1 1/2 inches.

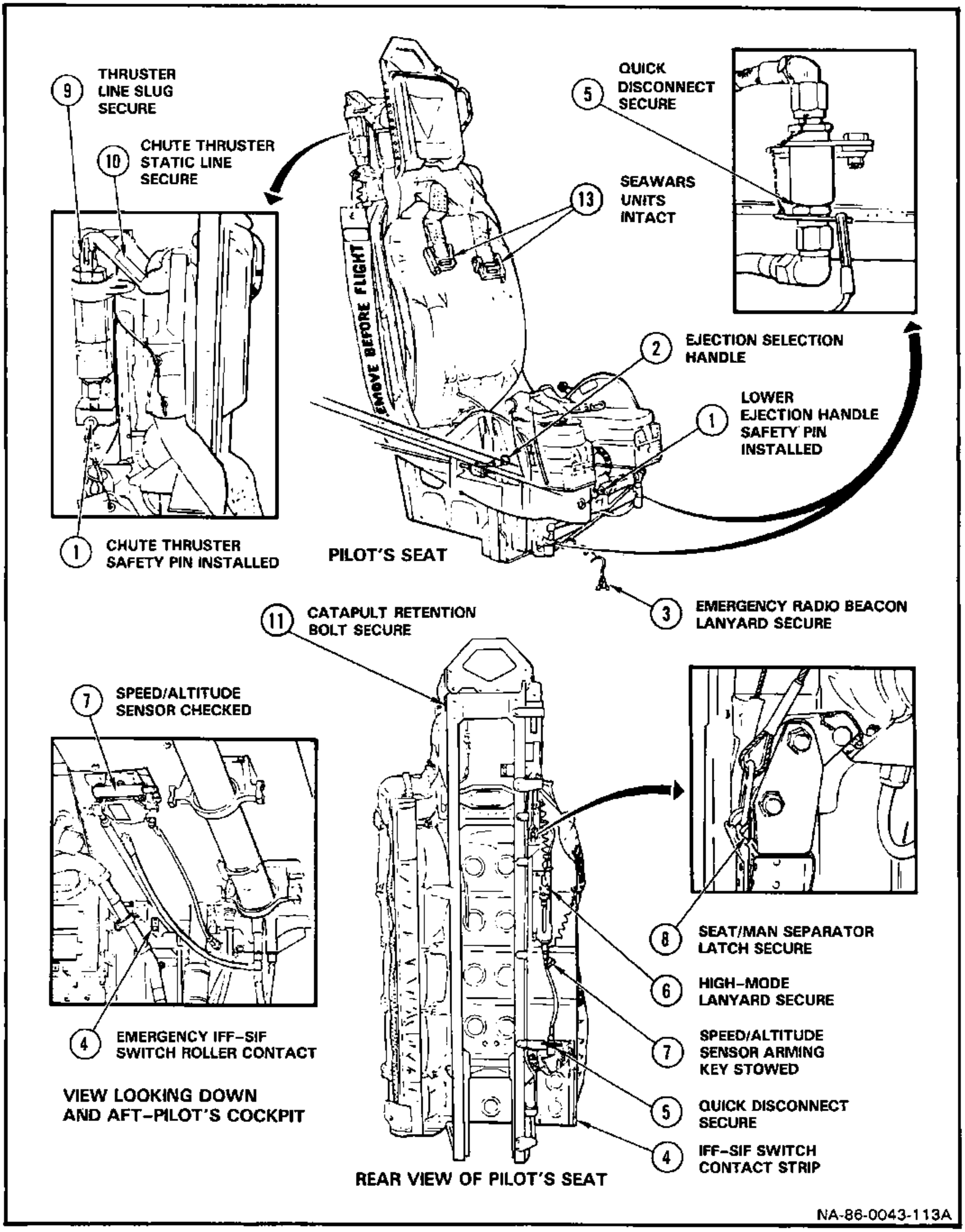


Figure 7-1. Ejection Seat Inspection

8. Seat/Man separator latch—SECURE.

9. Thruster line slug—SECURE.

10. Parachute thruster static line—SECURE.

11. Catapult retention bolt—SECURE.

12. Seat bucket—CHECK (seat pan installation, no FOD, belts fraying, and deterioration).

13. Parachute riser SEWARS units—CHECK TAMPER DOTS INTACT.

14. Shoulder harness—CHECK (ease of operation, fraying).

15. Ejection seat canopy breaker bar—PROPERLY POSITIONED.

7.5 COCKPIT CHECK

1. Parachute thruster slug safety pin—REMOVE (P,O).

2. Canopy brace—INSTALLED.

CAUTION

Ground operations without canopy brace installed may cause damage to canopy hinge.

3. Survival kit—FASTEN (P,O).

4. Lap belt—FASTEN (P,O).

5. Riser straps—FASTEN (P,O).

6. Landing gear and drop tank safety pins—REMOVED AND STOWED IN STARBOARD MAP CASE.

7. Paratroop ALARM switch—OFF.

8. JUMP SIGNAL switch—OFF.

9. VIDEO RCDR power switch—OFF (O).

10. GD/EMER radio switch—NORM.

11. Radar signal-detecting set PWR switch—OFF.

12. IRCM power switch—OFF.

13. ICS-SET, as desired (P,O).

14. FLAP handle—UP.

15. TRIM SELECT switch—NORM.

16. YAW DAMPER switch—OFF.

17. EXT LTS MASTER switch—EXT LTS.

18. Power levers—GROUND IDLE.

19. Condition levers—FUEL SHUTOFF.

CAUTION

If the conditions levers are found forward of the FUEL SHUTOFF position, any attempt to start the engine may result in engine fire.

20. BATTERY switch—OFF.

21. Generator switches—NORM.

22. INST PWR switch—OFF.

23. AIR START switches—AUTO.

24. MSTR ARM switch—OFF.

25. FLIR CMD switch—OPERATOR.

26. LASER ENABLE switch—OFF.

26A. NAV/HOV/TST switch—NAV.

27. Countermeasures power SALVO FLARE switch—OFF.

28. EMER FUEL SHUT OFF switches—NORM.

29. EXTERNAL FUEL TRANSFER switches—OFF.

30. Radar altimeter —OFF (P,O).

31. Fuel QTY switch—INT.

32. PITOT HEAT switch—OFF.

33. Windshield WIPER—OFF.

34. ANTI COLLISION switch—ON.

35. EXT LIGHTS switch—AS DESIRED.

36. Oxygen regulator—CHECK (P,O).

37. Diluter switch—100% OXYGEN (P,O).

38. COMPASS—SLAVED.

39. CMS AND RADIO PWR control panel switches—OFF.

40. BLEED AIR switches—NORM.

41. Interior lights—AS DESIRED (P,O).

42. Circuit breakers—IN.

43. Cargo bay light—OFF.

44. Utility light—AS DESIRED (P,O).

45. NO. 3 INV switch—OFF (O).

46. DOP NAV CDU mode selector switch—OFF (O).

7.6 BEFORE START

1. Parking brake—SET.

2. Access steps—CLOSED.

3. Chocks—REMOVE.

4. Propeller—CLEAR (P,O).

CAUTION

If propellers are feathered to any degree, unfeathering procedure shall be followed prior to starting engines.

5. BATTERY switch—ON; check voltage.

6. Chronometer—SET (P,O).

7. INST PWR switch—INV NO. 1.

8. ICS—CHECK OPERATION (P,O).

9. ICS TALK foot switch—CHECK OPERATION (O).

10. ENG INSTR switch HOLD TO TEST and release to NORM—Observe engine instruments for test indications and overtemperature and overtorque tests.

11. LT TST switch—FIRE DET/WRN LT TEST. Hold LT TST switch in FIRE DET for dc check, then hold in WRN LT to test all caution and warning lights, master caution light system, ejection selection handle light, and rudder pedal shaker operation.

12. WARN LIGHTS switch—TEST (O). Hold WARN LIGHTS switch in TEST to test all caution, warning and advisory lights, master caution light system, and ejection selection handle light.

13. Fuel QTY indicator—CHECK.

14. Fuel REM indicator—SET.

15. External power—APPLIED, as required.

7.6.1 Unfeathering. (If required).

1. Condition levers—FUEL SHUTOFF.

2. Power lever—FULL REVERSE.

3. AIR START switch—CRANK. Hold in CRANK until blades reach full reverse then release to AUTO.

4. Power lever—GROUND IDLE.

5. Repeat for other engine.

7.7 STARTING ENGINES

Engine starts may be made, either engine first, using aircraft battery power or external electrical power. For engine and starter limits refer to Part I, Chapter 4 (Figure 4-2). For ground operation, see Figure 7-2 in this Chapter.

1. Propeller—CLEAR (P,O).

2. START switch—START. Hold desired START switch momentarily in START and check the START IGN ON light illuminated at approximately 10% rpm.

3. Condition Lever—NORMAL FLIGHT ON PROPELLER ROTATION. Observe EGT rise at 10% to 12% rpm.

CAUTION

If external power unit fails during start, overtemperature could occur. Proceed as outlined in Part V.

4. Monitor rpm, oil pressure, EGT, and observe START IGN ON light out at 50% rpm. Check GEN and BOOST PUMP light out (battery starts only; for external power starts, lights remain on until external power plug is removed).

WARNING

- If external electrical power unit fails when initiating start, the engine will be motored by the starter if the external power cable is unplugged. To prevent undesired engine rotation, execute ABORTED/HUNG START procedure.

WARNING

When performing an engine ground start, with or without external power, selection of the generator to TRIP prior to 50 percent on the engine being started will abort the start cycle. An engine fire/hot start may occur.

CAUTION

Abort start if light-off is not indicated within 15 seconds or if rpm hangup occurs after initiating start. Four consecutive 15-second maximum duration start attempts, each to engine light-off, may be made with a 1-minute cooling period prior to a second attempt, a 2-minute cooling period prior to a third attempt and a 10-minute cooling period prior to a fourth attempt. A 60-minute cooling period shall be observed prior to a repeat of the starter-generator duty cycle.

5. Power lever—SET AT 65% RPM.

6. External power—DISCONNECT (if applicable). Check GEN and BOOST PUMP lights out.

NOTE

Pull external power control circuit breaker. Then turn off the ground power cart prior to disconnecting the ground power plug. Reset the external power control circuit breaker after ground power plug has been disconnected from aircraft.

7. Fire warning—TEST.

8. Compute temperature and torque limits.

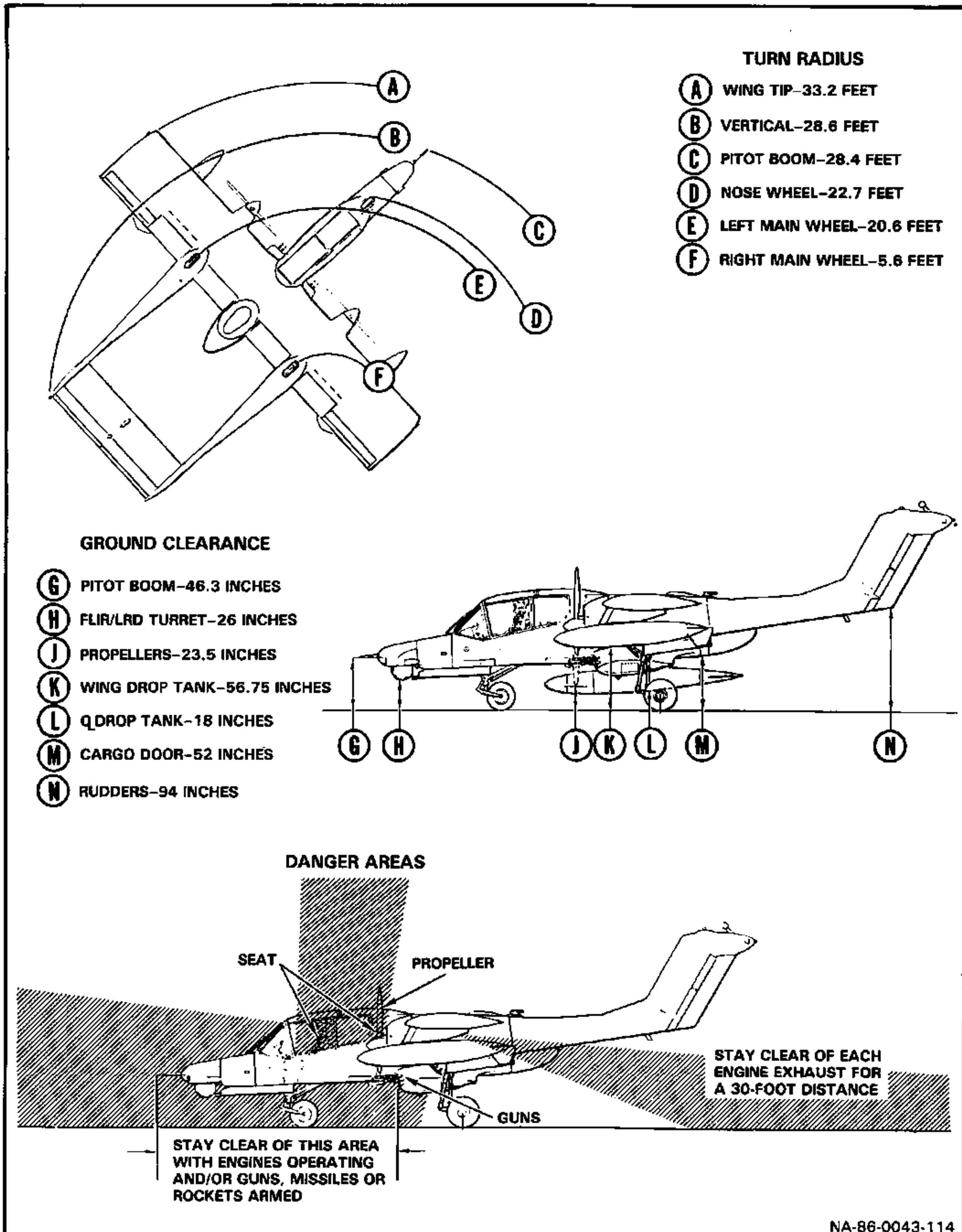


Figure 7-2. Ground Operation

9. Repeat procedures for second engine.

CAUTION

- If starting the second engine with an NC-8A with adapter, the operating generator should be placed to TRIP prior to initiating the start of the second engine. If the generator has a greater voltage output than the NC-8A, the NC-8A will be tripped, providing no power to the starter. With the batteries holding the start relays closed, a hot start is highly probable.

- If battery start, wait until generator has recharged batteries and ammeter shows less than 100 amperes. If rpm of running engine decays more than 4 percent, abort start of second engine.

7.7.1 Aborted/Hung Start

1. Condition lever—FUEL SHUTOFF.

2. START switch—ABORT.

WARNING

If start switch is energized and the engine fails to crank, move the start switch to ABORT to deenergize the automatic ignition circuit prior to attempting any further corrective action. Failure to do so may cause inadvertent engine start if the circuit is later completed.

7.8 BEFORE TAXI

1. INST PWR switch to INV NO. 2—CHECK. Reset to INV NO. 1.

2. AMM SEL switch—CHECK NO. 1 GEN and NO. 2 GEN.

3. RADIO 1, 2, 3, and HF switches—ON (as required).

4. CMS POWER switch—ON. Adjust brightness as desired.

5. CMS COMM key—SELECT. Set up RADIO 1, 2, 3 and HF (as required).

6. Gunsight—CHECK (Filament 1 and 2).

6A. Multipurpose indicator NAV/HOV/TST switch—TST.

7. Radar altimeter—ON (P,O) (as required).

8. Compass PUSH TO SET knob—SET.

9. Elevator trim—CHECK FOR OPERATION IN ALT AND NORM; RESET TO NORM.

10. Elevator trim—CHECK FOR OPERATION WITH OBSERVERS TRIM SWITCH (O).

11. Set trim for take-off.

(a) Normal take-off:

(1) Elevator—1/2 UNIT DOWN

(2) Aileron—NEUTRAL

(3) Rudder—NEUTRAL

NOTE

For aircraft trim configuration, press the CMS IDX key and select Trim (LS6).

12. ATTITUDE GYRO ERECT switch—NORM.

13. FLIR system—ON (O). Ensure No. 3 INV switch—ON. Rotate to forward azimuth position.

NOTE

On SOLO flights, place FLIR CMD switch to WIDE position. The FLIR turret will drive to approximately 0° azimuth and elevation. Placing the FLIR CMD switch to OPERATOR will turn FLIR system off with turret locked in forward position.

14. Doppler navigation system—ON (as required) (O). Select TEST position on DOP NAV CDU mode switch and determine system status.

15. Doppler navigation system initialization—SET (O). Insert coordinates and checkpoints, deviation and variation.

NOTE

Doppler navigation unit may be installed on the pilot's right console for SOLO flight.

16. Video recorder POWER switch—ON (O) (as required).

17. KY-75—PLAIN/CIPHER switch to PLAIN and OFF/ZEROIZE switch to 1, 2, or 3 if KY-75 processor installed.

18. CMS IDX KEY—Select Power page.

Turn ON the following equipment:

(a) TACAN

(b) IFF

(c) KY 1 and KY 2 (as required).

19. TACAN—SET as required (CMS NAV key).

20. IFF—SET as required (CMS IFF key).

NOTE

If √ STATUS annunciator is displayed on CMS screen; press CMS STAT key and check for NOGO status of:
- RADIO 1, 2, 3 and HF
- IFF
- Tacan (TCN)
- CMS system (CDU No. 1 and No. 2 and BSIUs 1, 2, and 3)

21. CMS CM key—SELECT and SET (as required).
Ensure countermeasures load on aircraft matches CMS CM Page indications.

NOTE

Verify SALVO FLARE switch (countermeasures power) is OFF (P).

22. CMS WPNS key—SELECT and SET (as required).
Ensure external fuel and/or weapon stores loaded on aircraft match CMS WPNS Configuration Page.

Check CMS Jettison page to verify all stations loaded indicate SAFE (P).

23. Attitude indicator—CAGED (O).

24. Standby gyro—CAGED.

25. Cargo bay door caution light OFF—CHECK.

26. Flight controls—CHECK FULL TRAVEL.

27. Flaps—CHECK OPERATION.

(a) 40°

(b) 20°

(c) Hold, check alternate operation

(d) 0°

In each position note flap indicator.

28. Ejection seat lower ejection handle pin—REMOVED (P,O).

29. Power levers—REVERSE MOMENTARILY. Observe slight rpm increase after propellers unlock.

30. Altimeters—SET (P,O).

7.9 TAXI CHECKS

1. Brakes—CHECK.

CAUTION

To prolong life of brake assemblies, maximum use of reverse thrust and differential power should be used, and condition levers should be maintained at NORMAL FLIGHT for taxiing.

2. Nose wheel steering—CHECK.

3. YAW DAMPER switch—TEST/OFF. Hold YAW DAMPER switch in TEST while taxiing. Check for normal rudder pedal movement opposing turns.

4. LEFT, CENTER, RIGHT EXTERNAL FUEL TRANSFER switches—ON. Check applicable AUX FUEL caution lights ON, then go OFF, indicating transfer flow. Turn switches OFF after check.

7.10 BEFORE TAKE-OFF

1. Seats—ARMED (P,O).

2. Ejection selection handle—AS DESIRED.

3. Fuel quantity—CHECK.

4. Center wing tank—174 to 322 (248 ± 74) pounds.

5. LEFT, CENTER, RIGHT EXTERNAL FUEL TRANSFER switches—OFF.

6. PITOT HEAT switch—AS DESIRED.

7. Cockpit heat—AS DESIRED.

8. FLAPS—AS DESIRED.

9. Set Trim—TAKE-OFF.

(a) Rudder/Aileron—NEUTRAL.

(b) Elevator (NORMAL)—1/2 UNIT DOWN.

10. Take-off data—REVIEW.

11. Canopy—LOCKED (P,O).

12. Harness—LOCKED (P,O).

13. Condition levers—TO/LAND (94 to 96 percent).

14. Controls—CHECK.

CAUTION

To preclude foreign object damage, the FLIR turret should be pointed forward on take-off.

15. Power levers—MILITARY (101%). Maximum available torque is attained at 115-degree detent position (99.8 to 100.2 percent) which is slightly aft of the MILITARY position. The maximum available thrust is attained at the MILITARY (101%) position. Do not exceed TIT and torque limits.

NOTE

- A 200 foot-pound torque split between engines is acceptable for take-off. If engine torque indication is below rated torque, refer to power correction chart, Figure 26-10. For engine limits, refer to ENGINE LIMITS in Part I, Chapter 4 (Figure 4-2).

- Under colder than Standard Day conditions, the brakes may not hold the aircraft at maximum power.

7.11 TAKE-OFF

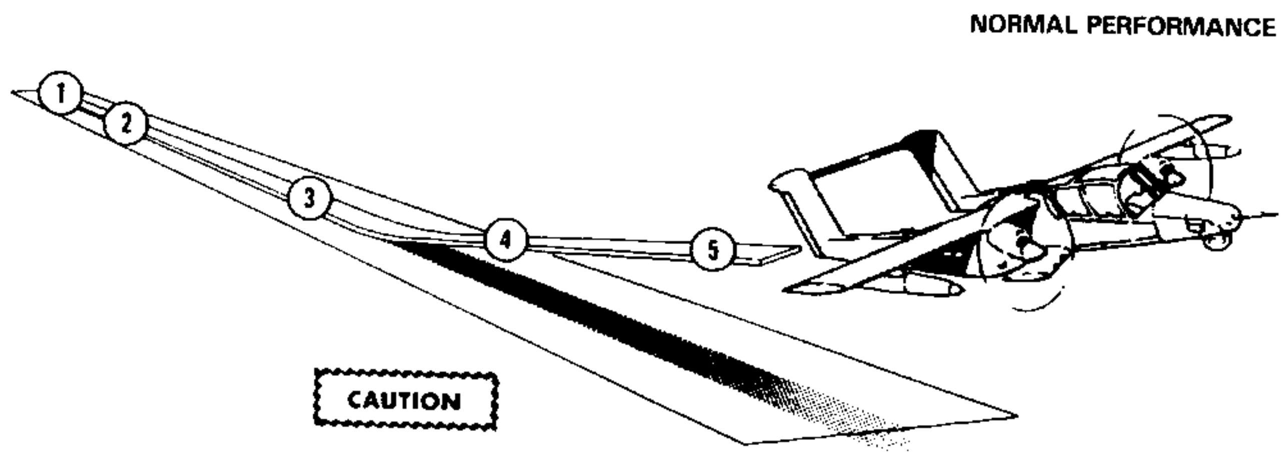
Normal take-offs at gross weights below 12,000 pounds near Standard Day conditions result in short take-off runs. Take-off airspeed and distance should be computed from the performance data charts in Part XI, Chapter 26.

7.11.1 Normal Take-Off. For typical take-off procedure, see Figure 7-3. Directional control with rudder alone is adequate and accurate under most conditions immediately on brake release. Nose wheel steering reduces the directional control task during initial acceleration on unprepared surfaces and for crosswinds. Smooth, positive back pressure application for rotation to take-off attitude should be initiated 5 KIAS below recommended take-off speed, so as to arrive at the proper attitude for lift-off. A no-flap take-off is recommended when runway length, terrain clearance, or operational requirements are not a factor. The no-flap configuration affords a more favorable safety margin between lift-off speed and minimum safe single-engine speed, especially at high gross weight and high ambient temperature conditions.

CAUTION

Check engine torque and temperature indications during take-off, retarding the power levers as necessary to avoid exceeding limits as speed increases.

7.11.2 Crosswind Take-Off. For crosswind component, refer to the wind component chart, in Part XI, Chapter 25. Use nose wheel steering as required during take-off run until directional control can be maintained with rudder. Aileron into the wind and/or slightly higher torque on the upwind engine will assist in maintaining wings level; however, reducing power on the downwind engine will result in significantly increased



CAUTION

Lowering or raising of landing gear while in a full flap configuration may cause inboard gear door to jam on landing gear roller.

1. Advance power to maximum available within limits, check engine instruments, and release brakes.
2. Use rudder and/or nose wheel steering as required.
3. When speed approaches 5 Kias below recommended take-off speed, use positive back stick pressure to rotate to lift-off attitude.
4. When safely airborne, retract landing gear.
5. Above 110 KIAS, retract flaps if used.

NA-86-0043-115A

Figure 7-3. Take-Off

take-off distance. For take-off under near-limit crosswind component (20 knots), delay rotation to lift-off attitude until airspeed approaches recommended take-off speed; then, apply back pressure to make a positive break from the ground. Correct for drift after lift-off by making a coordinated turn into the wind.

7.12 AFTER TAKE-OFF

1. Landing gear—UP.
When safely airborne, retract the gear. Ensure the gear is fully retracted before exceeding 158 KIAS.

2. FLAP handle—UP.
Above 110 KIAS, retract flaps. Ensure flaps are fully retracted before exceeding 158 KIAS.

3. Oxygen diluter lever—NORMAL OXYGEN, as required (P,O).

4. YAW DAMPER switch—ON, as desired.

5. LEFT, CENTER, RIGHT EXTERNAL FUEL TRANSFER switches—ON, as required. Check AUX FUEL caution lights go out.

6. Condition levers—NORMAL FLIGHT, individually as desired above 1000 feet AGL.

NOTE

When retarding to NORMAL FLIGHT, take care not to inadvertently select FUEL SHUTOFF.

7.13 CLIMB

For climb speed schedules and climb performance data, refer to Part XI, Chapter 27.

7.14 CRUISE

For cruise performance data, refer to Part XI, Chapter 28. To initially set up cruise power, move the condition levers to NORMAL FLIGHT and adjust the power levers to maintain the desired airspeed.

7.15 FLIGHT CHARACTERISTICS

For flight characteristics data, refer to Part IV and Part XI, Chapter 25.

7.16 DESCENT

For optimum descent, set condition levers to NORMAL FLIGHT and power levers to FLIGHT IDLE. For airspeed distance, time, and fuel usage, refer to Part XI, Chapter 30. Prior to descent, proceed as follows:

1. CKPT AIR/DFR knob—AS REQUIRED.

2. Altimeter—SET.
Set altimeter to destination barometric pressure.

3. Radar altimeter minimum altitude—SET.

4. Oxygen—100%.

7.17 BEFORE LANDING

1. Condition lever—TO/LAND.

2. Landing gear—DOWN.

3. Flaps—AS DESIRED.

4. Brakes—CHECK.

5. Harness—LOCKED (P,O).

6. Message drop door—CLOSED.

7. Landing light—AS REQUIRED.

8. EXTERNAL FUEL TRANSFER switches—OFF.

9. MASTER ARM switch—OFF.

10. Countermeasures power SALVO FLARE switch—OFF.

11. LASER ENABLE switch—OFF.

12. FLIR turret—FORWARD (O).

CAUTION

To preclude foreign object damage, the FLIR turret should be pointing forward on landing.

7.18 LANDING

Approach the break with condition levers in TO/LAND. At the break, roll into no more than 90-degree angle of bank at an airspeed not to exceed 250 KIAS and reduce power as required. As the aircraft decelerates below 158 KIAS, lower landing gear and set flaps as desired. If flaps are extended, a pitch change will occur and power must be adjusted to arrive at the abeam position at the desired airspeed commensurate with gross weight. Complete the landing checklist prior to this point (Figure 7-4). Begin the turn into the base leg at the 180-degree point which is slightly downwind of the landing end of the runway in order to have a straightaway of approximately 1000 feet. A normal power controlled approach is flown utilizing airspeeds as indicated in Part XI, Chapter 31. Rapid power changes result in large lift changes due to the amount of wing and tail surface directly in the propeller wash envelope. Approach speed and glide slope control are simplified by making small, smooth power changes. Torque setting and glide slope angle are primary for airspeed control on final approach. With propeller rpm being relatively constant, changes in airspeed and power setting do not result in the sound variations normally expected.

After touchdown, lower the nose and select reverse thrust as desired, exercising caution not to exceed engine limits.

CAUTION

After landing, power levers shall not be retarded aft of GROUND START position until airspeed is less than 75 KIAS (OAT in excess of 100 °F/37.8 °C) or 100 KIAS (OAT less than 100 °F/37.8 °C).

Nose wheel steering may be used for directional control if desired; however, directional control can easily be maintained using rudder and differential reverse thrust.

CAUTION

Do not attempt to maintain a nose-high attitude for aerodynamic braking below approximatly 50 knots. Loss of pitch control authority in a nose-high attitude may cause overrotation and damage to the rudders. If landing rollout overrotation is encountered, apply brake pressure to rotate the aircraft nose down to the normal attitude. For 13,000 pounds landing weight, recommend brake application at speed no higher than 60 knots.

NOTE

If "gate" does not retract, raise the power levers 1/4 inch and pull back to obtain reverse thrust.

7.18.1 Touch-and-Go Pattern. Following touchdown, raise the flaps, if they are down, and smoothly add Military power. When 5 KIAS below computed take-off speed, rotate the nose and fly aircraft into the air. When safely airborne, raise the gear if desired. (Normally the gear is left in the down position to decrease wear on the hydraulic system.) Climb to a minimum of 300 feet AGL and accelerate to 120 KIAS prior to turning downwind. Maintain 120 KIAS in the turn and on the downwind leg. Prior to the abeam point, complete the landing checklist and slow to approach speed. Adjust the turn from the 180-degree point to arrive on final with approximately 3000 feet of straightaway, 200 to 300 feet AGL. Touchdown airspeed is determined by weight and landing configuration.

7.18.2 Crosswind Landing. Refer to the crosswind chart in Part XI, Chapter 25, to determine crosswind component. Adjust position of the downwind for wind to avoid undershooting/overshooting the final approach. The normal (wing-down) approach procedure is effective, but may produce easily controllable lateral oscillations under gusting conditions. After touchdown, retract flaps as soon as practicable; hold

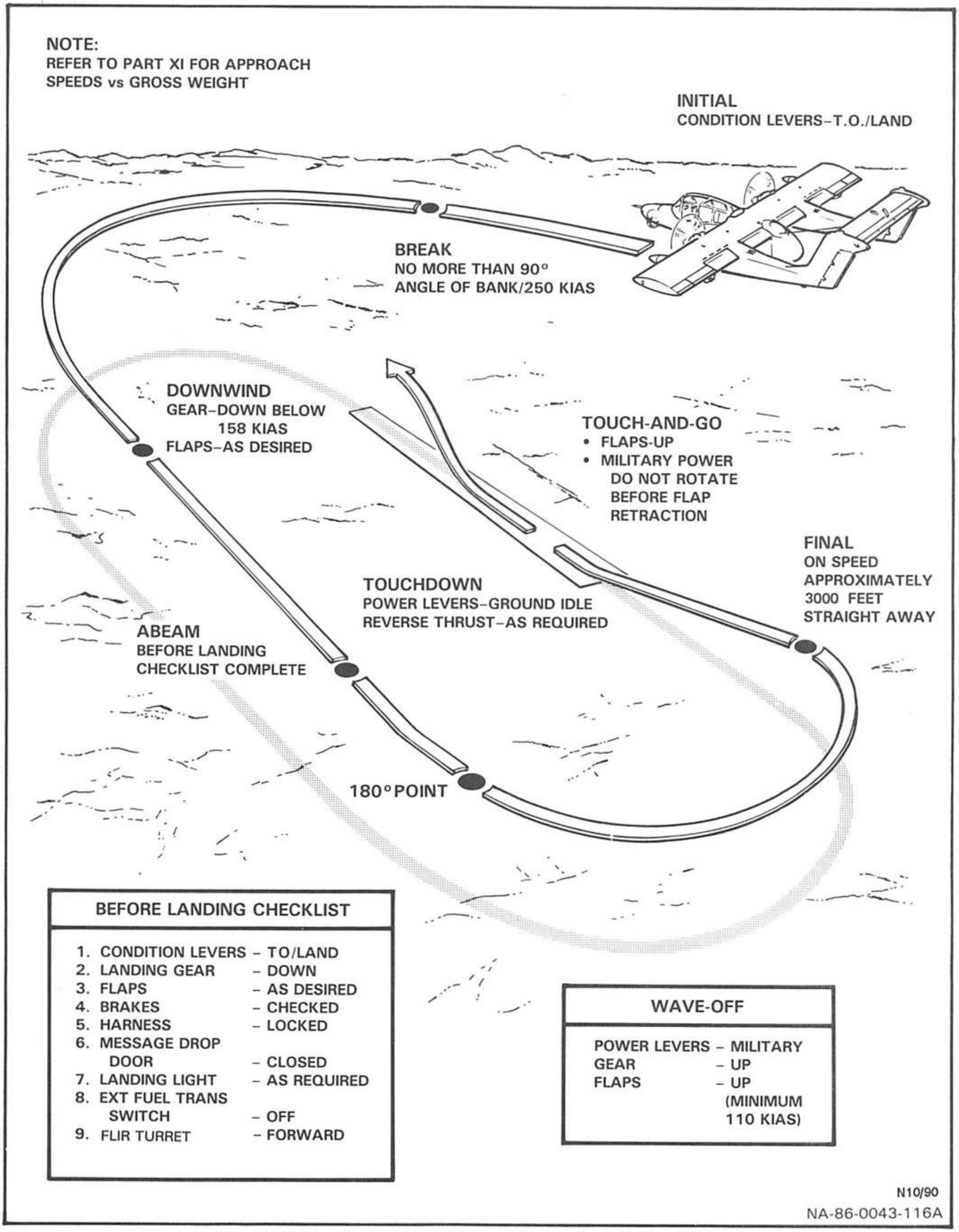


Figure 7-4. Typical Landing and Touch-and-Go Pattern

the stick into the wind and use differential reverse thrust and nose wheel steering for directional control.

7.18.3 Slippery Runways. Refer to ICE AND RAIN, in Part VI.

7.18.4 Wave-Off

1. Power levers—MILITARY.

CAUTION

Monitor engine indicators to avoid exceeding torque or temperature limits.

2. Rotate nose up to arrest sink rate.

3. FLAP handle—T/O.

4. Landing gear handle—UP.

5. FLAP handle—UP, as desired (minimum 110 KIAS).

CAUTION

Under certain air loads which develop during wave-offs with full flaps selected, the main landing gear doors may NOT be fully open and may prevent the landing gear from retracting normally. If this occurs, relower the landing gear and land.

7.18.5 After Landing (When Clear of Runway)

1. Lower ejection handle safety pin—INSERT (P,O).

2. FLAP handle—UP.

3. Condition levers—NORMAL FLIGHT.

CAUTION

To prevent engine overtemperature, monitor TIT when operating in the normal flight mode and utilizing full or partial reverse. Overtemperature is more likely to occur when a headwind component exists.

4. Landing Lights—AS REQUIRED.

WARNING

The observer shall not release his harness fittings until cleared by the pilot after the front seat is safe. An inadvertent ejection by the pilot will eject the rear seat even with all rear safety pins installed.

5. IFF—AS REQUIRED.

7.19 SHUTDOWN

CAUTION

Allow engines to idle at ground start rpm (65% to 66%) for 2 minutes prior to shutdown to minimize heat soakback and engine binding after shutdown.

For operational convenience, shut down the engines with the propellers in flat pitch. Proceed as follows:

1. Lower ejection handle safety pin—INSERTED (P,O).

2. PARK BRAKE—SET.

3. NO. 3 INV switch—OFF (O).

4. FLIR mode switch—OFF (O).

5. CMS controlled equipment—OFF (IDX page/Power page).

(a) TACAN

(b) IFF

(c) KY 1 and KY 2

6. Condition levers—FUEL SHUTOFF.

7. Power levers—FULL REVERSE (monitor temperatures).

Hold in FULL REVERSE until engine rotation stops. Advance power lever to GROUND IDLE and check that the propeller blades move to and stop at the flat pitch position.

CAUTION

Failure of an engine to stop running when condition levers are placed in FUEL SHUTOFF may indicate a broken or disconnected fuel control linkage or shutoff valve. Positioning the power lever to FULL REVERSE or the condition lever to FEATHER & FUEL SHUTOFF under these circumstances may result in engine overtemp/fire. When linkage failure occurs, shut down the engine using the EMER FUEL SHUT OFF switch.

NOTE

For feathered shutdown, pull condition levers full aft to FEATHER & FUEL SHUTOFF. Expect higher than normal temperatures and possible smoke from the intakes because rapid wind-down of the engines.

8. EMER FUEL SHUT OFF switches—SHUT OFF.

9. CMS PWR switch—OFF (record NOGO indications from STAT pages).

10. RADIOS 1, 2, 3, and HF PWR switches—OFF.

11. Nonessential avionic systems—OFF (P,O).

(a) Radar signal detecting system.

(b) Infrared countermeasures set—Observe IRCM caution light comes ON, and goes OFF after 60 seconds.

(c) Mission (video) recorder (O).

(d) KY-75.

12. Doppler navigation system CDU mode switch—OFF (O).

13. INST PWR switch—OFF.

14. BATTERY switch—OFF.

15. External/interior lights—OFF.

7.20 BEFORE LEAVING AIRCRAFT

1. Wheel chocks—IN PLACE.

2. PARK BRAKE—SET, as desired.

3. Oxygen regulator levers—NORMAL, 100% OXYGEN, OFF (P,O).

4. Control gust lock—INSTALL.

5. Parachute thruster safety pin—INSTALLED (P,O).

6. Landing gear and drop tank safety pins—INSTALL.

7. Engine oil quantity—CHECK.

8. LASER safety plug removed—CHECK.

9. Mission (video) recorder tape—Removed.

10. Conduct postflight inspection to cover all items of preflight inspection for possible damage/discrepancies.

CHAPTER 8

Carrier-Based Procedures

8.1 INTRODUCTION

The carrier landing is the end result of all field training. The effectiveness of the OV-10 weapons system depends on the overall efficiency of carrier landing operations if peak combat readiness is to be maintained. To ultimately carry out any assigned mission, each aviator must be able to perform carrier landings and take-offs within the standards set for these evolutions.

NOTE

Only experienced and appropriately trained aircrews should take part in carrier-based operations.

8.2 FIELD CARRIER LANDING PRACTICE

Field Carrier Landing Practice (FCLP) is defined as that phase of required flight training which precedes carrier landing operations. It must simulate, as nearly as practicable, the conditions encountered during carrier operations, including the configurations of the aircraft. The Landing Signal Officer (LSO) is responsible for maintaining the rigid standards of performance demanded for carrier operations. In order to maintain these standards, the LSO must demand that each FCLP approach represent the maximum capability of the individual pilot.

8.2.1 Ground Training. Prior to and during FCLP training, the following subjects shall be covered in lectures by the LSO.

1. Optical landing systems
2. Nonoptical landing system approaches
3. Communications
4. General FCLP procedures
5. Specific FCLP procedures
6. Postflight debriefings

8.2.2 Flight Procedures. Pilots shall be briefed by the LSO prior to each FCLP period in accordance with the NATOPS Briefing Guide. The following items shall also be included:

1. Take-off/Recovery times
2. Weather
3. Bingo fields
4. Formation procedures
5. Traffic rules and terrain of FCLP field
6. Patterns
7. Gross weight limitations
8. Communications
9. Emergencies
10. Practice wave-offs
11. Final recovery procedures
12. Debrief time/location

8.2.3 The FCLP Pattern. The FCLP pattern shall be flown in accordance with the pattern depicted in Figure 8-1. It should simulate to the maximum extent possible the carrier landing pattern. The distances and altitudes depicted are examples of the normal 180-degree positions for both day and night operations. The turns and pattern altitudes from the 180-degree position will be flown in such a manner as to ensure an adequate wings-level groove.

8.2.4 Pilot Certification. The FCLP training must be completed to the satisfaction of the senior LSO prior to carrier qualification. During this training the pilot will demonstrate his ability to operate with appropriate configurations and simulated emergency condition. When this has been completed, a recommendation will be submitted by the LSO to the Commanding Officer certifying the pilot as FCLP qualified. The LSO will also recommend revocation of a certification at any time a pilot's standard of performance is less than satisfactory.

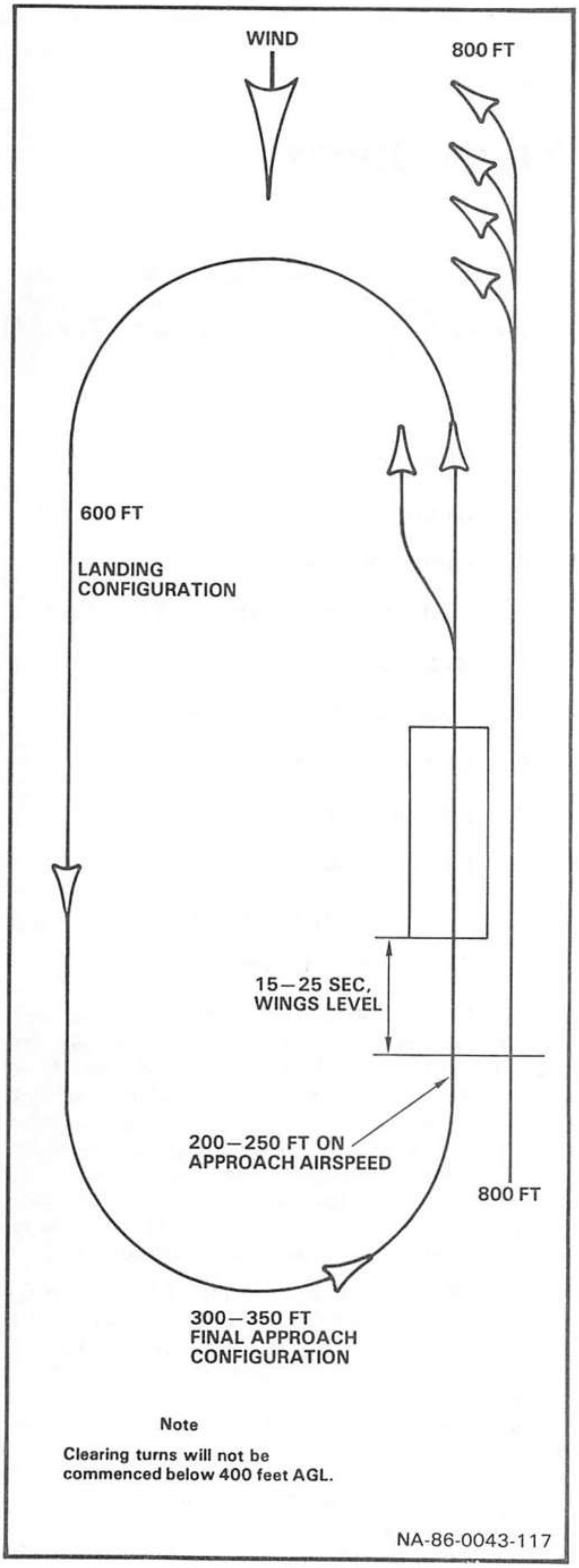


Figure 8-1. Standard FCLP Pattern

8.2.5 Pre-Carrier Briefing. The following subjects shall be covered by the LSO in briefings for pilots prior to and during carrier operations.

1. Carrier configuration
2. Recovery systems
3. Communications
4. General carrier operating procedures
5. Specific carrier operating procedures
6. Emergencies
7. Operations and air department briefings
8. Landing pattern and recovery procedures
9. Postflight briefings

8.2.6 Landing Pattern and Recovery Procedures

8.2.6.1 Day VFR Pattern. To be provided at a later date.

8.2.6.2 Night VFR Pattern. To be provided at a later date.

8.2.7 Aircraft Handling and Launch Procedures. Launches shall not be commenced when less than 700 feet of clear, unobstructed take-off distance is available. All carrier launches are to be made using 20-degree flaps and one unit of nose-down trim. Primary consideration is to obtain safe single-engine speed prior to lift-off, vice becoming airborne as quickly as possible. Safe single-engine speed where a loss of control about any one of the aircraft axes occurs with one engine feathered and the other at Military power. It does not mean that a safe flyaway will always be possible, but it does assure the pilot of sufficient time to eject, jettison the external load, or ditch, whichever is appropriate. The minimum wind-over-deck (WOD) requirements for a safe take-off are contained in the charts in shipboard operating bulletin. It is the responsibility of the pilot to ensure that the conditions required for launch are met.

WARNING

Launches with wind over deck lower than those delineated in shipboard operating bulletin are prohibited.

The take-off technique recommended is application of Military power prior to commencing the roll and a positive rotation to a fly-away attitude 5 to 10 KIAS prior to obtaining take-off speed.

NOTE

A power degradation in excess of 5 percent below computed rated torque will require recomputation of wind-over-deck requirements. If power degradation is in excess of 10 percent, do not attempt take-off.

CHAPTER 9

Special Procedures

9.1 STOL OPERATIONS

Short-field take-off and landings (STOL) are achieved through practice. Short-field technique should be perfected under controlled conditions on hard-surface runways. The objective of safely taking off or landing the aircraft in the shortest feasible distance depends on variables such as: runway length, obstacle heights, aircraft weight, center of gravity, and existing weather (including wind, temperature, and pressure altitude).

WARNING

STOL operations should be performed only by experienced OV-10D pilots.

NOTE

The OV-10D is prohibited from take-off and landings on other than smooth, hard-paved surfaces.

9.1.1 STOL Take-Off. Take-off performance can be improved by utilizing lower lift-off airspeeds and a higher climb angle after lift-off. The airspeeds for STOL take-off are based upon the minimum single-engine control speed of the aircraft. Engine failure at these airspeeds will result in an immediate yaw and roll into the failed engine. Full rudder deflection and almost full aileron deflection will be required immediately to maintain a wings-level attitude. In the STOL configuration, the aircraft cannot maintain level flight with only one engine operating. Loss of an engine will result in a rate of descent and crash landing; however, rapid rudder and aileron deflection on engine failure should allow a wings-level attitude to be regained. Existing conditions of runway remaining, altitude on engine loss, and surrounding terrain will dictate whether a crash landing or ejection is required for survival.

The technique for STOL take-offs is similar to normal take-offs. Set the flaps at 20 degrees and trim one unit nose-down. Compute take-off distance and airspeed, climbout flight path, engine performance, and complete take-off checklist before taxiing into take-off position. In take-off position, advance power levers to MILITARY, letting torque build to maximum possible while being careful not to exceed engine limits.

WARNING

Recompute performance data if expected performance is not realized.

Brakes may be unable to hold the aircraft on a hard, dry runway at Military power settings, at aircraft gross weights below 13,500 pounds.

At 10 knots below computed take-off speed, rotate the nose to approximately 20 degrees above the horizon and fly the aircraft off the deck at lift-off speed. When safely airborne, raise gear and flaps and continue normal climb. Positive forward stick pressure will be required to stop the rotation at 20 degrees and to prevent an overrotation as airspeed increases. For an obstacle take-off, raise the gear after take-off. Leave flaps down, and climb out at take-off speed until clear of the obstacle.

9.1.2 STOL Landing. Landing performance can be improved by utilizing lower approach speeds at 20 degrees flaps. The airspeeds for STOL (20 degrees flaps) are based on minimum single-engine control speed. Engine failure at these airspeeds will result in a yaw and roll into the failed engine. This roll and yaw, although less rapid than during STOL take-offs due to reduced engine power, will require almost full rudder and aileron deflection to regain wings-level flight. In the STOL configuration, the aircraft cannot maintain level flight with only one engine operating. Loss of an engine will result in an increased rate of descent and a crash landing. Existing conditions of runway remaining, altitude on engine loss, and surrounding terrain will dictate whether a crash landing or ejection is required for survival. Altitude permitting, retraction of gear and flaps may allow sufficient time to accelerate to a positive rate-of-climb airspeed at light gross weights. Maximum authorized landing weight for STOL landing is 13,000 pounds. The STOL landing pattern is flown the same as the normal pattern. Slow to recommended approach speed and lower flaps. Prior to being established on final, maintain minimum safe single-engine speed. Establish and maintain the computed touchdown speed and fly a power-controlled approach to a touchdown. Care should be taken to safe clearance of obstacles and to remain below the maximum allowable touchdown rate of descent (no greater than 840 fpm on prepared hard surfaces). On touchdown, retard the power control levers to GROUND START, apply slight forward stick, and commence moderate braking. When below 100 KIAS (OAT 100 °F/37.8 °C or less) or 75 KIAS (OAT in excess of 100 °F/37.8 °C), smoothly but rapidly retard the power levers to FULL REVERSE and apply maximum braking without skidding.

CAUTION

With reverse thrust selected, prevailing conditions of dust or precipitation can result in momentary obstruction of visibility.

NOTE

To ensure maximum braking capability, it is necessary to pump the brakes just prior to landing. The brakes will bleed down from the 180-degree position and full pedal travel will not be available without pumping the brakes on final approach.

9.2 REMOTE SITE OPERATIONS

Preliminary remote site selection will require an in-depth map reconnaissance and input by both squadron personnel and the Landing Force Intelligence personnel. Attention must be given to all areas of site evaluation to ensure adequate landing, parking, ordnance, and fueling areas are available. Modifications to the site should include only that necessary to ensure safety and camouflage. Ground support personnel and aircraft should both have the capability of rapid displacement from the site.

Obstacles and touchdown zones must be marked and identified to aircrews prior to commencement of site operations. In a training environment personnel should if possible, physically walk the entire remote site to familiarize themselves with its characteristics and obstacles.

A runway control officer (RCO) will be the controlling official at the site and as such may institute or remove from effect any restrictions on aircraft operation he may deem necessary to ensure safe standardized operation from the site. He is also responsible for landing surface marking, obstacle marking or removal security, instruction and positioning of support personnel, and initiating or terminating flight operations at the site.

The RCO will be an experienced pilot or NFO knowledgeable of forward site operations. When a MATC light and mobile team or combat control team is employed at the site, the duties of the RCO may be performed by the officer or SNCO in charge. The RCO will:

1. Be the controlling official at the site.
2. Be responsible for laying out visual aids and lighting, if required.
3. Verify the site is ready to receive aircraft.
4. Be responsible for all takeoff, landing, and ground evolutions at the site.
5. Supervise all ground personnel at the site.
6. Assure minimum crash/fire and rescue coverage is pre-positioned.
7. Maintain liaison with supported units.
8. Observe and evaluate all factors which may affect the safety of the operation.

Pilots operating from the remote sites will normally receive a briefing on the site by the runway control officer to include length of landing area, normal approach corridors, and prevailing wind direction. In addition, pilots shall have demonstrated their ability to remain on centerline during STOL landings.

9.3 AEROBATICS

Before starting an aerobatic flight, the pilot will ensure that the criteria set forth in OPNAVINST 3710 current series can be complied with. For aerobatic maneuver parameters, see Figure 9-1.

9.4 ENGINE-OUT OPERATIONS

For pilot training purposes, the following definitions will apply:

- Actual engine-out operations are those in which an air start would be required to regain use of the engine.
- Simulated engine-out operations are those in which immediate use of the engine is available.

Actual engine-out operations shall not be intentionally conducted below 4000 feet AGL. Simulated engine-out operations may be conducted at any altitude; however, they shall not be initiated below 500 feet AGL. Engine-out operations can be simulated by setting the power control lever of the simulated failed engine at the gate stop and placing that condition lever at 95.6% rpm.

9.5 FORMATION

Formation take-off, rendezvous, descent, and approach procedures (IFR/VFR) of aircraft with dissimilar weights and configurations must be considered during flight planning and discussed in the brief.

9.5.1 Parade Formation. Parade formation will normally be employed when operating around home base or during low visibility conditions. It is recommended that all power changes, climbs,

MANEUVER	COND LEVER	RPM	ENTRY AIRSPEED	MINIMUM MANEUVER SPEED
AILERON	NORMAL FLIGHT	95%–98%	150–200	- -
WINGOVER	↓	↓	200	100–110
BARREL ROLL	↓	↓	200	100–110
LOOP	↓	↓	270	100–110
CUBAN EIGHT	↓	↓	270	100–110
IMMELMANN	↓	↓	270	100–110
SPLIT S	↓	↓	120	- -

NOTE: MANEUVERS LISTED ABOVE ARE EXAMPLES ONLY. MANEUVERS NOT LISTED SHOULD BE ENTERED AND COMPLETED AT SPEEDS WITHIN THE AIRCRAFT LIMITS FOUND IN PART I, CHAPTER 4.

NA-86-0043-118A

Figure 9-1. Aerobatic Maneuver Parameters

glides, and turns be signaled by the leader. Bearing and stepdown are determined by placing the propeller spinner on the lead pilot's shoulder. Wing-tip separation should be adjusted to approximately 5 feet. On turns away, the wingman should turn about his own axis; on turns into the wingman, he should rotate about the leader's axis. The instrument parade position is flown in the same manner except that all turns are conducted about the leader's axis. For all parade formation, the wingman will position the condition levers to TO/LAND.

9.5.2 Crossunder. Upon receipt of the crossunder signal, the wingman will acknowledge and commence an arcing crossunder by reducing power, dropping the nose slightly, and sliding aft to clear the leader's tail section and propwash. As the nose passes approximately 20 feet below and directly aft of the leader's tail, smoothly add power and complete the crossunder by sliding up and forward to the proper wing position.

9.5.3 Free Cruise. Free cruise formation provides better look-out capabilities and maximum freedom of movement for the leader and other members of the flight. Normal cruise is flown within a 60-degree triangle, 30 degrees on either side of the leader's axis with 20 feet nose-to-tail clearance and sufficient vertical separation to clear the leader's prop-wash. A step-up position may be utilized to ensure mutual visual coverage.

9.5.4 Tail Chase. The tail chase position is flown in the leader's 6-o'clock position with a 10- to 20-foot stepdown and 20-foot nose-to-tail clearance. The leader will perform climbs, dives, and turns gradually increasing pitch and bank angles. Positive "g" will be maintained at all times.

9.5.5 Rendezvous

9.5.5.1 Turning Rendezvous. The turning rendezvous is made at 150 KIAS (unless otherwise briefed). After the second aircraft is in a loose trail position, the leader starts a 180-degree turn, using 20 degrees of bank. The second aircraft waits until the lead aircraft has started his rendezvous turn before rolling into 45 degrees of banked turn to the inside of the aircraft. The angle of bank is adjusted as necessary to maintain the 45-degree bearing until joining on the leader. As the joining aircraft approaches the leader, the closure rate is adjusted so as to join on the inside of the leader's turn. After joining on the inside of the leader, a crossunder is made to the outside, assuming the normal wing position.

9.5.5.2 Running Rendezvous. A running rendezvous is effected by closing from the rear on a prebriefed heading or radial. This rendezvous should be accomplished with the flight leader climbing at 130 knots and 95% to 96% rpm (unless otherwise briefed). If a level rendezvous is made, the leader should normally be at 150 KIAS at the designated altitude.

9.5.5.3 Safety Rules for Rendezvous. The safety rules for rendezvous are as follows:

1. Keep the aircraft ahead constantly in view.

2. During rendezvous, maintain the leader on the horizon until within three wing spans, then take step down required for the crossunder.

3. If necessary, a wingman should abort the rendezvous by leveling wings, reducing power, ensuring vertical separation from lead, and flying to the outside of the turn. The wingman should advise lead of this maneuver by broadcasting his intentions. When stabilized on the outside and cleared by lead, adjust power as necessary to join on that side.

4. All relative motions should be stopped when joining on an inside wing position. A crossunder to the outside may then be made.

5. During a running rendezvous, use caution in the final stage of join-up as relative motion is difficult to discern when approaching from astern.

6. Maximum closure rate by wingman should be 10 KIAS for day rendezvous. Night rendezvous should be flown at coairspeed.

9.5.6 Section Take-Off. After obtaining clearance to taxi into take-off position, the leader will take the downwind side of the runway. The wingman should position his aircraft with a 20-foot wing-tip separation. Both aircraft will perform power checks on the leader's signal and the leader will set his power with 100 pounds torque less than MILITARY power.

On signal, both aircraft will commence take-off roll simultaneously. At recommended lift-off speed, the leader will smoothly transition to the take-off attitude. After the wingman is safely airborne, the leader will signal for raising the gear. If during take-off roll, the leader must abort his take-off, the wingman will continue or abort as appropriate.

9.5.6.1 Section Approaches. Section approaches shall be flown in accordance with the OPNAVINST 3710.7 series at a minimum recommended airspeed of 120 KIAS.

9.6 NIGHT FLYING PROCEDURES

Night flying procedures are identical to day procedures with the following exceptions. For night lighting information, refer to Part I, Chapter 2.

9.6.1 Night Formation. It is important to maintain the correct bearing so that the wingman can be seen by the leader. Ensure that wingtip clearance is maintained at all times. Avoid staring at the lead aircraft and getting fixation on its lights. Instrument parade turns will be made with a 30-degree maximum angle of bank.

9.6.2 Night Rendezvous. Night rendezvous are similar to daytime, except that in the final portion the pilot should try to close to a position slightly astern rather than directly toward the aircraft. Pilots must be sure not to carry excess airspeed in the rendezvous. The leader must maintain a constant airspeed and altitude. Whenever it is necessary for a pilot to go to the outside of the rendezvous, he will report this to the Flight Leader. Stay on the outside of the rendezvous until stabilized and then add power as necessary to join up. Pilots joining from astern will move out to the side in order to enhance their judgement of closure rates, as well as to ensure safe clearance.

9.6.3 Night Formation Signals. See Figure 9-2.

SIGNAL	MEANING	RESPONSE
1. At hold short, wingman turns off formation lights.	T/O checklist complete and on briefed frequency.	Lead calls for T/O or takes position for T/O.
2. On runway, wingman turns on formation lights.	Engine runs up complete and ready for take-off.	N/A.
3. Steady light held high on side of canopy.	Wingman crossunder.	Execute crossunder.
4. In parade, lead puts formation and position lights on bright and anti-collision lights on.	Lead breaking off.	N/A.
5. On join-up, lead dims lights and turns anti-collision lights out.	I resume lead.	N/A.
6. During final approach for landing, lead puts position lights to bright momentarily.	Prepare to lower landing gear.	Prepare to lower gear on execution signal.
7. Lead returns lights to DIM.	I am lowering gear.	Lower gear.
(If WX requires lead's lights on bright, prepare by going to DIM; execute when return to bright.)		
8. During final approach for landing, lead puts anti-collision lights on.	Wingman detach, you are cleared to land.	Execute.
9. When inside of ATA, lead puts on anti-collision lights.	Wingman(men) take separation for landing.	Execute.
10. Flicker landing light several times.	I am completely NORDO on briefed frequencies/nets.	N/A.
11. Leader shines flashlight on helmet, then towards wingman.	Wingman take lead.	Wingman turns anti-collision lights off to accept lead. (To be followed by step 12 immediately.)
12. New wingman turns on anti-collision lights.	I am wingman.	Execute lead change.

NA-86-0043-119

Figure 9-2. Night Formation Signals

CHAPTER 10

Functional Checkflight Procedures

10.1 INTRODUCTION

A "Functional Checkflight" is an operation conducted to determine if the aircraft and its systems are in a satisfactory condition for the performance of regular missions. It differs from regular or normal operations flying, since the pilot is flying in accordance with a specific plan designated to test all functional systems and determine if any operational discrepancies exist.

10.1.1 Check Pilots. An important factor in obtaining good checkflights on the aircraft is the selection of experienced and conscientious check pilots. Commanding Officers shall designate, in writing, those pilots within their command who are currently qualified to perform this duty.

10.1.2 Checkflights and Forms. Checkflights will be performed when directed by, and in accordance with OPNAVINST 4790.2 series and the directions of NAVAIRSYSCOM, type Commanders, or other appropriate authority. Functional checkflight requirements and applicable mimimums are described. Functional checkflight checklists are promulgated separately.

10.1.3 Rear Cockpit System Checks. Certain conditions may require flight checks to determine if the rear cockpit systems are in satisfactory condition for the performance of regular missions. These flights should be accomplished by an aerial observer/pilot/maintenance technician occupying the rear cockpit.

10.2 CONDITIONS REQUIRING FUNCTIONAL CHECKFLIGHT

Perform applicable flight profile and associated checks in accordance with the following conditions:

A. At the completion of aircraft rework and appropriate phase inspections (all checkflight items required are prefixed A).

B. Following major structural repair of airframe components that could affect aerodynamic reaction during flight. When fixed-flight surfaces have been installed or reinstalled, or when movable flight surfaces or flight control system components have been installed or reinstalled, adjusted or rerigged, and improper adjustment or replacement could cause an unsafe operational condition (all checkflight items are prefixed B).

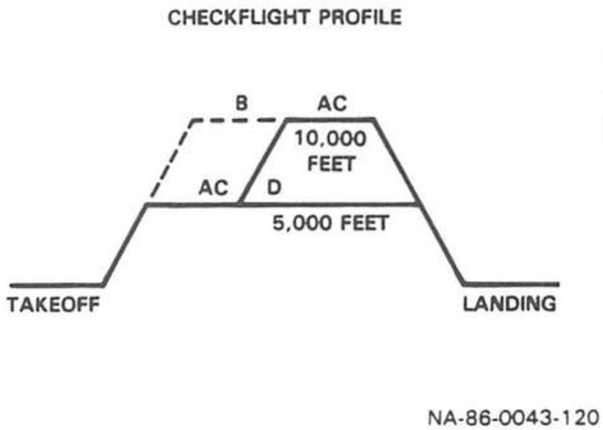


Figure 10-1. Checkflight Profile

C. Installation or reinstallation of engine, propeller, propeller governor, major fuel system components, or any component or mechanism which cannot be checked during ground operations (all checkflight items are prefixed C).

D. When landing gear components are installed or reinstalled and ground checks are not adequate due to absence of air loads (all checkflight items are prefixed D).

10.3 PROCEDURES

The following items provide a detailed description of the functional checks, sequenced in the order in which they should be performed. In order to complete the required checks in the most efficient and logical order, a flight profile has been established for each checkflight condition and identified by the letter corresponding to the purpose for which the checkflight is being flown, A through D. The applicable letter identifying the profile prefixes each check both in the following text and in the NAPTOPS Functional Checkflight Checklist (A1-O10DA-NFM-700). Checkflight personnel will familiarize themselves with these requirements prior to the flight. NATOPS procedures will apply during the entire checkflight unless specific deviation is required by the functional check to record data or ensure proper operation within the approved aircraft envelope. A Daily inspection is required prior to any checkflight.

PROFILE

10.4 BEFORE START

A C — 1. Unfeather pump check—Place left power lever in FULL REVERSE and move NO. 1 AIR START switch to CRANK. Note movement of propeller toward reverse. Return AIR START switch to AUTO and power lever to GROUND IDLE. Repeat for right engine.

10.5 PRETAXI

A — 2. Cockpit Management System (CMS).

(a) Ensure MASTER ARM switch OFF and turn ON RADIOs 1, 2, 3 and HF and CMS system (allow 90 seconds for warm-up and adjust CDU CRT brightness).

(b) Apply Power to CMS-associated equipment and set up radios, TACAN, and IFF for operation.

(c) Check for CMS and associated equipment NOGO indications on STAT page.

(d) Check WPNS and CM pages for external fuel, weapon stores, or countermeasures indications.

A B — 3. Trim.

(a) Utilizing CMS Trim page, check trim controls on all three axes for rates, full deflection, and set take-off positions.

(b) Check alternate trim operations.

A B — 4. Check flaps and alternate flaps for proper operation and indication.

A B — 5. Check controls for full deflection in proper direction and ease of operation.

A — 6. AN/ASN-75 Compass System—Set the compass system for normal magnetic slaved operation with the SLAVED-FREE switch in the SLAVED position. Approximately 3 minutes after starting the engine, rotate the PUSH TO SET knob to cause the indicators to indicate the heading of the aircraft. Note that the annunciator needle is close to the zero position.

A — 7. Doppler Navigation System (AN/APN-233).

(a) Select mode switch to TEST and check for indicator lighting, and correct display sequence.

(b) Check deviation and variation, check year and month.

(c) Select LAND mode and UTM-L/L function, insert checkpoints.

(d) Multipurpose indicator, check test display sequence and lighting/dimming functions.

A — 8. Interior Lights—Check operation of all cockpit lights.

PROFILE	
A	9. Oxygen System — Check all modes of operation.
A	10. Exterior Lights — Check (with plane captain).
A	11. Smoke Generator — Check.
A	12. Chronometer — Check.
A C	13. Engine Performance.
	(a) Overspeed governor (prior to unlocking).
	(1) Propellers locked in flat pitch.
	(2) Power levers at GROUND IDLE and condition levers at NORMAL FLIGHT.
	(3) After stabilization, advance condition levers to TO/LAND. Advance power levers to MILITARY slowly to avoid overspeed.
	(4) Engine rpm should stabilize from 103.8% to 104.3% (5-second limit).
	(5) Record maximum rpm observed.
	(6) Record oil pressure (90–120 psi acceptable).
	(b) Underspeed governor (prior to unlocking).
	(1) Power levers to GROUND IDLE and condition levers to NORMAL FLIGHT.
	(2) Slowly retard power lever aft of GROUND IDLE to GROUND START.
	(3) Minimum rpm should be 65.5 (±0.5)%.
	(4) Record minimum rpm observed.
	(5) Record oil pressure (48 psi min).
A	14. Radar Signal Detecting Set (AN/APR-39) — Self-Test (if applicable).
A	15. Infrared Countermeasures Set (AN/ALQ-144) — IRCM caution light extinguishes.
	10.6 TAXI CHECK
A B C D	16. Brakes.
	(a) Check brakes for dragging or chattering.
	(b) Brake forces required for stopping should be moderate to heavy and brakes should not require pumping.

PROFILE

A D 17. Nose Wheel Steering.

(a) Check nose wheel steering for approximately 55-degree turn angle left and right of center.

(b) Check for shimmy during turns.

A 18. Magnetic Compass and Needle Ball—Check for proper indication during turns.

A B 19. Yaw Damper—With YAW DAMPER switch in TEST position, rudder pedal pressure opposite to direction of turn should be evident.

A B 20. Gunsight Check—Check brightness of both filaments, mil adjustment ring operating freely, both clear and red filter intact. Check alignment through taxi check.

10.7 PRETAKE-OFF

A C 21. Engine Performance.

(a) Idle rpm (NORMAL FLIGHT).

(1) Condition lever at NORMAL FLIGHT and power lever at GROUND IDLE.

(2) Record rpm (65% minimum to 71% maximum).

(3) Record oil pressure (minimum 48 psi).

(b) Idle rpm (TO/LAND).

(1) Power levers at GROUND IDLE and condition levers to TO/LAND.

(2) Record rpm (94% to 96%).

(3) Record oil pressure (90 to 120 psi).

(c) Maximum Thrust.

(1) Refer to AIRCRAFT OPERATING LIMITATIONS, Part I, Chapter 4, or NATOPS Pilot's Pocket Checklist (A1-O10DA-NFM-500) for maximum TIT and minimum torque. (Record.)

(2) With condition levers at TO/LAND, advance power levers to MILITARY position within 1 second.

(3) Check rpm stabilized between 99.8% and 101%. The minimum torque achieved should be 93% of maximum rated torque.

(4) Check development of 95% maximum static torque in approximately 4 seconds. Static torque is the torque developed by that particular engine at MILITARY power and is not synonymous with rated torque.

(5) Check oil pressure (90 to 120 psi).

PROFILE

(d) Maximum Torque.

(1) Condition levers to TO/LAND and power levers to 115- to 117-degree detent position (slightly aft of the MILITARY position).

(2) Check rpm 99.8% to 100.2%.

(3) TIT and torque should rise slightly above that obtained at maximum thrust.

(4) Record maximum torque when maximum TIT is obtained. Check for development of 93% of calculated rated torque.

(5) Check oil pressure (90 to 120 psi).

(e) Engine Acceleration.

(1) With condition levers at TO/LAND, advance power levers to MILITARY position within 1 second.

(2) Check development of 95% of maximum static torque (recorded in item 21(d)(3)) in 10 seconds or less.

(f) Deceleration.

(1) After maximum torque, pull power levers to GROUND IDLE.

(2) RPM should decrease to 94% to 96% within 3 seconds.

(3) Check oil pressure (90 to 120 psi).

(g) Reverse Thrust.

(1) Condition levers TO/LAND and power levers to FULL REVERSE.

(2) Check rpm (100.0% to 100.5%).

(3) Record torque (2300 MAX continuous and 2640 for 5 seconds limit).

CAUTION

FLIR should be pointed forward for all take-offs to preclude glass damage.

10.8 TAKE-OFF

A C — 22. Engine Performance.

Check engine instruments during take-off and initial climb-out. Note any tendency for engines to exceed torque and temperature limits and any substantial differential torque output between the two engines.

A B C — 23. Check Nose Wheel Vibration After Lift-Off.

10.9 CLIMB 5000 FEET (PROFILES ABCD)

A — 24. Observe Vertical Velocity Indicator.

A — 25. Observe operation of radar altimeter for proper altitude indication and low-altitude warning indication.

(a) Press push-to-test knob: check indication 100 (± 15) feet. Release knob, pointer should return to proper altitude.

(b) Note proper operation of the low-altitude warning light and low-altitude aural warning tone (tone initiated by pilot's indexer only).

10.10 LEVEL FLIGHT 5000 FEET

A C

26. Aircraft Performance.

Trim at Military rated power and stabilize for 3 to 5 minutes and record instrument readings:

(a) OAT

(b) Torque

(c) RPM

(d) TIT

(e) Oil pressure

(f) Airspeed

(g) Attitude indicator

(1) Bank angle — Level surface: ±2 degrees.

(2) Pitch attitude — Rotate adjustment knob from 10 to 20 degrees nose down to 5 to 10 degrees nose up.

A B

27. Flight Control Trim.

(a) Place condition levers in TO/LAND, set equal torque on both engines to produce 180 KIAS with rudder trim neutral light ON and CMS Trim page selected indicating ailerons and rudder neutral. Elevator adjusted for level flight and record position of the ball.

(b) Release flight controls and record any rolling of the aircraft in degrees per second (i.e. a 10-degree angle of bank after 5 seconds equates to a 2-degree-per-second roll).

(c) Attitude indicator check: Bank angle — Trim aircraft for level flight. Check ±2 degree angle of bank utilizing the turn needle and BDHI.

A B

28. Stability Checks.

(a) Longitudinal—Trim the aircraft in level flight between 5,000 to 10,000 feet at 180 KIAS. The aircraft is statically stable if a push force is required to increase and stabilize 50 knots above trim and a pull force is required to decrease and stabilize 50 knots below trim.

PROFILE

(b) Dynamic lateral-directional—With the YAW DAMPER ON, trim the aircraft in level flight between 5,000 to 10,000 feet at 180 KIAS. Apply a rudder pedal force (approximately 100 pounds) in either direction and release all controls abruptly. Observe aircraft lateral-directional oscillation characteristics. Repeat the maneuver with YAW DAMPER OFF. The aircraft lateral-directional oscillations should damp in one and one-half cycles or less with the YAW DAMPER ON.

(c) Static lateral-directional. The aircraft is laterally statically stable if left aileron force is required for left sideslips and right aileron force is required for right sideslips. The aircraft is directionally statically stable if left rudder pedal force is required for right sideslips and right rudder pedal force required for left sideslips. With the YAW DAMPER ON, trim the aircraft in level flight at 180 KIAS between 5,000 to 10,000 feet to establish a constant heading 20-degree bank. The aircraft should return to approximately level flight when the controls are released. Repeat the maneuver with the YAW DAMPER OFF.

(d) Aileron rolls—Right and left aileron rolls shall be performed in level flight between 5,000 to 10,000 feet at 180 KIAS. Full throw lateral stick should be obtained smoothly with no restrictions. Abnormally low roll rates should be noted. Full aileron control deflections should produce 360-degree rolls in 4 seconds or less at 180 KIAS.

(e) Stalls—Perform stalls in the take-off, cruise, power approach, and landing configurations. Check for the presence of stall warning buffet, rudder pedal shaker operation, yawing, and excessive roll-off. A mild roll-off in either direction at the stall break is acceptable. An abrupt roll-off with 45 degrees or more angle of bank is unacceptable.

A C

29. Beta Check.

(a) Trim the aircraft out at MILITARY power at 150 KIAS.

(b) With the condition levers in the TO/LAND mode, pull the power levers to the hard stop. Check that rpm indications begin to droop on both engines at approximately 90 to 110 KIAS. Droop does not have to occur simultaneously on both engines provided mismatch yawing thrust is acceptable. Continue to decelerate to 85 knots.

(c) Note any excessive yaw tendencies. Ball displacement should not exceed one-half ball width, left or right at anytime, during this check.

(d) Should the aircraft fail Beta checks, record the following information:

(1) Ball position and movement from 150 to 85 knots.

(2) Torque at MILITARY and 150 knots for each engine.

(3) Torque with power levers at hard stop for both engines.

(4) RPM that engine settles at before droop for both engines.

(5) Droop airspeed for each engine.

(6) RPM that engines settle at after droop for each engine.

A B C

10.11 CLIMB AND LEVEL FLIGHT 10,000 FEET (PROFILES ABC)

30. Aircraft Performance—Trim the aircraft at Military power, stabilize for 3 to 5 minutes, and record instrument readings.

(a) OAT

(b) Torque

(c) RPM

(d) TIT

(e) Oil pressure

(f) Airspeed

PROFILE

A

31. Anti-G Suit Valve.

(a) The anti-G suit system should be checked for adequate pneumatic pressure.

(b) Check modulating valve for ease of operation and absence of sticking by manually depressing it several times.

A

32. Heat-Vent-Defrost Operation.

(a) Pull RAM AIR knob and check for airflow from defrost ducts.

(b) Pull TEMP knob and check for increase in air temperature.

(c) Pull CKPT AIR/DEFR knob and check for airflow diverted from defrost ducts to cockpit vents.

(d) Position BLEED AIR switches to EMERG OFF to test for proper operation.

A D

33. Landing Gear.

(a) Slow aircraft to 120 KIAS. Check emergency extension by pulling the hydraulic pump control circuit breaker and placing landing gear handle down. Reset circuit breaker.

(b) Check normal operation by cycling landing gear two times. Retraction should require approximately 10 seconds; extension should require approximately 7 seconds.

A B C

34. WHEELS Warning Light.

(a) Set condition levers to TO/LAND, gear and flaps up, and retard power levers—Ensure illumination of wheels warning light.

(b) With WHEELS warning light flashing, move No. 1 power lever (PL) forward until the light goes out. PL movement should only be 1/4 to 1/2 inch for light to go out. Reposition PL rearward to cause light to flash and repeat for No. 2 PL. Record if PL must be moved more than 1/2 inch before light goes out.

(c) Below 158 knots lower landing gear; light should go out.

(d) Lower flaps 40-degrees below 130 knots; lights should remain OUT.

(e) Raise landing gear; light should flash at any power setting.

(f) Position power levers well forward in quadrant and raise flaps; light should extinguish as flaps pass 30-degree position.

A B

35. Flaps.

(a) Cycle flaps two times by normal control system and note proper indication of flap position.

(b) Place flap handle in HOLD, cycle flaps with the ALT FLAPS switch. Extension should not require more than 60 seconds.

PROFILE

A 36. Electrical System.

(a) Check generator voltage at 28 (±0.8) volts. Trip each generator (individually) and reset.

(b) Check generator-out caution light comes on and goes out immediately after RESET is selected. No equipment should fail as a result of one generator being off.

NOTE

Ensure FLIR system is OFF prior to electrical system check and engine shutdown to preclude unnecessary electrical load on single generator.

A C 37. Engine Shutdown.

(a) NTS check—Move the left condition lever to FUEL SHUTOFF while power lever is at military RPM; rpm should decrease to below 40% within 30 seconds or less.

CAUTION

If the engine slows to below 40 percent at an unusually fast rate (less than 15 to 18 seconds), suspect a bowed shaft. If time and altitude permit, allow engine to cool. Attempt next air start at a higher than normal airspeed (150 KIAS). To aid in cooling and to assure propeller unfeathering, FEATHER & FUEL SHUTOFF should not be selected until engine is rotating normally (propeller continuing to windmill or to sway in the NTS condition).

(b) Feather Check—Retard left condition lever to FEATHER & FUEL SHUTOFF. Propeller should be fully feathered in 2 seconds or less.

(c) Perform air start—During air start, after turning AIR START switch on, momentarily keep condition lever in FUEL SHUTOFF and monitor EGT to ensure fuel enrichment operation. Engine should light off with EGT oscillating around 450 (±50). Note any abnormalities such as no light-off or EGT not oscillating. Place condition lever in NORMAL FLIGHT and continue air start procedures.

A 38. Standby Gyro—Check.

A 39. VHF/UHF Radios 1, 2, and 3 (AN/ARC-182).

(a) Utilizing CMS, check transmission and reception in all modes for signal strength, quality of speech, and noise at various VHF/FM, VHF/AM, UHF/AM, and guard frequencies, altitudes, and distances. Check communications while maintaining a 3.0 "g" turn.

(b) Proper function of on/off squelch disable.

PROFILE

A 40. Radio 1—UHF/ADF (AN/ARA-50).

(a) ADF for audio reception on known station locations within 110 miles.

(b) Indicated bearing should be within ±5 degrees true bearing and bearing needle should not "hunt" more than ±1 degree.

A 41. TACAN [AN/ARN-118(V)].

(a) Check known station ID signal.

(b) Select REC mode, check radial indication to be ±3 degrees through ground check and ±1 degree airbourne with an established ground reference point.

(c) Select T/R mode and check for absence of OFF flag and DME to within 1/2 nm or 3 percent of distance to station, whichever is greater.

(d) Check air-to-air DME functions.

A 42. IFF-SIF [AN/APX-100(V)].

(a) Check all modes.

A 43. Compass System (AN/ASN-75) Check.

(a) Check for agreement with magnetic compass on three cardinal headings.

(b) Check reset capability by offsetting and recentering annunciator indicator.

A 44. HF Radio (AN/ARC-199).

(a) Select MED power-out and check transmission and reception for signal strength, speech quality, and noise in USB, LSB and AM.

(b) Check squelch disable for proper operation.

(c) Check frequency retuning for satisfactory performance.

A 45. FLIR/AVT (AN/AAS-37).

(a) Turn FLIR system ON. Check proper operation of indicator lights.

(b) Check intensity of background and target display and focus of target display on video indicators.

(c) Check proper function of FLIR modes of operation.

(d) Perform BIT check of FLIR and AVT system.

(e) Check that system control can be assumed by pilot when FLIR COMD switch is in WIDE or NARROW position.

(f) Check via video indicator that FLIR turret goes to stowed position when MODE switch is in STBY.

PROFILE	
	10.12 DESCENT
A B	46. High-Speed Drive.
	(a) In a dive, obtain 350 KIAS. Roll 60 degrees left and right with lateral control deflections no greater than one-half stick input to check stick force gradient.
	(b) Perform symmetrical pull-out at maximum allowable "g's" and check for air-frame buffet. (Do not overtemp).
	10.13 LANDING
	CAUTION
	To preclude foreign object damage, the FLIR turret should be pointing forward on landing.
A C	47. Reverse Thrust—Check for rpm, torque effectiveness, and directional control.
A	48. Wheel Brakes—Check for equal pressure and effectiveness during taxi.
A	49. Nose Wheel Steering—Directional control during roll-out.

PART IV

Flight Characteristics

CHAPTER 11

Flight Characteristics

11.1 INTRODUCTION

The unique design of the lateral control system, coupled with the conventional arrangement of the longitudinal and directional systems, provides for acceptable handling qualities throughout a wide range of airspeeds and configurations within operational center-of-gravity loadings. Control harmony is excellent and trim rates and limits are more than adequate for most flight conditions. The flight characteristics of this aircraft in general are similar to those of other straight-winged, conventionally controlled aircraft with the exception of high-speed rolling, sudden engine failure, and longitudinal oscillation characteristics.

11.2 FLIGHT CONTROL CHARACTERISTICS

11.2.1 Longitudinal Control Characteristics. Longitudinal control is accomplished through conventional dual control sticks in the forward and aft cockpit which are connected by bellcranks, rods, and cables to two spring tabs in the trailing edge of the elevator. When the control stick is moved forward or aft, the elevator spring tabs (outboard) are mechanically positioned up or down proportionate to stick travel. These tabs act as aerodynamic boost surfaces utilizing airflow to position the elevator. Two geared tabs (inboard) are incorporated to provide aerodynamic boost. External counterweights are installed at the chordwise centerline of the upper and lower portions of the elevator leading edge for maneuvering balancing and a viscous damper is installed in the system to reduce longitudinal oscillations. At zero airspeed, the elevator system, including the control stick, rests in the position determined by the pitch trim setting. To move the spring tabs in this condition, the stick must be pulled or pushed far enough to drive the elevator to the surface travel limits. At this point, stick forces increase and further stick movement moves the spring tabs. With flight speed dynamic pressure loading, the spring tab/elevator sequence is reversed, making the stick operate the tabs initially and operating the elevator directly when the tab spring force is overcome. The pitch trim system provides positive, stable elevator trim, permitting long-period stability for "hands-off" attitude control. Below 150 KIAS, pitch trim capacity is approximately 20 pounds stick force, nose up or nose down. Elevator travel is 35 degrees trailing edge up and 25 degrees trailing edge down. Spring tab travel is 28 degrees trailing edge down and 20 degrees trailing edge up.

11.2.2 Lateral Control System. Lateral control is accomplished through an aileron-spoiler system. The control stick, located in the pilot's cockpit, is connected by bellcranks, rods, and cables to full-span spring tabs in the trailing edge of each aileron. The spoilers, consisting of four rotating spoiler plates located in each wing, are linked to the aileron and rotate out of the wing when the trailing edge of the respective aileron is deflected upward by stick movement. Under no-load conditions, the lateral control system presents an unfamiliar, disconnected feel. The force gradient with lateral movement of the stick is very light, control stick centering is totally absent, and no positive neutral point is apparent. As in the longitudinal system, the stick must be deflected laterally until the aileron travel limit is reached (approximately half stick) to move the spring tab under no-load conditions. A slight increase in force gradient is then felt and further stick movement moves the spring tabs. Flight dynamic pressure (speeds above 20 knots) loading reverses the tab/aileron sequence with stick movement initially moving the spring tab and driving the ailerons when full tab spring force is overcome. Proper operation of the lateral system is evident if the spoilers, which can be seen from the cockpit, operate (rotate upward) on the side toward which the stick is deflected. A spring between the tab linkage and aileron provides for positive force gradients and the ailerons are interconnected by cables and linkages to prevent up float and to assure synchronized action. The stick force relief capacity of the lateral trim system is 5 pounds left or right. Maximum aileron travel is 25 degrees up or down.

11.2.2.1 Directional Control System. Directional control is accomplished through rudders in the right- and left-hand vertical stabilizers that travel to a maximum of 25 degrees left or right. Crewmember control is exercised through two conventional pedals in the forward and aft cockpits, connected by bellcranks, rods, and cables to the rudders. The left-hand pedal moves both rudders to a trailing edge left position, and the right-hand pedal moves both rudders to a trailing edge right position. The yaw trim system provides pedal force relief capacity of 85 pounds left or right.

11.3 FLIGHT CHARACTERISTICS

11.3.1 Take-Off. Directional control is available almost immediately after initiation of ground roll as propeller wash covers nearly the entire span of both vertical stabilizers. Light brake application or nose wheel steering may be necessary for fine alignment adjustment below 20 knots.

NOTE

> Nose wheel steering to the left is extremely weak and a slight amount of left brake may be required to achieve effective steering to the left.

Lateral control starts to become effective at 20 knots and longitudinal control is sufficient to rotate the aircraft 10 knots below the take-off speeds. Refer to Part XI, Chapter 26. With normal trim setting of 1/2 unit nose down, a slight positive stick force is required to rotate the aircraft to a normal take-off attitude. For maximum performance take-off, the control stick must be pulled full aft 5 knots below minimum take-off speeds. In crosswinds in excess of 10 knots, a pronounced up-wind wing rise is evident. Through lateral control is insufficient to maintain wings-level attitude until just prior to lift-off, directional control with rudders is more than adequate to maintain heading in crosswinds up to 20 knots. Rotational longitudinal control effectiveness is sensitive to center-of-gravity loadings with force requirements reducing as center-of-gravity location shifts aft; however, even at the aft service loading, longitudinal force requirements are sufficient to preclude unintentional overrotation. Trim requirements with gear and flap retraction are light and climb-out attitudes are easily maintained.

11.3.2 Low-Speed Flight. The aircraft is responsive and maneuverable to near stalling speeds in all configurations and loadings. Though maneuvering stick force requirements are somewhat high below 140 KIAS which flaps up, maximum available load factors ("g's") are well within normal pilot capabilities. Lowering the flaps to T/O (20 degrees) reduces maneuvering stick force requirements, increases rate of turn, and reduces radius of turn providing an excellent reconnaissance or station keeping platform. Full flaps (40 degrees) allow for very slow airspeeds and minimum radius of turn. Care must be taken with light stick forces and slow acceleration characteristics which are associated with full flap operations. Refer to LANDING, in Part III, Chapter 7. Though yaw from roll becomes adverse below 140 KIAS, it is of small magnitude and easily countered with rudder at all flying speeds. Lateral response may appear sluggish until the pilot becomes familiar with aircraft handling characteristics. Lateral control effectiveness is adequate for all flight conditions. The aircraft is primarily a tab-flown platform; longitudinal and lateral control surfaces may be moved when tab limits are reached, the resultant increase in pitch or roll rate is negligible.

11.3.3 High-Speed Flight

11.3.3.1 Longitudinal. Steep, power-on dives from altitudes above 12,000 feet allow speeds near design limit to be attained. As speed increases, nose-up stick forces build up rapidly and maneuvering force requirements are greatly reduced. Due to this design characteristic, ensure that "g" limits during pullouts or pitch maneuvers at high airspeed are not exceeded. Stick forces are easily trimmed out throughout the flight envelope to near limit speed. On entry into turbulent air above 150 knots, a low-frequency vertical oscillation may be evident in the forward cockpit. This effect is due to natural flexing of the wing between the booms and the fuselage and is most noticeable between 200 and 210 knots.

11.3.3.2 Lateral. Abrupt lateral control deflections, greater than one-half stick input, and bank angle changes of greater than 90 degrees are prohibited at airspeeds greater than the maximum attainable in level flight. Roll response increases greatly with increasing airspeed. At high speeds, steady-state roll rates of 128 degrees per second, can be attained. Abrupt rolling maneuvers (reversals) at high speeds cause fairly large sideslip angles to be generated on recovery. A moderate amount of favorable yaw (in the direction of the roll) exists above 160 knots.

WARNING

Rapid lateral cycling of the control stick at high speed may excite the aircraft natural frequency. One-half lateral stick deflections are restricted to no greater than 1 cps.

11.3.3.3 Lateral-Directional. Abruptly executed rolling maneuvers at speeds below 150 KIAS generate a moderate amount of adverse yaw (away from the direction of roll). At speeds above 160 KIAS, yaw generated as a function of roll reverses to become favorable. Aircraft directional damping is somewhat weak and appears as a slight Dutch-Roll to the pilot. A yaw damper system is installed to reduce directional oscillations during air-to-ground weapons deliveries. With the yaw damper engaged, system signal inputs to the rudder will be felt at the rudder pedals. Approximately 100-pound pedal force is required to overcome yaw damper authority.

11.4 NORMAL STALLS

Though stall characteristics vary slightly with configuration and power, the stall itself is mild and recovery positive. Power-on stalls are characterized by high pitch angles (angles of attack up to 30 degrees), slight directional wandering, stick force lightening, random pitch oscillations, and increasing rate of sink. Airframe buffet is unnoticeable and rapid rolloff occurs at stall break. Rolloff at stall is generally in the direction of the engine which is producing the least amount of torque. Lowering the flaps or reducing power increases the amount of airframe prestall vertical buffet and reduces rolloff rate at stall. Stick force lightening and directional wandering are apparent regardless of flap or power setting. At stall, the aircraft pitches down and rate of rolloff is dependent on yaw excursion rate accompanying the stall. Control may be regained at any point by relaxing control stick back pressure. A stall warning (pedal shaker) system provides warning 1 to 7 knots above stall.

WARNING

Stalls in the power approach configuration result in steep nose-down attitudes (up to 70 degrees) with airspeeds in excess of the flap limit speed and altitude loss up to 400 feet before recovery is effected.

Depending on power and aircraft configuration, the rudder pedal shaker is activated 1 to 7 knots above stall speed during normal 1-g stalls. Dependent on rate of entry, the pedal shaker may not activate prior to accelerated stall.

11.5 ACCELERATED STALLS

Accelerated stall warning is experienced in the form of buffet with severity and warning margin depending upon initial speed, "g" load, gross weight, and how rapidly "g" is applied. At stall, the aircraft usually pitches down and, as in normal stalls, rolls into the engine developing the lower torque. Directional oscillations prior to stall increase with higher flap settings. With full flaps (40 degrees), yaw excursions as great as 30 degrees have been noted.

NOTE

For stall speeds, see Figures 11-1 and 25-11.

INDICATED AIRSPEED—KNOTS

FLAPS	GROSS WEIGHT—POUNDS	ANGLE OF BANK—0° LOAD FACTOR—1.0		ANGLE OF BANK—30° LOAD FACTOR—1.2		ANGLE OF BANK—60° LOAD FACTOR—2.0	
		GEAR UP	GEAR DOWN	GEAR UP	GEAR DOWN	GEAR UP	GEAR DOWN
POWER OFF							
0°	10,000	84	91	90	98	119	129
	12,000	92	100	99	107	130	141
	14,000	99	109	106	117	140	154
20°	10,000	72	76	77	82	102	107
	12,000	85	88	91	95	120	125
	14,000	95	98	102	105	134	139
40°	10,000	68	68	73	73	96	96
	12,000	79	79	85	85	112	112
	14,000	90	90	97	97	127	127
POWER ON							
0°	10,000	65	65	71	71	92	92
	12,000	76	76	83	83	107	107
	14,000	86	86	94	94	122	122
20°	10,000	55	55	60	60	78	78
	12,000	65	65	71	71	92	92
	14,000	73	73	79	79	103	103
40°	10,000	48	48	52	52	68	68
	12,000	59	59	63	63	84	84
	14,000	77	77	83	83	109	109

NA-86-0043-112

Figure 11-1. Stall Speeds

11.6 STALL PROCEDURES

All stall maneuvers should be performed with the condition levers in the TO/LAND position and be fully recovered by 4000 feet AGL. Prior to commencing any stall maneuvers, the pilot will ensure the area required to clear the maneuver is clear. All stall maneuvers should be approached with the thought in mind of minimizing altitude loss.

11.6.1 Power On. The power-on stall is accomplished at Military power by raising the nose 30 degrees above the horizon and holding this attitude until the stall. Recovery is effected by lowering the nose and raising the landing gear if extended.

11.6.2 Power Off. The power-off stall is accomplished with the power levers at FLIGHT IDLE by raising the nose 30 degrees above the horizon and holding this attitude until the stall. Recovery is effected by lowering the nose, applying Military power, and raising the landing gear if extended. This stall maneuver with a power-off recovery is accomplished by establishing a 130-knot descent with power set to simulate a flamed-out condition. Trim the aircraft for this attitude. Raise the nose 30 degrees above the horizon and hold this attitude until the stall. Recovery is effected by lowering the nose slightly below the 130-knot attitude. Maintain this attitude until regaining the 130-knot descent.

11.6.3 Approach Turn. The approach turn stall is accomplished in the normal landing configuration and power levers set at FLIGHT IDLE. Establish a wings-level descent at approach airspeed, determined by gross weight and trim aircraft for this attitude. Roll into a 30-degree angle of bank and raise the nose 10 degrees above the horizon. Hold this attitude until the stall. Recovery is effected by lowering the nose, applying Military power, leveling the wings, and raising the landing gear.

11.6.4 Accelerated. The accelerated stall is accomplished with flaps set at 20 degrees and power set as required to maintain 110 KIAS. Roll into 60-degree angle of bank and apply back stick until stall occurs. Recovery is effected by relaxing back pressure, applying Military power, and rolling to the wings-level attitude. High-speed accelerated stall can be accomplished in the same manner with the exception of an entry airspeed of 160 KIAS and flaps up.

11.7 SPIN AVOIDANCE

A spin requires the simultaneous achievement of stalled angle of attack and yaw. If either of these conditions is absent, the aircraft will not enter a spin. For erect stalls, angle-of-attack information is displayed on the angle-of-attack indicator and indirectly through the rudder pedal shaker. Maintaining angle of attack below 25 units or below that required to activate the rudder pedal shaker is an effective means of avoiding a stall. Maintaining zero sideslip is effected by keeping the ball of the turn-and-bank indicator centered.

11.8 SPINS

NOTE

Intentional spins in the OV-10D aircraft are prohibited.

Tests indicate that the aircraft is not prone to unintentional spins in symmetric power or pretrimmed asymmetric power configurations. However, the aircraft will spin easily from untrimmed asymmetric power configurations and will readily spin in any configuration provided pro-spin controls are applied and held. Recoveries are positive and rapid in all configurations. Positive application of the recommended recovery controls will produce the most consistent recovery characteristics. Simply releasing controls will effect recovery in most cases, but is not recommended because a developed spin mode does exist (asymmetric power-oscillatory mode) from which recovery cannot be effected using this method. Further, positive control action will preclude nonrecovery due to an inadvertent application of full nose-up trim during the spin.

11.8.1 Erect Spins

11.8.1.1 Symmetric Power. Symmetric power is defined as any combination of condition lever and/or power lever position that results in an indicated torque difference between engines of 150 foot-pounds or less. Elevator effectiveness is reduced at idle power settings and forward center-of-gravity positions. The aircraft is less prone to stall and spin under these conditions and attempted spin entry usually results in a diving spiral. However, normal center-of-gravity positions (25%–27% MAC) and low torque power settings are conditions from which spins are easily achieved.

There is a definite departure from controlled flight in a 1.0-g spin entry. The entry is characterized by little or no poststall gyration with the nose of the aircraft falling sharply through to 90 degrees (straight down) in one-half turn and then pitching up to 60 degrees (down) during the next one-half turn. Succeeding turns are characterized by steep nose-down attitudes, fast rotation rates about the roll axis, and considerable airframe buffet.

The spin will normally become steady-state within one and one-half to two and one-half turns. Lateral control opposite to spin direction (cross controls) applied concurrently with departure from controlled flight will often prevent the development of a spin by opposing the buildup of both yaw and roll. Aileron applied opposite to spin direction, once the spin has developed, has the effect of slowing the turn rate and flattening the pitch angle slightly. Aileron applied with the spin will increase turn rate to approximately 200 degrees per second. Turn rates of this magnitude are best described as extremely fast and multiturn spins can cause disorientation and dizziness. External stores can produce high yaw and turn rates (sometimes exceeding those obtainable in the clean configuration); however, overall spin and recovery characteristics are not appreciably altered with external stores. There is no tendency toward a flat spin mode. Spins entered from accelerated flight conditions are characterized by a sudden departure from controlled flight and a one and one-half to two and one-half turn snap roll. The nose falls through to a near vertical attitude and the ensuing spin closely resembles the spin resulting from a 1.0-g entry. Spins entered from vertical, climbing flight are characterized by tail-sliding (if zero airspeed is obtained) or rolling pitchover. Aerodynamic feedback in the control system is experienced during tailslide, but the pilot's counteracting force requirements are light. A typical erect spin results after one-half to one incipient-type turn. Altitude loss during the preceding spins varies between 300 and 700 feet per turn. Spins in the power approach configuration, with either 20- or 40-degree flap deflection are much the same as the spins in the preceding description. The steep nose-down attitude that follows the first one-half turn will result in recovery airspeed approaching flap and landing gear limit. Spins in excess of one turn will likely result in limit speeds being exceeded during recovery. Altitude loss during recovery from landing gear and flaps down spins is approximately 2000 feet.

11.8.1.2 Asymmetric Power. Spins entered with a large asymmetric power condition result in large pitch oscillations and high turn rates. Spins with one engine at MIL and the other engine at IDLE power can become violent. Developed spins can occur under these conditions without application of pro-spin rudder. Departure from controlled flight is characterized by sudden yaw and roll into the inoperative engine. If pro-spin rudder is applied concurrently with this departure, the ensuing roll rate exceeds the turn rate to the extent that an apparent outside snap roll occurs with the nose passing vertically down, then returning to level or above by the completion of one turn. This gyration resembles an oblique cartwheel. A sudden slowing of roll and pitch rate occurs in the second or third turn. This usually appears to the pilot as a momentary slowing and flattening of the spin. Very deep stall penetrations (70 degrees angle of attack or greater) can occur during the most violent of these spins. Yaw, roll and pitch excursions are of such rate and amplitude that high "g" forces are exerted on the pilot's body and control placement requires considerable force. However, all asymmetric power spins do not develop to such violent proportions. Forward center-of-gravity positions, reduced asymmetric power, and internal fuel consumption (to reduce lateral moment of inertia) all have a moderating effect upon the spin. Nevertheless, it is important for the pilots to realize the magnitude that the gyrations can assume so that if a pilot should encounter such a spin, it can be recognized as a known aerodynamic characteristic and one from which recovery can be positively effected. Spins of this type can be easily avoided by flying in balanced flight when maneuvering with an inoperative engine and/or by quickly recovering from asymmetric power stalls.

11.8.2 Erect Spin Recovery. The spin recovery technique for all configurations is rudder opposite to spin direction, neutral aileron, neutral to slightly forward stick. (Neutral stick requires forward stick pressure due to the high up float forces on the elevator during the spin.) True spin direction is always indicated by the turn needle; therefore, the turn needle should be used as the primary instrument for determining spin direction. This is especially true if accurate outside visual cues are not available. Normally, control forces required for spin recovery are moderate. However, pilots must be aware that asymmetric power spins can sometimes produce deep stall penetrations which require strong forward stick pressure to ensure proper recovery control placement. The required forward stick force may reach 115 pounds and it is recommended that the pilot use both hands to position the stick in these cases. Improper recovery control placement during asymmetric power spins may significantly delay or entirely preclude spin recovery. Recovery in all configurations is positive with proper flight control placement. Asymmetric power spins usually require one and one-half turns for recovery, while symmetric power spins usually require only one-half turn to recover. The nose-down attitude will be steep and altitude loss from initiation of recovery controls to wings-level flight is approximately 2500 feet. Airspeed build-up during the dive recovery is rapid and significant "g" force is quickly available for pull-out.

Progressive stalls/spins will normally not be encountered. The aircraft will recover from all spins, with correct flight control placement, regardless of power control lever position (including asymmetric). However, power increases turn rate and altitude loss during the recovery dive. Power opposite to spin direction has very little effect once the spin has developed and, therefore, is of no value as a spin recovery technique. For standardization and simplification, it is recommended that the power control levers be placed in FLIGHT IDLE during recovery.

11.8.2.1 Erect Spin Recovery Procedure

1. Power levers—FLIGHT IDLE.
2. Controls—NEUTRALIZE.
3. Gear and flaps—UP.
4. Harness—LOCKED.
5. Analyze for spin. Check for:
   (a) Airspeed—STEADY.
   (b) Turn needle—FULLY DEFLECTED (note direction).

If spin confirmed:

6. Rudder—FULL OPPOSITE TURN NEEDLE.
7. Stick—CHECK NEUTRAL TO SLIGHTLY FORWARD.
8. When rotation stops, neutralize rudder and execute controlled recovery.
9. If aircraft is not under control by 2500 feet AGL—EJECT.

11.8.3 Inverted Spins. Inverted spins from vertical or −1.0-g flight conditions are characterized by the nose falling through to the 60-degree nose-down attitude as the aircraft rotates in the direction of applied rudder. The inverted spin has steady, moderate turn rates (100 degrees per second), nose-down attitudes of 40 to 70 degrees, and negative "g" ranging from −2.0 to +1.0 "g's." Altitude loss during inverted spins varies between 200 and 650 feet per turn.

11.8.4 Inverted Spin Recovery. Recovery procedure consists of opposite rudder (push the rudder in the direction it tends to go) and neutral stick. Recovery will be in a split "S" requiring 800 to 1500 feet from initiation of recovery controls to wings-level flight after recovery. It is recommended that both propellers be feathered immediately to prevent engine overtemperature. This action also places the aircraft in a known value of symmetrical thrust and allows straight forward recovery. Engines are restarted normally following recovery. This procedure of feathering engines to obtain known thrust values during spins is unorthodox, but not unsafe, provided the pilot is mentally ready to perform the proper restart procedures immediately upon recovery. The aircraft glides very well with a glide ratio equal to that of both engines providing 400- to 450-pound thrust symmetrically. The characteristics of the power plant system can cause high asymmetrical drag/thrust relationships between engines. Retarding the engine power levers to FLIGHT IDLE will usually cure the situation, but if the propeller governor senses a low oil pressure, the propeller may move toward the feathered position. With the engine still ignited, high drag will result on that side, thus feathering the propeller will protect the engine. In an inverted spin, it is difficult for a pilot to monitor his engine instruments, and feathering both propellers, recovering, and restarting are recommended if altitude permits.

11.8.4.1 Inverted Spin Recovery Procedure

1. Power levers—FLIGHT IDLE.
2. Controls—NEUTRALIZE.
3. Gear and flaps—UP.
4. Harness—LOCKED.
5. Analyze for inverted spin. Check for:
   (a) Zero to negative "g."
   (b) Turn needle—FULLY DEFLECTED (note direction).

If inverted spin confirmed:

6. Condition levers—FEATHER & FUEL SHUTOFF.
7. Rudder—FULL OPPOSITE TURN NEEDLE.
8. Stick—CHECK NEUTRAL TO SLIGHTLY FORWARD.
9. When rotation stops, neutralize rudder and execute controlled recovery.
10. If aircraft is not under control by 2500 feet AGL—EJECT.
11. If recovered—EXECUTE AIR STARTS.

11.9 FLIGHT WITH EXTERNAL STORES

External stores effects, other than those of weight and drag are relatively slight. Large external loads result in decreased climb and cruise performance but no adverse rolling inertia or yaw characteristics are exhibited. Near-limit airspeed with an Aero 1C external fuel tank at the centerline station, speed warning in the form of moderate airframe buffet is noted.

WARNING

Flight in the landing configuration with asymmetric external store loading results in reduced lateral controllability. This configuration can result in aircraft handling difficulties, especially if landing in a crosswind or if an engine failure occurs.

11.10 SINGLE-ENGINE CHARACTERISTICS

11.10.1 Engine Failure. The aircraft power plant installation incorporates a negative torque sensing (NTS) feature in order to reduce propeller drag if engine failure occurs. The NTS system will drive the propeller to a near-feathered condition if a negative torque is applied to the engine by the propeller (loss of fuel, fuel control failure, etc). Provisions are not made for catastrophic failure of the propeller or gearbox. Engine failure characteristics in which NTS system is in operation are as follows:

1. Yaw excursion into the failed engine. The rate of this excursion is dependent on flight speed in relation to single-engine stall speed. The nearer to stall, the more rapid the excursion in yaw.

2. Rapid roll-off into the failed engine coupled with a rapid nose-down pitch movement.

Aircraft response to engine failure with the NTS system inoperative will greatly magnify the characteristics as previously described.

The minimum static airspeed (no yaw, pitch, or roll excursions) is nearly the same for the negative torque sensing condition as for the full feather condition; however, the pilot should select the FEATHER & FUEL SHUTOFF position of the condition lever once engine failure has been determined.

11.10.2 Minimum Single-Engine Control Speeds. Static minimum single-engine control airspeed (V_{MCS}) is the minimum airspeed at which, with either engine inoperative, it is possible to control the aircraft in steady state flight (equilibrium). Dynamic minimum single-engine control speed (V_{MCD}) is the minimum airspeed at which, following a sudden engine failure, it is possible to regain control of the aircraft and place it in equilibrium. Simply speaking, V_{MCD} takes into account the pilot reaction time required to control the rates and accelerations that occur immediately following an engine failure. This reaction time takes into account the time to recognize the problem (engine failure), the time to deliberate the problem (decision time), and the time to react (take corrective action). In the OV-10D, V_{MCD} varies from 3 to 6 KIAS higher than V_{MCS} depending on gross weight and aircraft configuration.

11.10.2.1 Dynamic Conditions. Proper actions taken by the pilot following a sudden engine failure are critical for regaining control of the aircraft, especially if the airspeed is at or near V_{MCD}. Two prime things occur when an engine fails: the aircraft yaws into the inoperative engine and it rolls into the inoperative engine. The yawing moment causes a large sideslip angle that results in an increase in drag compounding an already serious performance problem. Aileron against the roll causes adverse yaw resulting in an increased yawing moment into the inoperative engine; roll rates must be stopped, judicious use of coordinated aileron and rudder are essential, with rudder being the most powerful control for the situation. If the pilot is unable to achieve equilibrium flight with full lateral and directional control inputs, a power reduction on the operative engine and/or an increase in airspeed will be required. Obviously, these actions may not be possible in a low altitude, low airspeed flight condition.

11.10.2.2 Static Conditions. The asymmetric power flying qualities problem is invariably a lateral-directional control problem. Yawing and/or rolling moments generated by the asymmetric power condition must be counteracted by aircraft stability and pilot control inputs. The amount of each control deflection required is primarily related to the amount of power being generated by the operative engine. The method used to determine the V_{MCS}'s presented in Part XI was to define the equilibrium flight airspeed at which the pilot reached a control deflection limit while maintaining zero sideslip with the operating engine generating maximum power and the other engine feathered. A reduction in power on the operating engine obviously requires less control deflection and results in a lower airspeed for V_{MCS}. Thus, the V_{MCS}'s presented are "worst case." Maintaining zero sideslip will produce the least amount of drag for equilibrium flight conditions with asymmetric power (the best situation for the OV-10) and will require approximately 5 degrees of bank into the operative engine. It should be noted that V_{MC} will be higher if any technique other than the zero sideslip is used to maintain steady state flight (i.e., zero bank angle).

Two conditions identify the actual V_{MCS} during flight tests: reaching the aileron deflection limit or aerodynamic stall. Stall generally occurs prior to reaching full aileron deflection at altitudes above 4000 feet MSL for gross weights above 11,000 pounds and defined V_{MCS}.

Below this altitude, reaching the aileron control limit defines V_{MCS}. The OV-10 is significantly different from most aircraft in that controlled flight is possible at airspeeds slightly below classical V_{MCS}. As discussed above, V_{MCS} is the minimum airspeed at which it is possible to control the aircraft and is defined by the pilot reaching a control deflection limit. In most multi-engine aircraft, V_{MCS} is defined by the airspeed at which maximum rudder deflection is reached. Flight below this airspeed for those aircraft is not possible because aileron alone cannot counter the increasing yawing moment because of loss of rudder effectiveness. However, in the OV-10, once maximum aileron deflection is reached, controlled flight can still be maintained as airspeed is decreasing through the pilot increasing rudder deflection. The increasing rolling moment, as the ailerons/spoilers lose their effectiveness because airspeed decreases, can actually be countered by the rudder. The OV-10 rudders are extremely effective because they are in the thrust axis of the engines. They can still produce yawing moments, even at the slowest airspeeds, and this yaw produces roll through the aircraft's positive dihedral effect, essentially obviating the loss of aileron effectiveness. Although test flights were conducted in the area between loss of aileron effectiveness and the requirement for full rudder deflection, results were not quantified since they are beyond the definition of minimum control airspeed. Flight in this area is not recommended, but it is a capability which can be employed in emergency situations.

11.10.2.3 Single-Engine Performance. As in normal flight, the best single-engine performance capabilities exist with the gear and flaps up and a clean aircraft. The most significant detriment to performance is the landing gear, followed by the flaps and external fuel tanks in that order. Having the gear down has roughly the same effect on single-engine climb performance as the aircraft being 2000 pounds heavier. Flaps and stores also degrade single-engine climb performance, but even both together do not degrade it nearly as severely as the landing gear.

WARNING

Single-engine level flight at any altitude may not be possible with the landing gear extended.

11.10.3 Minimum Safe Single-Engine Speed. The minimum safe single-engine speed is defined as that airspeed required to maintain wings level and a 100 fpm rate of climb with one engine at maximum power. This speed is a function of aircraft gross weight and outside air temperature. These speeds are depicted in Figures 25-13 and 25-14. Numerous factors influence the aircraft's fly-away capability during single-engine operations. These include delay in reducing drag (such as failing to raise the gear or jettison the stores), inadvertently increasing drag by premature initiation of a climb or allowing airspeed to decrease below the minimum safe speed. Once the aircraft is stabilized and trimmed, handling characteristics with one engine shut down and the propeller feathered are good. Exercise caution and carefully cross-check airspeed, vertical velocity, and altitude. The airspeed differential for rudder shaker operation may decrease to within 1 knot above stall speed.

WARNING

Should engine failure occur at or near stall speed, or if the aircraft is stalled during single-engine operation at altitudes below 1000 feet AGL, safe recovery may not be possible.

11.10.4 Single-Engine Handling. Once the aircraft is stabilized and trimmed, handling characteristics with one engine shut down and the propeller feathered are good. Relatively high rates of descent may be generated, which are deceptive if the flight instruments are not cross-checked, particularly under conditions of poor visibility. Under these conditions, exercise caution and carefully cross-check airspeed, vertical velocity, and altitude. The airspeed differential for rudder shaker operation may decrease to within 1 knot above stall speed.

11.10.5 Angle-of-Attack Relationship. Figure 25-12 shows the relationship of aircraft angle-of-attack in degrees at the fuselage reference line and in units indicated angle-of-attack to gross weight, dive angle, and calibrated airspeed. By examining the angle-of-attack block, it is seen that the effects of power change (between cruise power and Military power) have a large effect on angle of attack.

PART V

Emergency Procedures

CHAPTER 12

Ground Emergencies

12.1 INTRODUCTION

The procedures contained in this section are considered best for handling various emergencies that may be expected to occur. Only single failures are considered; however, each failure presents a different problem. A thorough knowledge of these procedures will better equip you to handle emergencies. Even though the procedures are considered to be the best possible, sound judgement must be used when confronted with multiple emergencies, adverse weather, low altitudes, etc. The recommended procedures in this section are meant to cover actions to be taken by the PILOT ONLY. Under most conditions, the trained observer or copilot may be expected to offer assistance in radio coordination, checklist reading, or other such assistance as the pilot may require.

The pilot's and observer's warning and caution lights (Figures 2-17 and 2-18) will aid in determining the nature of the equipment malfunction.

12.1.1 Special Instructions. The following terms indicate the degree of urgency in landing the aircraft.

1. Land immediately—Self-explanatory.

2. Land as soon as possible—Means land at the first site at which a safe landing can be made.

3. Land as soon as practicable—Means extended flight is not recommended. The landing site and duration of flight is at the discretion of the pilot in command.

Procedures with an asterisk (*) before each step are considered critical action and must be performed without reference to the checklist if the emergency is not to be aggravated, and injury or damage is to be avoided. Procedures appearing without an asterisk (*) are noncritical and reference to the checklist is recommended.

12.2 FIRE

12.2.1 Engine Fire On Start/Hot Start. An engine fire on start/hot start will be indicated by engine temperatures beyond limits. Proceed as follows:

*1. Condition lever—FUEL SHUTOFF.

*2. Signal ground crew to disconnect external power, if connected.

*3. AIR START switch—CRANK.

4. EMER FUEL SHUT OFF switch—SHUT OFF.

5. If fire persists, call for firefighting assistance.

6. START switch—ABORT.

7. AIR START switch—RELEASE.

CAUTION

It is imperative that the START switch be moved to ABORT prior to release of the AIR START switch. If these steps are reversed, the start cycle will be momentarily reinitiated introducing ignition and start fuel into the combustion chamber increasing the probability of residual fire.

8. BATTERY switch—OFF.

9. Abandon aircraft (refer to EMERGENCY GROUND EGRESS).

NOTE

External power unit failure during start may be indicated by increasing temperature and decreasing rpm.

12.2.2 Engine Nacelle Fire. An engine nacelle fire will be indicated by a nacelle fire warning light.

*1. Condition levers — FEATHER & FUEL SHUTOFF.

2. EMER FUEL SHUT OFF switch—SHUT OFF.

3. START switch—ABORT (when starting).

4. BATTERY switch—OFF.

5. Abandon aircraft. (Refer to EMERGENCY GROUND EGRESS.)

WARNING

Placing the condition lever in the FEATHER & FUEL SHUTOFF position prior to having taken the propeller off the "start locks" will NOT feather the propeller. It will continue to windmill as after a normal shutdown. Therefore, extreme caution should be used in executing emergency ground egress procedures.

12.2.3 Engine Fire On Shutdown (Propellers Unfeathered)

1. Condition lever—FUEL SHUTOFF.

2. EMER FUEL SHUT OFF switch—SHUT OFF.

3. AIR START switch—CRANK.

CAUTION

It is imperative that the AIR START switch be held in the CRANK position before the START switch is moved to START to ensure that ignition and start fuel are not momentarily activated.

4. START switch—START.

5. Crank engine until fire is out.

CAUTION

Motoring the starter in excess of 15 seconds may cause starter-generator damage/fire.

6. If fire persists, call for firefighting assistance.

7. START switch—ABORT.

CAUTION

The START switch must be moved to ABORT prior to releasing the AIR START switch to prevent momentarily reactivation of the normal start sequence.

8. AIR START switch—RELEASE.

9. BATTERY switch—OFF.

10. Abandon aircraft (refer to EMERGENCY GROUND EGRESS).

12.2.4 Engine Fire On Shutdown (Propellers Feathered). During engine shutdown, inadvertently placing the condition levers to FEATHER & FUEL SHUTOFF instead of FUEL SHUTOFF, may cause an internal fire as a result of raw fuel having been dumped into the hot combustion chamber from the fuel control. If fire results, proceed as follows:

1. Condition lever—FUEL SHUTOFF.

2. EMER FUEL SHUT OFF switch—SHUT OFF.

3. Power lever—FULL REVERSE.

4. AIR START switch—CRANK.
Hold until propeller unfeathers; continue to hold in CRANK, move POWER LEVER to FLIGHT IDLE.

CAUTION

It is imperative that the AIR START switch be held in the CRANK position before the START switch is moved to START to ensure that ignition and start fuel are not momentarily activated.

5. START switch—START.

6. Crank engine until fire is out.

CAUTION

Motoring the starter in excess of 15 seconds may cause starter-generator damage/fire.

7. If fire persists, call for firefighting assistance.

8. START switch—ABORT.

CAUTION

The START switch must be moved to ABORT prior to releasing the AIR START switch to prevent momentary reactivation of the normal start sequence.

9. AIR START switch—RELEASE.

10. BATTERY switch—OFF.

11. Abandon aircraft (refer to EMERGENCY GROUND EGRESS).

12.3 EMERGENCY GROUND EGRESS

Should emergency ground egress become necessary, install seat pin if time permits. Retain helmet and exit by the right canopy door if possible. Egress while propellers are rotating is not recommended.

1. Condition levers—FEATHER & FUEL SHUTOFF.

2. Lap belt—OPEN.

3. Survival kit fittings—RELEASE.

4. Riser attach fittings—RELEASE.

5. Personal leads—DISCONNECT (if time permits).

6. Canopy—OPEN.

7. Abandon aircraft.

WARNING

Placing the condition lever in FEATHER & FUEL SHUTOFF position prior to having taken the propeller off the "start locks" will NOT feather the propeller. It will continue to windmill as after a normal shutdown. Therefore, extreme caution should be used in executing emergency ground egress procedures.

CHAPTER 13

Take-Off Emergencies

13.1 ABORTED TAKE-OFF

The procedure required for aborting a take-off is basically the same for any emergency.

1. Power levers—REVERSE THRUST RANGE, as required.

2. Nose wheel steering—as necessary.

3. Brakes—APPLY, as required.

CAUTION

If fire is involved, shut down engines as soon as the aircraft is under complete control and stopping is no longer a problem.

4. If unable to stop on runway, condition lever—FEATHER & FUEL SHUTOFF.

5. EMER FUEL SHUT OFF switches—SHUT OFF.

6. BATTERY switch—OFF.

13.2 ENGINE FAILURE

Engine failures fall into two main categories: those which occur instantly and those which give ample warning. Instant failures are most often encountered and usually occur on sudden complete mechanical malfunctions such as propeller shaft failure, fuel control failure, engine fuel pump shaft failure, or tubine wheel failure. Some engine failures are gradual, giving the pilot time to take corrective action before complete failure occurs. Sudden engine vibration, sudden or uncontrollable rise in temperature, propeller overspeed, or flame-out with loss of torque are typical indications of failure.

13.2.1 Engine Failure/Gross Power Loss During Take-Off Roll. If engine failure/gross power loss occurs at any time during take-off roll, the take-off must be aborted, since it is impossible to take off fly-away single engine at most operating gross weights. If failure occurs above refusal speed for runway length and take-off cannot be aborted safely, due to obstructions or other factors, immediate ejection is recommended. The pilot shall refer to Part XI, Chapter 25 during mission planning for minimum single-engine speeds.

13.2.2 Aborted Take-Off (One Engine). Aborting a take-off run at near lift-off speed following an engine failure presents a different problem than that posed by a two-engine abort. Single-engine reverse thrust is not usable except under optimum conditions on a hard-surface runway. Low power reverse thrust used carefully on the operating engine may prove effective, only if surface condition provides sufficient braking coefficient to prevent skidding of the opposing wheel. At speeds above approximately 80 knots, the use of opposing brake can easily result in a blown tire. In a typical aborted take-off, following one engine failure, use a combination of single-engine reverse thrust, flaps up, brakes, and nose wheel steering to maintain directional control and to stop the aircraft. Nose wheel steering may prove only marginally effective. Use rudder and brakes as required.

13.2.3 Engine Failure/Fire After Take-Off. Should an engine failure occur immediately after take-off, the aircraft will yaw and roll rapidly into the failed engine. Immediately apply FULL RUDDER and FULL AILERON to level the wings. (A reduction of power on the operating engine may be necessary.) The best possible course of action, runway/terrain and/or aircraft control permitting, is to re-land the aircraft if the gear is down. If any of these conditions cannot be met, eject immediately. If the engine failure occurs after gear retraction has been initiated, the best possible course of action, aircraft control permitting, is to fly-away. The external stores must be jettisoned IMMEDIATELY to ensure a fly-away capability. In the event of a fire, if airspeed is critical and a gross loss of power is not evident, the pilot may elect to maintain maximum power on both engines until a safe single-engine airspeed is attained. In either situation, a failure or fire, a premature climb will result in a loss of airspeed and significantly degrade aircraft controllability.

During mission planning, the pilot shall compute his minimum single-engine control speed and minimum safe single-engine speed. Refer to MINIMUM SINGLE-ENGINE CONTROL AND FLY-AWAY SPEEDS charts, in Part XI, Chapter 25.

WARNING

If, for any reason, a safe recovery cannot be made, or if a fire is accompanied by a gross loss of power, EJECT IMMEDIATELY.

*1. Power levers—AS REQUIRED, maintain minimum safe single-engine speed.

*2. Landing gear—UP.

*3. External stores—JETTISON, as required.

4. Determine affected engine.
The aircraft will roll and yaw into a failed engine. Check engine instruments and rudder pressure to determine which engine has failed. In case of suspected fire, check for secondary indications.

5. Condition lever—FEATHER & FUEL SHUTOFF (affected engine).

6. EMER FUEL SHUT OFF switch—SHUT OFF (affected engine).

7. Flaps—UP, as desired (above 110 KIAS).

8. If fire persists—EJECT.
If fire goes out—LAND AS SOON AS PRACTICABLE.

9. Attempt air start (if applicable).

NOTE

- Operate both power levers together in order to actuate WHEELS warning light.
- When all obstructions have been cleared, accelerate to the best climb speed. Before making any turns, conditions permitting, climb straight ahead to a minimum of 1000 feet AGL and accelerate to at lease 120 knots. All turns should be made using shallow bank angles. If possible, all turns should be made into the operating engine. Once positive aircraft control is established, control pressures should be trimmed out to assist in maintaining coordinated flight.
- If mechanical malfunction is apparent or a fire was extinguished, do not attempt air start.
- Prior to manuevering for final approach the rudder trim should be reduced to near neutral. This is accomplished by trimming until the trim neutral light illuminates or by observing rudder pedal position. Failure to neutralize rudder trim will induce adverse yaw tendencies as power is reduced for touchdown and roll-out.

13.3 TIRE FAILURE ON TAKE-OFF

13.3.1 Nose Tire Failure on Take-Off. If a nose tire fails early in the take-off run, take-off should be aborted, using differential reverse thrust and light wheel braking as required for directional control. Reverse thrust will act to lighten loads on the nose gear at low speed.

CAUTION

Leave the gear extended after take-off to prevent possible gear well damage and to permit a prelanding visual inspection.

If a nose tire fails during take-off, proceed with tire failure procedure.

13.3.2 Main Tire Failure on Take-Off. If a main tire fails early in the take-off run, abort take-off, using differential reverse thrust and nose wheel steering as required. If a main tire fails just prior to lift-off, it may be desirable to continue take-off in order to stop the aircraft at reduced weight on a subsequent landing.

WARNING

Left main tire failure may result in damage to the ground safety switch linkage. This damage may cause loss of NOSE WHEEL STEERING and the POWER LEVER GATE SOLENOID. In this event, use of reverse thrust can only be gained by lifting the throttles approximately 1/4 inch to bypass the reverse gate (solenoid) to apply reverse thrust. Directional control may then be maintained by use of flight controls, differential braking, and differential reverse thrust. (Nose wheel steering will not be available.)

CAUTION

When take-off is continued, leave the gear extended to prevent possible wheel well damage and to provide prelanding visual inspection.

If a main tire fails after take-off, proceed with tire failure procedure.

13.3.3 Tire Failure Procedure

1. If possible—ABORT.
   Use reverse thrust, NWS, and light wheel braking for directional control.

2. If abort not possible, leave gear down and have prelanding inspection made.

3. Land at reduced weight.

13.4 NOSE TURRET ACCESS DOOR OPENING ON TAKE-OFF

1. Abort the take-off immediately.

2. Maintain directional control by reference to the side of the runway (FLIR video may also be available).

WARNING

There will be increased drag, no forward visibility, no airspeed indication, unreliable pressure altimeter and VSI, unreliable angle of attack, and possibility of damage to engine, propellers, or controls if door separates from aircraft.

CHAPTER 14

In-Flight Emergencies

14.1 ENGINE FAILURE/FIRE DURING FLIGHT

Should an engine fail or catch fire during flight, proceed as follows:

*1. Power levers—AS REQUIRED, maintain minimum safe single-engine speed.

*2. Landing gear—UP.

*3. External stores—JETTISON, as required.

4. Determine affected engine.
The aircraft will roll and yaw into a failed engine. Check engine instruments and rudder pressure to determine which engine has failed. In case of suspected fire, check for secondary indications.

5. Condition lever—FEATHER & FUEL SHUTOFF (affected engine).

6. EMER FUEL SHUT OFF switch—SHUT OFF (affected engine).

7. Flaps—UP, as desired (above 110 KIAS).

8. If fire persists—EJECT.
If fire goes out—LAND AS SOON AS PRACTICABLE.

9. Attempt air start (if applicable).

NOTE

- Operate both power levers together in order to actuate WHEELS warning light.
- If mechanical malfunction is apparent or a fire was extinguished, do not attempt an air start.

14.1.1 Engine Failure Below Minimum Single-Engine Control Speed. As airspeed approaches minimum control speed, the magnitude of the roll and yaw will increase. Below minimum control speed, aircraft may not be controllable with rudder and aileron inputs. The proper corrective actions to regain control are as follows:

*1. Power levers — RETARD as required.

*2. Lower nose of the aircraft to obtain a safe airspeed (altitude permitting); otherwise EJECT.

3. Reapply power on operable engine.

14.1.2 Failure of Both Engines in Flight

1. Maintain 130 KIAS.
2. Condition levers — FEATHER & FUEL SHUTOFF.
3. Gear and flaps — UP.
4. Fuel quantity — CHECK.
5. Attempt simultaneous air starts.
6. If air start cannot be obtained and optimum forced landing is not feasible — EJECT.
7. External stores — JETTISON, if required.
8. Condition levers — FEATHER & FUEL SHUTOFF.
9. FUEL EMERG SHUTOFF switches — FUEL SHUTOFF.
10. Execute precautionary approach.
11. BATTERY — OFF.
12. Abandon aircraft when stopped.

14.1.3 Maximum Glide. The maximum glide distances available with both propellers feathered are shown in Figure 14-1. These distances are obtained under no-wind conditions by maintaining 130 KIAS. At an aircraft gross weight of 11,000 to 12,000 pounds (flaps and gear up with nc external stores) a glide distance of 8.2 nautical miles per 5000 feet of altitude can be expected. With the landing gear extended, glide distance is reduced to approximately 5.2 nm per 5000 feet of altitude.

14.1.4 Engine Air Start. Air starts may be obtained below 20,000 feet over a wide range of airspeeds.

1. EMER FUEL SHUT OFF switch—NORM.

2. Condition lever—FUEL SHUTOFF.

3. Power lever—FORWARD OF FLIGHT IDLE.

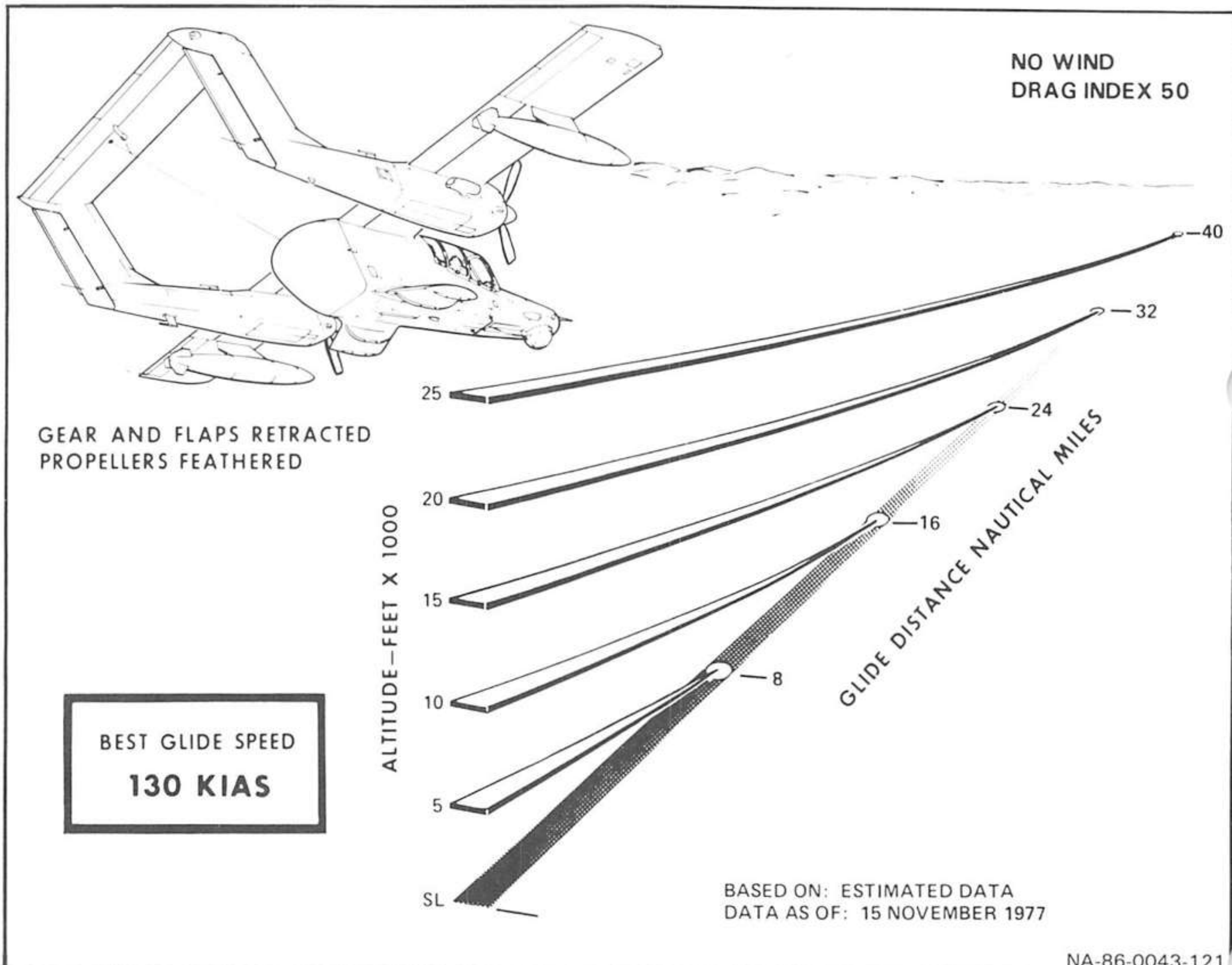


Figure 14-1. Glide Distance

4. AIR START switch—ON.
   Check START IGN ON light ON. Monitor EGT.

CAUTION

The prop will slowly accelerate. Do not move condition lever to NORMAL FLIGHT with less than 10% rpm if time and altitude permit. If necessary, increase airspeed. At very low altitude and airspeed, move condition lever to NORMAL FLIGHT on propeller rotation.

NOTE

If unfeathering does not occur after the AIR START switch is placed to ON, recheck condition lever is in FUEL SHUTOFF and the unfeathering pump circuit breaker is in.

5. Condition lever—NORMAL FLIGHT AT 10% RPM.

NOTE

Light-off is primarily noted by a rise in EGT.

6. AIR START switch—AUTO ABOVE 50% RPM.
   Monitor TIT.

7. Power lever—ADJUST.

CAUTION

If there is any evidence of an engine rpm decay during an air start, suspect a bowed shaft. If time and altitude permit, allow engine to cool. Attempt next air start at higher than normal airspeed (150 KIAS). Observe unfeathering pump limits.

14.1.5 Unsuccessful Air Start. In the event of an unsuccessful air start attempt, recheck condition lever in FEATHER & FUEL SHUTOFF and unfeather pump circuit breaker IN; if still unsuccessful, proceed as follows:

1. Condition lever—FEATHER & FUEL SHUTOFF.

2. AIR START switch—AUTO.
   Check START IGN ON light OFF.

3. EMER FUEL SHUT OFF switch—SHUT OFF.

4. Land as soon as practicable.

14.2 OIL SYSTEM FAILURE

Impending failure of an engine oil system may be indicated by fluctuating and/or abnormal oil pressure, accompanied by surges in engine rpm and torque. Should impending failure of an oil system be suspected, the affected engine should be shut down as soon as possible. Loss of oil pressure eventually results in initiation of automatic feathering of the propeller accompanied by uncontrolled rise in temperature. Intentionally retarding the condition lever to FEATHER & FUEL SHUTOFF provides an earlier and a smoother propeller feathering drag transient than that produced by the torque sensing system. If oil system failure occurs, proceed as follows:

1. Condition lever—FEATHER & FUEL SHUTOFF.

2. EMER FUEL SHUT OFF switch—SHUT OFF.

3. Land as soon as practicable.

NOTE

- Slight engine surge may be the result of air in the oil system rather than an indication of impending engine failure. Feathering the affected engine will allow trapped air to escape and usually results in normal engine operation after air start.
- During single-engine operations, place failed engine power lever in the FLIGHT IDLE position, or operate the power levers simultaneously to ensure WHEELS warning light capability.

14.2.1 High Oil Pressure (Above 120 psi)

1. Condition levers—NORMAL FLIGHT.

2. Power lever—RETARD (affected engine).
   Reduce engine rpm is an attempt to reduce oil pressure below 120 psi.

3. Land as soon as practicable.

CAUTION

If high oil pressure persists, engine failure may occur.

14.2.2 Chip Detector Caution Light Illumination. If L/R CHIP detector caution light illuminates:

1. Check engine instruments for abnormal indication.

2. If abnormal, secure the engine.

3. If abnormal indications not present, continue to monitor engine instruments.

4. Land as soon as practicable.

14.3 ELECTRICAL FIRE/ELIMINATION OF SMOKE OR FUMES

Circuit breakers and fuses isolate most electrical circuits, automatically interrupting power to prevent fire in the event of a short circuit. If electrical fire does occur, it is usually accompanied by acrid fumes, ozone smell, and smoke. A malfunction in the bleed air system may cause smoke or fumes to enter the cockpit and may not be easily distinguishable from an electrical fire. In either event, proceed as follows:

*1. GEN switches—OFF.

*2. BLEED AIR switches—EMER OFF.

If smoke or fumes are still entering the cockpit:

*3. BATTERY switch—OFF.

*4. RAM AIR knob—FULL OUT.

*5. Oxygen mask—ON, and regulator levers selected to 100% OXYGEN, Supply ON (P, O).

6. All electrical equipment—OFF.

7. Cockpit air vents—OPEN (P, O).

8. Cockpit air/defrost knob—AS REQUIRED.

9. GEN switches—RESET SEPARATELY.

10. Voltammeter—CHECK.

11. Turn on only required equipment, checking for highload indication.

12. Defective equipment—OFF.

13. Land as soon as practicable.

14.4 FUEL SYSTEM FAILURES

14.4.1 BOOST PUMP Caution Light. Illumination of the boost pump caution light indicates reduced output of the center tank fuel boost pump. There is a possibility that one of the BOOST PUMP circuit breakers on the panel behind the rear cockpit has popped. Check these breakers and attempt to reset if popped. If these breakers will not reset or if resetting does not extinguish the BOOST PUMP caution light, proceed as follows:

NOTE

Illumination of caution lights on the pilot's caution light panel will also initiate the master caution light system. Reset pilot's master caution light when time permits to arm the master caution light system.

1. CTR WING FUEL QTY—CHECK.

2. Maintain internal tanks near full with auxiliary tank fuel transfer, if available.

3. If necessary, reduce altitude, and maintain at least 90% rpm to retain motive flow pressure (L MTV FUEL, R MTV FUEL lights out).

4. Plan to land before feed tank quantity reaches FUEL FEED warning, regardless of total fuel on board.

14.4.2 FUEL LOW Caution Light. Illumination of the FUEL LOW caution light indicates that the quantity of fuel in the center wing tank has fallen to 220 (± 15) pounds (approximately 20 minutes of flight).

1. External Fuel Transfer switches—ON (if applicable).

WARNING

Do not maneuver the aircraft into steep bank angles or pitch attitudes if fuel level in center wing tank indicates less than full. Possible ingestion of air into fuel feed lines and subsequent engine flameout may result.

14.4.3 FUEL FEED Warning Light. Illumination of the FUEL FEED warning light indicates that the level of fuel in the feed portion of the center wing tank has dropped to approximately 50 pounds (approximately 5 minutes of flight), and may indicate that only this amount of fuel is usable before flame-out will occur. Should the FUEL FEED warning light illuminate, proceed as follows:

*1. Power levers—RETARD to minimum practical torque, and reduce speed to obtain a nose-high attitude.

*2. External fuel transfer switches—ON, if applicable.

3. FUEL QTY switch—CTR WING.

4. Remain at current altitude until a suitable landing area is accessible.

5. Land as soon as possible, using a precautionary approach pattern.

6. Monitor fuel quantity, and prepare for possible complete power failure.

14.4.4 MTV FUEL Caution Light. Illumination of a motive fuel flow caution light indicates reduced output at the respective engine fuel pump. Should one or both lights come on with pump failure, proceed as follows:

1. CTR WING FUEL QTY—CHECK.

2. Maintain internal tanks near full with auxiliary tank fuel transfer, if available.

3. Transfer auxiliary tank fuel, if applicable.

4. Plan to land before feed tank quantity reaches FUEL FEED warning, regardless of total fuel on board.

NOTE

If gravity transfer rate is unsufficient, descent to lower altitude.

14.4.5 External Fuel Tank Transfer Failure. Should fuel from an external fuel tank fail to transfer, the electrical transfer pump may have failed or may have not been primed. External tank fuel is not recoverable in the event of a failed pump. The probability of regaining external fuel transfer is improved if a descent is made to below 8000 feet MSL. Proceed as follows:

1. Cycle external fuel transfer switch — OFF, then ON.

2. Maintain straight and level flight for 10 to 60 seconds, checking for external transfer.

3. If external fuel is not transferring, porpoise aircraft to zero g.

NOTE

External transfer operation will stop, but AUX FUEL caution lights will not illuminate if attempting to transfer external fuel into full wing tanks. Pump shutoff will occur during this condition. Transfer pumps that were OFF cannot be selected ON. Transfer pump operation will resume when fuel consumption causes fuel float switches in the outboard wing tanks to open.

14.5 ELECTRICAL SYSTEM FAILURES

14.5.1 Battery Check. Pilots should monitor the ammeter indication at least every 15 minutes while in flight. Normally the total ampere load with all electrical equipment operating is less than 200 amperes. If the pilot observes readings in excess of 200 amperes, he should immediately secure the battery switch to determine if the batteries are the cause of the abnormally high load. If so, the battery switch should be left OFF and the aircraft landed as soon as practicable.

NOTE

Turning the battery off will result in loss of engine indicating instruments.

14.5.2 Generator Failure. Should one generator fail, the applicable GEN caution light will illuminate, and, on selection of the applicable ammeter select (AMM SEL) switch position, the voltammeter reads 0 amperes. In this case, all electrical loads are being supplied by the remaining generator. In the event of a generator failure, proceed as follows:

1. Applicable GEN switch—RESET.

2. If reset does not occur, select TRIP; then RESET.

3. If failed generator will not reset, continue mission at pilot's discretion.

4. FLIR SYSTEM—OFF to preclude unnecessary load on single generator (Unless Required for Mission).

Should failure of both generators occur, all equipment serviced by the monitor buses is deenergized and all power is provided by the batteries and the No. 1 inverter. Continue as follows:

5. All unnecessary electrical equipment—OFF.

6. BATTERY switch—EMERG, as required. Prior to landing, select EMERG to recover secondary bus powered equipment; exterior lights and Radios 2 and 3.

7. Land as soon as practicable.

WARNING

If emergency battery power is lost (night or IMC) and continued safe flight or a safe landing cannot be made, EJECT.

NOTE

Placing the landing gear handle in the down position also restores secondary bus power.

14.5.3 Instrument Power Failure. Failure of the primary ac bus is indicated by illumination of the INST PWR caution light. Should the INST PWR caution light illuminate, proceed as follows:

1. INST PWR switch—INV NO. 2.

NOTE

Failure of No. 1 and No. 2 inverters results in loss of primary, No. 2 monitor, and instrument ac buses which are not recoverable and indicated by illumination of the INST PWR caution light.

14.6 TRIM SYSTEMS FAILURES

14.6.1 Normal Failure. Failure or runaway of a normal trim system (pitch, roll, or rudder) requires that the ALT position of the TRIM SELECT switch be selected, and that only the alternate trim switches be used. Should trim failure be encountered, proceed as follows:

1. TRIM SELECT switch—ALT.

2. Alternate trim switches—TRIM, as required.

14.6.2. Normal and Alternate Pitch Trim Failure. If failure of both the normal and alternate pitch trim systems occurs, proceed as follows:

1. With full nose-up failure, land with 0 degrees flaps.

2. With full nose-down failure, land with 40 degrees flaps.

3. With neutral failure, use normal landing procedure.

14.7 COCKPIT MANAGEMENT SYSTEM FAILURE

14.7.1 Pilot's and/or Observer's Control Display Unit Failure. In the event that the pilot's or observer's control display unit fails (loss of video display) or determined to be unreliable (indicated by a WHITE BALL on the respective CDU, or √ STATUS annunciators), the remaining CDU will assume control of the data bus after a time out period and no functions will be lost. If both units or dual data bus fails or the pilot's CDU fails during solo flight, utilize the emergency radio and IFF procedures, and land as soon as practicable.

14.7.2 Emergency Radio and IFF Procedures. When utilizing the emergency radio procedure, all selected VHF-UHF radios will transmit and receive on 243.00 MHz UHF guard frequency regardless of CMS radio tuning and mode. The emergency IFF procedure will enable modes 1, 2, and 3A to reply to interrogations in the emergency mode and zeroize mode 4 regardless of CMS code settings.

1. Emergency Radio Procedure.

   (a) GD/EMER switch—ON.

   (b) RADIO 1, 2, and 3 transmit selector switches—ON.

   (c) Microphone selector switch—XMIT.

2. Emergency IFF Procedure.

   (a) IFF EMER switch—ON.

14.8 HYDRAULIC SYSTEM FAILURE

Failure of the hydraulic system because of pump malfunction or a broken line would be noted by failure of the gear to retract or the flaps to operate on selection and illumination of the HYD PRESS caution light or the HYD PUMP caution light on the pilot's caution light panel. Should this occur, the nose wheel STEER button should be depressed to check for failure of a normal gear or flap electrical circuit. If systems operate normally through the nose wheel STEER button, failure has occurred because of an electrical circuit malfunction. In the event of pump failure or hydraulic fluid loss, landing gear emergency extension and alternate flap extension procedure must be used.

14.8.1 Hydraulic Pump Shut-Off Failure

1. HYD PUMP CONT circuit breaker — PULL.

WARNING

Failure of the hydraulic pump to shut off normally will cause overheating the pump and fluid. This may result in pump failure or fluid loss into the cargo bay introducing a potential fire hazard.

NOTE

Power may be temporarily restored to lower gear and flaps, and then removed again.

14.9 LANDING GEAR EMERGENCY EXTENSION

1. Hydraulic pump circuit breaker—PULL.
2. Airspeed — REDUCE TO 120 KIAS.
3. Landing gear handle — DOWN.
4. Increase "g," if required, to lock main gear.

14.10 FLAP ALTERNATE OPERATION

If the flaps fail to respond to normal selection, proceed as follows:

1. HYD PRESS light—CHECK.

If light is not illuminated:

2. Nose wheel steering button — DEPRESS.

If light is illuminated, or if flaps still fail to extend:

3. FLAP handle — HOLD.
4. ALT FLAPS switch — AS REQUIRED.

NOTE

Alternate extension of flaps may require up to 90 seconds.

14.10.1 Asymmetric Flaps. If asymmetric flaps occur, return the wing flap select lever to previous position. If the condition is corrected by this method, do NOT attempt to change the flap setting. If not, perform controllability check and recover.

14.11 CANOPY OPEN IN FLIGHT

WARNING

Attempting to close canopy may result in traumatic injury.

1. Airspeed — REDUCE.
2. Slow flight aircraft to determine handling characteristics.
3. Land as soon as practicable.

14.12 CARGO BAY DOOR OPEN IN FLIGHT

Illumination of the DOOR OPEN caution light indicates that the cargo bay door is open or unlatched. The aircraft may exhibit low-frequency oscillations and/or cargo bay noises. Land as soon as practicable.

CAUTION

A no-flap landing is recommended. Damage to the left inboard flap and the upper surface of the cargo bay door may result if the flaps are lowered in flight.

14.13 STRUCTURAL DAMAGE/CONTROL MALFUNCTION

In the event of structural damage or flight control malfunction, determine the speed at which control effectiveness becomes marginal in the landing configuration. Maintain a minimum approach speed at least 10 KIAS higher. If possible, a straight-in approach should be made.

14.14 EMERGENCY JETTISON

All external stores can be released electrically with the exception of AIM-9 sidewinder missiles and the GPU-2A gun pod. All stores except the centerline-mounted store and the wing-mounted stores can also be jettisoned manually.

NOTE

A complete electrical failure, including loss of battery power, prevents release of the centerline store and the wing-mounted stores under any conditions.

1. STORES EMER REL button—PRESS.

OR

2. EMER ST JETT handle—PULL.

14.15 DEPARTURE FROM CONTROLLED FLIGHT

*1. Power levers — FLIGHT IDLE.

*2. Controls — NEUTRALIZE.

*3. Monitor airspeed and altitude.

*4. Recover.

14.16 NOSE TURRET ACCESS DOOR OPENING IN FLIGHT

1. If aircraft is not controllable—EJECT.

2. If door remains on aircraft, maintain symmetrical flight to prevent door separation.

3. Climb to safe altitude.

4. If available, have another aircraft join to give airspeed reference.

5. Determine flight characteristics in landing configuration.

6. Straight-in approach is recommended.

NOTE

Use torque indicators, radar altimeter, FLIR, and other instruments if reliable. Use approach radar, LSO, and chase aircraft if available.

CHAPTER 15

Landing Emergencies

15.1 FORCED LANDING

The "zero-zero" capability of the LW-3B ejection seat should always be considered when faced with an actual power-off emergency, especially at night, in weather, or over unknown terrain. Flight tests have determined that power-off landings can be made from an overhead pattern, starting at a high-key altitude of 3000 feet above the terrain. Refer to FLAME-OUT PATTERN, in this part.

15.2 DITCHING (WATER LANDING)

Under all conditions, the ejection capability afforded overrides any conceivable advantages of ditching. Safety studies show that when compared to ditching, ejections offer much higher chances of safe escape. If ditching is unavoidable, proceed as follows:

1. Follow emergency radio and IFF procedures.

2. External stores—JETTISON.

3. Loose equipment—STOW.

4. G-suit hose and communications lead—DISCONNECT.

5. Harness, survival kit straps, and lap belt—TIGHTEN.

6. Oxygen mask—OFF.

7. Landing gear handle—UP.

8. FLAP handle—40 DEGREES.

9. Harness—LOCK.

10. Fly power-on approach, if possible.

NOTE

Use normal approach speeds to maintain full control. Unless wind is high or the surface is rough, plan to approach parallel to the swell pattern and attempt to touch down along a wavecrest just after the crest passes. If high wind or rough surface prevails, best procedure is to approach into the wind, attempting to touch down on the falling side of a wave.

11. Condition levers—FEATHER & FUEL SHUTOFF, before impact.

12. Canopies—OPEN.

13. Continue to "fly" the aircraft until forward motion stops.

14. Lap belt—OPEN.

15. Parachute riser fittings—RELEASE.

WARNING

The survival kit release handle shall not be pulled until clear of the aircraft.

16. Abandon aircraft.

15.3 PRECAUTIONARY APPROACH (FIGURE 15-1)

If an engine fails in flight and all air start attempts are unsuccessful or continued operation of the remaining engine is in doubt, land as soon as practicable or possible, respectively. In either situation, the aircraft should be flown to a

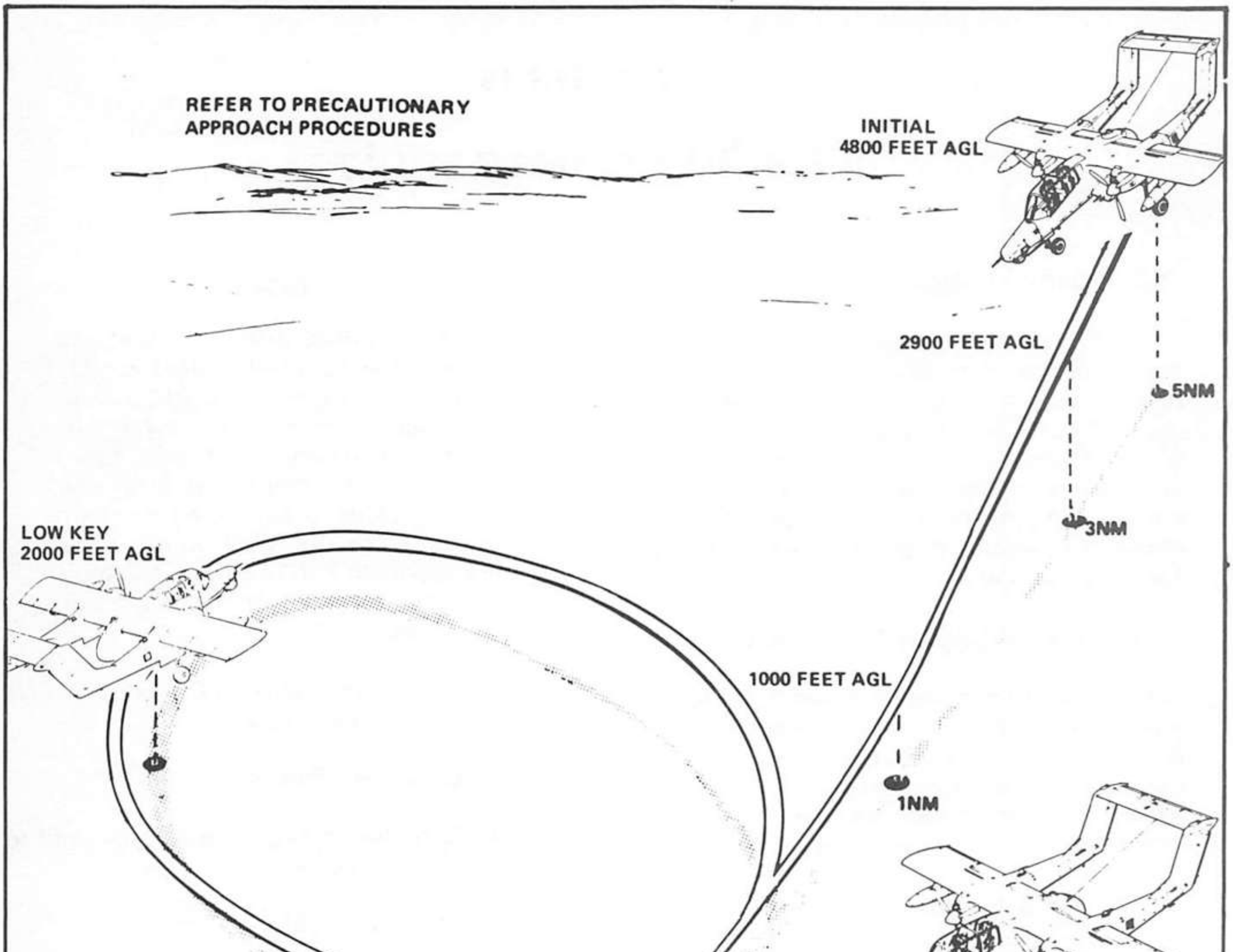


Figure 15-1. Precautionary Approach

position which would allow a safe landing if the second engine failed. If faced with this situation, the pilot should turn toward the nearest suitable landing sight as briefed (minimum length considered suitable is 3000 feet for single-engine landings). Depending upon the location of the engine failure in relation to the landing site and other variables such as populated areas, weather, winds, weight, etc., the pilot may elect to enter the precautionary approach pattern at any suitable point. It must be remembered that the ultimate goal is to touch down within the first one-third of the landing site at an airspeed commensurate with the length of available landing surface (i.e., if only 3000 feet are available, touch down at near minimum single-engine control speed; if 12,000 feet are available, touchdown at 130 KIAS would pose no problems). Until landing is assured, airspeed shall be maintained between the minimum single-engine approach speed, based on weight, and 130 KIAS for best energy conservation.

15.3.1 Minimum Single-Engine Approach Speeds

WEIGHT (LB)	KIAS
10,000	110
11,000	115
12,000	120
13,000	125
14,000	130

If entering the PA pattern from the high key:

1. Just prior to high key:

   (a) Gear down.

   (b) Airspeed — 130 KIAS.

2. At high key:

   (a) 3000 feet AGL.

   (b) Maintain airspeed between minimum single-engine approach speed and 130 KIAS.

   (c) Use approximately 15-degree angle of bank to low key.

3. At low key:

   (a) 2000 feet AGL.

   (b) Flaps — AS DESIRED.

   (c) Landing checklist — COMPLETE.

   (d) Use approximately 30-degree angle of bank to final.

   (e) Maintain airspeed between minimum single-engine approach speed and 130 KIAS.

4. When landing is assured nearing final, reduce airspeed as appropriate, but to no less than minimum single-engine control speed.

5. Flare as required.

If entering the PA pattern from an initial point:

1. Just prior to initial:

   (a) Gear down.

   (b) Airspeed — 130 KIAS.

2. At initial point, approximately 5 NM/ 4800 feet AGL (no wind):

   (a) Begin descent.

   (b) Maintain airspeed between minimum single-engine approach speed and 130 KIAS.

   (c) Flaps as desired.

   (d) Landing checklist — COMPLETE.

3. When landing is assured nearing final, reduce airspeed as appropriate, but to no less than minimum single-engine control speed.

4. Flare as required.

15.4 TIRE FAILURES

Following a tire failure, directional control and braking present the greatest problems. Aircraft structural damage, broken lines, and related fire potential must also be considered. The degree of difficulty depends on such variables as gross weight, speed, which tire fails, and availability of effective nose wheel steering.

NOTE

Nose wheel steering may prove entirely ineffective during rollout with tire failure.

15.4.1 Nose Tire Failure—Landing. For landing with a failed nose tire, gross weight should be reduced as much as practical and a normal approach and touchdown accomplished. Use reverse thrust to stop, while maintaining directional control with light differential braking. Use of nose wheel steering may not prove effective until late in the landing rollout with a flat or shredded nose tire. Reverse thrust will act to lighten loads on the nose gear as speed decreases during the rollout.

To land with a failed nose tire, proceed as follows:

1. Normal approach, flared touchdown.
2. Lower nose gently, reverse thrust to stop.

15.4.2 Main Tire Failure—Landing. For landing with a failed main tire, reduce weight as much as practical, and make a normal approach, utilizing full flaps and touchdown at the minimum allowable airspeed, planning to touch down on the side of the runway opposite the failed tire. After touchdown, use differential reverse thrust and nose wheel steering as required to control and stop the aircraft.

WARNING

Left main tire failure may result in damage to the ground safety switch linkage. This damage may cause loss of NOSE WHEEL STEERING and the POWER LEVER GATE SOLENOID. In this event, use of reverse thrust can only be gained by lifting the throttles approximately 1/4 inch to bypass the reverse gate (solenoid) to apply reverse thrust. Directional control may then be maintained by use of flight controls, differential braking, and differential reverse thrust. (Nose wheel steering will not be available).

To land with a failed main tire, proceed as follows:

1. Land at reduced weight.

2. Normal approach, use full flaps and minimum airspeed; land on side of runway opposite failed tire.

3. Use differential thrust and nose wheel steering to stop.

15.5 UNSAFE LANDING GEAR

The capability of the landing gear to extend by gravity and bungee force makes the incidence of actual unsafe landing gear a rarity. If any gear indicates unsafe down, cycle it, apply "g" or increase airspeed, as applicable, to attempt to get a safe down indication. Allowing the gear to freefall (HYD PUMP circuit breaker pulled) will eliminate some false unsafe indications).

Whenever a main landing gear is confirmed to be unsafe down and all attempts to achieve a safe down and locked configuration have failed, attempt to achieve a gear up landing configuration. Use Figure 15-2 to determine proper procedures based on final landing configuration. In this chart, the term "indicated unsafe" means that the gear appears to be in the down-and-locked position to an outside observer, but cockpit indications are to the contrary.

FINAL CONFIGURATION	LAND/EJECT	STEPS
NOSE INDICATES UNSAFE	LAND	1, 2, 6
NOSE CONFIRMED UNSAFE OR UP	LAND	1, 2, 3, 4, 6, 7, 9
ONE MAIN INDICATED UNSAFE	LAND	1, 2
ONE MAIN CONFIRMED UNSAFE OR UP	EJECT	10
ONE MAIN AND NOSE CONFIRMED UNSAFE OR UP	EJECT	10
BOTH MAIN CONFIRMED UNSAFE OR UP	LAND	1, 2, 3, 4, 5, 8, 9
ALL GEAR UP	LAND	2, 3, 4, 5, 8, 9

STEPS:

1. If pulled, reset HYD PUMP circuit breaker prior to landing.
2. Land on a smooth prepared surface. Perform the Before Landing checklist.
3. Jettison all external stores. If centerline fuel tank can be emptied or is empty, do not jettison.
4. Arresting gear should be removed.
5. Prior to touchdown, feather both propellers.
6. After touchdown avoid using brakes. Lower the nose smoothly to the runway. Do NOT attempt to hold a nose-high attitude below 50 KIAS.
7. After nose is on runway, feather both propellers.
8. Rudder control after touchdown may be marginal since the base of the surfaces may be in contact with the ground.
9. After the aircraft has come to a stop, EMER FUEL SHUT OFF switches–SHUT OFF, BATTERY switch–OFF, and EGRESS.
10. If ejection is not feasible and a landing is attempted, observe Steps 1, 2, 3, and 4. Prior to touchdown, feather the propeller on the side of the unsafe main gear. Reverse thrust will then be available for directional control after touchdown.

NA-86-0043-123A

Figure 15-2. Landing with Unsafe Landing Gear

15.6 WHEEL BRAKE FAILURE

Wheel bake failure should be countered through use of reverse thrust, or allowing a free landing ground roll after touchdown, using differential reverse thrust as required late in the roll for directional control. Should complete failure of the brake system occur, proceed as follows:

1. Use reverse thrust to stop.

2. Block the nose wheel if feasible.

3. Condition levers—FEATHER & FUEL SHUTOFF.

CAUTION

Do not attempt to taxi unless operationally necessary.

15.6.1 Hot Brakes. If prolonged or heavy braking is used during abort or landing rollout, hot brakes may occur.

1. Use reverse thrust to stop aircraft away from personnel and other aircraft, if feasible.

2. Chock the nose wheel.

WARNING

Overheated brakes may cause the wheel to explode. If so, it will explode to the side. Therefore, approach the main landing gear from the rear only.

3. Request fire fighting assistance.

NOTE

Lowering the flaps with the engines running will increase cooling airflow over the brakes.

4. When available fire fighting assistance is in position, complete normal shutdown procedures.

CAUTION

Engine shutdown causes excess fuel to be vented in the immediate vicinity of the brakes.

15.7 EMERGENCY RESCUE

For emergency rescue procedures, see Figure 15-3.

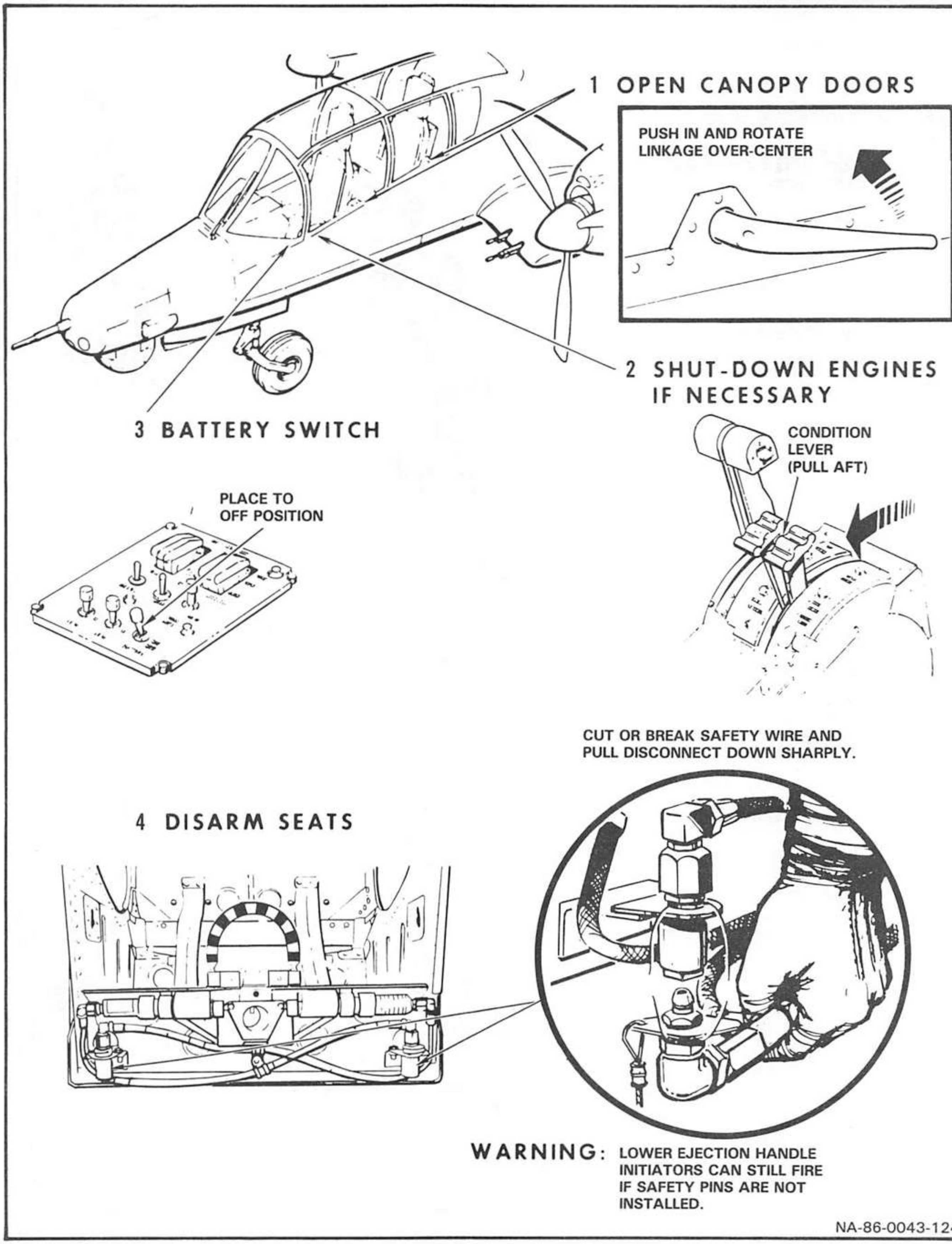


Figure 15-3. Emergency Rescue (Sheet 1 of 2)

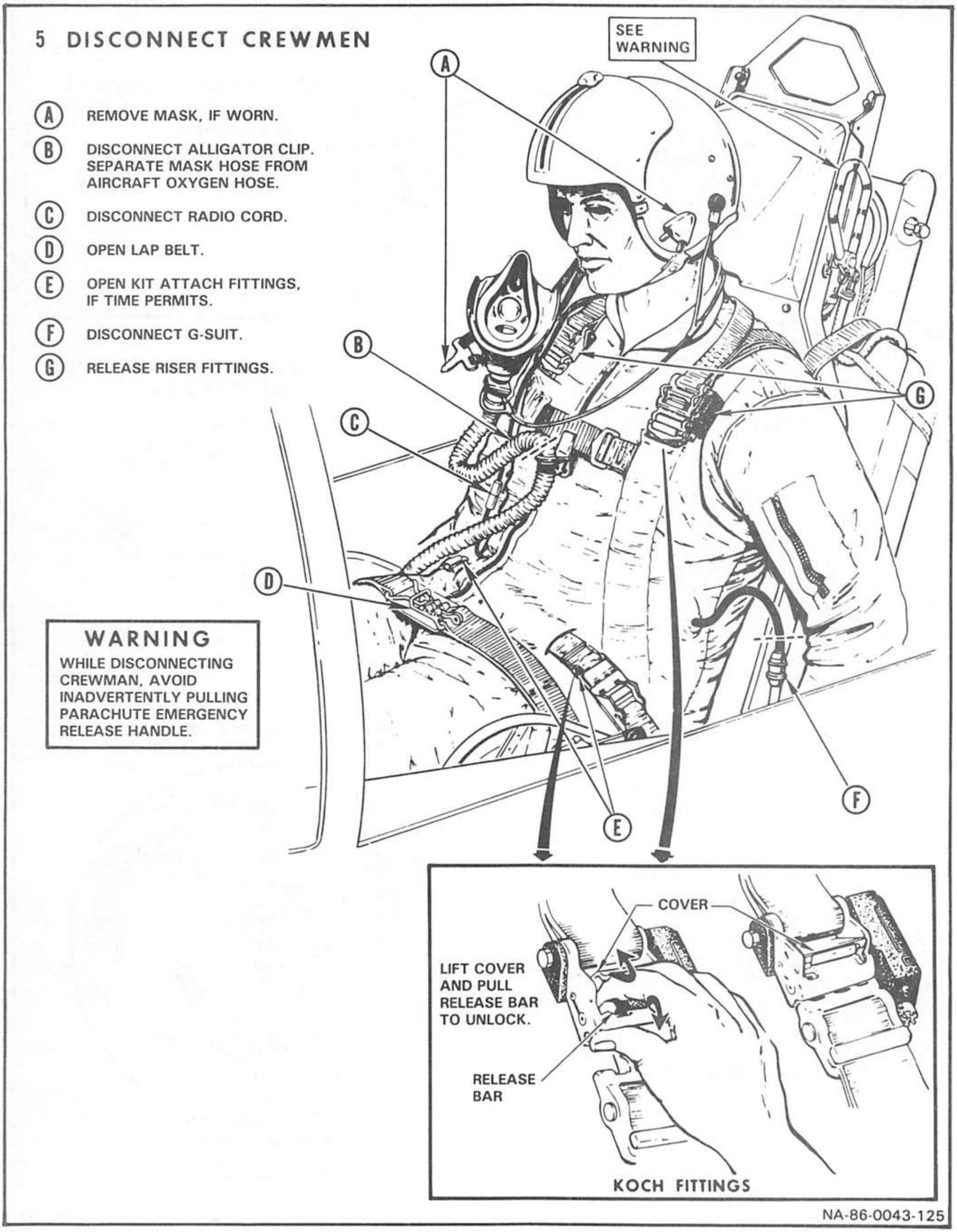


Figure 15-3. Emergency Rescue (Sheet 2 of 2)

CHAPTER 16

Ejection/Survival Procedures

16.1 GENERAL

In-flight escape from the aircraft must be made by ejection. The capabilities and limitations of the ejection seat are presented in Figure 2-22 which shows the absolute minimums at which the system will consistently provide recovery capability.

WARNING

Alternate escape (overside bailout) is NOT POSSIBLE because of the design and mounting of the recovery parachute which is an integral part of the seat. The advantage of forced-chute deployment and the reliability of dual systems outweigh the lack of an alternate bailout capability.

Prior to ejecting from a flyable or controllable aircraft, it is the pilot's responsibility to do everything reasonable to ensure that his abandoned aircraft will inflict the least possible damage on impact.

The LW-3B ejection seat affords exceptional escape capability. For ejection seat operation sequence, see Figure 16-1. Common sense should be used in establishing ejection minimums to increase ejection capability and reliability. The following rules are presented as a guide for establishing ejection criteria:

1. Under controlled, wing-level conditions, eject at least 1000 feet above the terrain, if feasible.

2. Under spin or dive conditions, eject at least 2500 feet above the terrain, if feasible.

3. If ejection is necessary, eject at whatever altitude and speed exist, as this offers the only chance of survival.

16.2 EJECTION–PASSENGERS ABOARD

Personnel in the cargo bay present circumstances which must be considered in the event of an emergency. The following rules are stated as basic considerations where human life is at stake and the decision is up to the aircraft commander:

1. If an emergency which would ordinarily require crewmember ejection occurs during paratroop mission, activate troop alarm at least 15 seconds before ejecting and attempt to ensure the cargo compartment is clear before initiating ejection to prevent injury to passengers from ejection seat rocket blast.

NOTE

For safe bailout from the cargo bay, a minimum of 500 feet above the terrain is required with static lanyard connected. Without the static lanyard (manual D-ring), a minimum of 1500 feet is required.

2. If passengers do not have parachutes (medical evacuation or assault troops), the aircraft commander must determine his action based on aircraft controllability.

16.3 EJECTION PROCEDURES

16.3.1 Immediate Ejection. Time permitting, the pilot shall notify the crewmember/passenger(s) either by ICS or by visual signals (if the ICS fails).

16.3.2 Controlled Ejection. Time permitting, do the following:

1. Ejection selection handle—AS DESIRED.

2. Crewmember—ALERT.

3. IFF EMER switch—ON.

4. GD/EMER switch—ON.

5. Mayday—TRANSMIT (position, situation, intentions).

6. AIRCRAFT—GUIDE AWAY FROM POPULATED AREA.

7. Oxygen mask—REMOVE.

8. Lap and shoulder belts—TIGHTEN.

9. Visor—DOWN.

10. Helmet chin strap and nape strap—TIGHTEN.

11. Kneeboard—REMOVE.

12. Wings—LEVEL.

13. Airspeed—TRADE EXCESS FOR ALTITUDE (minimize rate of descent).

14. Condition levers—FEATHER & FUEL SHUTOFF.

15. Assume proper body position:
    - Head pressed against headrest
    - Chin slightly elevated (10 degrees up)
    - Back—straight
    - Hips against seat back
    - Thighs flat on seat
    - Feet on rudder pedals, heels on deck, elbows close to body

16. Initiate Ejection.

NA-86-0043-126

NA-86-0043-127

WARNING

- Minimum ejection altitudes are dependent upon dive angle, airspeed, and angle of bank.
- During ejection, when the control stick is more than one-half inch aft of the neutral position, the ejection handle may be difficult to reach because of the stick partially blocking access to the ejection handle.
- Positioning the legs aft prior to ejection will cause the spine to flex and will increase the possibility of spinal injury.
- Proper body position is a critical factor in preventing ejection injuries.
- Ejection above 235 KIAS may result in severe opening shock causing structural damage to the main parachute.

16.4 EJECTION INITIATION

16.4.1 Lower Ejection Handle. There are two acceptable methods for ejection initiation, the two-handed grip and the single-handed grip.

16.4.1.1 Two-Handed Grip

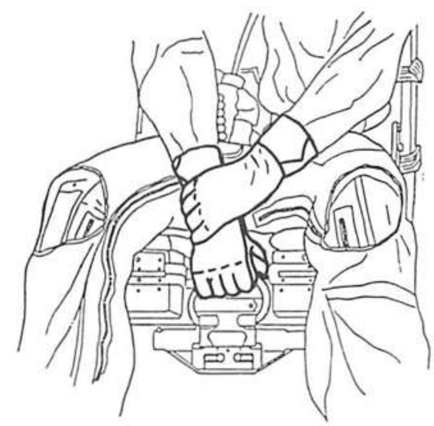
NA-86-0043-128

1. Grip ejection handle with the thumbs and at least two fingers of each hand.

2. Palms toward body, elbows close to body.

3. Pull handle sharply up and toward abdomen, keeping elbows in. Be sure to pull handle to end of travel.

16.4.1.2 Single-Handed Grip



NA-86-0043-129

1. Grip handle with strong hand, palm inward.

2. Grip wrist of strong hand with other hand, palms toward body and elbows close to body.

3. Pull handle sharply up and toward abdomen, keeping elbows close to body. Be sure to pull handle to end of travel.

16.5 EJECTION SYSTEM OPERATION SEQUENCE

For ejection system operation sequence see Figure 16-1.

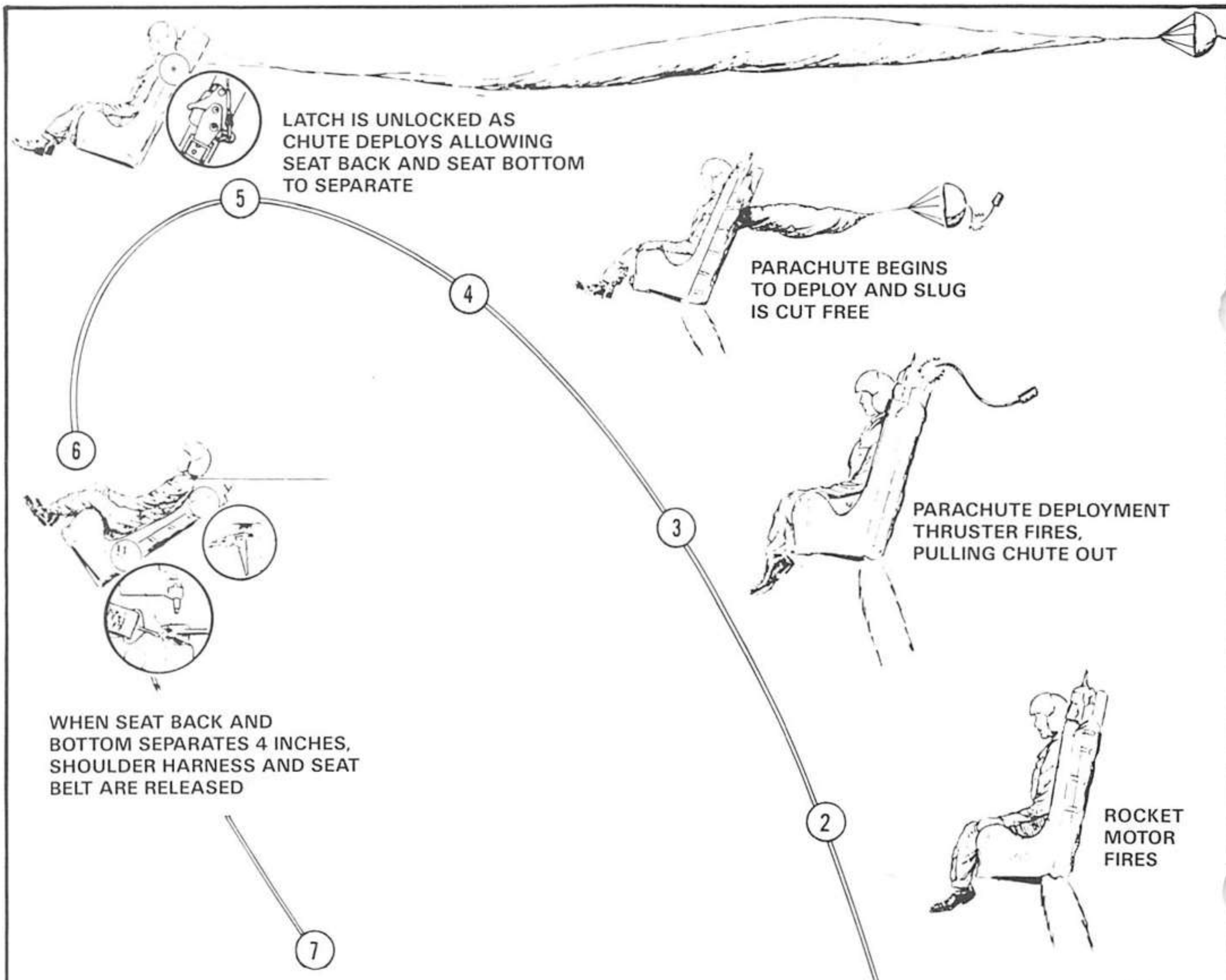
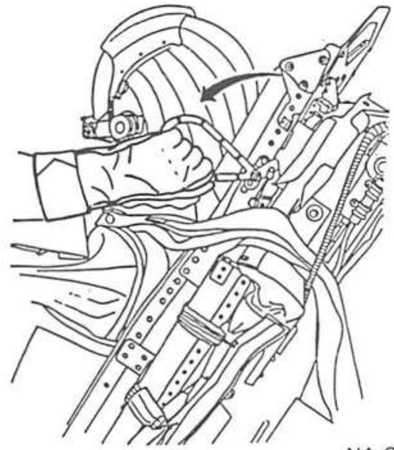


Figure 16-1. Ejection System Operation Sequence

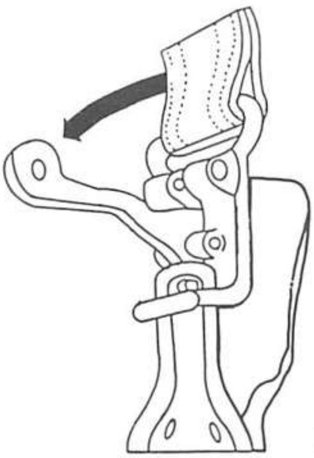
16.6 SEAT/MAN SEPARATION

16.6.1 Emergency Parachute Release



NA-86-0043-131

1. If automatic parachute deployment does not occur, pull parachute emergency release handle on left side of seat.



NA-86-0043-132

2. Open lap belt manually to ensure seat/man separation.

16.6.2 No Seat/Man Separation Procedures.

In the event seat/man separation does not occur after parachute deployment, proceed as follows:

NA-86-0043-133

1. Over land—Reconnect lap belt.

NA-86-0043-134

2. Over water—Release lap belt (if still attached) and inflate life vest. Release parachute release fittings immediately upon water entry.

16.7 POST-EJECTION PROCEDURES

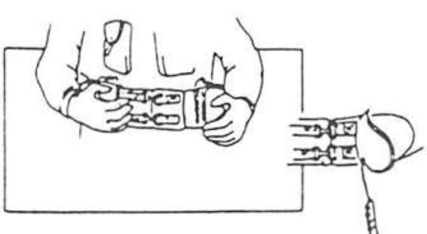
16.7.1 LPU Inflation

WARNING

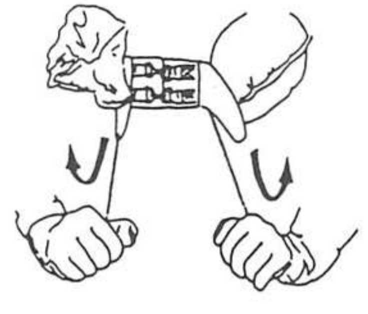
Although the FLU-8 automatic inflation device is designed to inflate the LPU upon saltwater contact, manual inflation remains the primary mode of operation. Automatic actuation is intended for disabled or unconscious survivors or if there is insufficient time to manually activate the LPU.

NA-86-0043-135

1. Immediately following opening shock, check the condition of the parachute. If no malfunction or damage exists locate beaded handles on LPU.

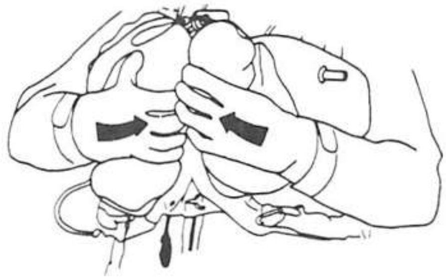


NA-86-0043-136



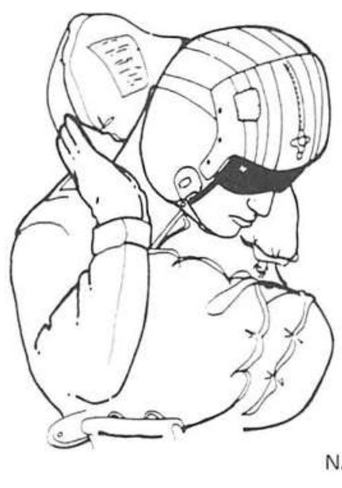
NA-86-0043-137

2. Pull beaded handles down and straight out to inflate.



NA-86-0043-138

3. Squeeze LPU waist lobes together to help release velcro on collar lobe or manually release velcro on collar, if necessary to achieve complete collar lobe inflation.

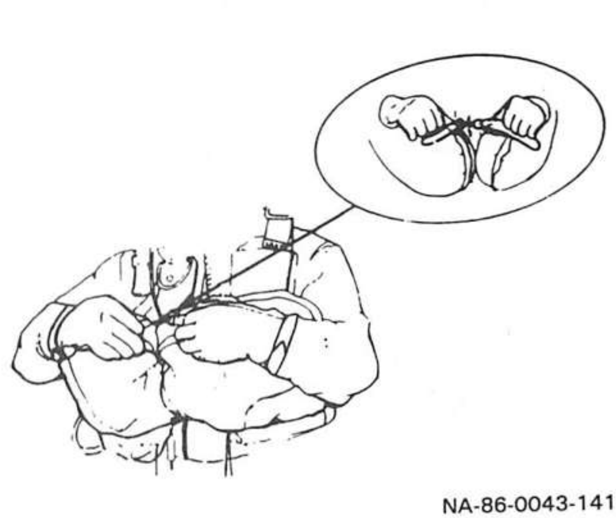


NA-86-0043-139

16.7.1.1 Optional Procedures

NA-86-0043-140

1. Remove chaffing material (when required) from waist lobe snaps.



NA-86-0043-141

2. Snap waist lobes together.

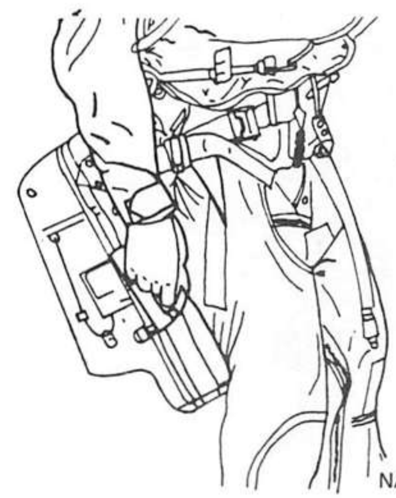
WARNING

Failure to snap waist lobes can result in face down flotation.

16.7.2 Seat Kit Deployment

NOTE

Seat kit deployment is not recommended over land.



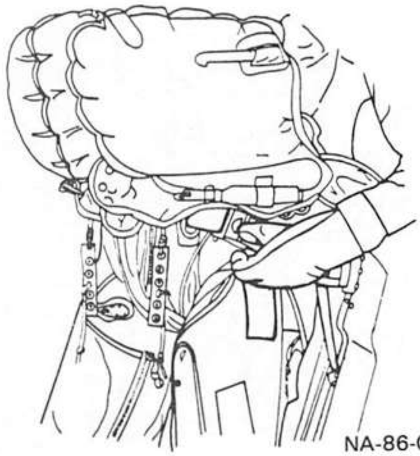
NA-86-0043-142

1. After inflating the LPU, prepare to deploy the seat kit. With the right hand, locate the single raft release handle on the right side of the seat kit.

NA-86-0043-143

2. Firmly pull up on the raft release handle until handle is free of kit and the lower half of seat kit falls away.

16.7.2.1 Injured Arm Procedures. In the event of injured right arm and seat kit deployment is desired, the following procedures must be accomplished:

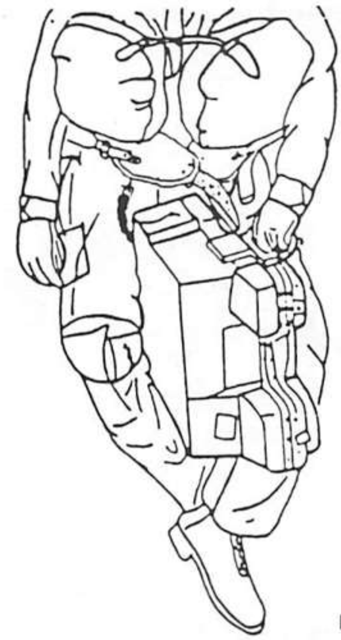


NA-86-0043-144

1. Release left seat kit quick-release fitting.

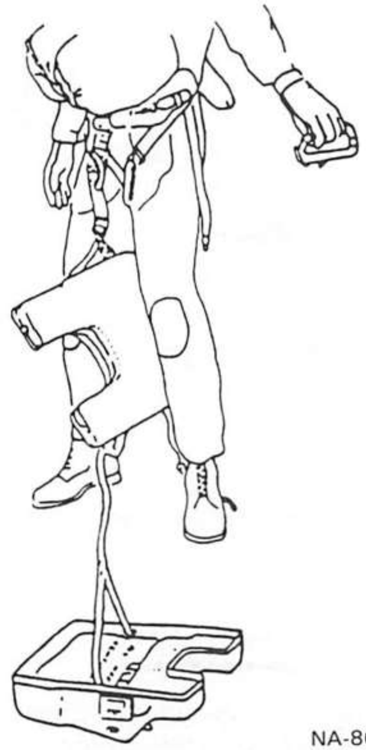
NA-86-0043-145

2. Using the left hand, rotate the seat kit until the kit release handle can be reached with the left hand.



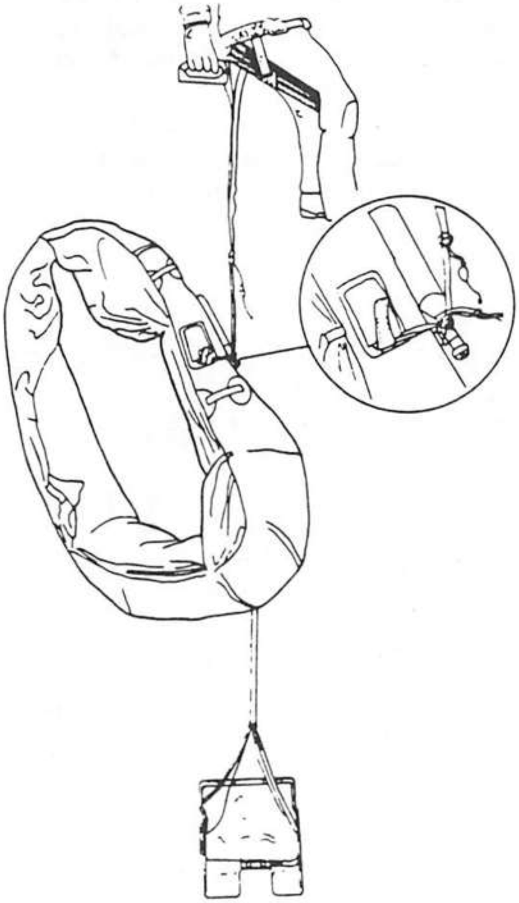
NA-86-0043-146

3. Use legs to position and hold the seat kit.



NA-86-0043-147

4. Pull the raft handle until it is completely free. Allow the lower portion of the seat kit to fall free. Pulling the seat kit release handle unlocks the container; the lower half falls away but remains attached by a drop line. At full stretch of the drop line, the life raft is automatically inflated by gravity.



NA-86-0043-148

Seat kit deployed with the life raft fully inflated, approximately 17 feet below the upper half of the seat kit container.

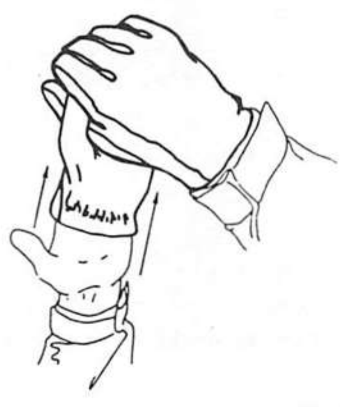
NOTE

If the survival kit is deployed after water entry, a snatch pull on the drop line near the CO_2 bottle is required to inflate the life raft.

16.7.2.2 Options. If time and altitude permit or rescue is not imminent, the following options for the visor, gloves, and parachute four-line release may be considered:

NA-86-0043-149

1. Raise visor.



NA-86-0043-150

2. Remove gloves.

NOTE

Stow gloves in a secure place to prevent loss. Removal of gloves may facilitate subsequent release of parachute release fittings.

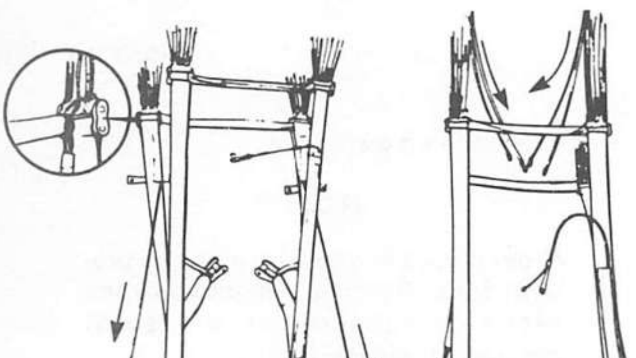
3. Activate four-line release system.

WARNING

- Carefully inspect the parachute and suspension lines prior to using the four-line release system. If any parachute damage or broken suspension lines are evident, do not use the four-line release.
- Do not activate the four-line release at night as parachute damage may be difficult to determine.

NA-86-0043-151

(a) To deploy four-line release, locate parachute control lanyards on the inside of rear risers and pull down sharply.

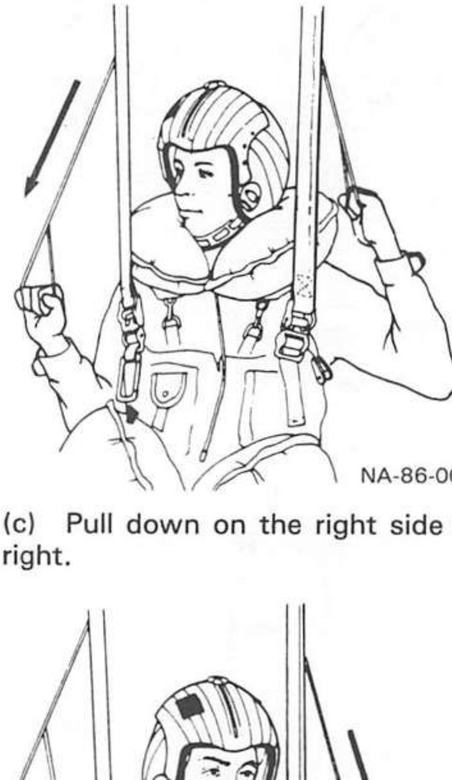


NA-86-0043-152

(b) Four suspension lines release from their connector links and a lobe forms at the center rear of the parachute creating a controlled channel for air escape.

NOTE

- In case of an injured arm, it is safe to activate only one side of the four-line system. The parachute will turn into the direction of the side activated.
- A 180-degree turn may be accomplished in about 20 seconds.



NA-86-0043-153A

(c) Pull down on the right side to steer right.

NA-86-0043-154A

(d) Pull down on left side to steer left.

16.7.3 Landing Preparation. Try to determine the wind direction at the surface using white caps, smoke from the wreckage, or known surface winds in the vicinity. Winds at the surface may be quite different from those encountered at altitude. When nearing the surface, maneuver the parachute so that you are facing into the wind. Then assume the proper body position for landing as follows:

1. Feet and knees together.

2. Knees slightly bent.

3. Toes pointed slightly downward.

4. Eyes on the horizon.

NA-86-0043-155

5. Firmly grasp parachute release fittings.

6. Tuck elbows in prior to water entry.

16.7.3.1 Tree Landing Procedure. Perform the same procedures for over-water landing, but with the following exceptions:

1. Visor—DOWN.

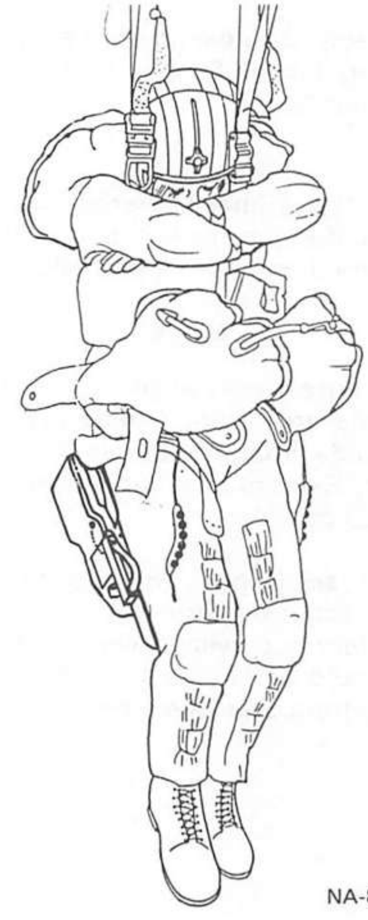
2. Gloves—ON.

3. Do NOT deploy seat kit.

4. Four-line release—DEPLOY AND TURN PARACHUTE INTO THE WIND.

NOTE

Turning parachute into the wind counteracts the prevailing wind to some degree and reduces chances of tree landing injury.



NA-86-0043-156

5. After turning the parachute into the wind, assume the following tree landing body position:

(a) Feet and knees together.

(b) Knees slightly bent.

(c) Toes pointed slightly down.

(d) Place hands in armpits, palms down.

(e) Tuck chin in and turn head to the side.

WARNING

Do not try to slow or stop descent by grabbing tree limbs.

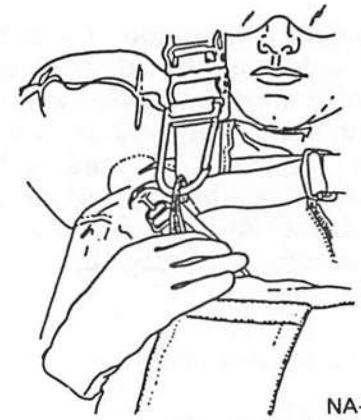
NOTE

Be prepared to execute a parachute landing fall (PLF) if entanglement does not occur.

16.7.3.1.1 Personnel Lowering Device (PLD) Procedures. If entangled in tree and PLD is available, perform the following procedures:

NOTE

- Ensure parachute suspension lines are "hung" securely on a sturdy limb prior to releasing seat kit. Release seat kit and retrieve PLD container.
- If possible, pass snap hook over a strong tree limb for additional safety to prevent falling to ground should parachute lines disentangle from tree (see step 3).



NA-86-0043-157

1. Attach PLD container snap hook to gated helicopter-hoist lift ring. Then disconnect PLD container retrieving line from raft retaining lanyard.

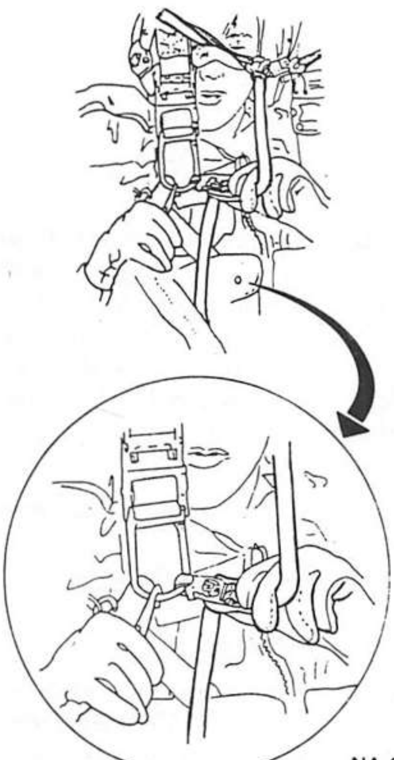
NA-86-0043-158

2. Open PLD container flap panel, locate the lowering line snap hook and disconnect it from the nylon cord loop.

NA-86-0043-159

3. Pass lowering line snap hook through the "V" of the right riser, then through the "V" of the left riser.

NA-86-0043-160

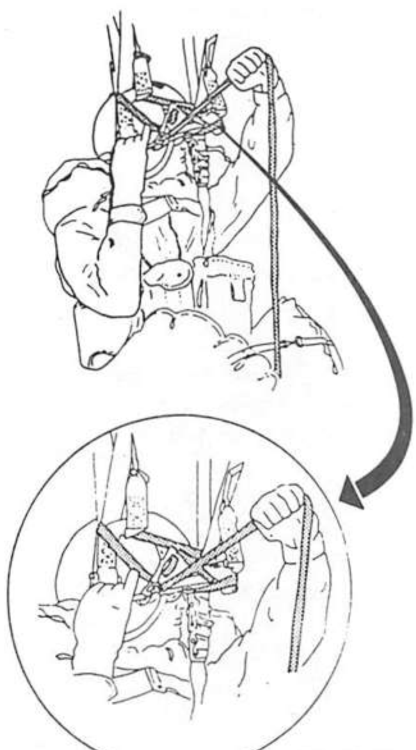


NA-86-0043-161

4. Attach lowering line snap hook to the O-ring, thus encircling the front left and right risers.

WARNING

- The snap hook must be installed on the O-ring from inside with hook portion facing out (see step 4) in order to prevent parachute risers or moving lowering line from touching lowering line snap hook, possibly causing inadvertent release of the snap hook.
- To prevent injury, turn face to the side away from quick-release fittings being released.



NA-86-0043-162

5. Attach the braking device snap hook to the gated helicopter-hoist lift ring. Detach the container snap hook and drop the container and lines to the ground.

6. Grasp the lanyard trailing from the braking device very tightly with the left hand and hold in the stop position (directly overhead with elbow bent) (see detail B). Turn face to the side, and disconnect the right quick-release fitting.

NOTE

- Ensure all excess lanyard between lowering line snap hook and braking device is removed. This will decrease distance of fall when left quick-release fitting is released.
- When left quick-release fitting is released, there will be a drop of from 2 to 6 feet.

NA-86-0043-163

7. Exchange hands on lanyard while maintaining the stop position, then turn face to the side and with the left hand, disconnect the left quick-release fitting.

NA-86-0043-164

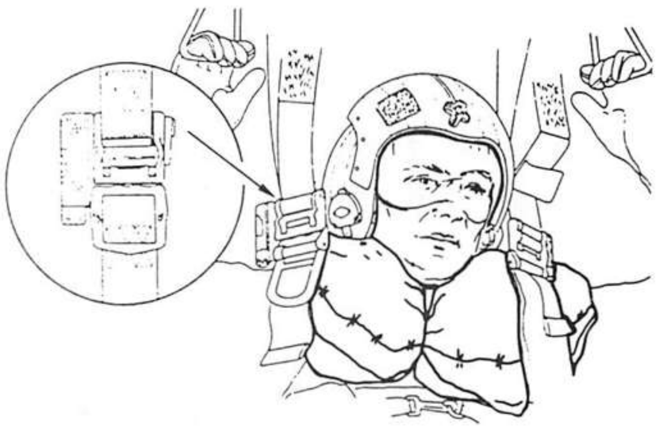
8. Descend from the risers slowly lowering the lanyard from the stop position with the left hand, thereby letting it feed through the braking device. Control the rate of descent by pulling the lanyard toward the vertical with the right hand, while feeding the lanyard from the trailing end with the left hand.

16.7.3.2 Parachute Landing into the Water

16.7.3.2.1 Parachute Fitting Release

NOTE

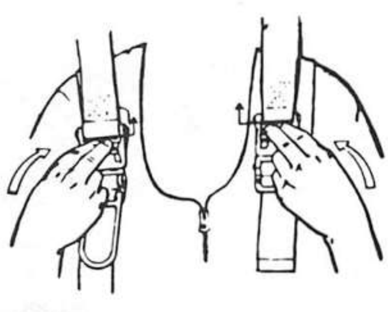
If seawater-activated parachute release system (SEAWARS) is installed on the parachute risers in the aircraft, it will automatically release the parachute from the harness upon immersion in seawater. This will help prevent entanglement and/or dragging injured survivor. SEAWARS does not interfere with the manual operation of the parachute release fittings. Manual operation remains the primary mode of release with SEAWARS intended as a backup.



NA-86-0043-165A

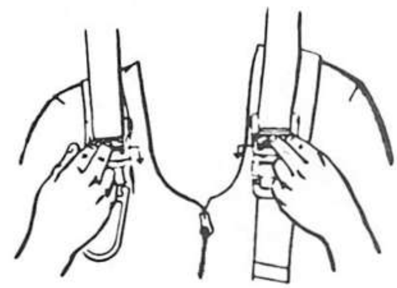
WARNING

- If a parachute landing is made into the water or a high wind prevents normal spilling of parachute canopy, disconnect both quick-release fittings that attach risers to torso-harness suit, thus jettisoning parachute canopy.
- Do not disconnect quick-release fittings until after contact with ground or water.



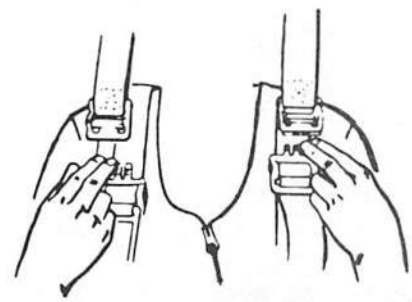
NA-86-0043-166A

1. Push up on quick-release locking lever cover.



NA-86-0043-167A

2. Pull down on quick-release locking lever.



NA-86-0043-168A

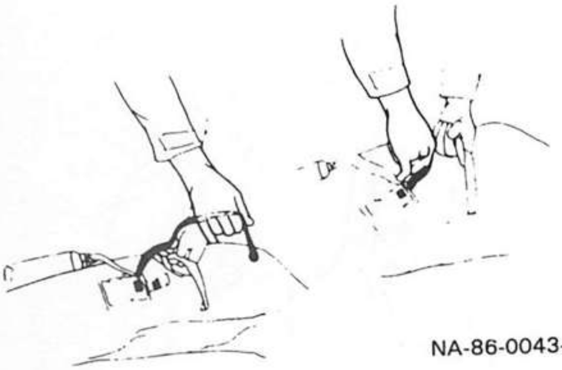
3. Parachute released.

16.8 RAFT BOARDING

16.8.1 LR-1 Life Raft Boarding Procedures. When clear of the parachute canopy, retrieve the LR-1 life raft by locating the dropline and pulling the raft to you.

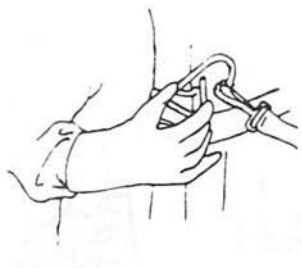
NOTE

Ensure that the raft retaining lanyard is securely attached before releasing upper half of seat kit.



NA-86-0043-169

1. Locate and remove the raft retaining lanyard from its pocket just above the CO_2 cylinder.



NA-86-0043-170

2. Attach snap hook to gated helicopter-hoist D-ring.

NA-86-0043-171

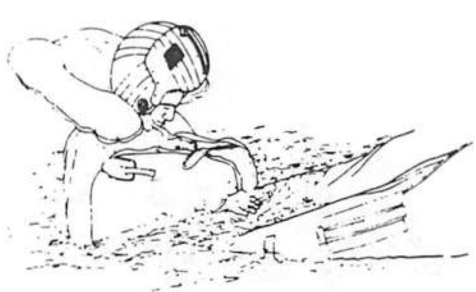
3. Locate quick-release fitting and release upper half of seat kit.

NA-86-0043-172

4. Bring raft around for entry, push into smaller end (stern).

WARNING

Ensure that no sharp edges contact the life raft.

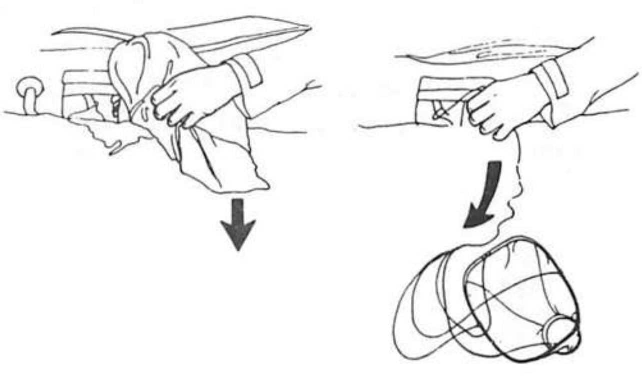


NA-86-0043-173

5. Grasp stern and push forcibly under LPU waist lobes.

NA-86-0043-174

6. Using boarding handles, pull into raft and turn toward a seated position. Move into a comfortable and well-balanced position.



NA-86-0043-175

7. If sea anchor has not deployed, locate it on the left side and deploy it.

NA-86-0043-176

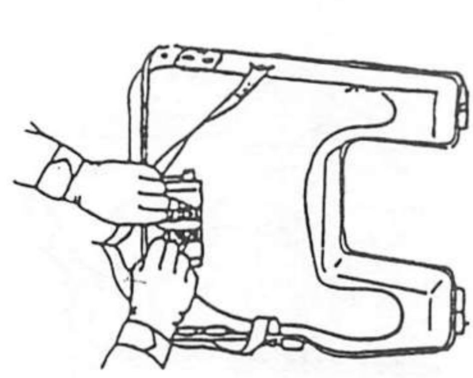
8. Retrieve lower half of kit and secure equipment container to your body or life raft.

WARNING

The URT-33A radio beacon is not tied and once removed from the seat pan, care must be taken to prevent its loss.

NOTE

The URT-33A has a retrieval lanyard secured to it. Secure the lanyard to a suitable place on survival equipment, then remove the URT-33A from its bracket.



NA-86-0043-177

9. Locate and retrieve the AN/URT-33A from the lower portion of the seat kit.

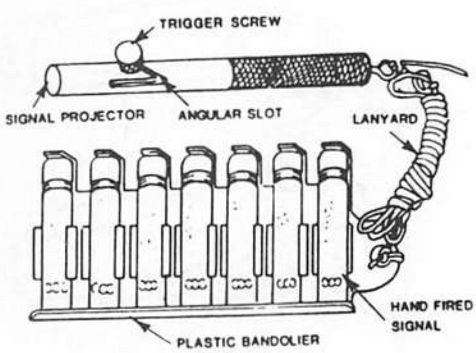
NA-86-0043-178

10. Immediately secure equipment container to gated helicopter-hoist lift ring.

16.9 SIGNALING DEVICES

The following information describes the use of signaling devices while in the life raft and is not intended to prescribe any given order or priority which would be dictated by the immediate situation of the survivor.

16.9.1 Mk 79 Mod O Illumination Signal Kit. The Mk 79 Mod O illumination signal kit uses a pencil-type launcher and cartridge flare.



NA-86-0043-179

WARNING

To prevent premature launching and serious injury, ensure launcher is in cocked-position prior to attaching cartridge flare.

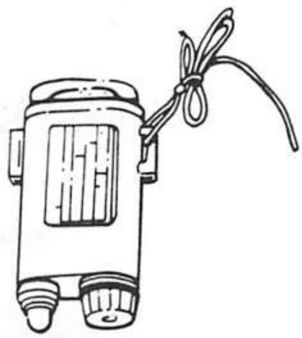
NA-86-0043-180

1. Screw cartridge flare into launcher while keeping flare pointed in a safe direction.

NA-86-0043-181

2. Hold launcher from 45 degrees to slightly overhead. Pull back on trigger and release. Cartridge flare has a minimum $4^1/_2$-second duration and can be launched to about 200 feet.

16.9.2 SDU-5/E Distress Marker Light. SDU-5/E is actuated by pressing the button on bottom of light. It emits 360-degree beam of light which flashes at a rate of 40 to 60 flashes per minute for approximately 12 hours. SDU-5/E distress marker light can be attached to helmet by mating hook and pile (velcro) tape. This frees hands for using other signaling devices.



NA-86-0043-182

NA-86-0043-183

16.9.3 Emergency Signaling Mirror. Mirror flashes reflect light with a brilliancy of up to 8 million candlepower, which can be seen 45 to 50 miles on a clear day from an altitude of 5000 feet.

1. Place lanyard overhead and around neck.

2. Reflect sunlight onto nearby surface (raft, hand, or foot).

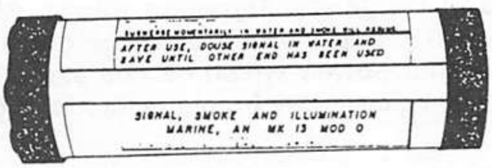
NA-86-0043-184

3. Slowly bring mirror up to eye level and look through sighting hole. You will see a bright spot: the aim indicator.

4. Hold mirror close to eye, slowly turn and manipulate so that bright spot is on target.

5. Even if there are no aircraft or ships in sight, continue to sweep horizon. Mirror flashes can be seen for miles, even in hazy weather.

16.9.4 Mk 13 Mod 0 Marine Smoke and Illumination Signal. The Mk 13 Mod 0 marine smoke and illumination signal is used to attract attention and to give wind drift direction. Flare burns approximately 20 seconds with approximately 3000 candlepower.



NA-86-0043-185

WARNING

Mk 13 Mod 0 signal may reach a temperature that is uncomfortable to handle after ignition. Use of gloves is suggested.

16.9.4.1 Day/Night End Cap Identification

1. Night End

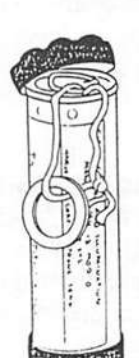
   (a) Red cap
   (b) Protrusion on cap
   (c) Metal washer attached to lanyard

2. Day End

   (a) Orange cap
   (b) No protrusion on cap

NOTE

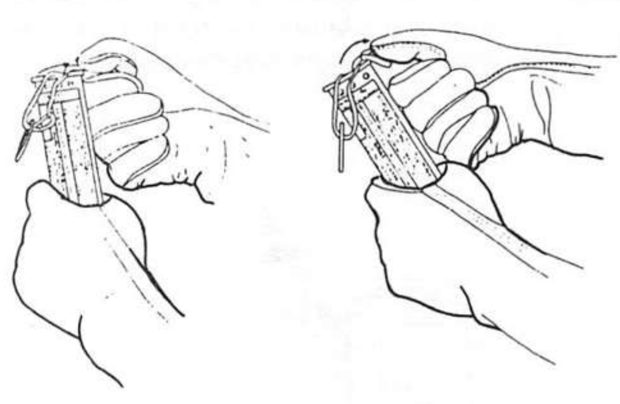
Flares incorporating paper end caps instead of plastic end caps have no protrusions.



NA-86-0043-186

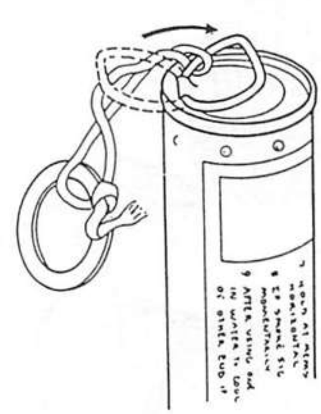
16.9.4.2 Flare Ignition

1. To use Mk 13, remove cap from desired end.



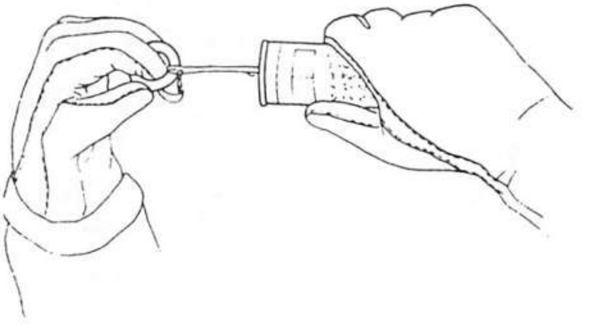
NA-86-0043-187

2. Pull flip ring over ring to break lead seal. If seal doesn't break, push ring until it bends against case.



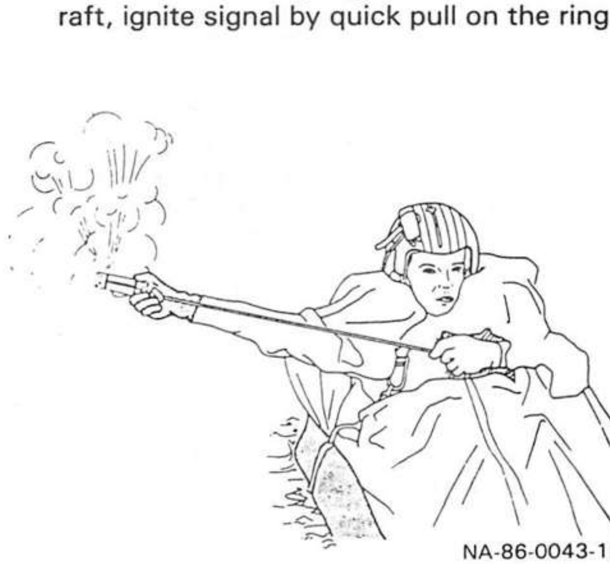
NA-86-0043-188

3. Push bent flip ring back to original position and use as a lever to break seal.



NA-86-0043-189

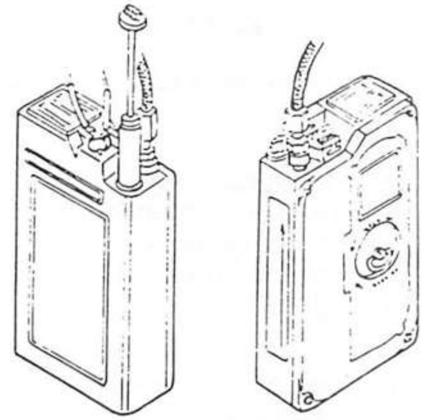
4. While holding signal over side of life raft, ignite signal by quick pull on the ring.



NA-86-0043-190

5. The ignited Mk 13 Mod 0 must be held at arms length, downwind, no more than shoulder high and over side of life raft to prevent damage to raft from hot residue.

16.9.5 AN/URT-33A Radio Beacon Set. The AN/URT-33A automatically transmits a swept-tone signal on 243.0 MHz when the ejection seat leaves the floor of the aircraft.

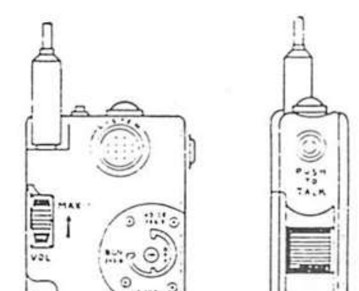


NA-86-0043-191

NOTE

The AN/URT-33A must be turned off when using the PRC-90 on 243.0 MHz to prevent interference. When word "ON" is visible, the radio is ON.

16.9.6 AN/PRC-90 Radio Set. The AN/PRC-90 radio set is a dual-channel transmitter/receiver survival radio capable of transmitting (voice-mode) up to 60 nm (line of sight, depending on receiving aircraft altitude). Two-way voice communication is available on guard (243.0 MHz) or on SAR primary operating frequency (282.8 MHz). BCN mode transmits a swept-tone emergency beacon signal on 243.0 MHz only. Transmission of the emergency beacon signal or Morse code on 243.0 MHz can be up to 80 nm.



NA-86-0043-192

NOTE

- Do not point antenna at receiving aircraft.
- Radio is equipped with external earphone and helmet connector to assist in avoiding enemy detection or for use in the event of aircraft radio failure.

16.9.7 Dye Marker. The dye marker consists of a yellow vinyl, resin-coated, cloth pouch with attaching tape. The dye medium is contained within the pouch. The green dye marker chemical is used by the survivor, during daylight or twilight conditions, to attract the attention of SAR. By dispensing the dye medium in water or sprinkling it across the snow, it produces a bright fluorescent green that can be seen for a distance of approximately 2 miles from an altitude of 3000 feet providing a good target for approximately 1 hour in calm to moderate seas.

NA-86-0043-193

16.10 RESCUE

When the recovery aircraft is ready to effect rescue:

NA-86-0043-194

1. Stow or discard loose gear and roll out of raft on the right side (the side with the CO_2 cylinder).

NA-86-0043-195

2. Swim away from the raft. Ensure that helmet visor has been lowered.

NA-86-0043-196

3. Remove raft retention lanyard after rescue device has been lowered. Swim toward device.

16.10.1 Procedures for Use of the Rescue Hook. The rescue hook has a small and large hook. The large hook is the primary hook for hoisting personnel.

NA-86-0043-197

WARNING

- To allow discharge of static electricity and prevent electrical shock, do NOT touch helicopter-hoist cable or rescue device until it has made contact with the water/ground.
- To avoid severe injury, keep hands clear of gated helicopter-hoist lift ring and rescue hook after hooking up.
- Under no circumstances should survivors attempt to assist their entrance into the helicopter or move from the rescue device until helicopter aircrewmember assists them to a seat in the aircraft.

NA-86-0043-198

1. Attach large hook to gated helicopter-hoist lift ring.

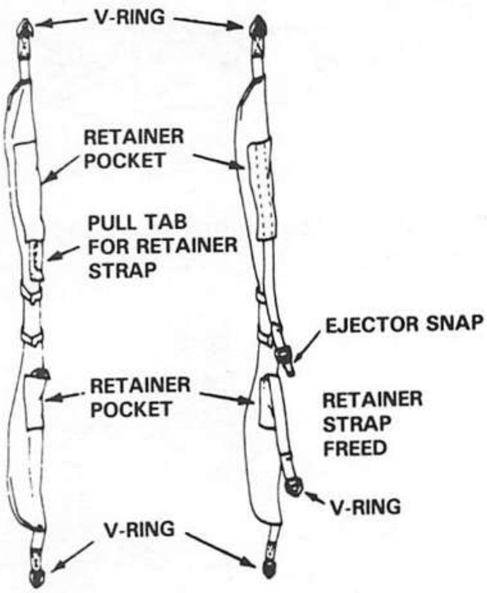
NA-86-0043-199

2. Cross arms in front of chest and place head down and to the left. Give thumbs-up to helicopter-hoist operator.

NA-86-0043-200

3. Position of aircrew during helicopter hoist. Upon clearing water, cross feet.

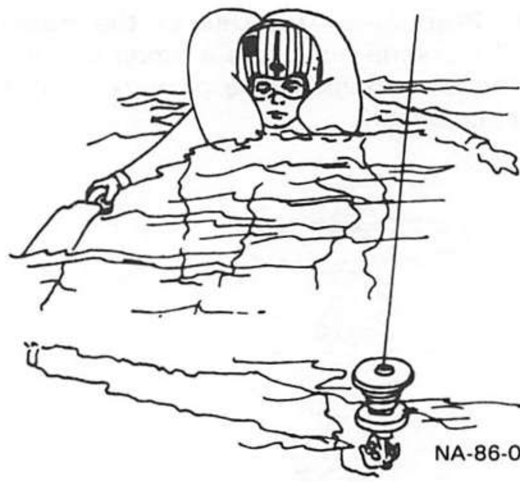
16.10.2 Procedures for Use of the Rescue Strop. Rescue strop (horse collar) is designed to accommodate one survivor at a time.



NA-86-0043-201

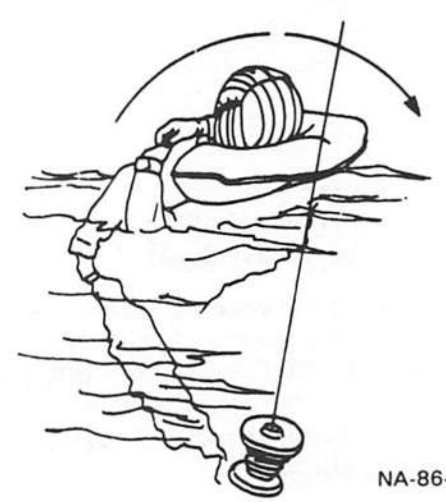
WARNING

- To allow discharge of static electricity and prevent electrical shock, do NOT touch helicopter-hoist cable or rescue device until it has made contact with water/ground.
- To avoid severe injury, keep hands clear of helicopter-hoist lift ring and rescue hook after hooking up.



NA-86-0043-202

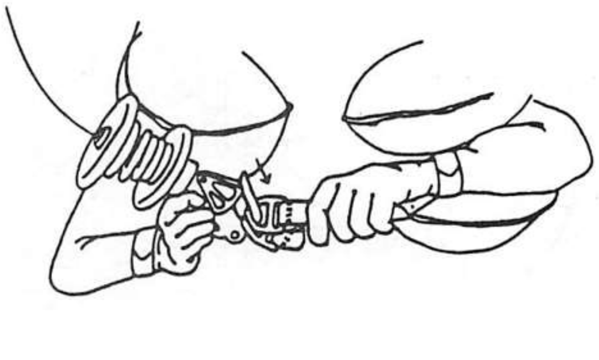
1. Grasp free end of rescue strop.



NA-86-0043-203

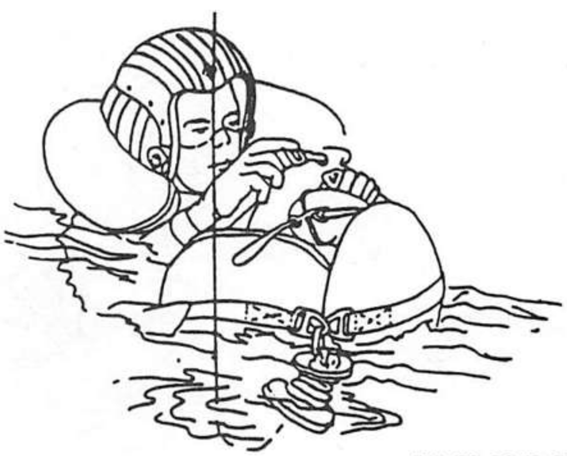
2. Swim in a circle toward rescue hook completely encircling body with rescue strop.

NA-86-0043-204



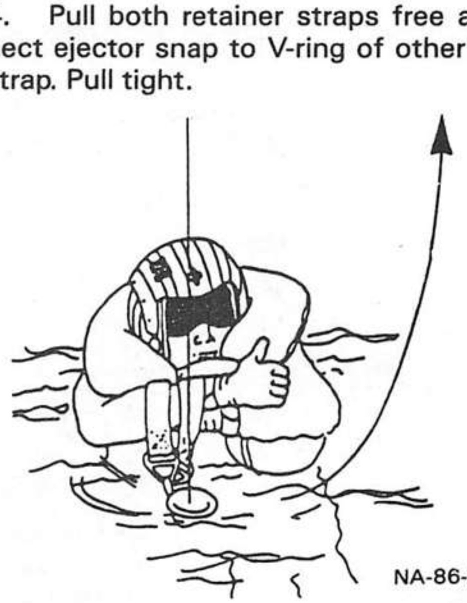
NA-86-0043-205

3. Attach free end of strop to large hook.



NA-86-0043-206

4. Pull both retainer straps free and connect ejector snap to V-ring of other retainer strap. Pull tight.



NA-86-0043-207

5. Ensure rescue strop is above LPU waist lobes and high on the back. Wrap arms around strop and place hands in armpits. Keep head down and give thumbs-up signal to helicopter-hoist operator.

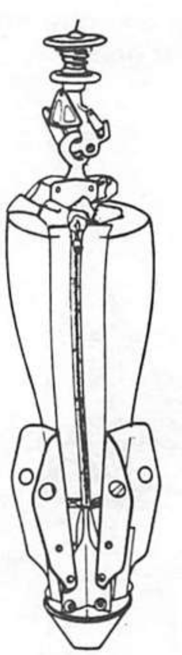
NA-86-0043-208

6. Position of aircrewmember during hoist. Upon clearing water, cross feet.

16.10.3 Procedures for Use of the Forest Penetrator

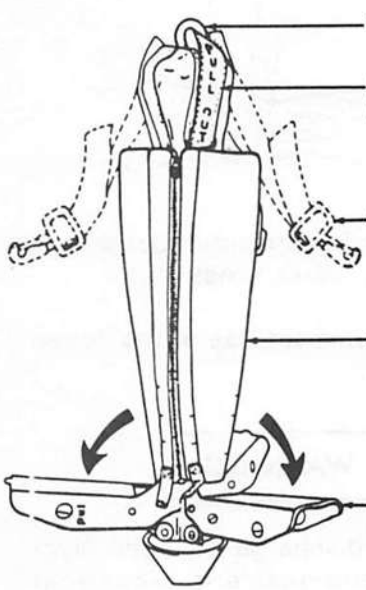
WARNING

- To allow discharge of static electricity and prevent electrical shock, do NOT touch helicopter-hoist cable or rescue device until it has contacted the water/ground.
- To avoid severe injury, keep hands clear of helicopter-hoist lift ring and rescue hook after hooking up.



NA-86-0043-209

Forest penetrator with floatation collar and showing seats retracted (safety straps omitted to show connection of rescue hook to eyebolt).

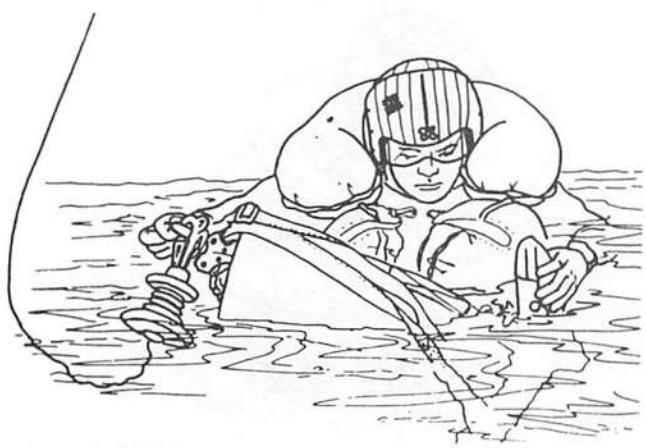


NA-86-0043-210

Forest penetrator with floatation collar showing seats extended.

NA-86-0043-211

1. Unsnap LPU waist lobes.



NA-86-0043-212A

2. Extend only one seat on forest penetrator.

NA-86-0043-213

3. Sit on seat facing floatation collar. Using elbows, separate LPU waist lobes and pull shaft of penetrator close to chest.

NA-86-0043-214

4. Pass safety strap under arm, around back, and under other arm. Connect safety strap and tighten.

NA-86-0043-215

5. Give thumbs-up signal to helicopter-hoist operator.

NA-86-0043-216

6. Position of aircrewmember during hoist. Upon clearing water, cross feet.

PART VI

All-Weather Operation

CHAPTER 17

Instrument Procedures

17.1 INSTRUMENT FLIGHT PROCEDURES

Except where repetition is necessary for clarity, emphasis, or continuity of thought, this section contains only those procedures that differ from, or are in addition to, the normal procedures in Part III, Chapter 7.

WARNING

Intentional flight in known areas of icing shall not be attempted, as there are no provisions installed for wing, empennage, and engine anti-icing.

17.2 INSTRUMENT FLIGHT CHECKLIST

1. PITOT HEAT switch—ON.

2. WIPER control switches—AS REQUIRED.

CAUTION

Do not operate the windshield wiper on dry glass.

3. CMS IFF key—SELECT AND SET AS REQUIRED.

4. Flight instruments—CHECK OPERATION.

   (a) Compass/BDHI—SET, SLAVED.

   (b) Attitude indicator—SET AT 4 DEGREES (NOSE DOWN) ON RUNWAY PRIOR TO APPLYING POWER FOR TAKE-OFF.

   (c) Standby Gyro—Caged.

   (d) Altimeter—SET (error noted, if any).

   (e) Radar altimeter—SET (P, O).

   (f) Wet compass—FLOATING FREELY.

   (g) Chronometer—SET (P, O).

   (h) Turn-and-slip indicator—OPERATING PROPERLY (ball floating freely).

   (j) Vertical velocity indicator—INDICATING 0 (P, O).

   (k) Airspeed indicator—INDICATING 0 (P, O).

5. CMS, radio, and navigation equipment—CHECK OPERATION.

   (a) TACAN-radial—± 4 DEGREES.

   (b) DME—WITHIN 1/2 NM.

   (c) Doppler navigation system—As desired.

   (d) CMS—ON.

6. Navigation publications—AS REQUIRED.

17.3 INSTRUMENT TAKE-OFF

Complete the normal procedures outlined in Part III, Chapter 7. If taxiing and taking off in visible moisture, the windshield wiper should be on as required and pitot heat should be turned on before taxiing into take-off position. When lined up, check BDHI and standby compass for agreement with known runway heading and check sync signal for null. After cross-checking all engine instruments for proper operation at Military power, release brakes and begin take-off roll. Use rudder or nose wheel steering as required. During the take-off run, BDHI heading is primary for directional reference; however, if runway markings are visible, they should be used as an aid in maintaining directional control. At 5 knots below recommended take-off speed, smoothly apply stick back pressure to establish a take-off attitude of approximately 4 to 6 degrees (nose up) on the attitude indicator. On becoming airborne, the attitude indicator is primary for determining pitch and bank angles. When the altimeter and vertical velocity indicator refelct a definite climb, retract the landing gear, and at approximately 110 knots, retract the flaps, if utilized. Maintain a 500- to 1000-foot per minute climb until best climb speed is attained, then adjust nose attitude to hold climb schedule.

17.4 INSTRUMENT CLIMB

Turns should not be attempted below 500 feet above the terrain on instruments and bank angle should not exceed 30 degrees while establishing the recommended climb schedule.

17.5 INSTRUMENT CRUISE

After level-off, it may be necessary to hold climb power until cruising airspeed is established. A bank of 30 degrees should not be exceeded except in unusual situations; however, the aircraft can be easily controlled in turns up to 60 degrees of bank. Handling characteristics are good during instrument flight within all normal speed ranges. Refer to Part XI, Chapter 28.

17.6 COMMUNICATION AND NAVIGATION EQUIPMENT

Installed avionics equipment permits navigation in the low-altitude route structure using TACAN with UHF-ADF as an emergency back-up system. In the absence of ground-based navigation aids, back-up navigation is possible with the doppler navigation system. For operation of electronic equipment, refer to Part VII, Chapter 19. With the exception of HF equipment, all navigation and communication equipment is limited to line-of-sight reception and flight should be conducted at altitudes high enough to receive stations enroute. UHF-ADF and radar vectoring using IFF can be used to supplement TACAN.

WARNING

UHF-ADF is unreliable with external stores.

17.7 HOLDING

Reduce speed to holding speed (150 KIAS) and maintain power as required.

17.8 DESCENT

Economical descent is achieved by retarding the power levers to minimum torque and maintaining 130 KIAS. If a penetration descent is required, retard power to 80% rpm, slowly advance condition levers to TO/LAND, and establish a rate of descent of approximately 4000 feet per minute at 220 to 230 KIAS. Adjust defrost air as necessary before beginning descent. The cockpit and windshield should be kept as warm as possible before and during descents, to eliminate fogging conditions on the transparent surfaces.

17.9 INSTRUMENT APPROACHES

TACAN or radar approaches may be made. Proper trim technique is important during approaches. With each change of power, attitude, configuration, or airspeed, retrimming is required. See Figures 17-1 through 17-3 for typical instrument approaches.

NOTE

The OV-10A/D is a category B aircraft; when instrument approaches are flown with no flaps at 130 KIAS, category C minimums must be used.

17.10 MISSED APPROACH

If a missed approach occurs, proceed as follows:

1. Power levers—MILITARY.

CAUTION

Monitor engine indicators to avoid exceeding torque or temperature limits.

2. Level wings.
3. Establish a positive rate of climb.
4. Gear—UP.
5. Flaps—UP AS DESIRED.

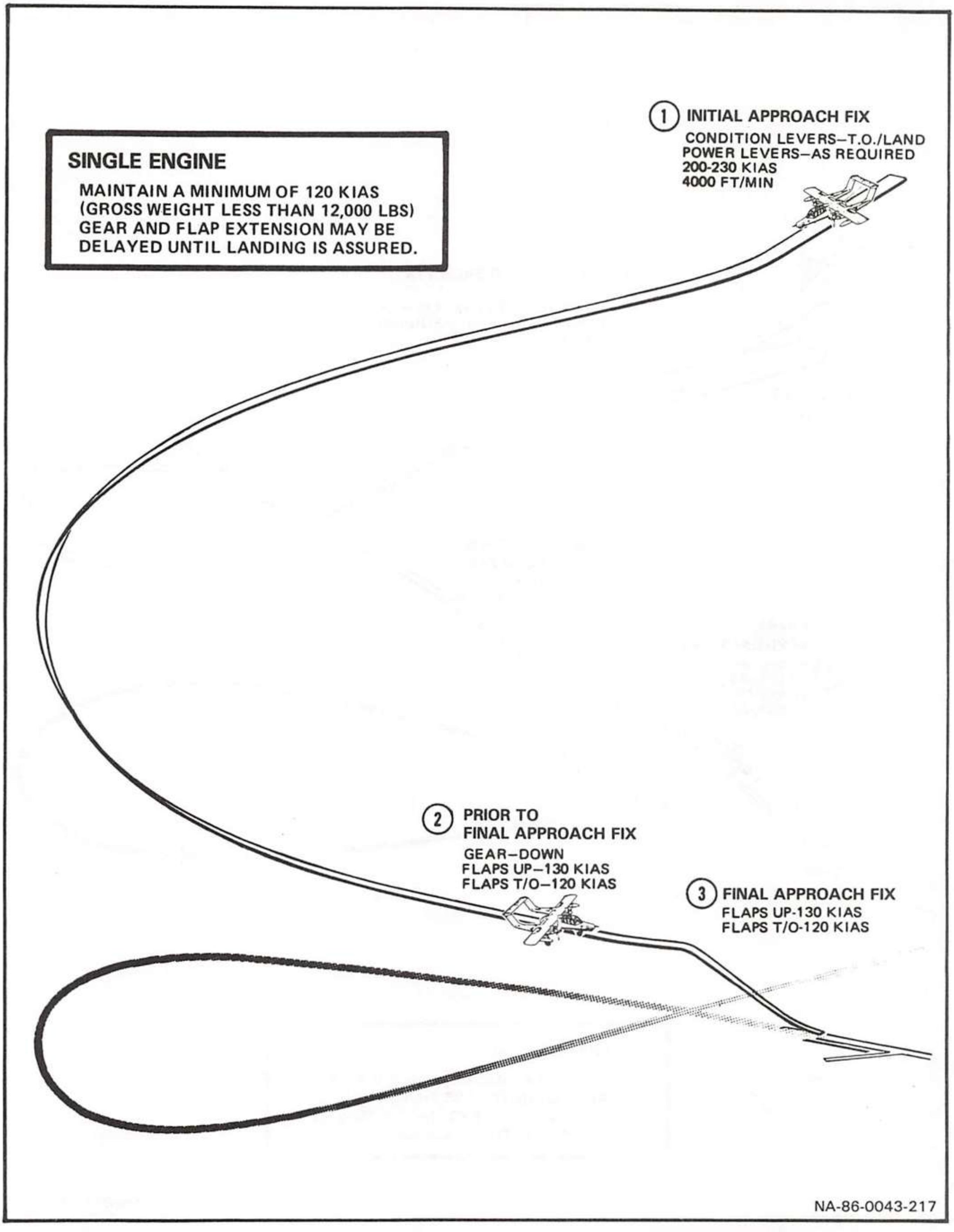


Figure 17-1. High Altitude Approach (Typical)

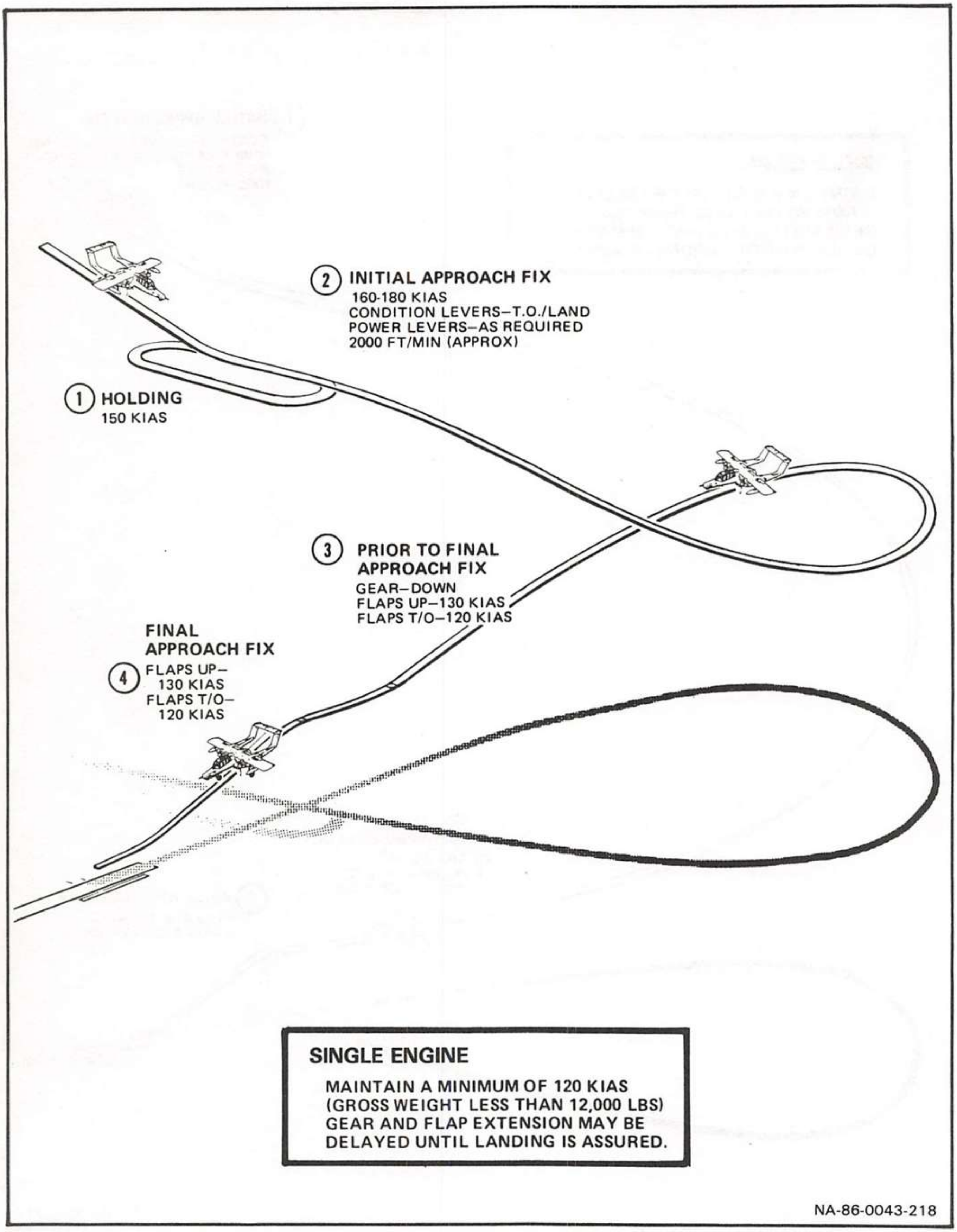
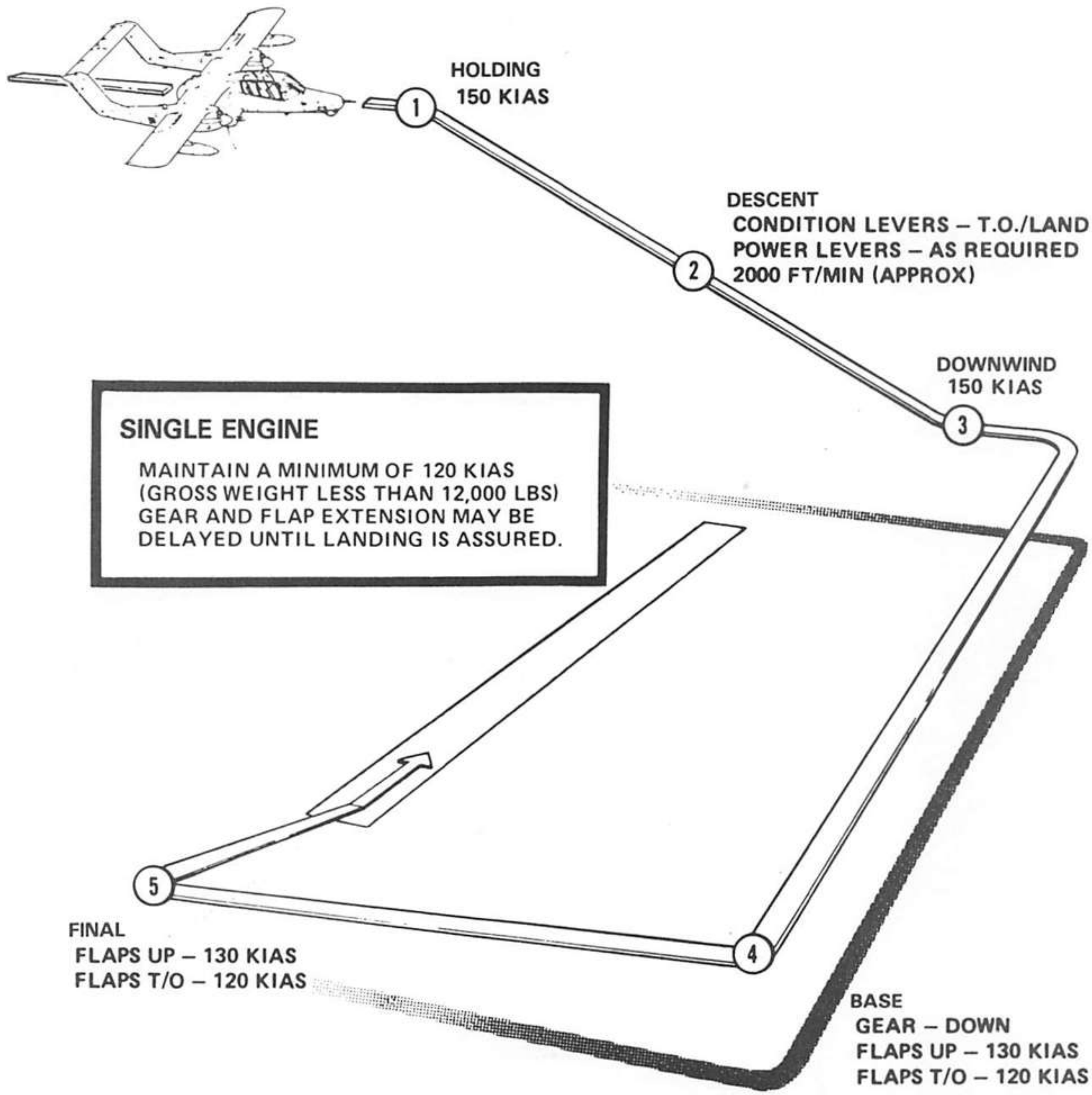


Figure 17-2. Low Altitude Approach (Typical)



NOTE FOR STRAIGHT IN APPROACHES, ACCOMPLISH BEFORE LANDING CHECKLIST PRIOR TO GLIDE SLOPE INTERCEPTION.

NA-86-0043-219

Figure 17-3. Radar Approach (Typical)

CHAPTER 18

Extreme Weather Operation

18.1 ICE AND RAIN

With visible moisture and freezing temperatures, ice will form on the windshield, wing leading edge, and empennage. Altitude should be changed immediately on the first sign of ice accumulation. The resultant drag and weight increase acts to reduce airspeed and increase power requirements, with consequent reductions in range.

WARNING

Heavy ice accumulations can cause stalling speed to be greatly increased. Extreme caution must be used when landing under such conditions.

If you are inadvertently caught in icing conditions, proceed as follows:

1. AIR START switches–ON.

NOTE

Positioning AIR START switches to ON provides continuous ignition to guard against engine flameout. Engine temperature indicators will indicate TIT.

2. Change altitude rapidly by climb or descent or vary course to avoid cloud formations.

3. Increase airspeed to decrease time spent in icing conditions.

4. If ice or frost forms on the windshield or canopy, push the CKPT AIR/DFR knob full in and adjust TEMP and RAM AIR knobs as required.

5. AIR START switches should be positioned to AUTO when icing conditions no longer exist.

6. Loss of a generator with continuous ignition selected–Loss of either generator with the AIR START switch positioned ON will be indicated by respective GEN caution light illuminating and EGT displayed on engine temperature indicator. Should this condition occur, attempt to reset failed generator one time.

If generator will not reset, proceed as follows:

(a) Open respective UNFEATHER PUMP circuit breaker–TIT indication restored on engine temperature instrument.

(b) When icing conditions no longer exist, close respective UNFEATHERING PUMP circuit breaker and position AIR START switches to AUTO.

18.1.1 Landing in Rain. The windshield wiper provides improved visibility in most forms of precipitation. At low airspeeds, such as in the landing pattern, visibility may remain impaired in extremely heavy rain or in snow. Braking action on wet runways is generally poor, requiring longer landing rolls. Plan to use reverse thrust or all the available runway when landing during wet runway conditions.

NOTE

Reverse thrust may cause momentary loss of all forward visibility at approximately 20 knots during deceleration.

18.1.2 Turbulence and Thunderstorms. Flight in heavy turbulence or thunderstorms should be avoided if at all possible. Under night-flying conditions, avoiding these areas may be difficult. The condition levers should be set to TO/LAND. The power settings and pitch attitude required for desired penetration speed should be established before entering the storm. The recommended penetration speed for turbulence is 160 KIAS. The proper power setting and pitch attitude, if maintained throughout the storm, will result in a relatively constant average airspeed, regardless of false readings on the airspeed indicator.

18.1.2.1 Approaching the Storm. Be sure to check for proper operation of all flight instruments, navigation equipment, pitot heater, and instrument panel lights before attempting flight into thunderstorm areas. Adjust the power levers to obtain the recommended penetration speed of about 160 KIAS. Be sure to check for following:

1. PITOT HEAT switch ON.
2. Gyro instruments for proper indication.
3. Lap belt and harness straps tightened.
4. Seat adjusted for adequate head clearance.
5. All loose equipment secured.
6. Cockpit lights full bright.

18.1.2.2 In the Storm. Maintain constant power setting and average band-and-pitch attitude throughout the storm. Hold these constant and the airspeed will remain relatively constant regardless of airspeed indication. Devote full attention to attitude control. The turbulence, lightning, and precipitation may be extreme; however, do not allow these conditions to cause you undue concern. Concentrate principally on holding level attitude by reference to the attitude indicator. Do not chase airspeed or altimeter indications because doing so could result in extreme attitudes. Differential barometric pressures within the storm will make the airspeed indicator and altimeter unreliable.

18.2 NIGHT FLYING

There are no specific techniques for flying at night which differ from those required for daylight operation. If a slight amount of canopy glare is noted in the rear cockpit, it can be relieved by dimming the instrument lights in the front cockpit. Before starting a night flight, be sure both crewmembers are equipped with an operable flashlight.

18.3 COLD-WEATHER PROCEDURES

The majority of cold-weather operating difficulties is encountered on the ground. The following instructions supplement the normal operating instructions when arctic-type weather is encountered. Extreme diligence on the part of both the ground and flight crews is required for successful arctic operation.

18.3.1 Exterior Inspection

1. Check all protective covers are removed.
2. Perform exterior inspection. Refer to EXTERIOR INSPECTION, in Part III, Chapter 7.

3. Check to ascertain that the entire aircraft is free of snow, frost, and ice. Brush off light snow and frost. Remove all ice and encrusted snow. For de-icing information, refer to Part I, Chapter 3.

WARNING

- Remove all snow and ice from the wings, fuselage, and tail before flight. Depending on the weight and distribution of the snow and ice, take-off distances and climb-out performance can be adversely affected. The roughness, pattern, and location of the snow and ice can affect stall speeds and handling characteristics to a dangerous degree. In-flight structural damage may also result, due to the vibrations induced by unbalanced loads of accumulated ice and snow.
- Be sure to check all spring tab hinges, spoiler openings, and flap slot door areas for ice. Ice buildup on elevator and aileron tabs can cause serious control surface unbalance.

CAUTION

Do not chip or scrape ice from aircraft surfaces, as this may cause damage.

NOTE

During freezing rain conditions, ice which is not visible during visual inspection, may form on propeller blade seals. This will result in oil leakage from the propeller assembly on engine start.

4. Check to see that engines are free of internal ice. If equipment is available, the engines may be preheated as necessary.

5. Check to ensure all dirt and ice are removed from shock struts, actuating cylinder pistons, and all limits switches. Clean struts and pistons with a rag soaked in hydraulic fluid to avoid damaging packings and seals.

6. Inspect the area behind the aircraft to ensure that loose snow and ice will not be blown into personnel, other aircraft or equipment during engine start.

7. If equipment is available, the cockpit area, propeller hub, and tail boom electronic compartments should be preheated.

18.3.2 Entering Aircraft. Use caution on the retractable steps. The metal steps may become extremely slippery as snow, ice, or water is deposited by personnel entering the aircraft.

18.3.3 Alternate Fuel Use. When alternate fuels are used, specific attention must be given to alternate fuel limitations. Refer to PRIMARY, ALTERNATE, AND EMERGENCY FUELS, Part I, Chapter 3.

NOTE

Ground and air starts characteristics may be improved in cold temperatures by using JP-4 fuel.

18.3.4 Starting Engines. At temperatures below 0 °C (32 °F), external dc starting power should be used. Battery power may not be adequate to provide the rpm required for normal starting after prolonged exposure to below −0 °C temperatures.

CAUTION

Below −22 °F (−30 °C), engine starts should not be attempted until the engines are thoroughly preheated. This procedure will lessen slow-starting effects.

18.3.5 Ground Checks

1. Normally, engine warm-up is unnecessary and as soon as the engines stabilize at idle rpm with normal oil pressure and the propellers are unlocked, the power levers may be advanced to MILITARY. However, if the engine has been "cold-soaked" at temperatures below 0 °F (± 18 °C), a 2-minute warm-up at GROUND IDLE is recommended.

NOTE

Difficulty may be encountered in unlocking propellers unless the engines are preheated. If unlocking cannot be obtained, allow time for engine temperatures to increase and reattempt unlocking.

2. Before taxi, conduct a thorough check of full-travel operation of all flight control surfaces and the flaps. Ensure proper operation of tabs and spoilers with flaps extended and retracted.

3. Check all communications-navigation equipment and instruments for proper operation, allowing at least 3 minutes for warm-up before checking.

18.3.6 Taxiing. The aircraft should not be taxied through water or slush if it can be avoided. Water or slush splashed into the wheel wells will freeze, causing possible gear retraction malfunctions. If taxiing behind another aircraft, maintain a greater interval than normal to avoid ice and slush from being blown onto the aircraft.

18.3.7 Take-Off. Monitor engine torque closely during take-off acceleration, as torque increase with ram effect in cold weather could result in exceeding engine limits.

18.3.8 After Take-Off. After take-off from wet snow or slush-covered surfaces, leave the landing gear down for a short period, or operate the gear and flaps through several complete cycles to prevent freezing in the retracted position. Use care to avoid exceeding gear and flap limit speeds during these cycles.

18.3.9 Landing. The basic, normal landing techniques apply to landing on slippery surfaces, except that the effects of crosswind are multiplied. Except as necessary to control direction on unprepared surfaces, the use of nose wheel steering is NOT recommended for landing rollout. More precise directional control is available using differential propeller thrust and rudder.

NOTE

Under conditions of intense rain, sleet, or snow, or when a depth of loose, dry snow, or standing water is present, use short bursts of partial reverse thrust as feasible. Full reverse thrust may cause momentary complete visual obstruction.

18.3.10 Before Leaving

1. When feasible, ensure fuel servicing as soon as possible.

2. If aircraft is to be idle for more than 4 hours at temperatures below −20 °F (−29 °C), remove batteries and store in a warm area.

3. Check that all protective covers are installed and that the aircraft is chocked and tied down as required.

18.4 HOT-WEATHER AND DESERT PROCEDURES

Hot-weather and desert procedures differ from normal procedures when high temperatures, coupled with flowing sand and dust, are encountered. Extreme caution must be exercised by both the ground and flight crews to prevent damage to systems during desert operations. Proper protection and inspection of the aircraft while on the ground and observance of the precautions covered in this section will ensure the most successful operation.

18.4.1 Exterior Inspection

1. Remove all protective covers.

2. Clean dust and sand from struts, hydraulic pistons and switches, and wipe down struts with hydraulic fluid.

3. Always place the aircraft in a position to avoid sandblasting equipment and personnel during engine starts and ground checks.

4. Check the intake ducts and remove any accumulation of dust and sand.

5. Clean dust and sand from windscreen and canopy with very wet cloth to prevent scratching and clouding surfaces.

CAUTION

Use gloves during exterior inspection to prevent serious burns from contact with extremely hot aircraft surfaces.

18.4.2 Before Starting Engines

1. Check instruments and electrical equipment for excessive moisture from high humidity and use ground heat, as necessary, to dry them.

2. Check cockpit for excessive accumulations of dust or sand.

NOTE

High temperatures may cause circuit breakers to pop when electrical power is applied.

18.4.3 Starting. Monitor starting EGT closely. Due to increased OAT, starting temperatures tend to be higher than normal.

18.4.4 Before Take-Off

1. Expect the engines to accelerate to idle more slowly than on a normal or cold day.

2. Minimize the duration of engine ground operation. The engine temperature may be reduced by advancing the condition levers slightly forward of the NORMAL FLIGHT position while waiting for take-off.

3. Keep sufficient distance between aircraft during taxiing to prevent sand and dust from being blown into the engines.

18.4.5 Take-Off. Delay rotation, if the take-off roll is not critical, until reaching take-off speed, to provide positive control and a higher initial rate of climb. Expect gusts and turbulence at low altitudes.

WARNING

Engine power decreases rapidly with increases in ambient temperature and take-off distances are greatly increased.

18.4.6 Approach and Landing. Maintain recommended approach and landing speeds. Refer to Part XI, Chapter 31. Allow for longer landing rolls resulting from slightly increased ground speeds with high outside air temperatures.

18.4.7 Before Leaving

1. Ensure that protective covers are installed on the pitot-static tube, angle-of-attack probe, engine intakes and exhaust pipes and the IRCM transmitter.

2. If the aircraft is parked in the sun, leave the cargo bay door slightly ajar and one cockpit door open to allow air circulation if wind-blown sand is not a problem.

3. Ensure the aircraft is tied down, central gust locks installed, and parking brake set if the possibility of a windstorm exists.

PART VII

Electronic Equipment and Communications

CHAPTER 19

Electronic Equipment

19.1 COCKPIT MANAGEMENT SYSTEM

The cockpit management system (CMS) provides the pilot and observer integrated control and display management of weapons, countermeasures, communications, navigation, and identification equipment. In addition, avionics power control, take-off/landing checklists, and trim indications can be displayed. Power for the CMS is 28 VDC provided by the primary dc bus. For CMS warm-up time see Figure 19-1. Two control display units (CDUs), installed on the pilot's (CDU 1) and observer's (CDU 2) instrument panels, are used to initiate or change user system modes and operating parameters, and to input data to the CMS. The CDU is equipped with a continuously running built-in-test (BIT) to advise the operator of the system status and also allows the operator to manually initiate BIT of selected communications, navigation, and identification equipment. All information and functions provided by the CMS will be available to both the pilot and observer with the exception of the store station jettison function which is available to the pilot only. The CMS consists of two CDUs, a dual (A and B) MIL-STD-1553B data bus, and three bus subsystem interface units (BSIUs). The BSIUs are located in the left boom (BSIU 3), right boom (BSIU 2) and forward cargo bay (BSIU 1). BSIUs provide an interface between non-data bus compatible equipment and CDUs. See block diagram, Figure 19-3. The pilot's CDU acts as the bus controller and the observer's CDU functions as a remote terminal during normal operation. Should the pilot's CDU fail, the observer's CDU will automatically assume control of the data bus. CMS preset radio channels are stored in a non-volatile memory and are recalled during subsequent power applications.

19.1.1 Cockpit Management System Controls. All controls for the CMS are located on the pilot's and observer's CDUs with the exception of the CMS ON/OFF power switch which is located on the pilot's right console on the CMS AND RADIO PWR CONTROL panel (Figure 19-2). Specific function and action of the CDU keys vary with each individual CMS page display and can be found in associated equipment descriptions and operation. Descriptions are provided for the CRT display arrangement, line select keys, BRT control, BIT indicator, CRT symbols and the alphanumeric keyboard including the function select keys, special function keys and slew switch.

19.1.1.1 CRT Display Description. Electronic pages and a page tree structure are used on the Cathrode Ray Tube (CRT) to display information and provide control of various aircraft systems. Pages are accessed by pressing the function select keys, slew switch, or line select key as required. Each page consists of an eight-line (22 characters per line) display (Figure 19-2). Not all lines will be utilized in each page. Included are four data lines, a title line, an information line, annunciator line, and a scratch pad line. Each of the four data lines are divided into two parts (left screen and right screen) and correspond to line select keys. The title, information, and annunciator lines are located between the data lines. Annunciator messages, displayed on the annunciator line, alert the operator to conditions requiring correction or monitoring. Refer to paragraph 19.1.2 in this chapter and see Figure 19-7. The scratch pad, between brackets, is the bottom line of the display and is used to display entered information. Error messages will be displayed in the scratch pad if operational or entry conditions are not met. Refer to paragraph 19.1.3 in this chapter and see Figure 19-8.

19.1.1.2 Line Select Keys. Eight line select (LS) keys are used to initiate functions selected, insert data from the scratch pad, change mode of operation, or change display to the page indicated when a GO TO PAGE arrow is displayed.

TYPE	DESIGNATION	WARM-UP TIME (MINUTES)	PRIOR TO	FUNCTION	RANGE
INTEGRATED ELECTRONIC SYSTEMS					
Cockpit Management System	CMS	1.5	Screen Display and Viewing Adjustments	System Control, Monitoring and Operation	–
COMMUNICATION SYSTEMS					
ICS	–	–	–	Intercom Transmission Selection, Signal Amplification	–
HF Radio	AN/ARC-199	1.5	Transmit	Two-Way Voice	1000 + NM
VHF/UHF Radio 1	AN/ARC-182	0.5 Maximum	Transmit	Two-Way Voice, UHF-ADF Bearing	Altitude Feet / Line-of-Sight Distance
VHF/UHF Radio 2	AN/ARC-182	0.5 Maximum	Transmit	Two-Way Voice, Relay Ability	10,000 123 NM 7,500 106 NM
VHF/UHF Radio 3	AN/ARC-182	0.5 Maximum	Transmit	Two-Way Voice, Relay Ability	5,000 87 NM
NAVIGATION SYSTEMS					
Compass	AN/ASN-75	3.0	Bearing Indication	Magnetic Compensated Gyro	–
TACAN	AN/ARN-118	1.5	Range Readout	Azimuth and Range	Line-of-Sight to Station Land-390 NM Air -200 NM
Doppler Navigation Computer	AN/APN-233	1.0 Maximum	Mode Selection	A/C Position, Target and Checkpoint Data	0–40,000 Feet
UHF-ADF	AN/ARA-50	1.0	Bearing Indication	Bearing to ADF Beacon	Line-of-Sight
Radar Altimeter	AN/APN-171(V)	3.0–5.0	Altitude Indication	Altitude Above Ground Level	0–5000 Feet
IDENTIFICATION SYSTEMS					
IFF-SIF	AN/APX-100(V)	2.0	Interrogation Response	Radar Identification (AIMS)	Line-of-Sight

NA-86-0043-220A

Figure 19-1. Electronic Equipment (Sheet 1 of 2)

TYPE	DESIGNATION	WARM-UP TIME (MINUTES)	PRIOR TO	FUNCTION	RANGE
SPEECH SECURITY SYSTEMS					
KY 1	KY-58	—	—	Speech Security (VHF-UHF) Radio 1	—
KY 2	KY-58	—	—	Speech Security (VHF-UHF) Radio 2 and/or Radio 3	—
KY	KY-75	—	—	Speech Security (HF) HF Radio	—
WEAPONS SYSTEMS/ELECTRONIC COUNTERMEASURES (SEE PART VIII)					
Countermeasures Dispensing Set	AN/ALE-39	None	—	Eject Countermeasures Materials	—
Infrared Countermeasures	AN/ALQ-144(V)	1.0	—	Protection Against Heat-Seeking Missiles	—
Radar Warning System	AN/APR-39(V)	1.0	—	Receives and Analyzes Missile Tracking and Guidance Signals	—

NA-86-0043-221

Figure 19-1. Electronic Equipment (Sheet 2 of 2)

The line select keys will operate in a rotary or toggle manner depending on modes or functions required. Rotary operation is used when more than two possible states are required (ON/OFF/STBY), toggle operation is used to change between two possible states (ON/OFF). Options are selected by pressing LS keys adjacent to a one or two word message displayed on the CRT. Data is entered into the scratch pad from the keypad and is then entered into data line 1, 2, 3, or 4 by pressing the appropriate LS key. Line select keys on the left side of the CDU enter data on the left side of the data line, line select keys on the right side of the CDU enter data on the right half of the data line. When the scratch pad is empty, line select keys are used to select options displayed on the associated data line (Figure 19-2).

19.1.1.3 Brightness (BRT) Control. Controls contrast and brightness of CRT display for day or night operations (Figure 19-2).

19.1.1.4 Built-In-Test (BIT) Indicator. Indicates when CMS-CDU BIT has detected a failure. A white ball indicates CDU failure and a black ball CDU operational (Figure 19-2).

19.1.1.5 CRT Display Symbols and Words. For CRT symbols and word definition, see Figures 19-4 and 19-5.

19.1.1.6 Alphanumeric Keyboard. The keyboard is an interactive keyboard that uses dual-purpose keys to input information on the CRT screen. The keyboard contains alphanumeric keys, function select keys, special control keys, and a slew switch. Function select keys are used to access associated top-level display pages on the CRT screen. Numeric keys are used to input number data into scratch pad.

19.1.1.6.1 Alphanumeric Keys. Alphanumeric keys allow the selection of either numbers or letters (selectable from the LTR key) for entry into a scratch pad displayed at the bottom of the CRT (Figure 19-2).

19.1.1.6.2 Function Select Keys. The communication (COMM), navigation (NAV), identification, friend or foe (IFF), countermeasures (CM), and weapons (WPNS) function select keys allow the crew to call up and display the related system data on the CRT display (Figure 19-2). For detailed operation of these keys, see applicable user system. The status (STAT) and index (IDX) function select keys permit access to a variety of integrated information applicable to the general flight operation and maintenance of the aircraft. Refer to paragraph 19.1.4 for detailed STAT key description and paragraph 19.1.5 for detailed IDX key description. Function select keys will act as alpha keys when the LTR key is selected to the LTR mode. For function select key page access data, see Figure 19-6.

19.1.1.6.3 Special Function Control Keys (LTR and CLR). Two special function control keys (LTR and CLR) are located on the CMS CDU keyboard. The LTR key permits selection of letters or numbers from the keypad to be input to the electronic scratch pad. Normally the keypad will operate with function select and numeric keys enabled and letter keys disabled. When selected for letter entry, LTR will be displayed in the lower right corner of the CRT and the function select keys, COMM, NAV, IFF, CM, WPNS, STAT, and IDX will be disabled. Letter mode is disabled by pressing LTR a second time, pressing CLR key, or by entering scratch pad data into the CMS using a LS key (Figure 19-2).

The scratch pad can be cleared with the CLR key. Pressing the key once will clear the last character entered, pressing the key twice will clear the entire display. It will also clear certain annunciator messages when scratch pad is blank and annunciator messages are displayed on the CRT. Error messages are also cleared by the CLR key (Figure 19-2).

19.1.1.6.4 Slew Switch. A spring-loaded, three-position toggle switch is provided to permit forwards or backwards scrolling of pages (example: page 1/2 to 2/2), change parameter values (example: squelch level) or activation of equipment functions (example: xmit tone) (Figure 19-2).

19.1.2 Annunciator Messages. Annunciator messages, which alert the operator to conditions requiring immediate attention, are displayed on the right or left side of the annunciator line. Annunciator messages are prioritized according to importance, if a high priority message is being displayed and there are other messages waiting to be displayed, clearing the high priority message with the CLR key (and blank scratch pad) will cause the next highest priority message to be displayed. See Figure 19-7 for annunciator message display listing, priority, location, and definition.

19.1.3 Error Messages. The CMS will display error messages in the scratch pad when data entered does not match parameters that LS key operation is programmed to accept (examples: letters entered instead of numbers, not enough characters to complete an instruction, or an improper LS key selected). The error message will alternate display with the incorrect entry until the condition is cleared by pressing the CLR key or corrected by proper LS key selection. Error messages will also be displayed if a selected mode of operation or condition is selected while a conflicting condition or mode is present. For a listing of error messages and corrective or clearing action see Figure 19-8.

19.1.4 Status (STAT) Key Functions. WRA Status pages provide GO/NOGO indications of the CMS or monitored system operating capability. The continuous CMS built-in-test (BIT) tests the CDUs, BSIUs, and data bus from the moment power is applied to the CMS until the CMS is secured with no action by the operator required. In addition to the continuous self-test, other systems (Radios, TACAN, and IFF) are monitored continously by the CMS. These systems perform their own continual self-test and report the results to the CMS via the data bus as a GO/NOGO status.

If all CMS and monitored system weapon replaceable assemblies (WRAs) are GO, STAT key selection will display the "WRA Status GO page 1 of 2" page. When the CMS detects itself or a monitored system going from a GO to a NOGO status, a √ STATUS annunciator will be displayed on the right side of the annunciator line on both CDUs. A NOGO system status is a result of either a self-test, in the case of Data Bus A or B, BSIUs, CDUs, or interface responses from monitored systems. When the STAT key is selected after a √ STATUS annunciator, the annunciator will be cleared and the CMS will display the WRA Status page that has recorded the most recent WRA failure. A check mark (√) and NOGO will be displayed adjacent to the failed WRA LS key. The title of both WRA Status pages will reflect a NOGO condition. If a √ is displayed next to a WRA and GO is displayed, it indicates that the WRA had failed but for some reason returned to a GO status (intermittent failure). After reviewing the Status pages and noting the GO/NOGO WRA Status, clear any checkmarks using LS8. If an intermittent WRA causes the √ STATUS annunciator to repeatedly occur and the operator is aware of the intermittent operation, inhibit the annunciator by entering a dash ("–") in the scratch pad and press the LS key next to the WRA causing the problem. The √ will disappear and a dash ("–") will be displayed. In this manner, future failures will not cause the √ STATUS annunciator to be displayed for that WRA. If desired, the annunciator function may be returned and the dash deleted by repeating the procedure.

Access to detailed individual system status (Radios, CDUs and BSIUs) and Bus Status pages is provided by selecting LS keys with the scratch pad blank. These pages will display checkmarks and GO/NOGO indications for subsystem level components for further system fault isolation normally used by maintenance technicians. These pages display BIT test word information, data bus status, SIM (subsystem interface module) status, and keep a count of NOGO failures. The annunciator disable function can also be used on these pages (Figure 19-9).

19.1.5 Index (IDX) Key. The Index function select key provides access to the Index page and the following page groups (Figure 19-10).

1. Power page
2. Take-Off Checklist page
3. Landing Checklist pages (Pilot and Observer)
4. Test pages
5. Aircraft Trim page

19.1.5.1 Power Page. Power control (ON/OFF) is provided for the;

1. IFF, AN/APX-100, and KIT-1A TSEC IFF system
2. KY 1 and KY 2, KY-58 secure voice crypto computers
3. TACAN, AN/ARN-118

NOTE

- Power for the KY 1 and KY 2 units may also be turned ON or OFF at the Radio 1, 2, and 3 mode control pages.
- IFF power can only be turned OFF from the power page but may also be turned ON from the IFF page.

19.1.5.2 Take-Off and Landing Checklist Pages. A common take-off checklist is provided for both the pilot and the observer. This nondetailed list of items may be used in conjunction with established NATOPS procedures. When an item has been checked, the crewmember can insert a √ by pressing the LS key adjacent to the checklist item to indicate completion. The checkmarks can be cleared by pushing the slew switch down or up. Access to the Aircraft Trim page is available from the Take-Off Checklist page by selecting LS5, when the Trim page is exited by pressing LS8, the display will return to the Take-Off Checklist page and a √ mark will appear adjacent to LS5 (Figure 19-10).

Separate landing checklists are provided to the pilot and observer. This nondetailed list of items may be used in conjunction with established NATOPS procedures. When an item has been checked, the crewmember can insert a √ by pressing the LS key adjacent to the checklist item to indicate completion. The checkmarks can be cleared by pushing the SLEW switch down or up (Figure 19-10).

19.1.5.3 Test Pages. The Test pages provide access to operator initiated or observed CMS system tests (COMM, NAV, CMS, and IFF) that may be used as confidence tests of systems for preflight checks or maintenance troubleshooting aids. Built-In-Test (BIT) is initiated (or observed in the case of the CMS test) from System Test pages by pressing applicable LS keys and the resulting WRA status is then displayed. System NOGO indications may be further isolated by maintenance personnel to a particular weapon replaceable assembly (WRA) by selecting System Detail test pages. In the event of a system NOGO test result in-flight, it is recommended that the flight crew make note of Detail Test page indications for postflight maintenance (Figure 19-10).

19.1.5.4 Aircraft Trim Page. A display is provided for aircraft trim surface indications of the elevator, rudder, and ailerons. This page is accessed from the Take-Off Checklist page or directly from the Index page. See Part I, Chapter 2 for Trim page description and indications.

19.1.6 CMS Preflight Operational Checkout. To check operation of the CMS system, proceed as follows:

1. After transfer to aircraft electrical power, INST PWR switch—INV NO.1.
2. RADIO 1, 2, 3, and HF switches—ON.
3. MASTER ARM switch—OFF
4. CMS PWR switch—ON. Allow 90 seconds for system warm up.

NOTE

After power is applied, each CMS-CDU will display the last page viewed during previous system use.

5. BRT control—ADJUST intensity as desired (P,O).

NOTE

When annunciators and error messages are displayed on the CDU CRT, see Figures 19-7 and 19-8 for definition and corrective/clearing action. A √ STATUS annunciator will be displayed on the CDUs if any of the following conditions exist:

- Radios and/or CMS units not installed.
- Radios and/or CMS units are installed but not powered-up (circuit breakers open).
- NOGO condition of a CMS or monitored system WRA.

6. IDX key—SELECT.

(a) TEST (LS5)—SELECT. Test Index page displayed.

(b) CMS (LS5)—SELECT. Ensure CMS-CDUs and BSIUs are GO.

7. To secure system, select CMS PWR switch—OFF.

1. LINE SELECT KEYS 1, 2, 3, 4 (TOP TO BOTTOM)
2. CRT DISPLAY
3. LINE SELECT KEYS 5, 6, 7, 8 (TOP TO BOTTOM)
4. BUILT-IN-TEST (BIT) INDICATOR
5. ALPHANUMERIC KEYS
6. SPECIAL CONTROL KEY (LETTER KEY)
7. SPECIAL CONTROL KEY (CLEAR KEY)
8. FUNCTION SELECT KEYS (7)
9. SLEW SWITCH
10. CRT BRIGHTNESS CONTROL
11. CMS PWR SWITCH

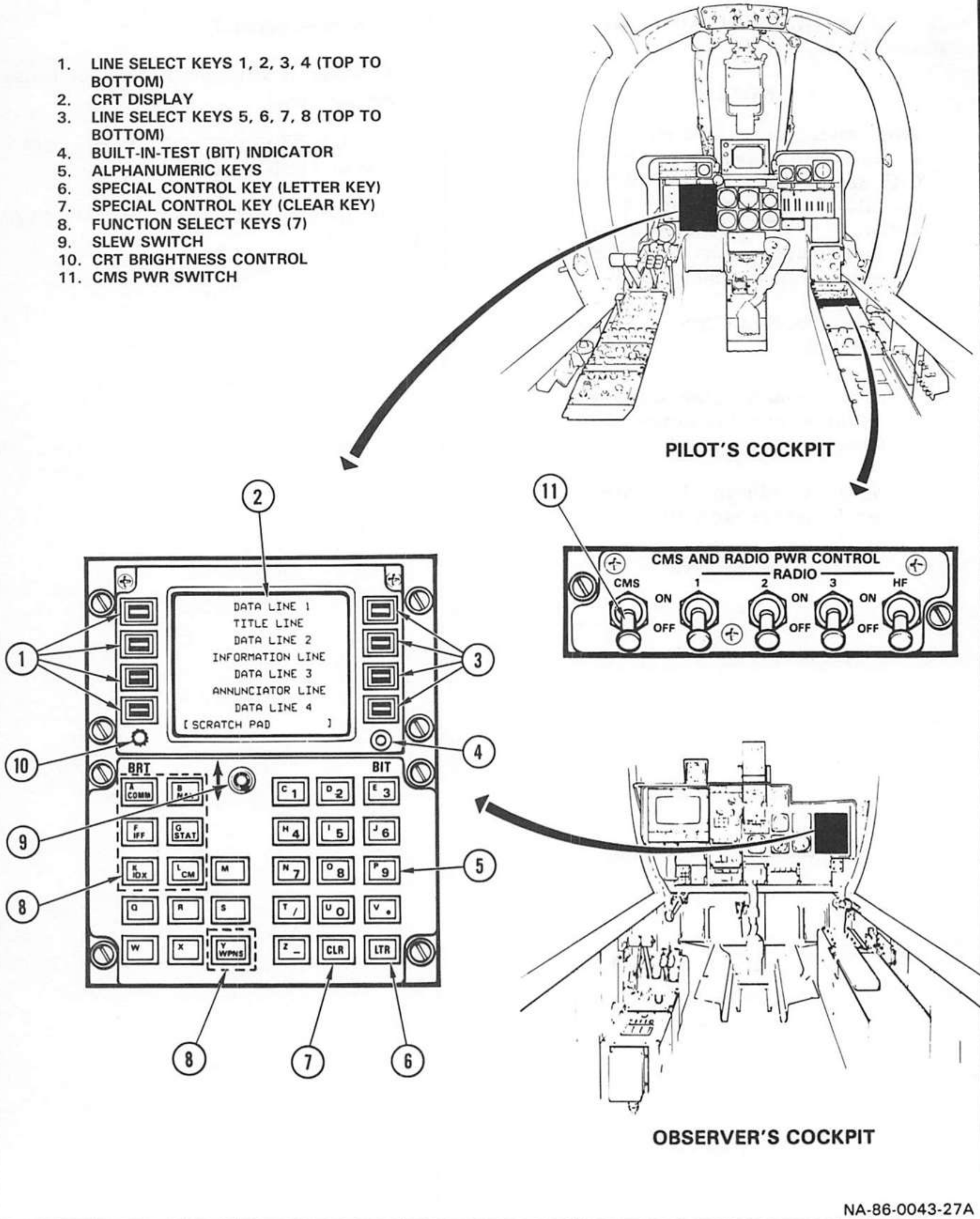
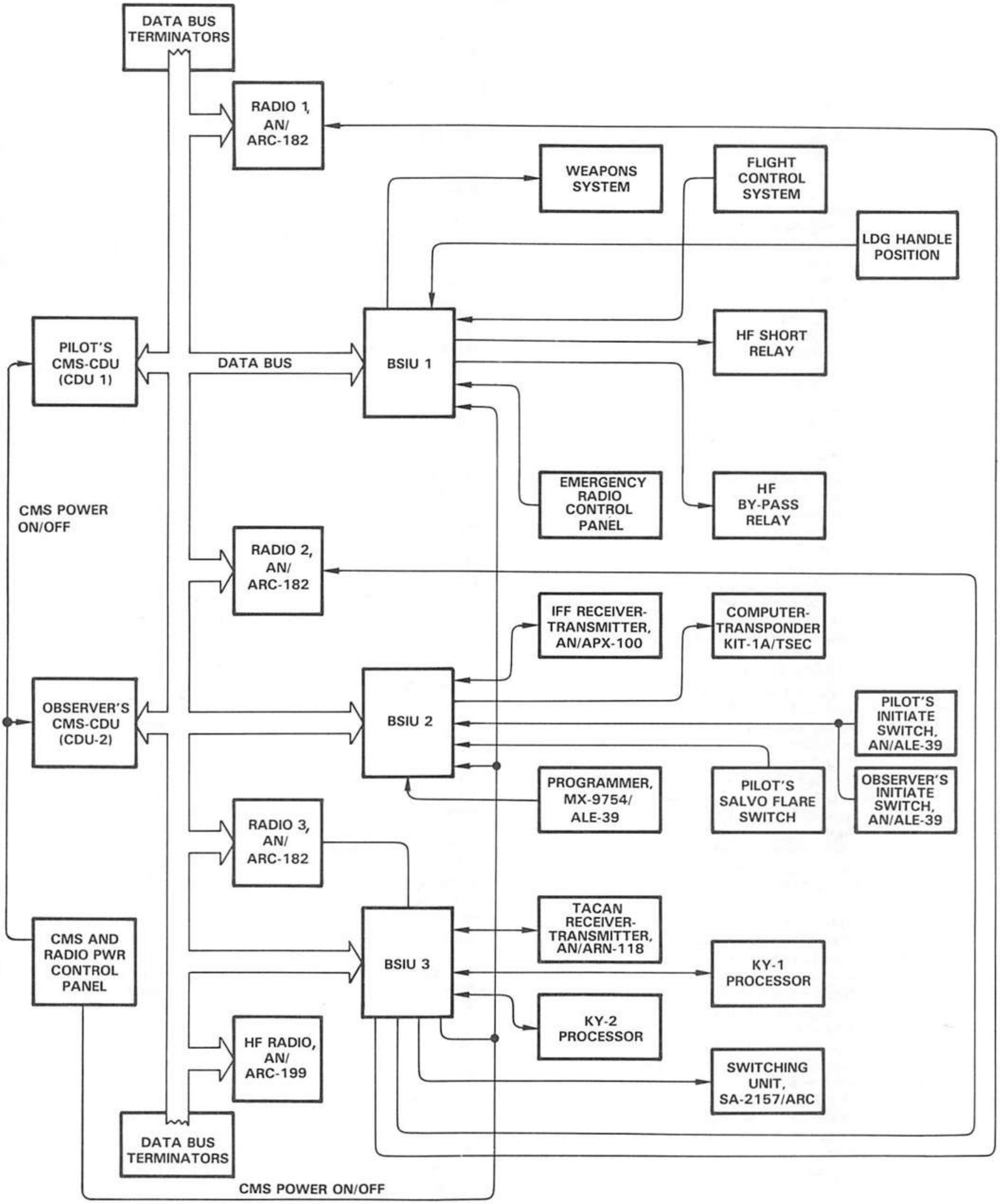


Figure 19-2. Cockpit Management System Control Display Units



NA-86-0043-28A

Figure 19-3. CMS Block Diagram

CMS GLOSSARY

A	AM Modulation/IFF Mode 4 Code A
A/A REC	TACAN Air-to-Air Receive Mode
A/A T/R	TACAN Air-to-Air Transmit/Receive Mode
ACMR	TACTS Pod
ADF	Automatic Direction Finder
AIMTR	Captive AIM-9
ALT	Barometric Altimeter
AM	Amplitude Modulation
ANT	Antenna
ASDTS	Not Used
AUD	IFF Mode 4 Audio Reply
B	IFF Mode 4 Code B
BIT	Built-In-Test
BSIU	Bus System Interface Unit
BSU	Bus System Interface Unit
BTM	Bottom IFF Antenna
BUS	MIL-STD-1553B Data Bus A or B
C	Cipher or Continuous Wave
CDU	Control Display Unit
CLEAR	Checkmark Clearing Function
CLT	AIM-9 Cooling
CM	Countermeasures
CMS	Cockpit Management System
COMM	Communication
COUPLER	AN/ARC-199 HF Amplifier Coupler
CT	Failure Count
CT ONLY	Cipher Text Only
CW	Continuous Wave Modulation
DELAY	KY 1 or KY 2 Delay Function
DIV	Diversity Antenna Operation
DROP	Weapon Delivery Mode
EMER	Emergency
EXC	HF Receiver-Transmitter
F	Frequency Modulation
FAE	CBU-55 Cluster Bomb
FIRE	MK-77 Fire Bomb or Weapon Delivery Mode
FL-25	Not Used
FL-44	SUU-44/A Flares
FWD	Forward
GCLR	GPU-2 Gun Clear Function
GO	Positive Test Result
HF	High Frequency Radio
HI	GPU-2 High Rate of Fire or High HF Power Out (150 Watts)
IDX or INDEX	Function Key or Pages
IFF	Identification, Friend or Foe
INHBT	Inhibited Jettison Function
INT GUNS	Sponson Machine Guns
JTSN	Jettison
KIT	Mode 4 Encryption Set
L	KY Load or Lower Sideband
LIT	IFF Mode 4 Reply Light Operation
LO	GPU-2 Low Rate of Fire or Low HF Power Out (4 Watts)
LOAD	KY 1 or KY 2 Loading Mode
LS KEY	Line Select Keys 1–8
LSB	Lower Sideband Modulation
LTR	Letters Key Selected
TXT	Text
M1	AN/APX-100 IFF Mode 1
M2	AN/APX-100 IFF Mode 2
M3A	AN/APX-100 IFF Mode 3A
M4	AN/APX-100 IFF Mode 4
M4 RPLY	IFF Mode 4 Reply Annunciator
MAJOR	HF Radio Fault, Transmit/Receive Function May Be Impaired
MAX	Maximum HF Squelch
MBRAD	ADSID-III, Acoustic Detector
MBRFL	Multiple Bomb Rack Flare
MBRPB	Multiple Bomb Rack Practice Bomb
MBRSM	Multiple Bomb Rack Smoke
MC	AN/APX-100 IFF Mode C
MED	Medium HF Power Out (40 Watts)
MIN	Minimum HF Squelch
MINOR	HF Radio Fault Transmit/Receive Not Impaired
MSG	Data Message
MSG, DROP, DR	Message Drop Door
NAV	Navigation Page
ND	Nose Down Trim
NET (1–6)	KY 1 or KY 2 Code Selection
NOB	KY Not On Board
NOGO	Negative Test Result
NORM	Normal
NU	Nose Up Trim
OUT	M4 Reply LIT and Audio Off
P	Plain Voice
PLAIN	Plain Voice
PMBR	Practice Multiple Bomb Rack
R1 or Radio 1	AN/ARC 182 Radio No. 1
R2 or Radio 2	AN/ARC 182 Radio No. 2
R3 or Radio 3	AN/ARC 182 Radio No. 3
RAD	AN/APX-100 Radiation Test
RCVR	AN/ARC-199 HF Radio Receiver
REC	TACAN Receive Mode
RLY	Radio 2 and 3 in Relay Mode
RTN	Return
RTW	Receive Test Word
SEC VOICE	Secure Voice Annunciator
SIM	Subsystem Interface Module
SQL	Squelch
SS#	Store Station
STAT or STATUS	Function Key or Condition
STBY	Standby Mode
SUBSY	Bus Interface Processor
SVS	Secure Voice Switch SIM
TR=G	Transmit-Receiver On Guard
TR+G	Transmit-Receive Monitor Guard
T/R	TACAN Transmit-Receive
TCN	AN/ARN-118 TACAN
TERM	Terminal
TOP	Top IFF Antenna
TR	Transmit-Receive
USB or U	Upper Sideband Modulation
WPNS	Weapons
WRA	Weapon Replaceable Assembly
XMIT TONE	Radio 1, 2, 3 Tone Broadcast
XTW	Transmit Test Word

NA-86-0043-227A

Figure 19-4. CMS Glossary

CRT SYMBOL	DEFINITION
← →	GO TO page arrow (displayed adjacent to LS key) indicates additional pages may be accessed.
⇧ ⇩ ⇳	On the Comm page control arrows indicate that pilot (⇧), observer (⇩), or both (⇳) have selected this radio for transmission. On Aircraft Trim page, a neutral trim state is indicated by (⇳), nose down trim (⇩), and nose up trim (⇧).
↕	When displayed on information line. Slew switch controls displayed function (ex. squelch ↕ −3). When displayed to left of scratch pad, indicates that slew switch activation changes page.
–	On any Status page, indicates √ status annunciator is disabled. On store station select annunciator indicates that station is not armed.
:	Indicates a function or mode may be changed by pressing line select key (ex. RELAY:ON).
----	On IFF Test page, indicates mode test not selected.
*	On IFF Test page, indicates mode test selected.
-----	On Weapons pages, indicates no stores configured.
√	On Status pages, indicates fault has been detected. On Checklist pages, indicates item has been verified. On various pages next to system nomenclature, indicates system not powered up or indicates NOGO condition (example: R1√).

NA-86-0043-223A

Figure 19-5. CMS CRT Display Symbols

FUNCTION KEY SELECTED	PAGE DISPLAYED	PAGES ACCESSED
1. COMM key	Comm page	Radio 1, 2, 3 Mode Control pages Radio Preset pages HF Radio Mode Control page HF Radio Preset pages
2. NAV key	Nav page	—
3. IFF key	IFF page	—
4. STAT key	WRA Status pages (2)	Radio 1, 2, 3 and HF Status pages Radio Bus Status pages * CDU Status pages CDU Bus Status pages * BSIU Status pages BSIU Bus Status pages *
5. IDX key	Index page	Power page Take-off page Landing page (P,O) Aircraft Trim page Test Index page Comm Test pages Radio Detail Test pages * Nav Test IFF Test CMS Test CDU Test pages * BSIU Test Pages *
6. CM key	Countermeasures page	—
7. WPNS key	Weapons Select pages (2)	Internal Guns page Jettison page Weapons Configuration page ** Bomb Configuration page Missile Configuration page Rocket Configuration page PMBR Configuration page Special Configuration page

* Maintenance-related pages are not illustrated.

** Weapons Configuration page accessed from Weapons Select page 2/2 with slew switch UP and landing gear handle down.

NA-86-0043-222A

Figure 19-6. Function Select Key Page Access

ANNUNCIATOR LINE MESSAGES–LEFT SIDE OF SCREEN		
PRIORITY	DISPLAY	DEFINITION/CLEARING ACTION
1	SEC VOICE	SECURE VOICE VIOLATION Indicates that two or more radios have been selected by the same operator for simultaneous transmission which are not selected in the same cipher transmission state. Conflicting radios will be placed in the plain voice mode, ICS Transmit select switches will flash, and the annunciator will appear on both CDUs. If the violation encompasses the UHF/VHF radios only, the annunciator (SEC VOICE) is cleared on both CDUs and both ICS Transmit select switches (lower portion) stop flashing by pressing either CDU CLR key. If violation encompasses the HF radio such that KY bypass is activated, the HF radio must be selected for the plain text mode prior to pressing either CLR key.
2	GL12345RG	STATION SELECT Indicates which stations have been armed for use. Only stations selected (G, L, 1, 2, 3, 4, 5, R, and/or G) will be displayed. The remaining stations will be indicated by a dash (–). L and R represent the left and right wing stations respectively. The G preceding L represents the left internal guns and the G following R represents the right internal guns. The annunciator (GL12345RG) is cleared when all stations have been deselected for firing or dropping.
3	HF TUNING	HF TUNING SEQUENCE Indicates HF radio tuning sequence (selected or automatic) is in progress. Annunciator clears automatically at completion of sequence.
4	TUNE HF	HF OUT-OF-TUNE Indicates that HF radio failed to tune, needs to be tuned to frequency selected or has drifted off frequency. Annunciator is replaced by HF TUNING annunciator when tuning is selected using LS4 on the HF Radio Mode Control page.

NOTE

HF TUNING and TUNE HF are mutually exclusive messages and therefore will not be displayed at the same time.

NA-86-0043-224A

Figure 19-7. Annunciator Messages (Sheet 1 of 2)

ANNUNCIATOR LINE MESSAGES–RIGHT SIDE OF SCREEN		
PRIORITY	DISPLAY	DEFINITION/CLEARING ACTION
1	M4 RPLY	MODE 4 REPLY Indicates IFF is replying to a valid mode 4 interrogation. Annunciator will automatically clear after reply has been transmitted. Appears only when LIT or AUD mode has been selected on IFF page. When OUT is selected annunciator will be disabled.
2	√ STATUS	CHECK STATUS Indicates a NOGO condition on any of the CMS monitored systems. Built-in-Test (BIT) circuitry continually analyzes the operating parameters of the CMS, TACAN, IFF, Radios 1, 2, 3, and HF. When the BIT senses a change in one of these systems from a GO to a NOGO status, a √ STATUS annunciation is displayed. The √ STATUS message may be cleared and armed for subsequent WRA failures by pressing the CLR key or STAT key. If STAT key is selected, the WRA status page with the most recent WRA NOGO will be displayed. The WRA STATUS pages display the current status of all monitored systems and will display a checkmark beside WRAs that have failed, are operating at a reduced capability, or have failed and returned to a GO status. WRA status pages will further define the NOGO condition and will display a numeric readout indicating the number of times a system or component has failed and returned to a GO status. When a NOGO status is detected, further fault isolation is available through the detail test pages accessed from the IDX key. A reoccuring √ STATUS annunciator caused by an intermittent fault may be inhibited by the operator. Entering a dash (–) in the scratch pad and pressing the LS key for the intermittent WRA will stop the √ STATUS annunciator from being displayed and inhibit the CMS from monitoring the affected WRA.

NA-86-0043-225A

Figure 19-7. Annunciator Messages (Sheet 2 of 2)

MESSAGE TYPE	SCRATCH PAD ERROR MESSAGE	DESCRIPTION AND CORRECTIVE/CLEARING ACTION
GENERAL	invalid entry	Displayed when entry exceeds or does not meet programmed input parameters or if wrong LS key was selected. Press CLR key to clear message and reenter corrected input data or select correct LS key.
RADIO	bit in progress	Displayed when HF tuning is attempted while radio is in BIT. Cleared at end of BIT or by pressing CLR key.
	out of ADF range	Displayed when attempting to tune Radio 1 to a frequency below 88 MHz while in ADF mode. Cleared by pressing CLR key. NOTE ADF function is only available in UHF frequency band (225.0 to 399.975 MHz)
	guard mode	Displayed when attempting to tune Radios 1, 2, or 3 to a new frequency while in the guard mode. Cleared by pressing CLR key.
	no cipher unit	Displayed when attempting to input a net variable for radios 1, 2, or 3 when KY-58 (KY 1 or KY 2) processors are not installed. Cleared by pressing CLR key.
	wheels up	Displayed when attempting to place KY-58 (KY 1 or KY 2) processors in LOAD mode while airborne. Cleared by pressing CLR key.
	in relay mode	Displayed when attempting to change cipher text state of Radio 2 or 3 while in the relay mode. Cleared by pressing CLR key.

NA-86-0043-226A

Figure 19-8. Error Messages

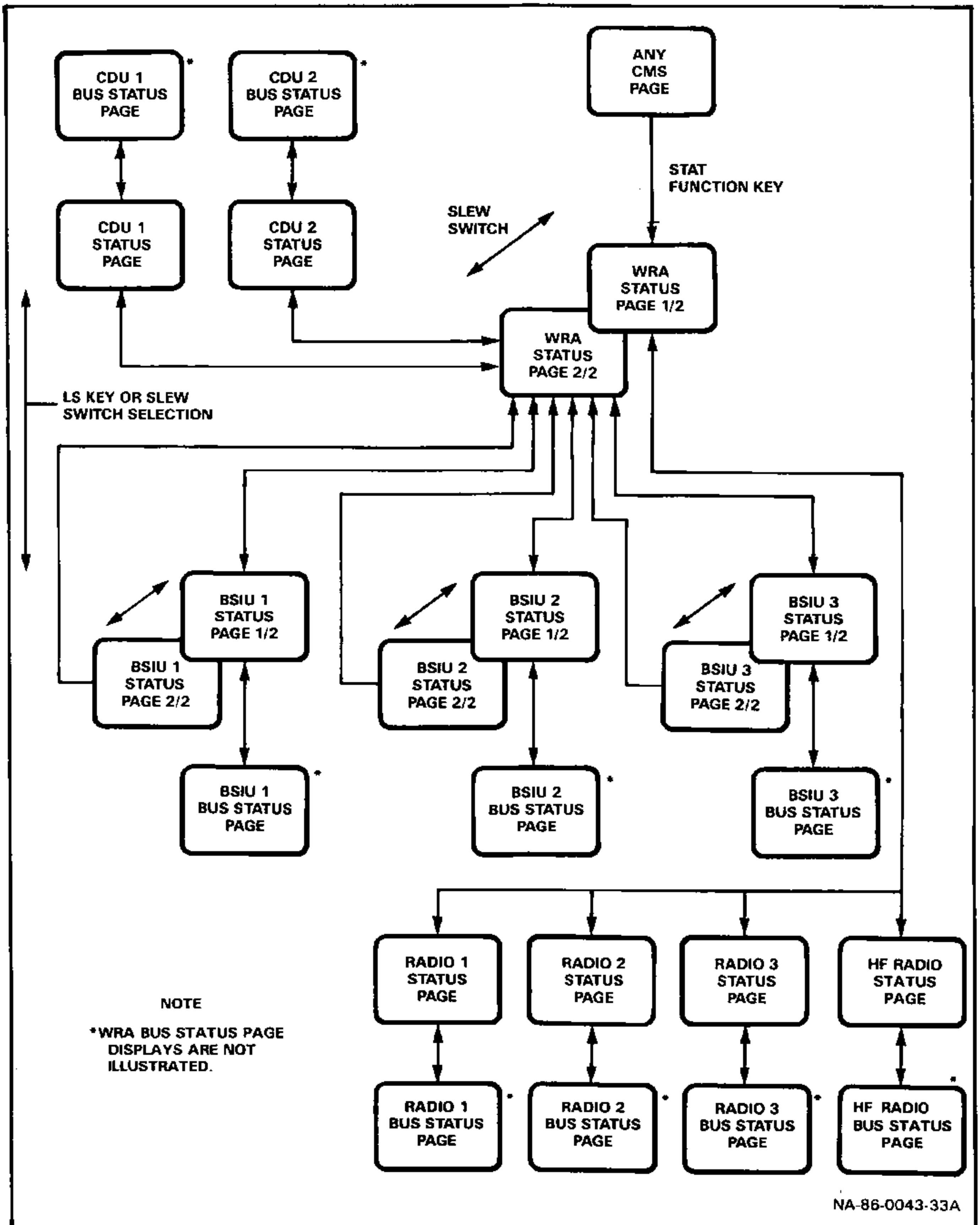
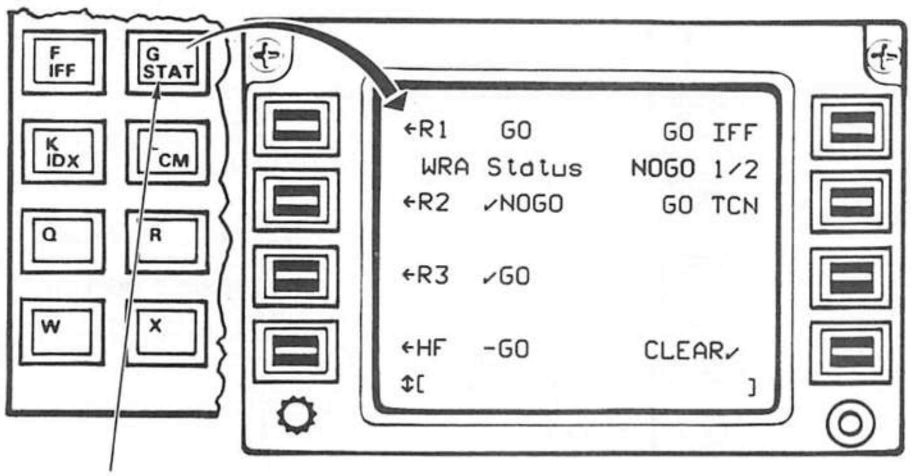
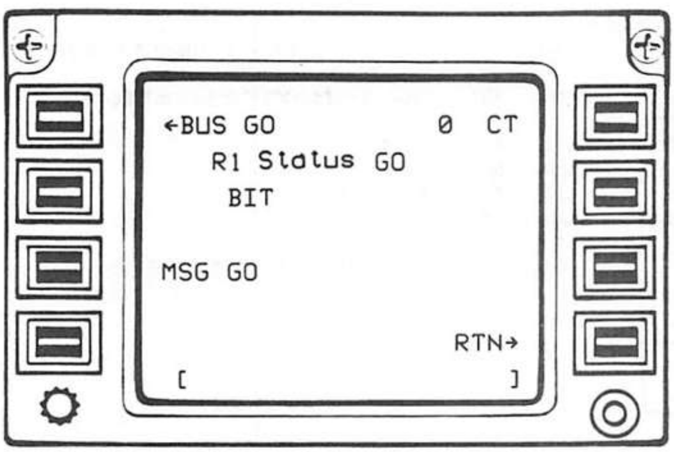


Figure 19-9. STAT Key Flow Chart and Page Displays (Sheet 1 of 5)



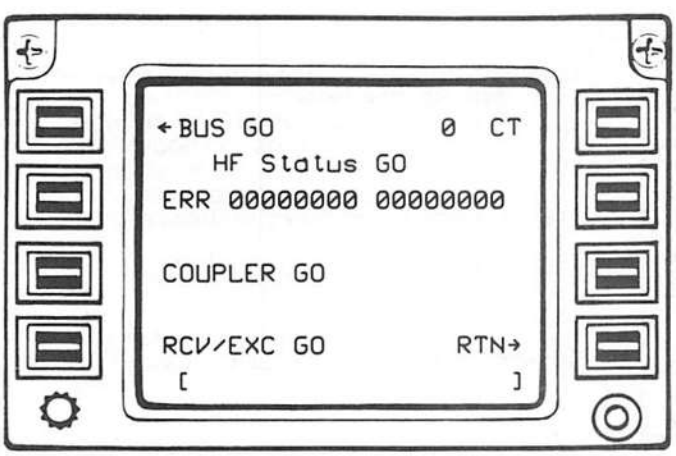
WRA STATUS PAGE 1 of 2

LS1: GO TO RADIO 1 STATUS PAGE. DISPLAYS R 1 STATUS (GO/NOGO).
LS2: GO TO RADIO 2 STATUS PAGE. DISPLAYS R 2 STATUS (GO/NOGO).
LS3: GO TO RADIO 3 STATUS PAGE. DISPLAYS R 3 STATUS (GO/NOGO).
LS4: GO TO HF RADIO STATUS PAGE. DISPLAYS HF STATUS (GO/NOGO).
LS5: NO ACTION. DISPLAYS IFF STATUS (GO/NOGO).
LS6: NO ACTION. DISPLAYS TACAN STATUS (GO/NOGO).
LS7: NO ACTION.
LS8: CLEAR ALL CHECKMARKS.
SLEW UP OR DOWN:
GO TO THE WRA STATUS 2/2 PAGE.



RADIO 1 STATUS PAGE (TYPICAL RADIO 2 AND 3)

LS1: GO TO BUS STATUS PAGE. DISPLAYS BUS STATUS (GO/NOGO).
LS2: NO ACTION. DISPLAYS BUILT-IN-TEST (BIT) WORD. IF RADIO STATUS IS GO, TEST WORD IS NOT DISPLAYED.
LS3: DISPLAYS STATUS OF BUS MESSAGE TO RADIO (GO/NOGO).
LS4: NO ACTION.
LS5: CLEARS RADIO FAILURE COUNT.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: RETURN TO THE WRA STATUS PAGE 1/2.



HF RADIO STATUS PAGE

LS1: GO TO BUS STATUS PAGE. DISPLAYS BUS STATUS (GO/NOGO).
LS2: NO ACTION. DISPLAYS HF RADIO CHANNEL UPDATE ERROR BIT WORD.
LS3: NO ACTION. DISPLAYS COUPLER FAULT STATUS (SEE NOTE).
LS4: NO ACTION. DISPLAYS RECEIVER/EXCITER FAULT STATUS (SEE NOTE).
LS5: CLEARS HF RADIO FAILURE COUNT.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: RETURN TO THE WRA STATUS 1/2 PAGE.

NOTE

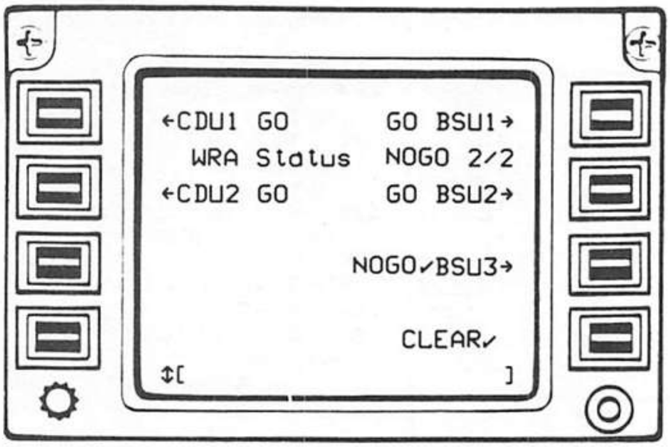
FAULT STATUS DISPLAYS FOR RECEIVER/EXCITER AND COUPLER ARE AS FOLLOWS:
- GO–NO FAULT
- MINOR–FAULT EXISTS WHICH IS NOT CRITICAL TO TX/RX FUNCTIONS.
- MAJOR–FAULT EXISTS WHICH MAY IMPAIR TX/RX FUNCTIONS.

NOTE

WRA BUS STATUS PAGE DISPLAYS ARE NOT ALL ILLUSTRATED.

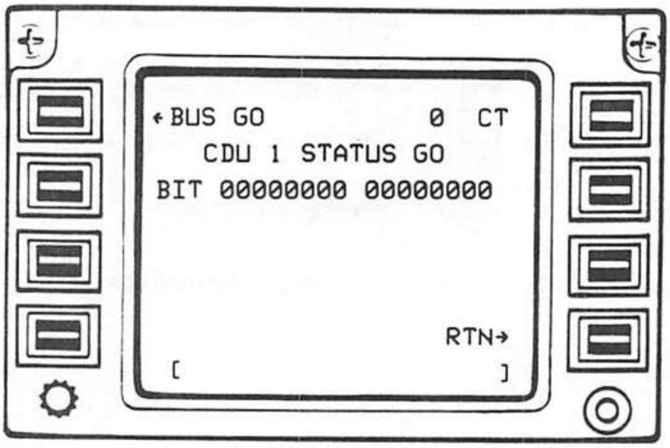
NA-86-0043-34B

Figure 19-9. STAT Key Flow Chart and Page Displays (Sheet 2 of 5)



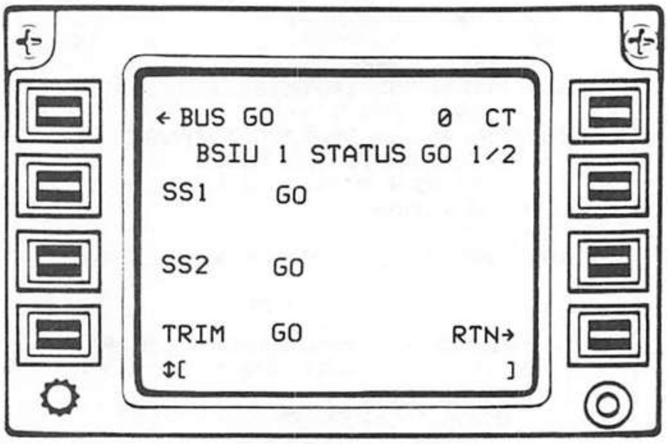
WRA STATUS PAGE 2 of 2

LS1: GO TO THE CDU 1 STATUS PAGE. DISPLAYS CDU 1 STATUS (GO/NOGO).
LS2: GO TO THE CDU 2 STATUS PAGE. DISPLAYS CDU 2 STATUS (GO/NOGO).
LS3: NO ACTION.
LS4: NO ACTION.
LS5: GO TO THE BSIU 1 STATUS PAGE. DISPLAYS BSIU 1 STATUS (GO/NOGO).
LS6: GO TO THE BSIU 2 STATUS PAGE. DISPLAYS BSIU 2 STATUS (GO/NOGO).
LS7: GO TO THE BSIU 3 STATUS PAGE. DISPLAYS BSIU 3 STATUS (GO/NOGO).
LS8: CLEAR ALL CHECKMARKS.
SLEW UP OR DOWN: GO TO THE WRA STATUS PAGE 1/2



CDU 1 STATUS PAGE
(TYPICAL CDU 2)

LS1: GO TO BUS STATUS PAGE. DISPLAYS BUS STATUS (GO/NOGO).
LS2: NO ACTION. DISPLAYS CDU BUILT-IN-TEST WORD.
LS3: NO ACTION.
LS4: NO ACTION.
LS5: CLEAR CDU FAILURE COUNT.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: RETURN TO THE WRA STATUS PAGE 2/2.



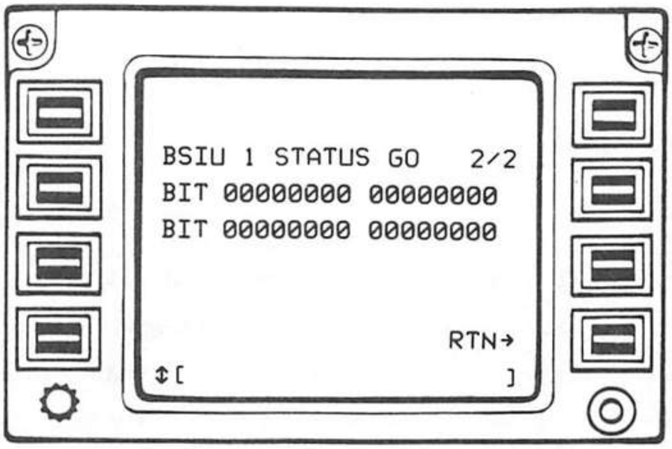
BSIU 1 STATUS PAGE 1 of 2

LS1: GO TO BUS STATUS PAGE. DISPLAYS BUS STATUS (GO/NOGO).
LS2: NO ACTION. DISPLAYS STORES STATION SELECT #1 SIM STATUS (GO/NOGO).
LS3: NO ACTION. DISPLAYS STORES STATION SELECT #2 SIM STATUS (GO/NOGO).
LS4: NO ACTION. DISPLAYS TRIM SIM STATUS (GO/NOGO).
LS5: CLEARS BSIU 1 FAILURE COUNT.
LS6: NO ACTION.
LS7: NO ACTION.
LS8 RETURN TO THE WRA STATUS PAGE 2/2.
SLEW: SELECTS BSIU 1 STATUS PAGE 2/2.

NOTE
WRA BUS STATUS PAGE DISPLAYS ARE NOT ILLUSTRATED

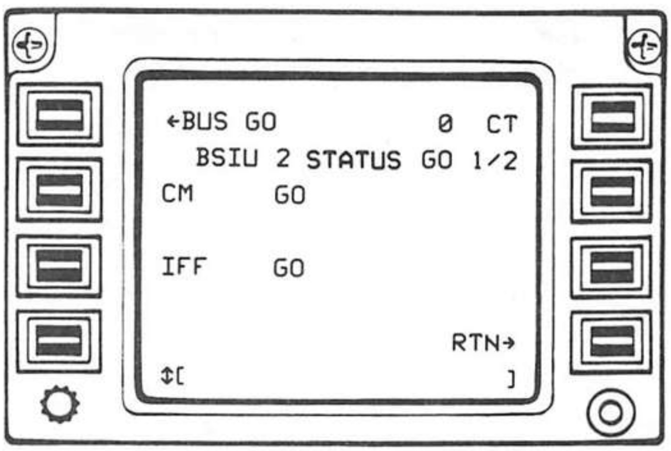
NA-86-0043-35 A

Figure 19-9. STAT Key Flow Chart and Page Displays (Sheet 3 of 5)



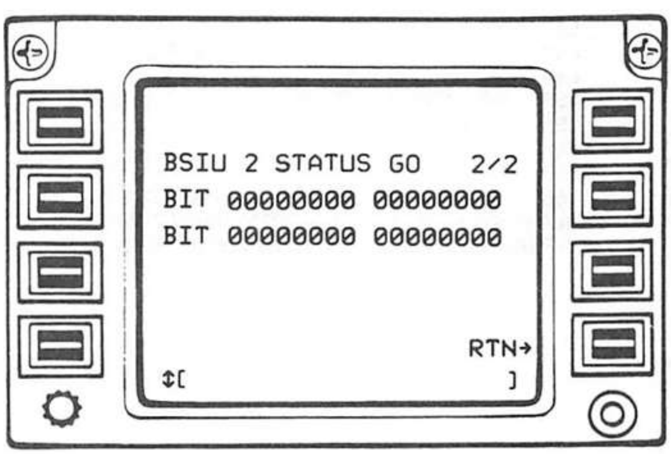
BSIU 1 STATUS PAGE 2/2

LS1: NO ACTION.
LS2: NO ACTION. DISPLAYS BIT WORD 1.
LS3: NO ACTION.
LS4: NO ACTION.
LS5: NO ACTION.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: RETURN TO THE WRA STATUS PAGE 2/2.
SLEW: SELECTS BSIU 1 STATUS PAGE 1/2.
INFORMATION LINE: DISPLAYS BIT WORD 2.



BSIU 2 STATUS PAGE 1 of 2

LS1: GO TO BUS STATUS PAGE. DISPLAYS BUS STATUS (GO/NOGO).
LS2: NO ACTION. DISPLAYS COUNTERMEASURES SIM STATUS (GO/NOGO).
LS3: NO ACTION. DISPLAYS IFF SIM STATUS (GO/NOGO).
LS4: NO ACTION.
LS5: CLEARS BSIU 2 FAILURE COUNT.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: RETURN TO THE WRA STATUS PAGE 2/2.
SLEW: SELECTS BSIU 2 STATUS PAGE 2/2.



BSIU 2 STATUS PAGE 2 OF 2

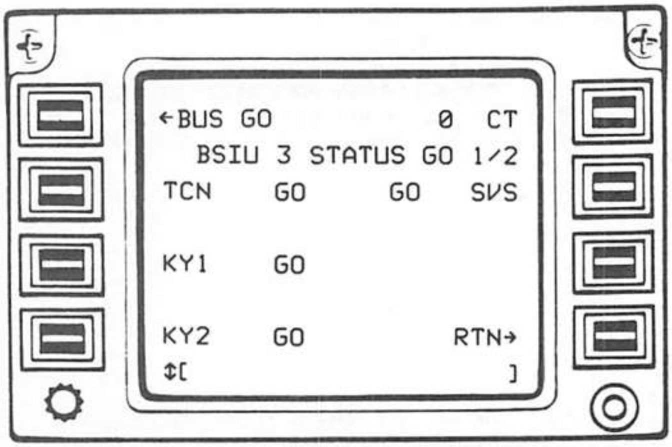
LS1: NO ACTION.
LS2: NO ACTION. DISPLAYS BIT WORD 1.
LS3: NO ACTION.
LS4: NO ACTION
LS5: NO ACTION.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: RETURN TO THE WRA STATUS PAGE 2/2.
SLEW: SELECTS BSIU 2 STATUS PAGE 1/2.
INFORMATION LINE: DISPLAYS BIT WORD 2.

NOTE

WRA BUS STATUS PAGES ARE NOT ILLUSTRATED.

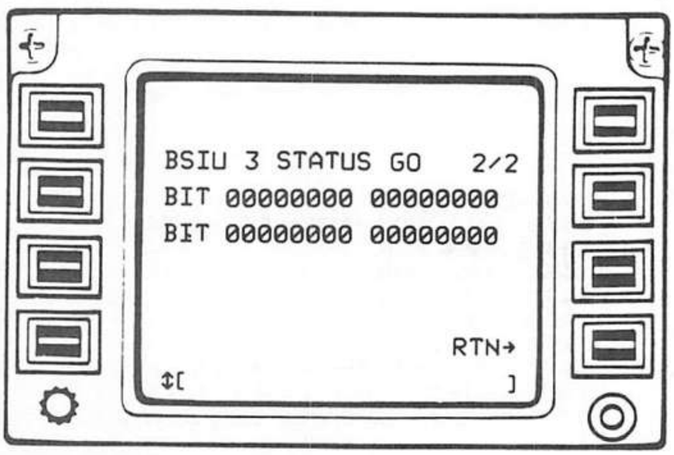
NA-86-0043-38B

Figure 19-9. STAT Key Flow Chart and Page Displays (Sheet 4 of 5)



BSIU 3 STATUS PAGE 1 of 2

LS1: GO TO BUS STATUS PAGE. DISPLAYS BUS STATUS (GO/NOGO).
LS2: NO ACTION. DISPLAYS TACAN SIM STATUS (GO/NOGO).
LS3: NO ACTION. DISPLAYS KY-58 #1 SIM STATUS (GO/NOGO).
LS4: NO ACTION. DISPLAYS KY-58 #2 SIM STATUS (GO/NOGO).
LS5: CLEARS BSIU 3 FAILURE COUNT.
LS6: NO ACTION. DISPLAYS SECURE VOICE SWITCH SIM STATUS (GO/NOGO).
LS7: NO ACTION.
LS8: RETURN TO THE WRA STATUS PAGE 2/2.
SLEW: SELECTS BSIU 3 STATUS PAGE 2/2.



BSIU 3 STATUS PAGE 2 of 2

LS1: NO ACTION.
LS2: NO ACTION. DISPLAYS BIT WORD 1.
LS3: NO ACTION.
LS4: NO ACTION.
LS5: NO ACTION.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: RETURN TO WRA STATUS PAGE 2/2.
SLEW: SELECTS BSIU 3 STATUS PAGE 1/2.
INFORMATION LINE: DISPLAYS BIT WORD 2.

NOTE

WRA BUS STATUS PAGE DISPLAYS ARE NOT ILLUSTRATED.

NA-86-0043-36B

Figure 19-9. STAT Key Flow Chart and Page Displays (Sheet 5 of 5)

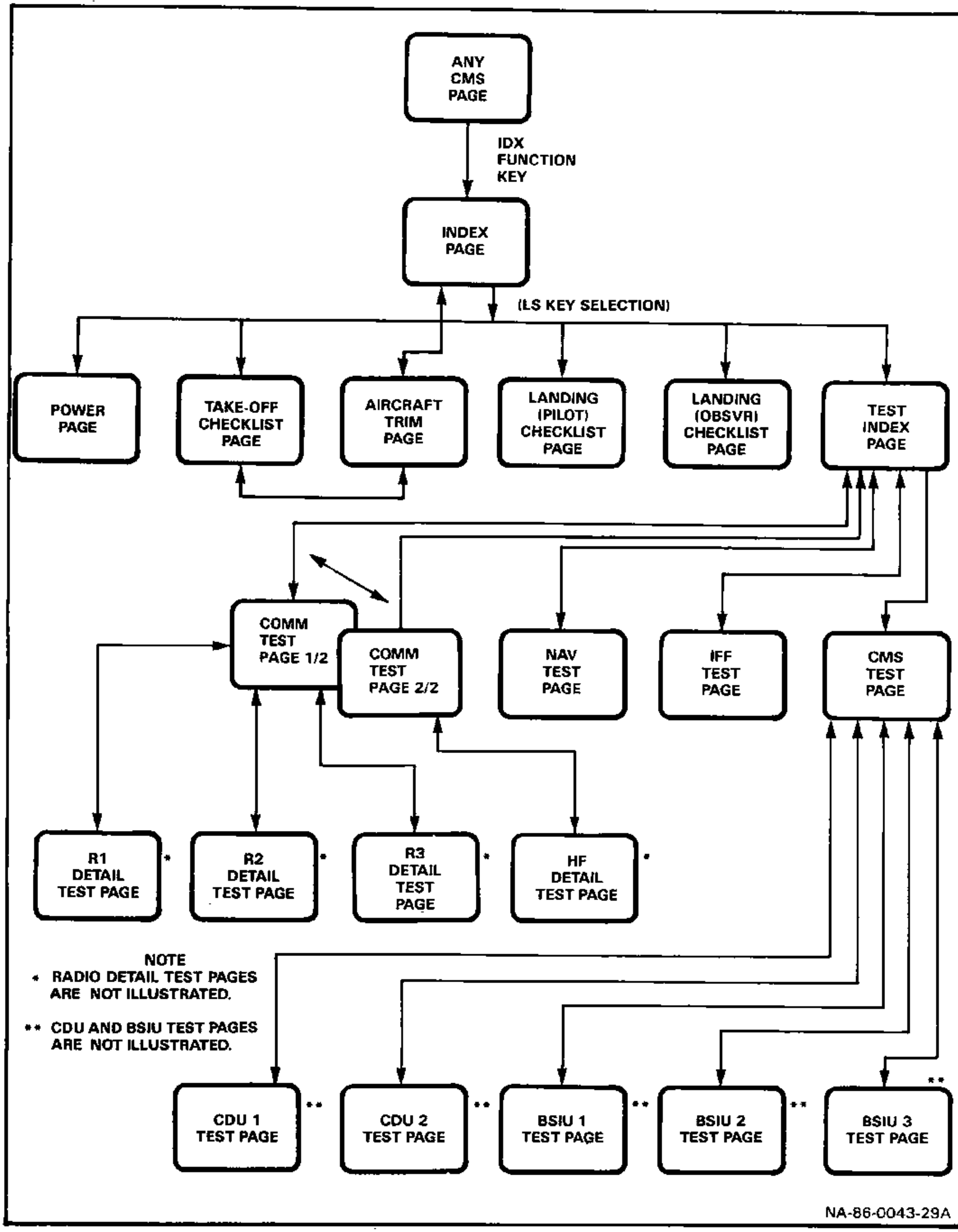
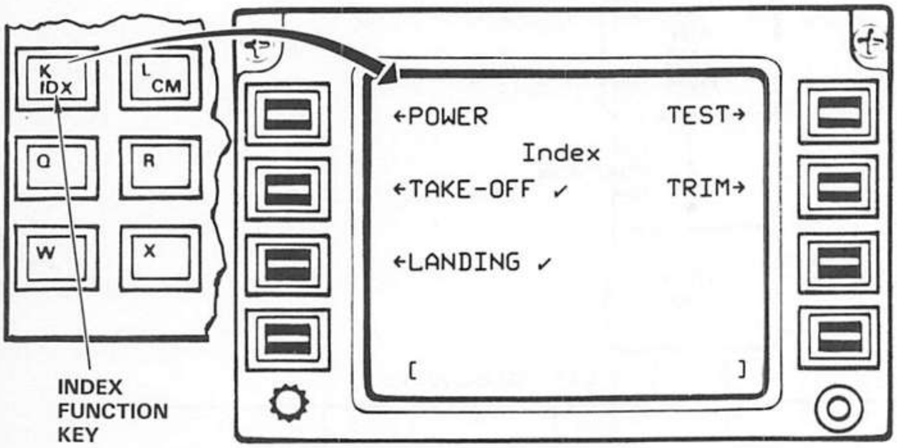
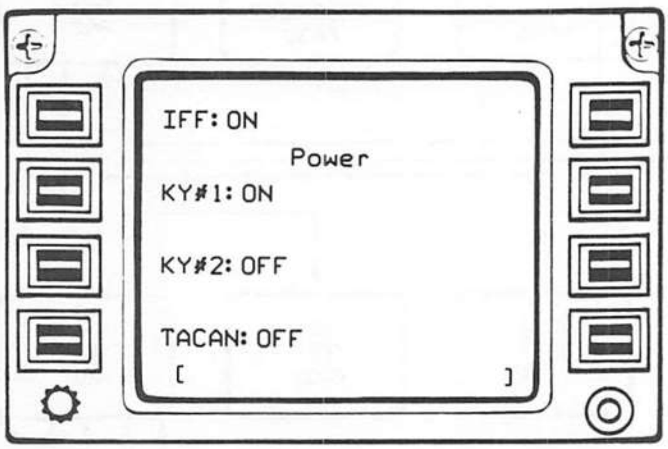


Figure 19-10. IDX Key Flow Chart and Page Displays (Sheet 1 of 5)



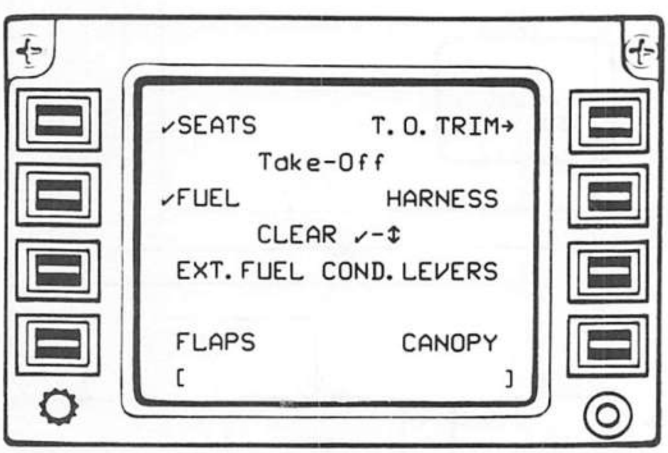
INDEX PAGE

LS1: GO TO POWER PAGE.
LS2: GO TO TAKE-OFF ✓ PAGE.
LS3: GO TO LANDING ✓ PAGES.
LS4: NO ACTION.
LS5: GO TO TEST PAGES.
LS6: GO TO TRIM PAGE.
LS7: NO ACTION.
LS8: NO ACTION.



POWER PAGE

LS1: TOGGLE THE IFF (AN/APX-100) POWER (ON, OFF).
LS2: TOGGLE THE KY #1 (KY-58) POWER (ON, OFF).
LS3: TOGGLE THE KY #2 (KY-58) POWER (ON, OFF).
LS4: TOGGLE THE TACAN (AN/ARN-118) POWER (ON, OFF).
LS5: NO ACTION.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: NO ACTION.

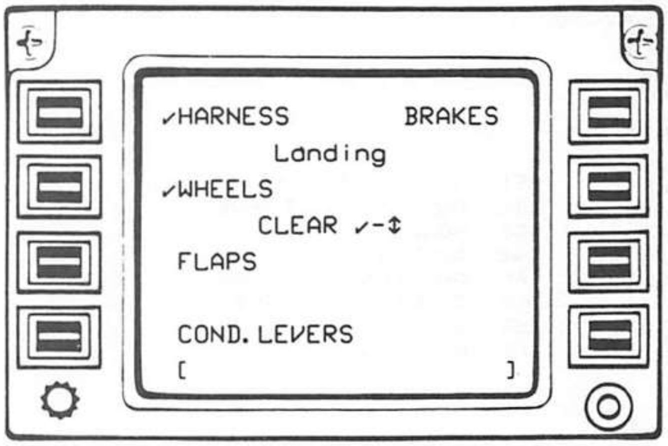


TAKE-OFF CHECKLIST PAGE

LS1–LS4: INSERT CHECKMARKS BESIDE THE CHECKED OFF ITEMS.
LS5: GO TO THE AIRCRAFT TRIM PAGE. INSERT CHECKMARK ON RETURN TO TAKE-OFF PAGE.
LS6–LS8: INSERT CHECKMARK BESIDE THE CHECKED OFF ITEM.
SLEW DOWN/UP: CLEAR ALL CHECKMARKS.

NA-86-0043-30A

Figure 19-10. IDX Key Flow Chart and Page Displays (Sheet 2 of 5)

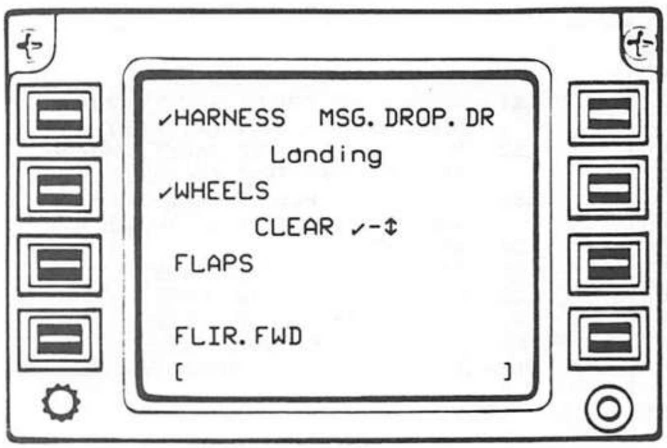


LANDING (PILOT'S) CHECKLIST PAGE

LS1–
LS5: INSERT CHECKMARKS BESIDE THE CHECKED OFF ITEMS.

LS6–
LS8: NO ACTION.

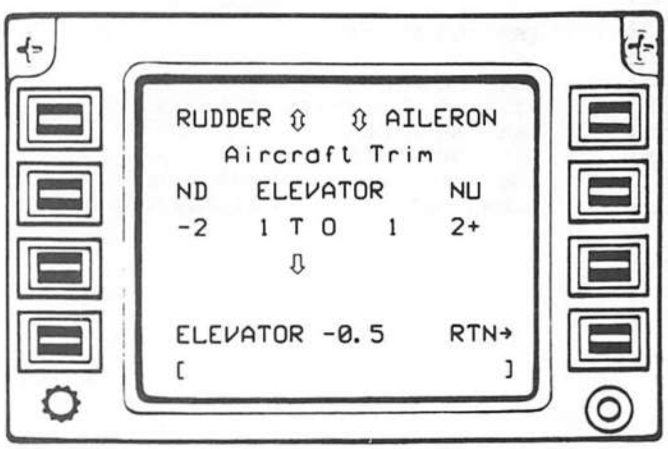
SLEW UP OR DOWN: CLEAR ALL CHECKMARKS.



OBSERVER'S LANDING CHECKLIST PAGE
(AVAILABLE ONLY ON OBSERVER'S CDU)

LS1–
LS5: INSERT CHECKMARKS BESIDE THE CHECKED OFF ITEMS.

LS6–
LS8: NO ACTION.
SLEW UP OR DOWN: CLEAR ALL CHECKMARKS.



AIRCRAFT TRIM PAGE

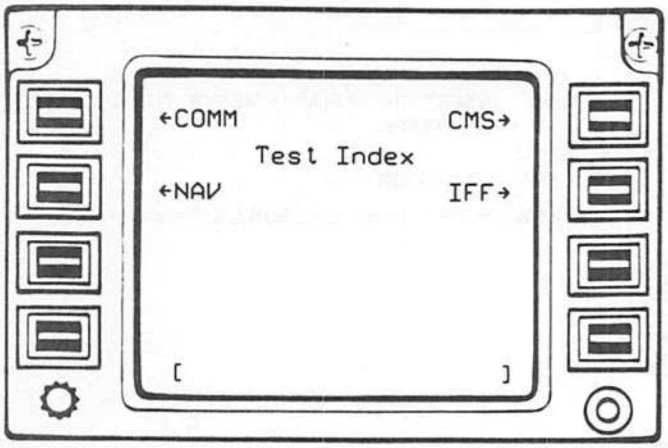
LS1: NO ACTION.
LS2: NO ACTION.
LS3: NO ACTION.
LS4: NO ACTION.
LS5: NO ACTION.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: RETURN TO PREVIOUSLY SELECTED PAGE, INDEX OR TAKE-OFF.

NOTE

- BAR GRAPH DISPLAYS CURRENT ELEVATOR POSITION FROM −2 TO +2 UNITS. INDICATED BY ⇩, ⇧, OR ⇕ ARROWS IN 0.25 UNIT INCREMENTS.
- ELEVATOR POSITION DISPLAYED NUMERICALLY WITH 0.1-UNIT RESOLUTION
- RUDDER AND AILERON NEUTRAL POSITION INDICATED BY ⇕.

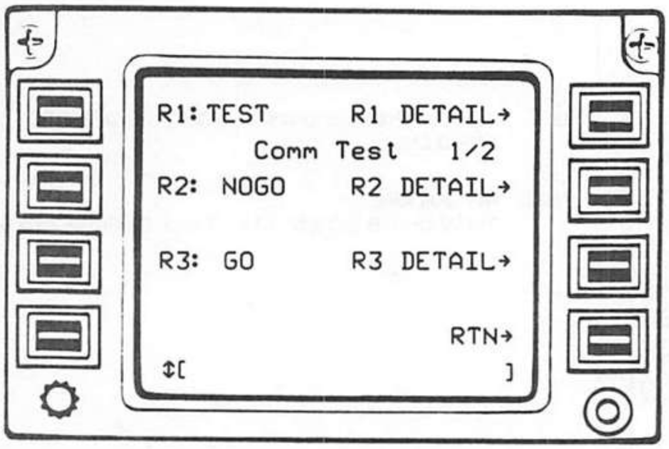
NA-86-0043-37A

Figure 19-10. IDX Key Flow Chart and Page Displays (Sheet 3 of 5)



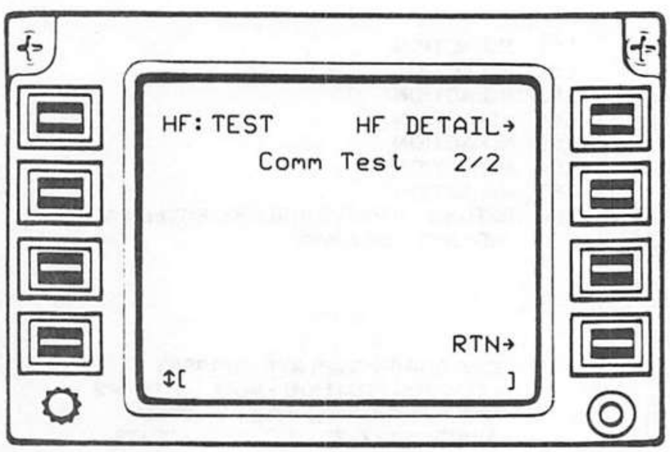
TEST INDEX PAGE

LS1: GO TO COMM TEST PAGE.
LS2: GO TO NAV TEST PAGE.
LS3: NO ACTION.
LS4: NO ACTION.
LS5: GO TO CMS TEST PAGE.
LS6: GO TO IFF TEST PAGE.
LS7: NO ACTION
LS8: NO ACTION



COMM TEST PAGE 1 of 2

LS1: INITIATES BIT FOR R1 (RADIO 1) WHEN SELECTED (OFF, TEST, GO, NOGO).
LS2: INITIATES BIT FOR R2 (RADIO 2) WHEN SELECTED (OFF, TEST, GO, NOGO).
LS3: INITIATES BIT FOR R3 (RADIO 3) WHEN SELECTED (OFF, TEST, GO, NOGO).
LS4: NO ACTION.
LS5: GO TO R1 DETAIL TEST PAGE.
LS6: GO TO R2 DETAIL TEST PAGE.
LS7: GO TO R3 DETAIL TEST PAGE.
LS8: RETURN TO TEST INDEX PAGE.
SLEW DOWN/UP: GO TO COMM TEST 2/2.



COMM TEST PAGE 2 of 2

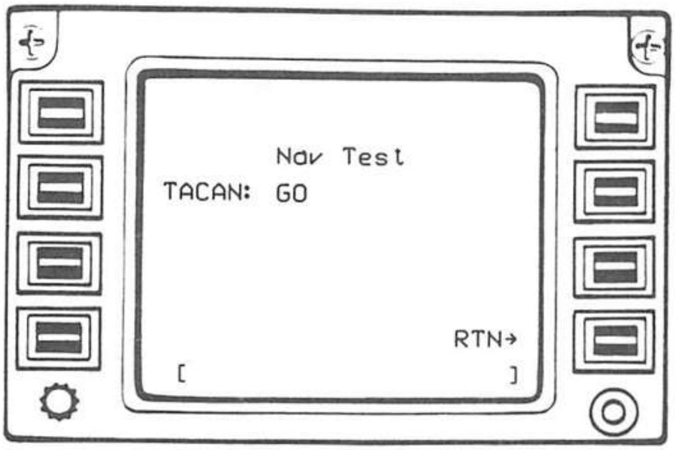
LS1: INITIATES BIT FOR HF RADIO WHEN SELECTED (OFF, TEST, GO, NOGO).
LS2: NO ACTION.
LS3: NO ACTION.
LS4: NO ACTION.
LS5: GO TO HF DETAIL TEST PAGE.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: RETURN TO TEST INDEX PAGE.
SLEW DOWN/UP: GO TO COMM TEST 1/2.

NOTE

RADIO 1, 2, 3, AND HF DETAIL TEST PAGES ARE NOT ILLUSTRATED.

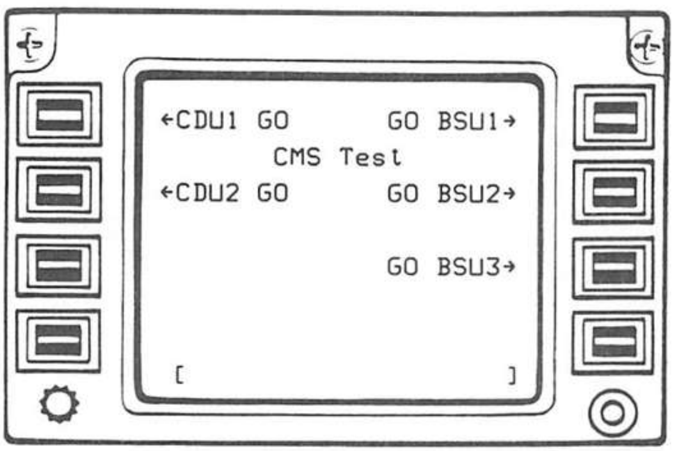
NA-86-0043-31A

Figure 19-10. IDX Key Flow Chart and Page Displays (Sheet 4 of 5)



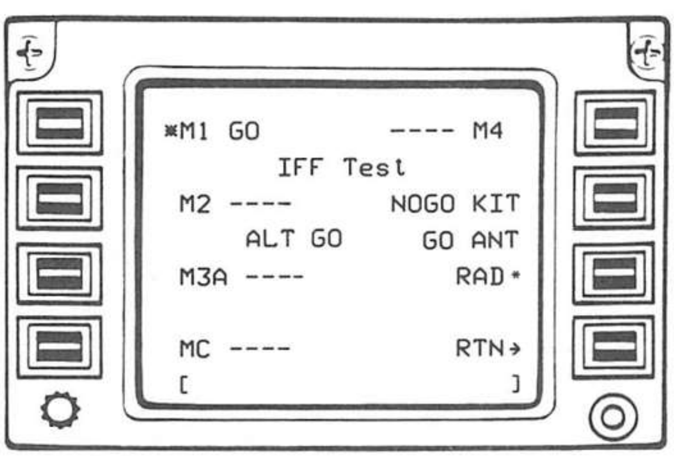
NAV TEST PAGE

LS1: NO ACTION.
LS2: TOGGLE TACAN TEST MODE (OFF/GO/NOGO).
LS3: NO ACTION.
LS4: NO ACTION.
LS5: NO ACTION.
LS6: NO ACTION.
LS7: NO ACTION.
LS8: RETURN TO THE TEST INDEX PAGE.



CMS TEST PAGE

LS1: GO TO CDU 1 TEST PAGE. DISPLAYS GO/NOGO.
LS2: GO TO CDU 2 TEST PAGE. DISPLAYS GO/NOGO.
LS3: NO ACTION.
LS4: NO ACTION.
LS5: GO TO BSIU 1 TEST PAGE. DISPLAYS GO/NOGO.
LS6: GO TO BSIU 2 TEST PAGE. DISPLAYS GO/NOGO.
LS7: GO TO BSIU 3 TEST PAGE. DISPLAYS GO/NOGO.
LS8: NO ACTION.



IFF TEST PAGE

LS1: IFF MODE 1 TEST (TEST, GO, NOGO).
LS2: IFF MODE 2 TEST (TEST, GO, NOGO).
LS3: IFF MODE 3A TEST (TEST, GO, NOGO).
LS4: IFF MODE C TEST (TEST, GO, NOGO).
LS5: IFF MODE 4 TEST (TEST, GO, NOGO).
LS6: NO ACTION.
LS7: IFF RAD TEST (* APPEARS DURING TEST).
LS8: RETURN TO THE TEST INDEX PAGE.

NOTE

- ONLY ONE IFF MODE TEST CAN BE SELECTED AT A TIME.
- ALT, KIT, AND ANT DISPLAY GO/NOGO STATUS.
- CDU AND BSIU TEST PAGES ARE NOT ILLUSTRATED.

NA-86-0043-32A

Figure 19-10. IDX Key Flow Chart and Page Displays (Sheet 5 of 5)

19.2 COMMUNICATION SYSTEMS

Communication systems include high frequency and very-high/ultra-high frequency radios, selected and monitored through the intercommunication system and controlled by the cockpit management system (CMS). See Figure 19-1 for a list of communication equipment.

19.2.1 Intercommunication System (ICS). The intercommunication set is a transistorized intercom system and radio monitor, providing audio and transmit selection by the pilot and observer. Remote ICS disconnects are provided in the nose compartment, cargo bay, and in the external power plug compartment. The ICS provides for selection of up to four radio transmitters individually or simultaneously and seven monitoring channels with individual volume controls. Aural warning and alarm tones from the TIT/low-altitude warning aural tone generator, radar signal detecting set, and the pilot's chronometer will be heard automatically on the ICS with no selection required. Observer ICS headset audio can be recorded on the video recorder if desired. ICS operation requires main dc bus power only.

19.2.1.1 ICS Aural Warnings, Alarms, and Tones. See Figure 19-12 for descriptions of alarms and tones heard on the ICS.

19.2.1.2 ICS Controls. The pilot's and observer's cockpits are each equipped with an ICS monitor panel and ICS selector panel. XMIT and ICOM microphone selector switches are located on the No. 2 power control lever in both cockpits. XMIT and ICS TALK switches are located on the floor in the observer cockpit (Figure 19-11).

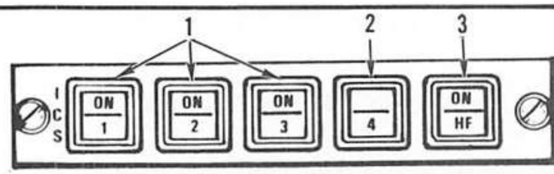
19.2.1.2.1 ICS Monitor Panel. Two ICS monitor panels are provided and are located on the pilot's left console and the observer's instrument panel (Figure 19-11). The monitor panels provide master volume (VOL) and individual volume control for TACAN (TAC), IFF, missile (MSL), intercom (INT), and Radios (1, 2, 3, and HF) audio. Radio 4 monitor control is not used. Radios are normally monitored and volume is controlled by pulling radio monitor controls UP and adjusting to mid-range.

The pilot's ICS monitor panel provides amplification and volume control of pilot and forward ICS maintenance disconnect audio. ICS headset audio for the pilot and forward disconnect is selected and the volume controlled by the pilot's INT control. The observer's ICS monitor panel provides amplification and volume control of observer, paratroop ICS panel, and aft maintenance disconnect audio. Selection and volume control is provided by the observer's INT control. Volume is adjustable by turning the monitor controls clockwise to increase volume and counterclockwise to decrease volume.

19.2.1.2.2 ICS Selector Panels. ICS selector panels are located on the pilot's and observer's instrument panels (Figure 19-11). The selector panels allow either crewmember to select one or more radios for transmission. The lower-half of the five transmit select switches (1, 2, 3, 4, and HF) are illuminated when power is applied to the aircraft. When radio setup is completed, pressing the desired transmit select switch on the panel will cause the upper-half of the selected transmit select switch to illuminate ON and allow crewmembers to transmit radio messages by pushing microphone XMIT selector switches. When a transmit select switch is deselected, the upper portion will extinguish and radio transmission will not be possible. Selecting a radio for transmit automatically enables monitoring of that radios received audio regardless of ICS monitor contol position, volume is adjustable with monitor controls UP or DOWN.

If a crewmember selects two or more radios for transmission and at least one, but not all, selected radios are in the secure voice mode, the lower portion of the radio select switches of the radios in conflict will flash. In addition, the CMS-CDU will display a SEC VOICE annunciator message. Radio transmissions sent during this condition will automatically be sent as plain voice.

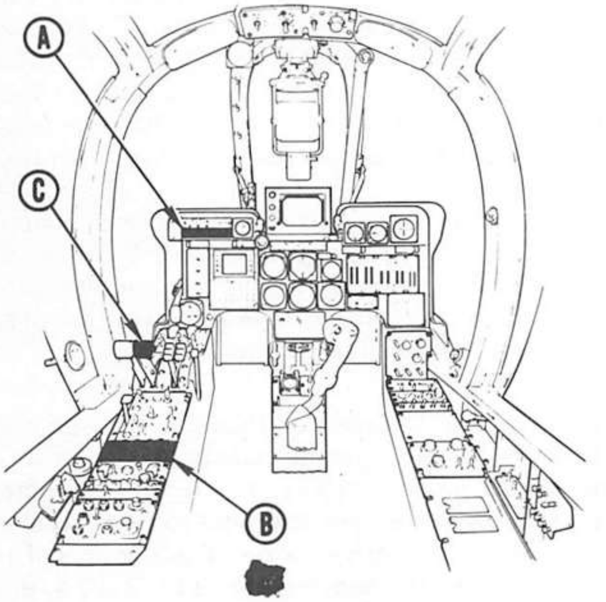
19.2.1.2.3 Microphone Selector Switches. A microphone switch is installed on the No. 2 engine power lever grip in both cockpits. When a crewmember holds the switch upward (XMIT) it will key the radio(s) for voice transmission selected on that crewmember's ICS selector panel (indicated by radio control arrows on the



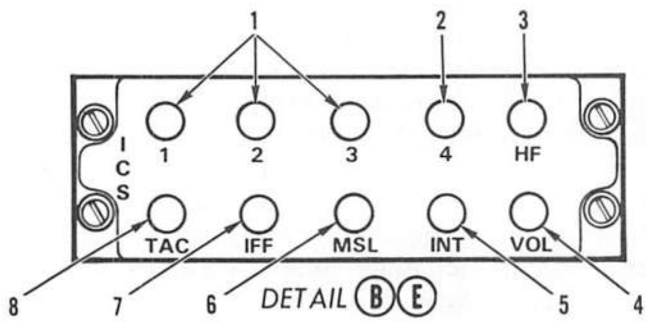
DETAIL (A)(D)

ICS SELECTOR PANEL

1. RADIO 1, 2, 3, TRANSMIT SELECT SWITCHES
2. SELECT SWITCH 4 (NOT USED)
3. HF TRANSMIT SELECT SWITCH



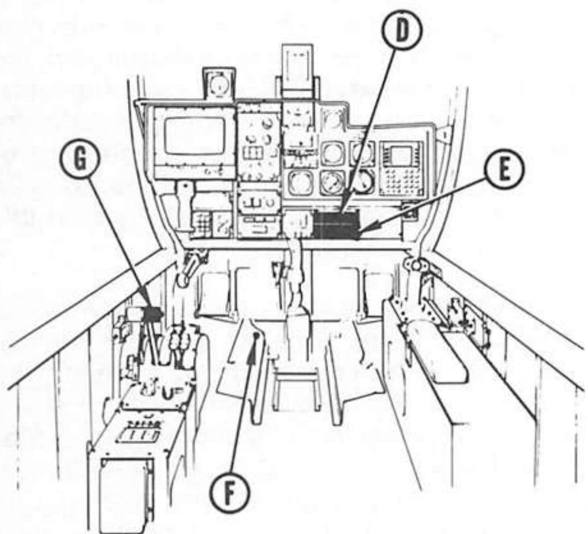
PILOT'S COCKPIT



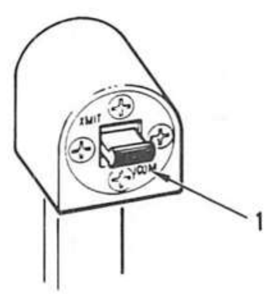
DETAIL (B)(E)

ICS MONITOR PANEL

1. RADIO 1, 2, 3, MONITOR CONTROLS
2. NO. 4 MONITOR CONTROL (NOT USED)
3. HF MONITOR CONTROL
4. MASTER VOLUME CONTROL
5. INTERCOM VOLUME CONTROL
6. MISSILE MONITOR CONTROL
7. IFF MONITOR CONTROL
8. TACAN MONITOR CONTROL



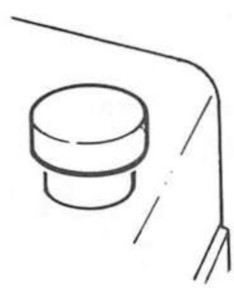
OBSERVER'S COCKPIT



DETAIL (C)(G)

NO. 2 ENGINE POWER CONTROL LEVER

1. ICOM MICROPHONE SELECTOR SWITCH



DETAIL (F)

ICS TALK FOOT SWITCH

NA-86-0043-40A

Figure 19-11. Pilot's and Observer's ICS Controls

WARNING/ TONE/ ALARM	SOUND/FREQUENCY	DURATION	SOURCE
Aircraft Below Pilot's Low Alt. Indexer Setting	700 to 1700 Hz Swept Tone with a Repetition Rate of 2 Hz	4.5 (±0.5) Seconds	Sound Initiated by Pilot's Radar Altimeter Indicator. Heard in Both Headsets.
TIT Exceeds 1125°C (Either Engine)	Alternating 700 and 1800 Hz Tone with a 6 Hz Repetition Rate	4.5 (±0.5) Seconds	Sound Initiated by Engine Temperature Indicator. Heard in Both Headsets.
SAM Missile Guidance and Tracking Composite Alarm	The Missile Guidance Signal is a 1100 to 700 Hz Swept Tone with a 2.5 Hz Rate. This Sound is Superimposed on the PRF of the Missile Tracking Signal. NOTE Either Portion of This Composite Signal May Be Heard Independently of the Other Depending on the Missile Threat Environment.	During Radar Tracking and Missile Guidance	Radar Signal Detecting Set. Heard in Both Crewmembers Headsets. Audio Level is Adjustable on Radar Warning System Control Panel, Pilot's Left Console.
Pilot's Chronometer Alarm. Zero Reached in Countdown Mode	Beeping, 1950 Hz Tone	5 Seconds, May Be Interrupted with START/ STOP Switch	Pilot's Chronometer. Heard in Pilot's Headset Only.
Radio 1, 2, 3 BIT Test Tone	1000 Hz Steady Tone	Duration of Test	Sound Initiated by the AN/ARC-182 Radio Selected for Test.
IFF Mode 4 Reply Tone	A 200–1000 Hz Tone That Varies with Interrogation Rate	Duration of Reply	AN/APX-100(V) System/Kit-1A System. Audio Level Is Adjustable on ICS Monitor Panel.
TACAN Station Identifier	1350 Hz Tone Three Character, Morse Code Station Identifier Signal	Signal Received at 30-Second Intervals With TACAN Station Lock-on	AN/ARN-118(V) TACAN System. Audio Level Is Adjustable on ICS Monitor Panel.
AIM-9 Missile Audio	1200 Hz Steady Tone	From IR Target Acquisition until Missile Is Fired or Target Is Lost	AIM-9 Missile Guidance Control System. Audio Level is Adjustable on ICS Monitor Panel.

NA-86-0043-230

Figure 19-12. ICS Aural Warnings, Tones, and Alarms

Comm page and by illuminated transmit select switches). With the switch in the ICS (down) position, the intercom system talk circuit is operative. Two additional microphone foot switches are installed on the observer's cockpit floor. Stepping on the RADIO XMIT switch keys the radio(s) selected on the observer's ICS selector panel. Stepping on ICS TALK switch operates the intercom system.

19.2.1.3 ICS Operation. With main dc bus power available (battery, external power, or generator) the ICS is ready for operation. To use the ICS, set the ICS selector panel as desired for external transmission, pull the desired monitor controls, and adjust volume as desired. External transmissions are made by holding the microphone switch to XMIT or stepping on the RADIO XMIT foot switch in the observers cockpit. Intercockpit communication is available by holding the No. 2 power control lever microphone switch to ICOM or stepping on the ICS TALK foot switch in the observer's cockpit.

19.2.2 VHF-UHF, AM/FM, Radio Set, AN/ARC-182 (Radios 1, 2, and 3). Three identical wide-band,VHF-UHF, AM/FM, AN/ARC-182 transceivers identified as Radios 1, 2, and 3 provide simplex two-way communications. The radios are controlled via the MIL-STD-1553B data bus with the CMS. The radios will transmit or receive amplitude or frequency modulated (AM or FM) signals over the frequency range of 30.00 to 399.97 MHz in 25-Hz increments providing 11,960 possible channels. In FM band operation, the transmitter power output is 15 watts and AM band power output is 10 watts. Electrical 28-VDC power is provided by the primary dc bus for Radio 1 and the secondary dc bus for Radios 2 and 3. Power ON and OFF control switches for all three radios are located on the pilot's right console CMS AND RADIO PWR CONTROL panel.

Radio control and operation can be controlled by either the pilot and/or the observer with the CMS-CDUs (function, mode and frequency selection), ICS selector panels (radio transmitter selection), and the ICS monitor panels (received radio audio). All three radios may be operated simultaneously or individually by one crewmember or both crewmembers at any time. Squelch, mode, relay, ADF, or secure voice operation is selectable via the CMS radio mode control pages. One set of 28 preset channels is available for all three radios, selected for use on the COMM page. Frequencies may also be manually inserted on the COMM page.

For navigation purposes, Radio 1 can be used for receiving a transmitted signal from a UHF-ADF beacon and converting it to relative bearing using the AN/ARA-50 ADF system. The relative bearing is displayed on the ID-663 D/U, BDHI No. 1 needle.

The use of two radios (Radios 2 and 3) provides a retransmission (relay) function allowing two ground or airborne radio stations to be connected for long-range, two-way communication with the aircraft radios acting as an operational link. During retransmit or relay operation it is possible for the relay aircraft to communicate with both of the linked stations.

Each radio is equipped with a separate guard receiver circuit that monitors the appropriate guard frequency for the band the radio is operating in when TR+G is selected on the Radio Mode Control pages. When TR=G is selected on the Radio Mode Control pages, the radios will automatically select and tune the main receiver and transmitter to the guard frequency of the present operating band.

Each radio will transmit a steady 1020-Hz tone for radio DF fixes if the slew switch is pushed up or down when the Radio Mode Control page is displayed. See Figures 19-13 and 19-14 for pilot and observer radio controls.

BAND	FREQUENCY (MHz)	GUARD	USE
VHF-FM LOW	30.00 to 87.97	40.50	Close Air Support
VHF-AM*	108.00 to 155.97	121.50	Air Traffic Control
VHF-FM HIGH	156.00 to 173.97	156.80	Maritime
UHF AM/FM	225.00 to 399.97	243.00	Military and NATO

19.2.2.1 Radio 1, 2, and 3 Controls. All AN/ARC-182 radio controls are located on the CMS AND RADIO PWR CONTROL panel, ICS monitor and selector panels, CMS Comm, Radios 1, 2, and 3 Mode Control and Preset pages, and the emergency radio control panel (Figures 19-13 and 19-14).

19.2.2.1.1 CMS AND RADIO PWR CONTROL Panel. The CMS AND RADIO PWR CONTROL panel, located on the pilot's right console, provides electrical power control for Radios 1, 2, and 3. Three switches labeled RADIO 1, 2, and 3 will apply electrical power ON or OFF when selected (Figure 19-14).

19.2.2.1.2 ICS Monitor Panel. Refer to paragraph 19.2.1.2.1 in this chapter for Radios 1, 2, and 3 ICS monitor control description and operation (Figures 19-13 and 19-14).

19.2.2.1.3 ICS Selector Panel. Refer to paragraph 19.2.1.2.2 in this chapter for Radios 1, 2, and 3 Transmit Select switch description and operation (Figures 19-13 and 19-14).

19.2.2.1.4 Comm Page. Either crewmember can display the Comm page by selecting the COMM key on the CMS-CDU. The following Radios 1, 2, and 3 operating information is displayed; radio control, selected preset channels and manual frequencies, and secure voice system selection. Frequency and preset channel information is inserted for radio tuning from the Comm page. See Figure 19-15 for detailed CDU key operation and page display description.

19.2.2.1.5 Radio 1, 2, and 3 Mode Control Pages. The Radio Mode control pages, selectable from the Comm page, provide either crewmember with the ability to select or change radio operating mode, squelch level, secure voice mode, ADF or relay functions. See Figure 19-15 for detailed CDU key operation and page display description.

19.2.2.1.6 Radio 1, 2, and 3 Preset Pages. Seven Radio Preset pages, selectable from the Radio Mode Control pages, provide either crewmember with the ability to view or update preset radio channels. Four preset channels, each displaying channel assignment number, modulation, and operating frequency are displayed on each of the seven preset pages for a total of twenty-eight available presets. Each preset may be assigned an five-character identifier to aid the crewmember in quick preset selection. In addition, secure net variables may be assigned to individual presets on these pages. Preset channels are available for selection to any Radio (1, 2, and 3) at any time. See Figure 19-15 for detailed CDU key operation and page display description.

19.2.2.1.7 Emergency Radio Control Panel, GD/EMER Switch. The guard/emergency (GD/EMER) switch, located on the pilot's left console, provides simultaneous selection of all VHF-UHF AN/ARC-182 radios to the guard mode (Figure 19-13). When the GD/EMER switch is placed to ON, all radios will be energized ON automatically (regardless of CMS AND RADIO PWR CONTROL panel Radio 1, 2, and 3 switch status) and 243.00 MHz will be automatically selected for all transmitter and receiver circuits regardless of Comm page frequency selections or CMS status. Guard (GD) will be displayed on the CMS Comm page next to the radio title (example: R1 GD) and guard frequency will be displayed. With desired ICS Transmit Select switches ON, keying of radio XMIT switches by either crewmember will allow single or multiple radio guard frequency transmission. Returning the switch to NORM will permit normal radio-CMS operation and return radios to their previous state.

19.2.2.2 Radios 1,2, and 3 Special Functions. In addition to normal transmit-receive radio operation, all radios have the ability to transmit a 1020-Hz tone. Radio 1 is used as a receiver for the UHF-ADF navigation system (AN/ARA-50) and Radios 2 and 3 can be used as an operational link (relay) between two distant radio stations. Refer to the following paragraphs for detailed description and operation.

19.2.2.2.1 XMIT TONE Operation. Radios 1, 2, or 3, can broadcast a 1020-Hz tone (regardless of ICS transmit select switch position) by pushing the slew switch up or down on the CMS-CDU. The tone function is available only when the respective Radio Mode Control page is displayed. The tone may be used for DF radio fixes, identification, morse code CW operation, or as a homing beacon. Release of the slew switch will turn the tone OFF.

19.2.2.2.2 UHF-ADF Operation. To select UHF-ADF operation, display the Radio 1 Mode Control page and press LS4 (ADF:ON) and wait 60 seconds for equipment warm-up. Press the COMM key to display the Comm page and insert UHF-ADF beacon frequency. Observe relative bearing to UHF-ADF beacon from aircraft on BDHI No. 1 needle. Bearing needle indication should be within ±5 degrees of the actual beacon position while in flight and ±15 degrees when on the ground. A Morse code station-identifier may be monitored by Radio 1 monitor control. To augment loudness of weak audio signals due to distance, select squelch to OFF (LS3) on Radio 1 Mode Control page. ADF may be deselected by pressing LS2 or LS4.

19.2.2.2.3 VHF-UHF Retransmission (Relay). During RELAY operation, VHF-UHF communications between two remote stations may be received and retransmitted to each other automatically throughout the entire frequency range of VHF-UHF Radios 2 and 3; however, selected frequencies must be at least 10 MHz apart. The RELAY function is selected and controlled by the state of Radio 3 Mode Control page. Relay may be used in either CIPHER or PLAIN modes of operation. During RELAY operation the pilot or observer may monitor and communicate with either of the two remote stations depending on the position of the ICS transmit select switches and ICS monitor controls. The following procedure is recommended for simplification and standardization:

1. Radio 2 and 3 monitor controls—PULL ON.

2. Radio 2 and 3 selected to TR (LS2, Radios 2 and 3 mode control pages).

3. Radio 2 frequency—SET (Comm page).

4. Radio 3 frequency—SET (Comm page).

NOTE

When RELAY is selected, the state of Radio 3 (PLAIN or CIPHER mode) determines whether relay message transmission or reception is in PLAIN or CIPHER mode. The mode cannot be changed until RELAY is deselected.

5. Radio 3 Mode Control page, Press (LS4)—RELAY: ON.

6. To exit RELAY mode on Radio 3 Mode Control page, Press (LS4)—RELAY:OFF.

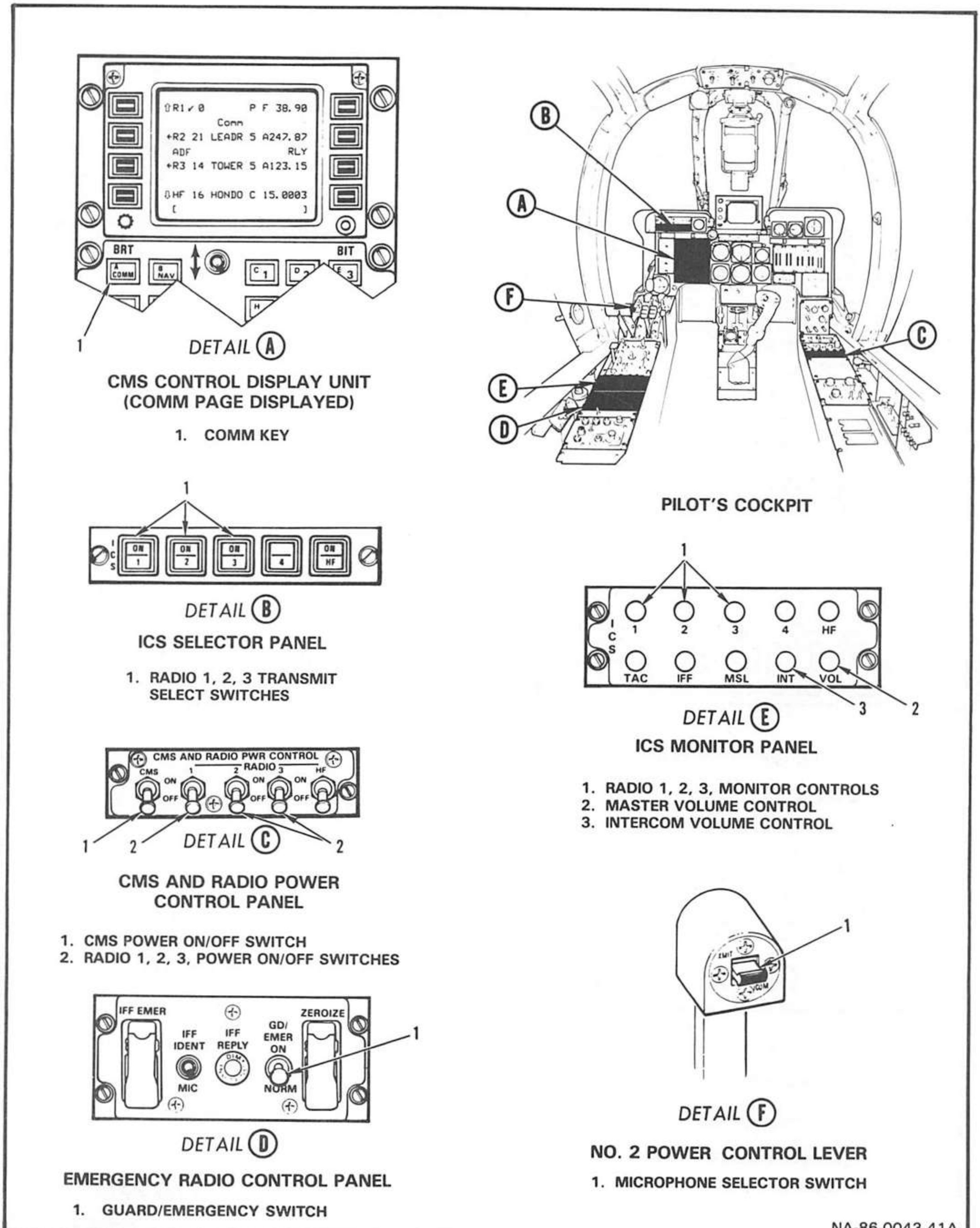
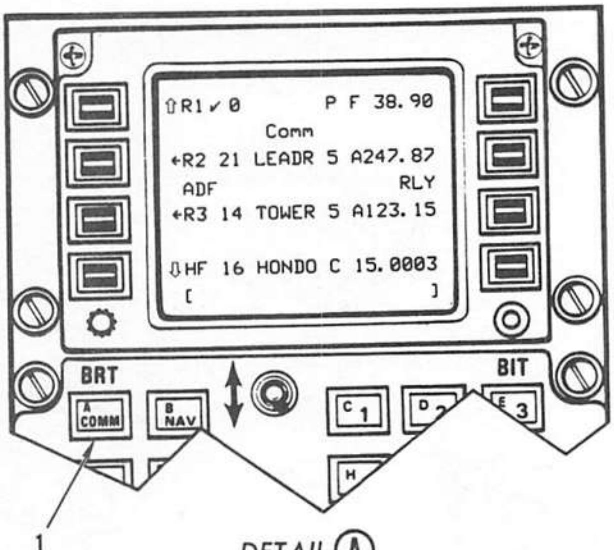


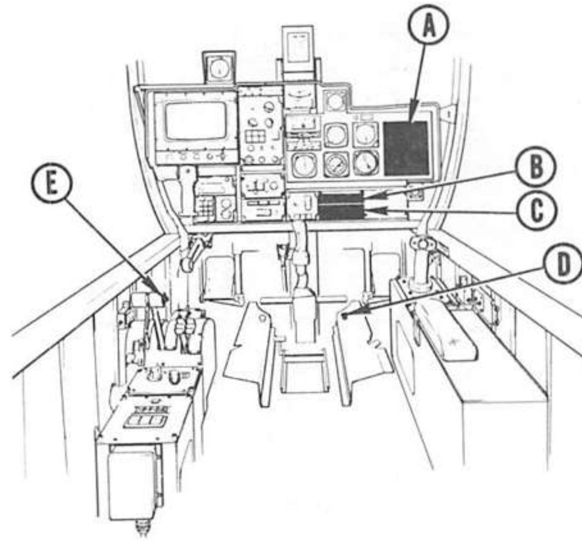
Figure 19-13. Radios 1, 2, and 3, Pilot's Cockpit Controls



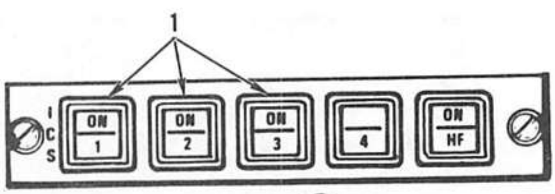
DETAIL Ⓐ

CMS CONTROL DISPLAY UNIT (COMM PAGE DISPLAYED)

1. COMM KEY



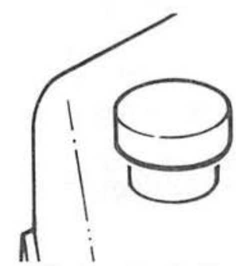
OBSERVER'S COCKPIT



DETAIL Ⓑ

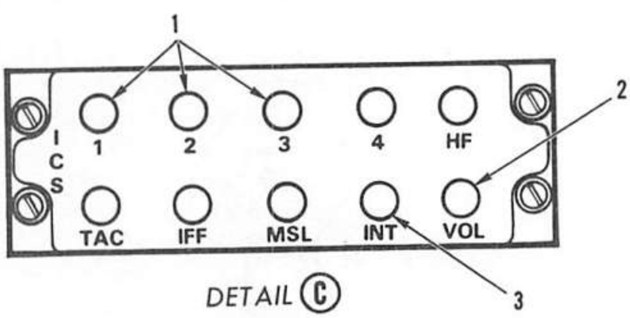
ICS SELECTOR PANEL

1. RADIO 1, 2, 3 TRANSMIT SELECT SWITCHES



DETAIL Ⓓ

RADIO XMIT FOOT SWITCH



DETAIL Ⓒ

ICS MONITOR PANEL

1. RADIO 1, 2, 3 MONITOR CONTROLS
2. MASTER VOLUME CONTROL
3. INTERCOM VOLUME CONTROL

DETAIL Ⓔ

NO. 2 POWER CONTROL LEVER

1. MICROPHONE SELECTOR SWITCH

NA-86-0043-42A

Figure 19-14. Radios 1, 2, and 3, Observer's Cockpit Controls

19.2.2.3 Radios 1, 2, and 3 Operation. Strict ICS and radio discipline must be observed while using a multiple radio arrangement. It is recommended that both crewmembers be aware of intended frequency use and monitor ground, tower, ATC, guard and mission frequencies on all flights. ICS conversation should be kept to a minimum. Before keying radio transmitter(s), assure that transmit select switches, radio monitor controls, and CMS Radio Mode Control pages are properly set. For normal voice operation for both crewmembers, proceed as follows and see Figure 19-15 for further information.

NOTE

- During radio transmissions in the same frequency band involving more than one radio (simultaneous transmission on multiple radios), a 10-MHz frequency separation must be observed between the transmitting radios to avoid interference and bleed through. For example, if Radio 1 is selected to transmit on 126.2 MHz, Radio 2 or 3 should not be tuned to transmit from 116.2 to 136.2 MHz.
- At extreme radio ranges, reception or transmission characteristics may be improved by presenting a tail aspect to the ground radio station while maintaining level flight.
- If RADIO 1, 2, 3 PWR switches are placed to ON after CMS PWR switch is selected to ON, a √ STATUS annunciator will appear on the CMS-CDU CRT.
- A CMS operational checkout should be performed prior to radio operation to assure GO status of CMS and radio systems. During VHF-UHF radio operational checkout, note √ STATUS annunciators and ERROR messages generated. See Figures 19-7 and 19-8 respectively for definition and corrective action.

1. Select Radios 1, 2, 3 PWR switches—ON.

2. Select CMS PWR switch—ON.

3. Select COMM key—Comm page displayed.

NOTE

If RADIO 1, 2, or 3 PWR switch is not ON, the Comm page will display a √ next to deenergized radio (example: R1 √). The Radio Mode Control page will also show a √ next to radio number (example: Radio 1 √). Should this occur, select radio power ON and clear √ STATUS annunciator with CLR key.

4. Connect headset to ICS disconnect.

5. Pull and turn Radios 1, 2, and 3 Monitor Controls to mid-range.

6. Turn VOL control to mid-range.

7. Set Radio Mode Control pages:

   (a) Select mode (LS2)—All Radio Mode Control pages.

   (b) Select squelch (LS3)—All Radio Mode Control pages.

   (c) Set ADF as desired (LS4)—Radio 1 Mode Control page only.

   (d) Set RELAY as desired (LS4)—Radio 3 Mode Control page only.

8. Select COMM key—Comm page displayed.

9. Tune radio to preset channel or insert frequency manually as follows:

   (a) Preset tuning:

      (1) On Comm page, enter preset channel number (1–28) in scratch pad.

(2) Press R1 (LS1), R2 (LS2), or R3 (LS3) as desired—New frequency, station ident and preset channel number displayed.

(b) Manual tuning:

(1) On Comm page, enter new frequency in scratch pad.

(2) Press LS5, LS6, or LS7 for selected radio—Manual frequency, station ident field blank and preset channel number indicates zero (0).

NOTE

After tuning the radio to the new frequency (preset or manual), the operator may recall the previously used frequency by pressing LS5, 6, or 7 as applicable with the scratch pad blank.

NOTE

When entering manual UHF-FM frequencies, preceed numeric entries with an "F" (example: F345.67). AM frequencies do not require any notation.

10. Select transmit select switches—ON.

11. Select XMIT/ICS microphone selector switch—XMIT.

12. To secure radios, select RADIO 1, 2, and 3 PWR switches—OFF.

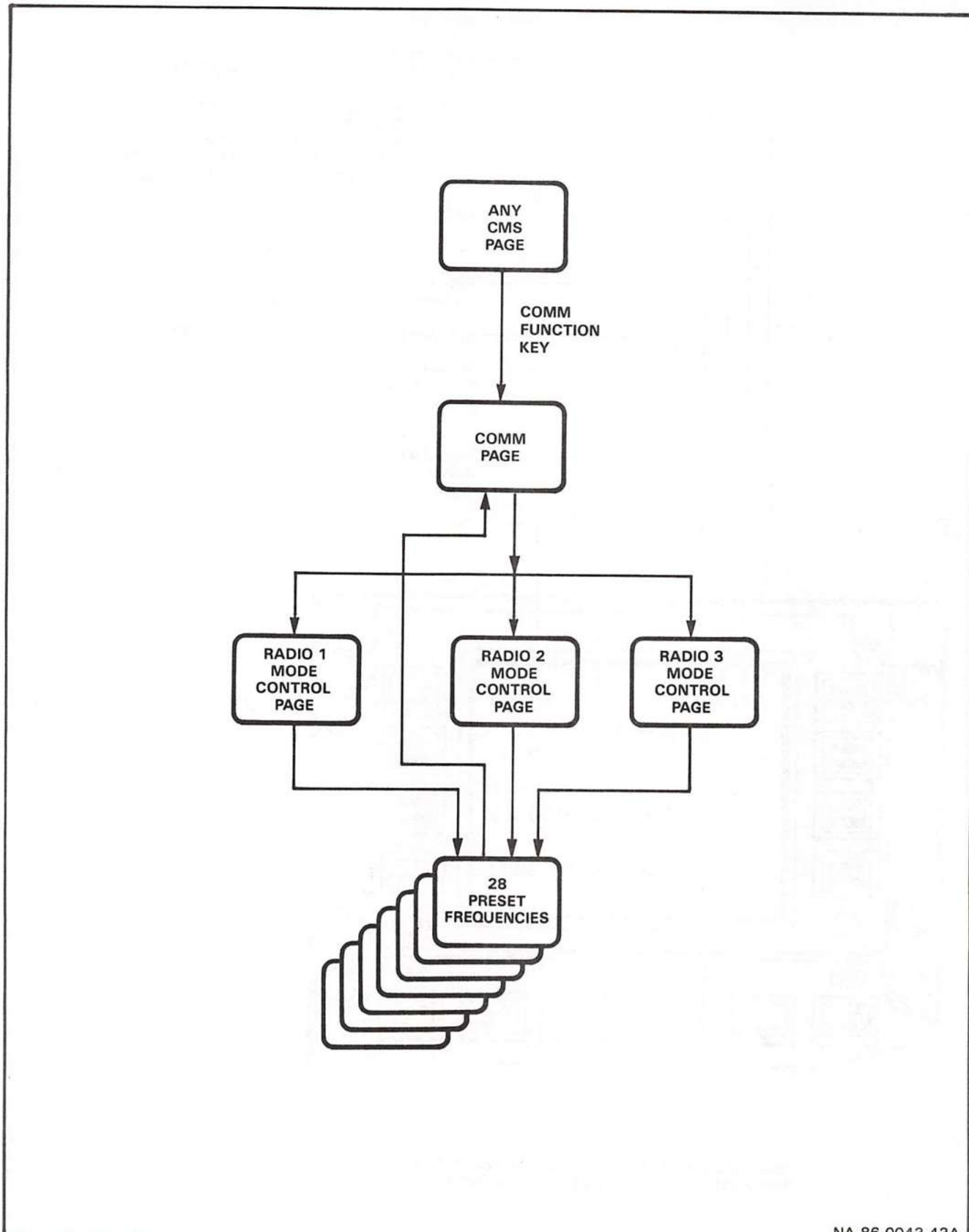
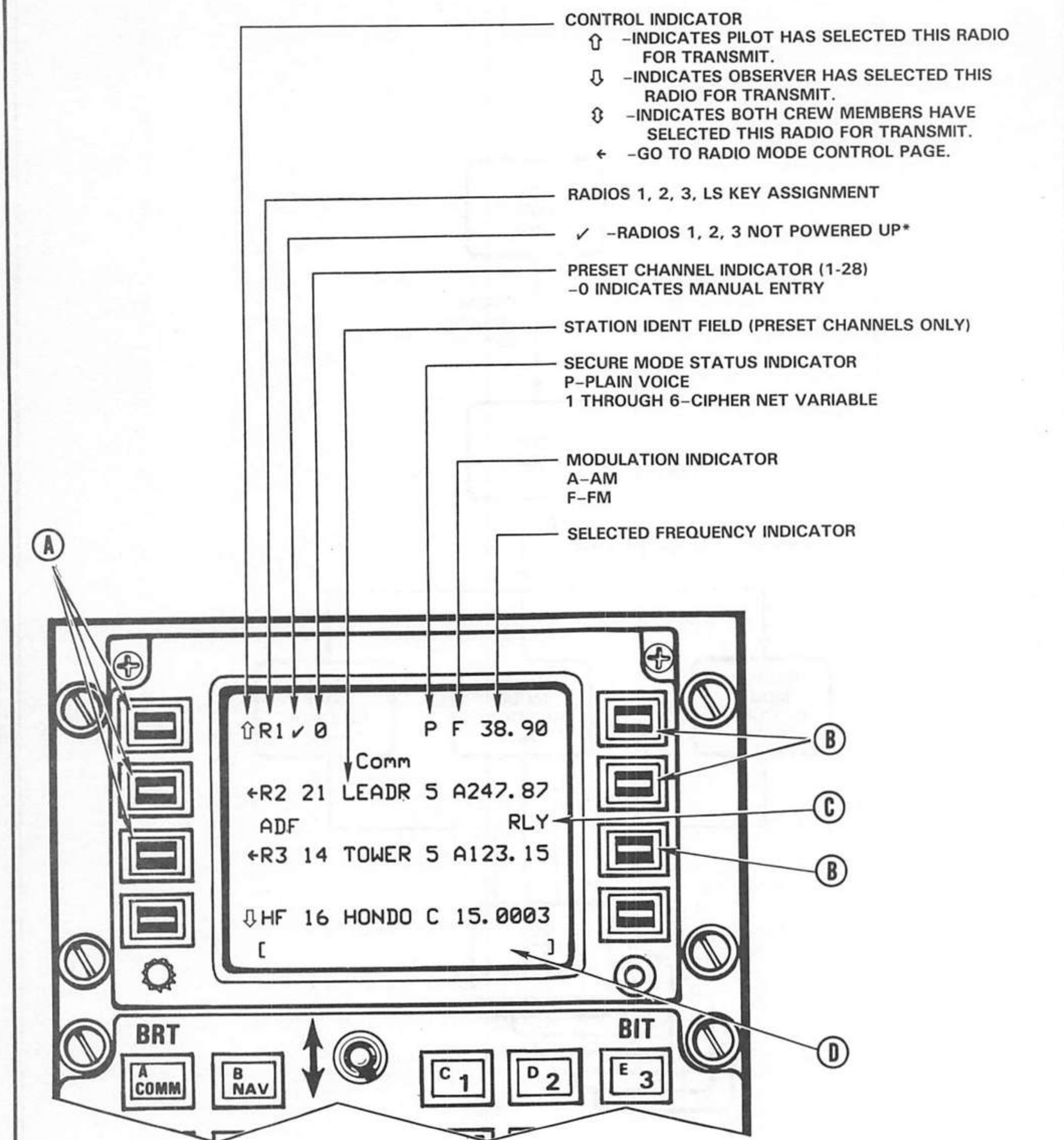


Figure 19-15. COMM Key Flow Chart and Page Displays for Radios 1, 2, and 3 (Sheet 1 of 7)



COMM PAGE

*WILL ALSO APPEAR IN TITLE LINE OF RESPECTIVE RADIO MODE CONTROL PAGE (EX. ✓ RADIO 1).

NA-86-0043-44A

Figure 19-15. COMM Key Flow Chart and Page Displays for Radios 1, 2, and 3 (Sheet 2 of 7)

A. LS KEY 1, 2, 3, OPERATION AND OPTIONS

When scratch pad is blank, pressing LS keys will cause the respective Radio Mode Control page to be displayed.

When preset channel number (1–28) has been entered in the scratch pad, pressing LS keys will cause respective radio to be tuned to entered preset channel.

B. LS KEY 5, 6, 7, OPERATION AND OPTIONS

When frequency is manually entered in scratch pad, pressing LS keys will cause respective radio to be tuned to entered frequency.

When scratch pad is blank, pressing LS keys will cause respective radio to be tuned to the previously used frequency.

If KY power is ON (KY 1 for Radio 1, KY 2 for Radios 2 and 3) LS keys will also perform the following:

(a) When P (plain) is entered in the scratch pad, pressing LS keys will cause P to be displayed and select the PLAIN voice mode of operation for the desired radio regardless of preset or manual frequency.

(b) When 1, 2, 3, 4, 5, or 6 (secure voice net variable) is entered in the scratch pad, pressing LS keys will cause the selected radio and KY unit to utilize the net variable selected and place the radio in the cipher mode. The net number will be displayed adjacent to the frequency.

(c) When C is entered in the scratch pad, pressing keys will activate any preset channel programmed net variable or if a manual frequency is displayed, will select net variable 1 and place the radio in the cipher mode.

C. INFORMATION LINE DISPLAY OPTIONS

ADF–Indicates Radio 1 Mode Control page selected to ADF mode.

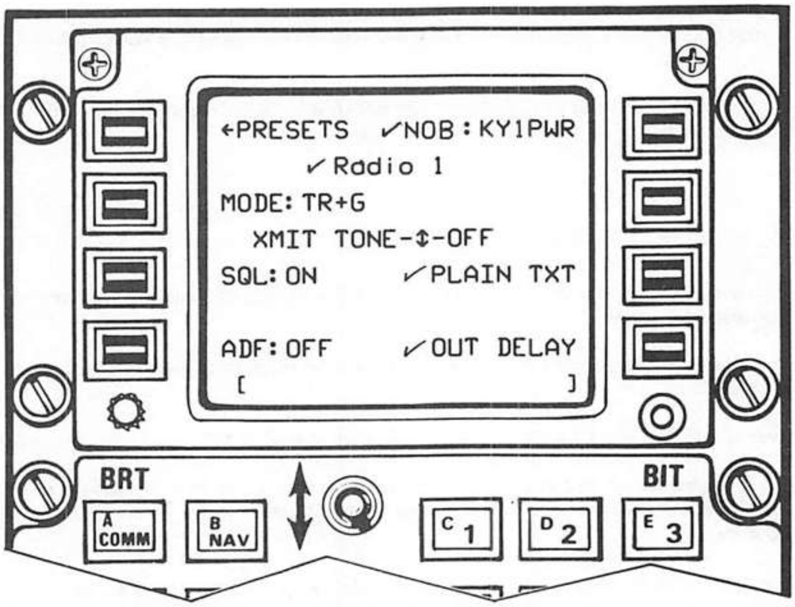
RLY–Indicated Radio 3 Mode Control page selected to relay mode.

D. SCRATCH PAD DISPLAY AREA

Will display numbers or letters entered from alphanumeric keyboard.

NA-86-0043-231A

Figure 19-15. COMM Key Flow Chart and Page Displays for Radios 1, 2, and 3 (Sheet 3 of 7)



RADIO 1 MODE CONTROL PAGE

LS1: GO TO RADIO 1 PRESETS PAGE 1 OF 7.

LS2: WHEN SELECTED WILL CHANGE RADIO 1 OPERATING MODE, WILL ALSO INDICATE WHEN ADF IS SELECTED.

OPERATING MODES:
- TR – TRANSMIT/RECEIVE
- TR + G – TRANSMIT/RECEIVE AND MONITOR APPLICABLE GUARD
- TR = G – TRANSMIT/RECEIVE ON APPLICABLE GUARD

LS3: SELECT RADIO 1 SQUELCH ON OR OFF.

LS4: SELECT ADF (AN/ARA-50) ON OR OFF.

- IF LS2 (RADIO 1 OPERATING MODE) IS PRESSED WHILE ADF IS SELECTED ON, RADIO MODE WILL GO TO PREVIOUSLY SELECTED MODE AND ADF (LS4) WILL GO TO OFF.
- IF ADF IS SELECTED OFF FROM ON, RADIO MODE (LS2) WILL RETURN TO PREVIOUSLY SELECTED OPERATING MODE.
- WITH ADF ON, RADIO 1 IS INHIBITED FROM TUNING BELOW 88 MHz.

LS5: WHEN SELECTED WILL TURN KY 1 POWER ON OR OFF OR WILL DISPLAY NOB (NOT ON BOARD).

LS6: NO FUNCTION.

LS7: WHEN SELECTED, WITH KY 1 POWER ON, WILL SELECT CIPHER MODE.
- PLAIN:TXT
- CIPHER:TXT
- CT ONLY:TXT
- LOAD:TXT
- RV:TXT

LS8: WHEN SELECTED, WITH KY 1 POWER ON, WILL SELECT KY 1 DELAY IN OR OUT.

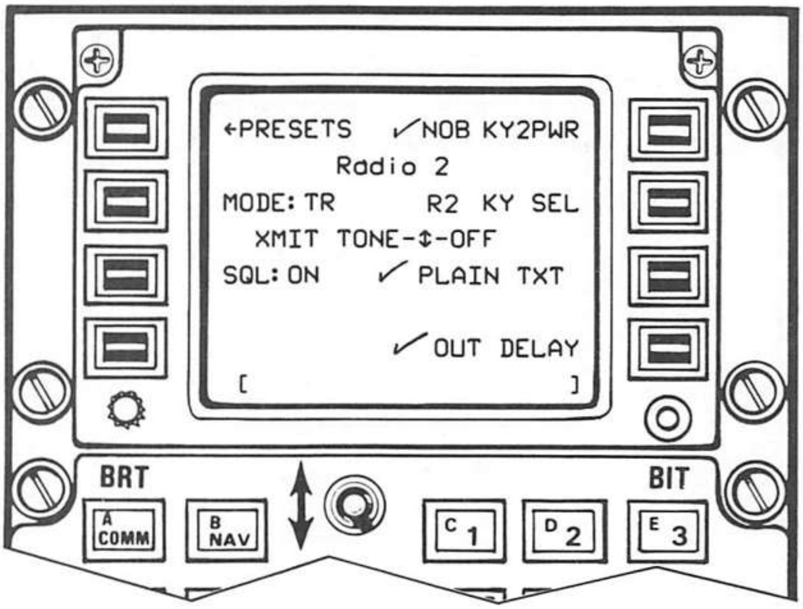
SLEW SWITCH: WHEN PUSHED UP OR DOWN, RADIO 1 WILL TRANSMIT A 1020 Hz TONE REGARDLESS OF MICROPHONE SWITCH POSITION OR RADIO 1 TRANSMIT SELECT SWITCH.

NOTE

IF KY 1 IS OFF OR NOT INSTALLED, NO COLONS (:) WILL BE DISPLAYED ON LS7 OR LS8 AND CIPHER MODE SELECTION AND DELAY WILL NOT FUNCTION. CHECKMARK (✓) WILL BE DISPLAYED ADJACENT TO LS5, LS7, AND LS8.

NA-86-0043-45A

Figure 19-15. COMM Key Flow Chart and Page Displays for Radios 1, 2, and 3 (Sheet 4 of 7)



RADIO 2 MODE CONTROL PAGE

LS1: GO TO RADIO 2 PRESETS PAGE 1 OF 7.

LS2: WHEN SELECTED WILL CHANGE RADIO 2 OPERATING MODE.

OPERATING MODES:
- TR – TRANSMIT/RECEIVE
- TR + G – TRANSMIT/RECEIVE AND MONITOR APPLICABLE GUARD
- TR = G – TRANSMIT/RECEIVE ON APPLICABLE GUARD

LS3: SELECT RADIO 2 SQUELCH ON OR OFF.

LS4: NO FUNCTION.

LS5: WHEN SELECTED WILL TURN KY 2 POWER ON OR OFF OR WILL DISPLAY NOB (NOT ON BOARD).

LS6: SWITCHES KY 2 BETWEEN RADIOS 2 AND 3 WHICH IS DISPLAYED AS R2 OR R3: KY SEL.
- DISPLAYS RLY IF RELAY IS SELECTED ON RADIO 3 MODE CONTROL PAGE.
- IF KY 2 POWER ON BUT SELECTED FOR RADIO 3, RADIO 2 WILL OPERATE IN PLAIN VOICE.
- WILL NOT FUNCTION IF RLY SELECTED.

LS7: DISPLAYS "PLAIN" WITH KY 2 POWER OFF OR KY 2 SELECTED FOR RADIO 3. ALSO SELECTS THE FOLLOWING MODES WHEN KY 2 POWER ON AND SELECTED FOR RADIO 2.
- PLAIN:TXT
- CIPHER:TXT
- CT ONLY:TXT
- LOAD:TXT
- RV:TXT

LS8: SELECT KY 2 DELAY IN OR OUT WITH KY 2 POWER ON AND KY 2 SELECTED FOR RADIO 2.

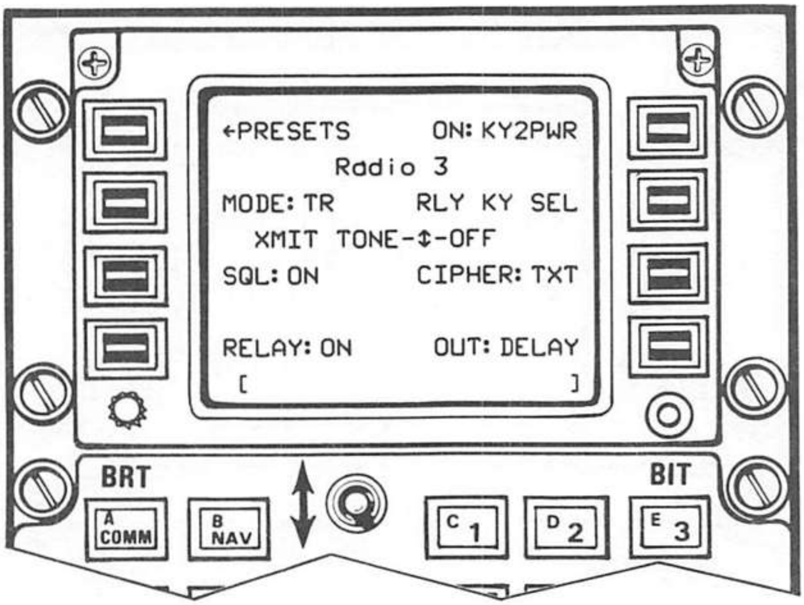
SLEW SWITCH: WHEN PUSHED UP OR DOWN, RADIO 2 WILL TRANSMIT A 1020 Hz TONE REGARDLESS OF MICROPHONE SWITCH POSITION OR RADIO 2 TRANSMIT SELECT SWITCH.

NOTE

- IF KY 2 IS OFF OR NOT INSTALLED, NO COLONS (:) WILL BE DISPLAYED ON LS7 OR LS8 AND THEIR FUNCTION WILL BE INHIBITED. RADIO WILL AUTOMATICALLY OPERATE IN THE PLAIN VOICE MODE.
- LS5, LS6, AND LS8 ON THE RADIO 3 MODE CONTROL WILL REFLECT IDENTICAL CONDITIONS.
- LS5, LS7, AND LS8 WILL NOT FUNCTION IF RADIO 3 HAS KY 2 SELECTED.

NA-86-0043-46A

Figure 19-15. COMM Key Flow Chart and Page Displays for Radios 1, 2, and 3 (Sheet 5 of 7)



RADIO 3 MODE CONTROL PAGE

LS1: GO TO RADIO 3 PRESETS PAGE 1 OF 7.

LS2: WHEN SELECTED WILL CHANGE RADIO 3 OPERATING MODE.

OPERATING MODES:
- TR–TRANSMIT/RECEIVE
- TR+G–TRANSMIT/RECEIVE AND MONITOR APPLICABLE GUARD
- TR=G–TRANSMIT/RECEIVE ON APPLICABLE GUARD

LS3: SELECT RADIO 3 SQUELCH ON OR OFF.

LS4: SELECT RELAY FUNCTION ON OR OFF.

LS5: SELECT KY 2 POWER ON OR OFF OR WILL DISPLAY NOB (NOT ON BOARD).

LS6: SWITCHES KY 2 BETWEEN RADIOS 2 AND 3 WHICH IS DISPLAYED AS R2 OR R3: KY SEL.

- DISPLAYS RLY IF RELAY IS SELECTED AT LS4.
- IF KY 2 POWER ON BUT SELECTED FOR RADIO 2, RADIO 3 WILL OPERATE IN PLAIN.

LS7: DISPLAYS "PLAIN" WITH KY 2 POWER OFF OR KY 2 SELECTED FOR RADIO 2. ALSO SELECTS THE FOLLOWING MODES WHEN KY 2 POWER ON AND SELECTED FOR RADIO 3:
- PLAIN:TXT
- CIPHER:TXT
- CT ONLY:TXT
- LOAD:TXT
- RV:TXT

LS8: SELECT KY 2 DELAY IN OR OUT WITH KY 2 POWER ON AND KY 2 SELECTED FOR RADIO 3.

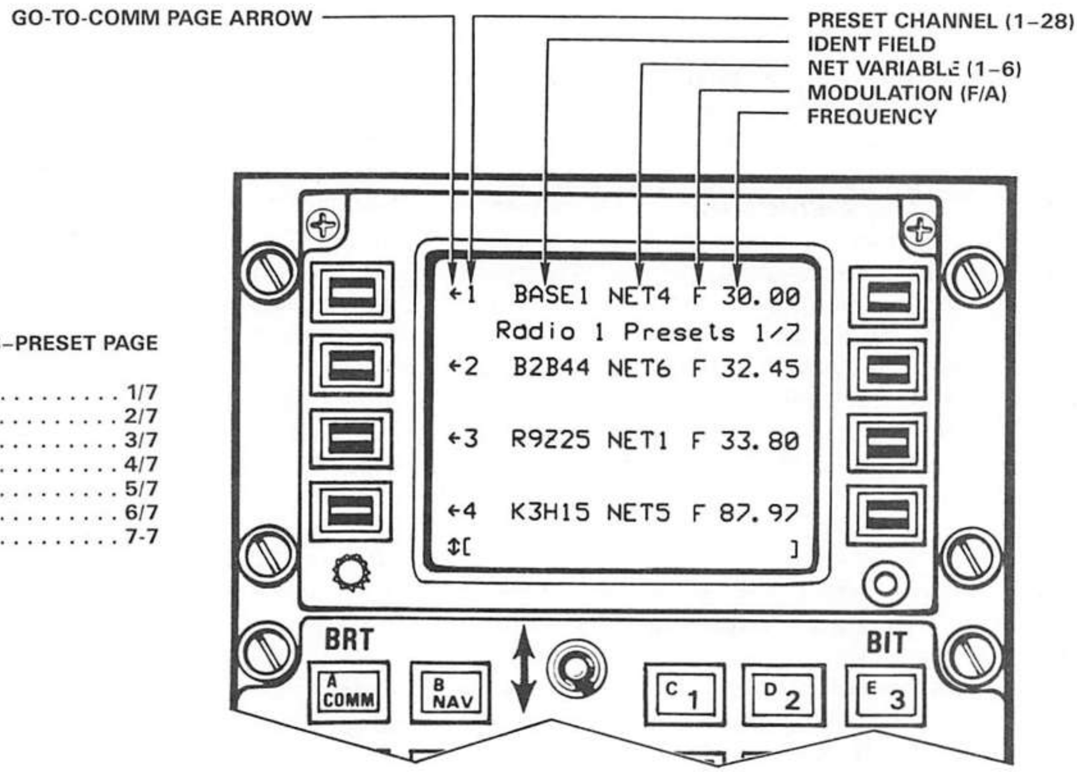
SLEW SWITCH: WHEN PUSHED UP OR DOWN, RADIO 3 WILL TRANSMIT A 1020 Hz TONE REGARDLESS OF MICROPHONE SWITCH POSITION OR RADIO 3 TRANSMIT SELECT SWITCH.

NOTE

- IF KY 2 IS OFF OR NOT INSTALLED, NO COLONS (:) WILL BE DISPLAYED ON LS7 OR LS8 AND THEIR FUNCTION WILL BE INHIBITED. RADIO WILL AUTOMATICALLY OPERATE IN THE PLAIN VOICE MODE.
- LS5, LS6, AND LS8 ON THE RADIO 2 MODE CONTROL WILL REFLECT IDENTICAL CONDITIONS.
- IF RELAY SELECTED (LS4) AND A NET VARIABLE CHANGE IS MADE IN RADIO 2 OR 3, BOTH RADIOS WILL REFLECT THE NEW NET VARIABLE.
- LS5, LS7, AND LS8 WILL NOT FUNCTION IF RADIO 2 HAS KY SELECTED.
- LS6, LS7, AND LS8 WILL NOT FUNCTION AFTER RLY SELECTED.

NA-86-0043-47A

Figure 19-15. COMM Key Flow Chart and Page Displays for Radios 1, 2, and 3 (Sheet 6 of 7)



PRESET CHANNELS-PRESET PAGE

1-4	1/7
5-8	2/7
9-12	3/7
13-16	4/7
17-20	5/7
21-24	6/7
25-28	7-7

RADIO 1, 2, AND 3 PRESET PAGE 1/7
(TYPICAL)

NOTE

- THE TITLE OF THE RADIO PRESET PAGE WILL REFLECT RADIO 1, 2, OR 3 TO INDICATE FROM WHICH RADIO MODE CONTROL PAGE THE PRESET PAGE WAS SELECTED. WHEN A PRESET CHANNEL IS SELECTED FROM THE PRESET LIST, THE RADIO INDICATED IN THE TITLE WILL BE TUNED TO THE SELECTED CHANNEL.
- IDENT FIELD IS LIMITED TO FIVE ALPHANUMERIC CHARACTERS.

LS1-LS4:

WHEN IDENT IS ENTERED IN SCRATCH PAD, PRESSING LS KEY WILL ENTER CHARACTERS IN IDENT FIELD. IF SCRATCH PAD IS BLANK, PRESSING THIS KEY WILL TUNE RADIO TO INDICATED PRESET CHANNEL (1-28) AND RETURN TO COMM PAGE.

LS5-LS8:

WHEN FREQUENCY OR NET VARIABLE (1-6) IS ENTERED IN SCRATCH PAD, PRESSING THIS KEY WILL ENTER INFORMATION IN PRESET FIELD.

SLEW SWITCH: UP ACTION ON THE SWITCH WILL CAUSE PRESET PAGE 2/7 THROUGH 7/7 TO BE DISPLAYED. DOWN ACTION WILL CAUSE PREVIOUS PAGES TO BE DISPLAYED.

NA-86-0043-48A

Figure 19-15. COMM Key Flow Chart and Page Displays for Radios 1, 2, and 3 (Sheet 7 of 7)

19.2.3 KY 1 and KY 2 Secure Voice System. Two KY-58 processors (KY 1 and KY 2) are installed and provide the pilot and observer with VHF-UHF encrypted voice communication when linked with the AN/ARC-182 Radio systems. Each KY unit may be loaded with six codes (or net variables) from a loading device. Whichever code is selected for use must agree with the code used by the participating secure net users. The CMS provides power, mode, and code selection control on the Radios 1, 2, and 3 Mode Control Pages and Comm Page. Each KY-58 processor provides the encode/decode functions in accordance with the code (fill) set in the processor.

Both KY processors may be turned ON or OFF by selecting the Power page (via the IDX function select key) and toggling LS2 (KY 1) and LS3 (KY 2). The codes (net variables) will be maintained for use by way of the KY unit internal battery regardless of the aircraft power state. The KY codes can only be zeroed by physically removing the KY units from the aircraft or by selecting the ZEROIZE switch on the pilot's left console. The KY secure voice system is operable throughout the entire frequency range of the AN/ARC-182 radio (Figure 19-15).

19.2.3.1 KY 1 Description. KY 1 is located in the left boom electronic equipment bay and is used with Radio 1. In addition to Power page ON/OFF control, the KY 1 processor may also be turned ON or OFF by toggling LS5 (KY 1 PWR) on the Radio 1 Mode Control page to ON. The KY 1 mode of operation may be selected on the Comm Page and/or the Radio 1 Mode Control Page. Refer to paragraph 19.2.3.3. The DELAY function is enabled on the Radio 1 Mode Control page and is selected when the aircraft is part of an encrypted radio relay operation with a remote station or relay aircraft that has a compatible KY-58 system. The DELAY function provides a longer system synchronization signal required for encrypted relay operation. All Radio 1 functions are routed through the KY 1 processor, if KY 1 is not installed, the radio will not function unless special jumper wire connections have been made. KY 1 receives 28-VDC electrical power from the secondary dc bus (Figure 19-5).

19.2.3.2 KY 2 Description. KY 2 is installed in the right boom electronic equipment bay and is selectable on either the Radio 2 or Radio 3 Mode Control pages for dedicated radio use. In addition to Power page control, the KY 2 processor may be turned ON or OFF by toggling LS5 on the Radio 2 or Radio 3 Mode Control page. When KY power is initially turned ON, KY 2 will be assigned to Radio 2. If the KY 2 processor is ON, loaded with the proper codes, cipher mode selected and assigned to Radio 2, Radio 3 will automatically operate in PLAIN voice mode and vice versa. Whichever radio has KY 2 assigned to it will have the ability to control KY 2 power, change cipher modes and initiate DELAY operation as indicated by colons adjacent to LS keys 5, 7, and 8 on the controlling Radio Mode Control page. If Radio 2 is the controlled radio (KY 2 selected), Radio 3 Mode Control page will reflect identical conditions as seen on Radio 2 Mode Control Page except LS7 (mode of operation) will be in the PLAIN cipher mode and the colons will be absent. When toggling LS6 (KY SEL) on either the Radio 2 or Radio 3 Mode Control page with KY 2 power ON, will alternate between R2 KY SEL or R3 KY SEL indicating the controlled radio. Radios 2 and 3 will function normally with no special jumper requirements if KY 2 is not on board. Radio functions are controlled via a switching unit that will permit normal plain voice operation without a KY 2 unit. KY 2 receives 28-VDC electrical power from the secondary dc bus (Figure 19-5).

NOTE

If CIPHER:TXT is selected on Radio 2 and Radio 3 has control of KY 2 (R3:KY SEL), the CMS error message "no cipher unit" will be displayed in the scratch pad. This error message will also appear anytime the CIPHER:TXT mode is selected for any radio and the KY unit required for operation is not on board (NOB) or has not been turned ON.

19.2.3.3 KY 1 and KY 2 Modes of Operation. Each KY has five modes of KY-Radio operation available. The current mode will be displayed on the Radio 1, 2, and 3 Mode Control pages and the Comm page. To change modes enter P (plain voice), C (cipher), L (load), CTO (cipher text only), RV and net variables 1 through 6 (receive variable) or a net variable (1–6) on the Comm page for the desired radio or toggle LS7 on the selected Radio Mode Control page for the desired mode. Descriptions of the KY modes are as follows:

1. PLAIN:TXT. Normal mode of operation, all VHF-UHF voice communication (transmit and receive) will be in plain voice. PLAIN: TXT will automatically be selected with KY power OFF and when KY power is initially turned ON.

2. CIPHER:TXT. When selected, all VHF-UHF voice communication broadcast will be encrypted. All encrypted transmissions received will be decoded and heard as plain voice. All plain voice broadcasts on the secure frequency will be heard.

3. CTO:TXT. Not Used.

4. LOAD:TXT. Mode slected during code fill operation. Can only be selected when main landing gear is down and locked. If selected in-flight or when gear is up, a WHEELS UP annunciator will be displayed on the CMS-CDU.

5. RV:TXT. Data not available, to be provided later.

19.2.3.4.1 Radio Cipher Operation. A single radio or a combination of radios may be used for cipher operation. Prior to cipher operation assure selected Radio(s) CMS status is GO and the selected KY(s) are ON, loaded with the proper codes and selected for radio use (in the case of KY 2, either Radio 2 or 3). For cipher operation proceed as follows:

NOTE

Radio 1, Radio 2 or Radio 3 (depending on KY 2 assignment), and HF radios can be selected in combination for simultaneous cipher operation provided the following conditions are met:

- At least a 10 MHz frequency separation must be maintained between radios.
- The ICS transmit select switches for radios in the PLAIN:TXT mode are OFF.

1. Selected Radio monitor controls to mid-range.

2. Select preset or insert manual secure voice frequency for radio(s) to be used on Comm page.

3. Select net variable (1–6 or C) for desired radio(s) on Comm page;

(a) If manual frequency is inserted—The cipher mode (CIPHER:TXT) and net 1 may be entered automatically on the Comm page by inserting C in the scratch pad and selecting LS5, LS6, or LS7 for the desired radio. Net variable 1, 2, 3, 4, 5, or 6 and the cipher mode may be selected automatically by entering the desired net number in the scratch pad and selecting LS5, LS6, or LS7 for the desired radio.

(b) If preset frequency is recalled from CMS memory and a net variable was assigned to preset when programmed—The programmed net variable may be activated and cipher mode entered by entering C in the scratch pad and selecting LS5, LS6 or LS7 for the desired radio. The programmed preset net variable will be displayed next to the frequency and the radio will be in the CIPHER:TXT mode. If a new net variable is desired or if the preset did not have a net variable, this net variable may be entered by inserting the variable in the scratch pad and selecting the desired radio, (LS5, LS6, or LS7). After this operation, the preset frequency will remain but the ident field will blank and a 0 will appear in the preset channel indicator. The new net variable will be displayed adjacent to the frequency and the cipher mode will be enabled. The preset channel will now appear as a manual frequency entry; however, the original preset information will be retained in CMS memory and may be recalled by pressing the LS again to recall the previous frequency.

4. Select ICS transmit select switch(es) ON for desired Radio Cipher operation.

NOTE

Assure that all radios not in cipher mode are deselected (Transmit Select switches OFF). When more than one radio is selected for transmit by the same operator (transmit select switch ON) and the cipher state of the radios selected are in conflict, the following indications will be displayed; each CMS-CDU will display a SEC VOICE annunciator message, the ICS transmit select switches (ON segment) of the radios in conflict will flash and PLAIN:TXT mode will automatically be selected for all radios and any transmission attempted will be in plain voice.

NOTE

If the violation encompasses the VHF-UHF radios only, the annunciator can be cleared by deselecting transmit select switch of the conflicting radio and pressing the CMS-CDU CLR key. The cipher state of the radio to be used must then be reset to CIPHER:TXT to resume cipher operation. If the HF radio is selected to CIPHER and the conflicting Radios (1, 2, or 3) are in PLAIN:TXT when the annunciator is displayed, the KY-75 must be manually switched to PLAIN voice on the KY-75 control panel before clearing the annunciator (CDU CLR key) and then reset to CIPHER to resume cipher operation.

5. To secure from cipher mode, enter P in the scratch pad while the Comm page is displayed and select LS5, LS6, or LS7 to select PLAIN:TXT mode.

19.2.3.5 Ciphered Relay Operation. When CIPHER:TXT and RELAY modes are selected on the Radio 3 Mode Control page, KY 2 will be alternated by the switching unit between Radios 2 and 3 for encrypted RELAY communication. Aircraft and remote station RELAY operation (three station, two-way encrypted voice communication) will not be possible unless the remote station KY processors and the aircraft KY 2 processor have been selected for a common code (or net variable). If the aircraft does not have a KY 2 processor installed or it is turned OFF, RELAY of encrypted voice between two remote stations is still possible. The transmissions, however, are not decoded by the aircraft station and cannot be monitored. The two remote stations however will be linked for CIPHER:TXT operation. If transmissions are made by the aircraft while in this mode, they will be in PLAIN voice. For ciphered RELAY operation proceed as follows;

1. Assure that Radio 2 and 3 status is GO and KY 2 codes loaded with power ON.

2. On Comm page select relay frequencies for Radio 2 and Radio 3.

3. On Comm page insert C (for net variable 1 or preset net variable) or desired net variable (1–6) in Radio 3 (LS7).

4. On Radio 3 Mode Control page select LS8 DELAY:ON

5. On Radio 3 Mode Control page select LS4 RELAY:ON

NOTE

Radio 2 will automatically use the net variable selected for Radio 3. If a net variable change is made while RELAY is ON, both radios will reflect the new variable. Cipher state (CIPHER:TXT to PLAIN:TXT) cannot be changed while in the RELAY mode.

6. To exit ciphered RELAY mode, select LS4 to RELAY:OFF on the Radio 3 Mode Control page, and select PLAIN:TXT (LS7).

NOTE

KY 1 and KY 2 are zeroized (codes erased) by lifting the guarded switch cover labeled ZEROIZE on the emergency radio control panel, located on the pilot's left console, and positioning the switch to the ZEROIZE position. The KIT-1A mode 4 code will also zeroize with this action.

19.2.4 HF Communications Set, AN/ARC-199. The AN/ARC-199 HF radio is a high-frequency, single-sideband, MIL-1553B data bus compatible radio with a selectable power output of 4 (LO), 40 (MED), and 150 watts (HI) peak-envelope-power. The radio will transmit and receive from 2.0 to 29.9999 MHz. The frequencies are programmable in 100 Hz increments for a total of 280,000 possible frequencies. A set of 20 preset channels are available for use. The modes of operation are upper-sideband (USB), lower-sideband (LSB), amplitude modulation (AM), and modulated carrier wave (CW). Squelch is adjustable in 16 levels. The radio will automatically tune to a preset pretuned channel in approximately 50 milliseconds and to a manually inserted frequency in approximately 30 seconds. The HF radio mode of operation is controlled by selecting the HF Radio Mode Control page from the Comm page. Secure voice operation is available with the TSEC KY-75 processor installed. When HF radio is initially turned on, it will automatically be selected to medium (MED) power out, USB, minimum squelch, and TUNE:OFF. The No. 1 monitor dc bus provides 28 VDC for operation provided that external power is available or an aircraft generator is on the line. The radio may be selected by both crewmembers simultaneously.

NOTE

Altitude, aircraft heading, time of day, or atmospheric conditions may affect transmit-receive operation in the HF frequency band.

19.2.4.1 HF Communication Set Controls. Control of operating modes, frequency selection, squelch and preset channels is accomplished by selection of the Comm page, HF Radio Mode Control page, and Preset pages. HF electrical power control is located on the CMS AND RADIO PWR CONTROL panel (Figures 19-16, 19-17, and 19-18).

19.2.4.1.1 CMS AND RADIO PWR CONTROL Panel. The CMS AND RADIO PWR CONTROL panel, located on the pilot's right console, provides electrical power control for the HF Radio. The HF power switch will apply electrical power ON or OFF when selected (Figure 19-16).

19.2.4.1.2 ICS Radio Selector Panel. Refer to paragraph 19.2.1.2.2 in this Chapter for HF transmitter selection description and operation.

19.2.4.1.3 ICS Monitor Control Panel. Refer to paragraph 19.2.1.2.1 in this Chapter for HF radio-received audio control description and operation.

19.2.4.1.4 Comm page. Either crewmember can display the Comm page by selecting the COMM key on the CMS-CDU. The following HF radio operating information is displayed; radio control, selected preset channel or frequency, and secure voice mode. Frequency and preset channel information is inserted for radio tuning from the Comm page. See Figure 19-18 for detailed CDU key operation and display description.

19.2.4.1.5 HF Radio Mode Control Page. The HF Radio Mode Control page provides either crewmember with the ability to select the HF radio operating mode, power output, preset pages, squelch level, and tuning initiation. Secure voice mode is displayed but cannot be changed on this page. Secure voice operation is controlled by the KY-75 T/SEC control panel on the pilot's left console. See Figure 19-18 for detailed CDU key operation and display description.

19.2.4.1.6 HF Radio Preset Pages. The HF Radio Preset pages, selectable from the HF Radio Mode Control page, provides either crewmember with the ability to review or update preset radio channels (1–20). Four preset channels, each displaying channel assignment number, mode (U, L, A, or C) and operating frequency, are displayed on each of the five preset pages for a total of 20 available presets. Each preset may be assigned a five-character identifier to aid the crewmember in quick preset selection. See Figure 19-18, for detailed CDU key operation and display description.

19.2.4.2 HF Radio Tuning and Annunciator Messages. The HF radio tuning sequence is initiated from the HF Radio Mode Control page. Whenever an HF frequency is changed (preset or manual) the TUNE HF annunciator may appear. The annunuciator indicates that the HF Radio Mode Control Page must be displayed and the tuning sequence initiated (LS4). While the tuning sequence is in progress, the annunciator will be replaced with a "HF TUNING" and TUNE:ON will be displayed adjacent to LS4. When the tuning sequence is complete the HF TUNING annunciator will disappear and TUNE:OFF will be displayed adjacent to LS4 indicating the radio is now ready for transmit/receive operation.

Whenever a new list of presets are entered on the preset pages the tuning sequence must be initiated. This is accomplished by returning to the HF Radio Mode Control page and pressing LS4 (twice if "TUNE HF" is displayed and once if not). This will tune the entire list of preset channels to provide rapid tuning when a preset is selected for use on the Comm page.

19.2.4.3 HF Radio Operation. For normal voice operation for both crewmembers, proceed as follows and see Figure 19-18.

NOTE

- If RADIO PWR switches are placed to ON after CMS PWR switch is selected to ON, a √ STATUS annunciator will appear on the CMS-CDU CRT.
- CMS operational checkout should be performed prior to radio operation to ensure GO status of CMS and radio systems. During HF radio operational checkout, note √ STATUS annunciations and ERROR messages generated. See Figures 19-7 and 19-8 respectively for definition and corrective action.

1. Select HF PWR switch—ON (allow 1.5-minute warm-up).

2. Select CMS PWR switch—ON.

NOTE

If KY-75 processor is installed, select PWR/FILL switch to one of the fill positions (1, 2, or 3), position the RMT/LOCAL/SIG CLR switch to LOCAL, and select PLAIN/CIPHER switch to PLAIN on the KY-75 control panel.

3. Connect headset to ICS disconnect.

4. Pull and turn HF monitor control to mid-range.

5. Turn ICS VOL control to mid-range.

6. Select COMM key–Comm page displayed.

NOTE

If HF RADIO PWR switch is not ON, the Comm page will display a √ next to the LS key selection (example: HF √). HF Radio Mode Control page will also show a √ next to the title (example: √ HF Radio).

7. Select HF Mode Control page (LS4)—HF Radio Mode Control page displayed. Setup HF Radio Mode Control page as desired:

(a) Select mode (LS2)—MODE: USB, LSB, AM, or CW.

(b) Select power output level (LS3)—HI, MED, LO.

(c) Select squelch level (slew switch)—MIN (minimum), 1–14, MAX (maximum).

8. Select COMM key—Comm page displayed.

9. Enter preset channel (LS4) or manual frequency (LS8).

NOTE

If TUNE HF annunicator displayed, select HF Radio Mode Control page and press LS4 once. TUNE:ON will be displayed while tuning sequence is in progress and the tuning annunciator will be displayed. When the tuning sequence is complete, the annunciator will disappear and TUNE:OFF will be displayed indicating that the radio is ready for transmit/receive operation on the selected frequency.

10. Select HF transmit select switch—ON.

11. Select microphone selector switch—XMIT

12. To secure HF radio turn HF RADIO PWR switch—OFF.

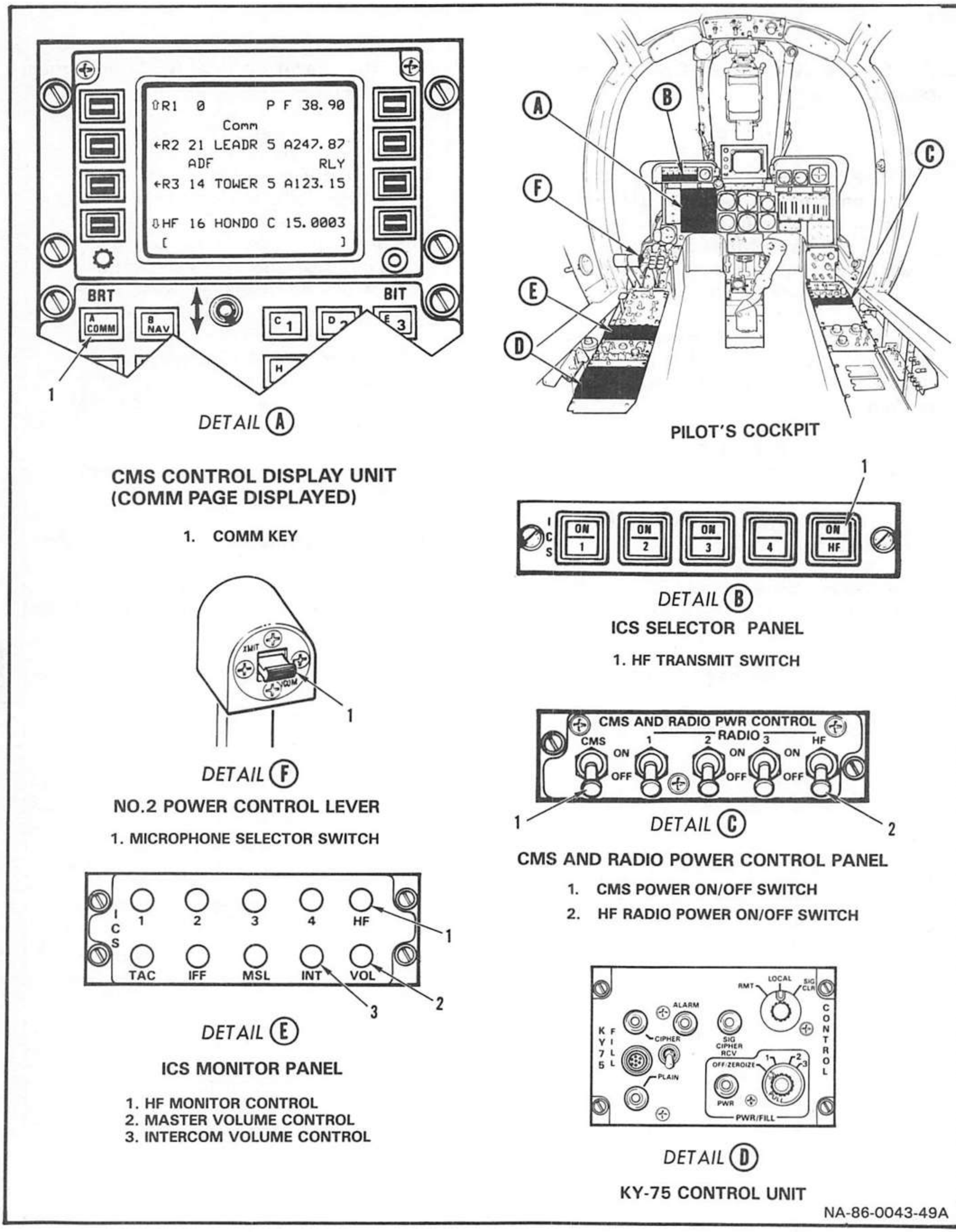
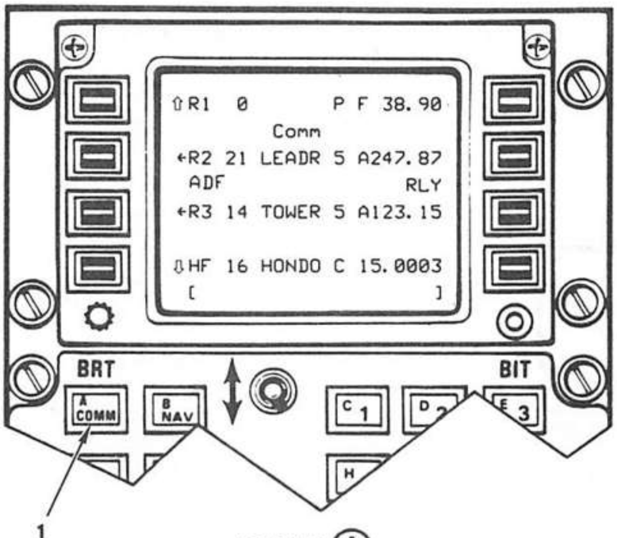


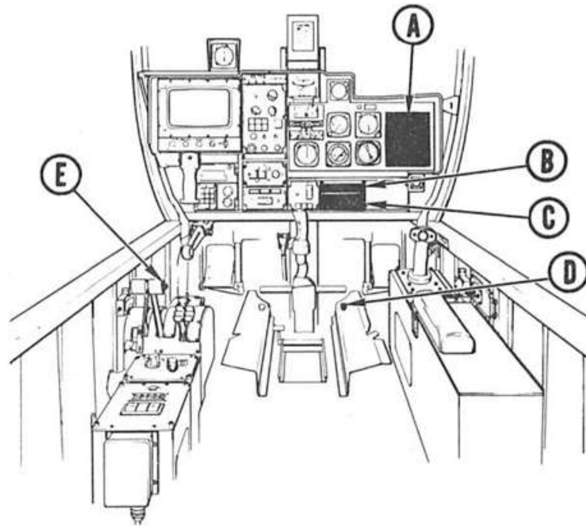
Figure 19-16. HF Radio Pilot's Cockpit Controls



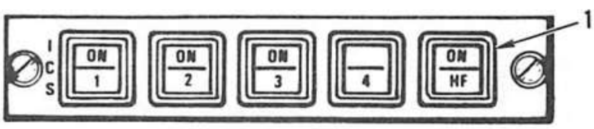
DETAIL (A)

CMS-CONTROL DISPLAY UNIT (COMM PAGE DISPLAYED)

1. COMM KEY



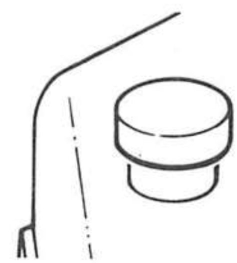
OBSERVER'S COCKPIT



DETAIL (B)

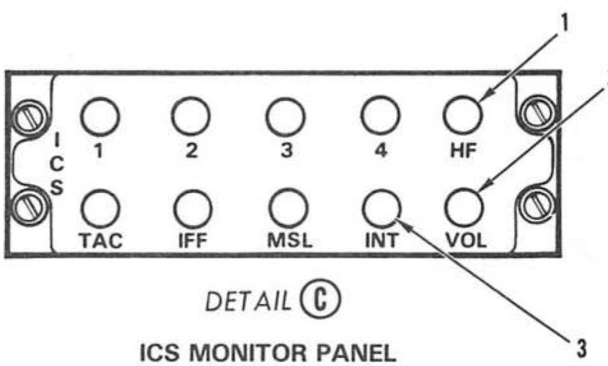
ICS SELECTOR PANEL

1. HF RADIO TRANSMIT SELECT SWITCH



DETAIL (D)

RADIO XMIT FOOT SWITCH



DETAIL (C)

ICS MONITOR PANEL

1. HF RADIO MONITOR CONTROL
2. MASTER VOLUME CONTROL
3. INTERCOM VOLUME CONTROL

DETAIL (E)

NO. 2 POWER CONTROL LEVER

1. MICROPHONE SELECTOR SWITCH

NA-86-0043-50A

Figure 19-17. HF Radio Observer's Cockpit Controls

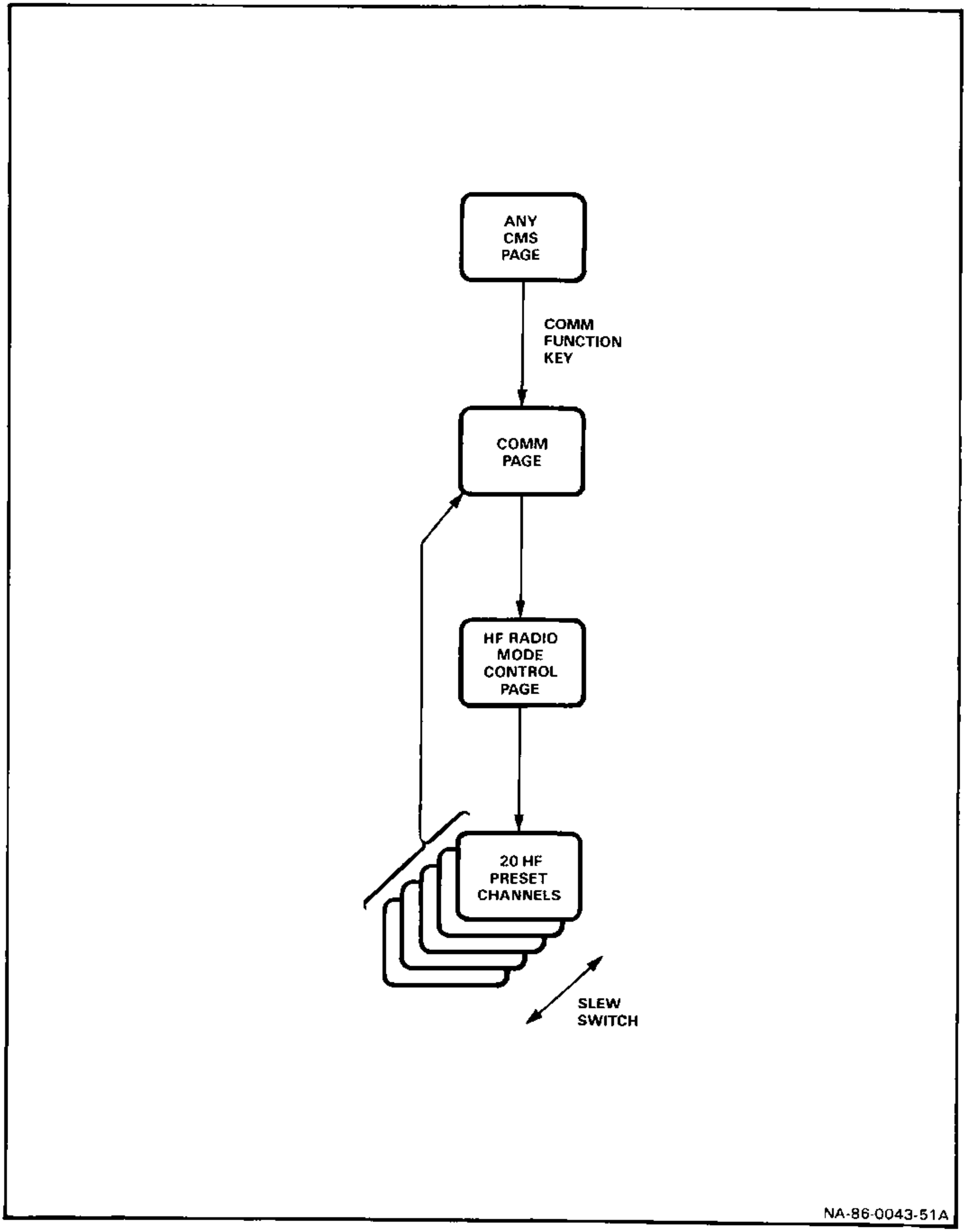
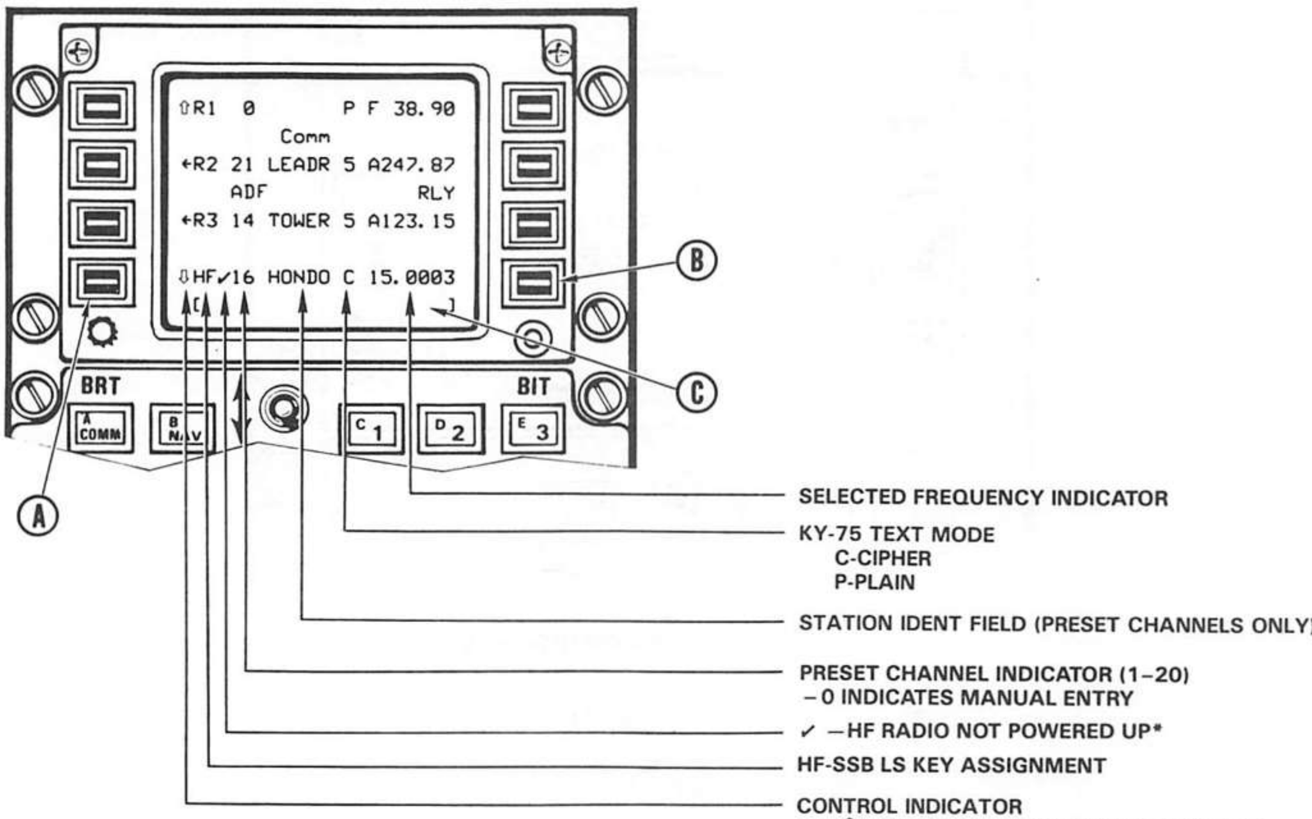


Figure 19-18. COMM Key Flow Chart and Page Displays for HF Radio (Sheet 1 of 4)



A. LS4 OPERATION AND OPTIONS

- WHEN SCRATCH PAD IS BLANK, PRESSING LS4 WILL CAUSE HF RADIO MODE CONTROL PAGE TO BE DISPLAYED REGARDLESS OF CONTROL INDICATOR.
- WHEN PRESET CHANNEL NUMBER (1–20) HAS BEEN ENTERED IN SCRATCH PAD, PRESSING LS4 WILL CAUSE RADIO TO BE TUNED TO ENTERED PRESET CHANNEL.

B. LS8 OPERATION AND OPTIONS

- WHEN FREQUENCY IS MANUALLY ENTERED IN SCRATCH PAD, PRESSING LS8 WILL CAUSE HF RADIO TO BE TUNED TO ENTERED FREQUENCY. PRESET CHANNEL INDICATOR WILL INDICATE 0 AND STATION IDENT FIELD WILL BE BLANK.
- WHEN SCRATCH PAD IS BLANK, PRESSING LS8 WILL CAUSE HF RADIO TO TUNE TO THE PREVIOUSLY SELECTED FREQUENCY.

C. SCRATCH PAD DISPLAY AREA

- WILL DISPLAY NUMBERS OR LETTERS ENTERED FROM ALPHANUMERIC KEYBOARD.

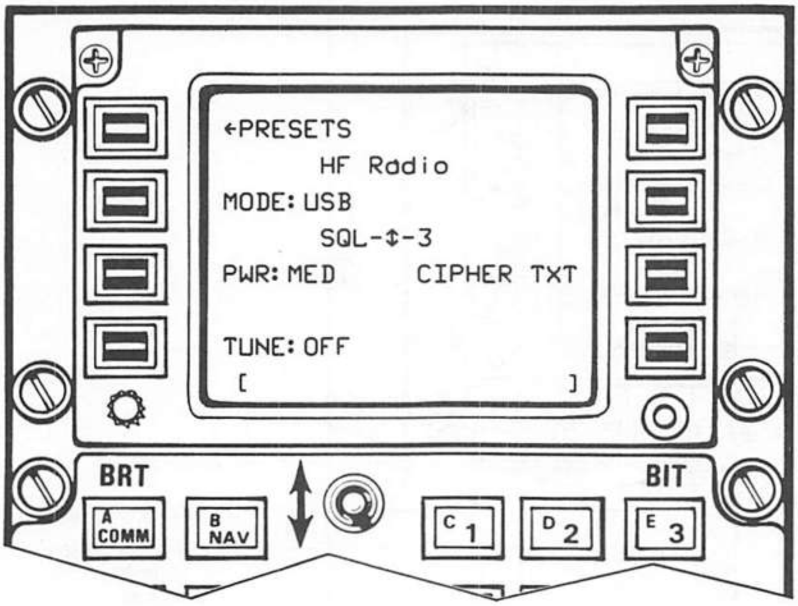
NOTE

- IF AN ERROR IS MADE WHEN ENTERING PRESET OR MANUAL FREQUENCIES IN THE SCRATCH PAD, THE CLR (CLEAR) KEY WILL CLEAR THE SCRATCH PAD FOR REENTRY. PRESSING CLR KEY ONCE WILL CLEAR THE LAST CHARACTER ENTERED, PRESSING THE CLEAR KEY TWICE WILL CLEAR THE ENTIRE SCRATCH PAD.
- IF AN INCOMPLETE MANUAL FREQUENCY IS ENTERED AND LS KEY SELECTION IS MADE, OR AN INCORRECT LS KEY SELECTION IS MADE, AN ERROR MESSAGE ("INVALID ENTRY") AND THE ERRONEOUS ENTRY WILL ALTERNATELY BE DISPLAYED IN THE SCRATCH PAD. THIS MAY BE CORRECTED BY ENTERING THE REMAINING NUMBERS FOR THE FREQUENCY AND RESELECTING THE LS KEY, SELECTING THE INTENDED LS KEY OR BY PRESSING THE CLR KEY.

* WILL ALSO APPEAR IN TITLE LINE OF HF RADIO MODE CONTROL PAGE.

NA-86-0043-52A

Figure 19-18. COMM Key Flow Chart and Page Displays for HF Radio (Sheet 2 of 4)



HF RADIO MODE CONTROL PAGE

LS1: GO TO HF PRESET PAGE 1 OF 5.

LS2: WHEN TOGGLED WILL SELECT AND DISPLAY HF RADIO OPERATING MODE:
- USB
- LSB
- AM
- CW

LS3: SELECT RADIO OUTPUT POWER
- HI
- MED
- LO

LS4: INITIATE HF TUNING CYCLE.
- WHEN "TUNE HF" ANNUNCIATOR DISPLAYED; ONE PRESS WILL TUNE SELECTED FREQUENCY ONLY. TWO PRESSES WILL TUNE ALL PRESET CHANNELS AND SELECTED FREQUENCY.

LS5: NO FUNCTION.

LS6: NO FUCTION.

LS7: NO FUNCTION, WILL DISPLAY KY-75 MODE.
- PLAIN:TXT
- CIPHER:TXT

LS8: NO FUNCTION.

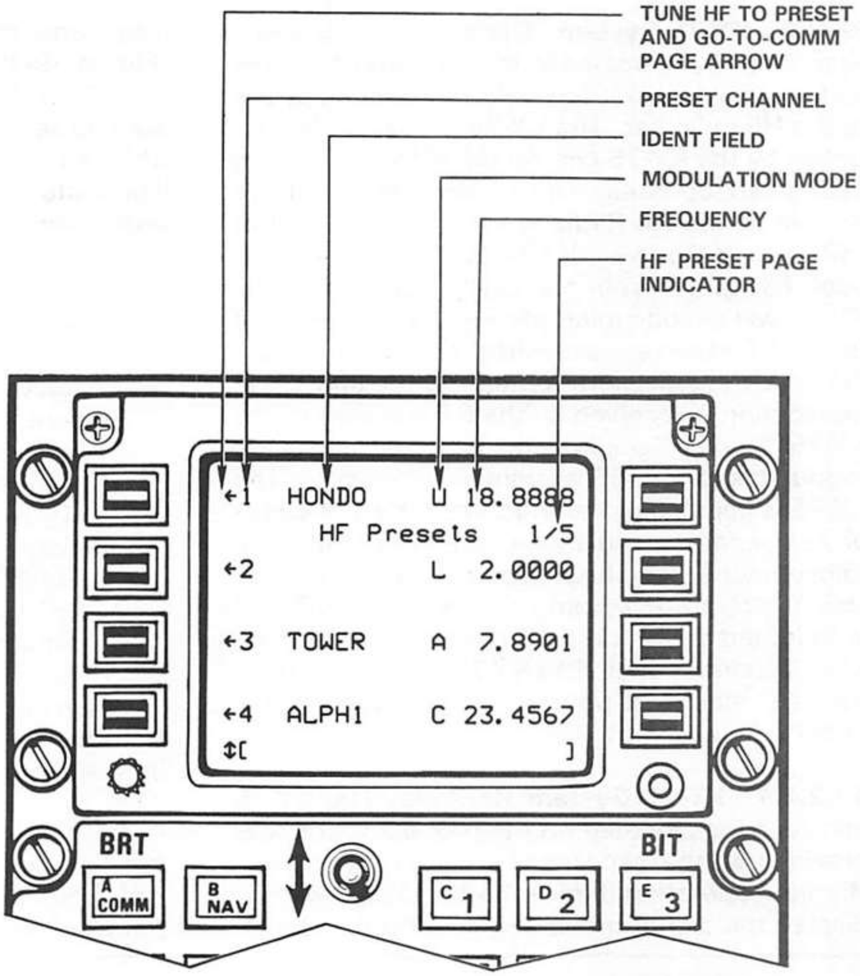
SLEW SWITCH: UP ACTION WILL INCREASE SQUELCH LEVEL, DOWN ACTION WILL DECREASE.
- MINIMUM, LEVEL 1 TO 14, AND MAXIMUM.

NA-86-0043-53A

Figure 19-18. COMM Key Flow Chart and Page Displays for HF Radio (Sheet 3 of 4)

PRESET CHANNELS–PRESET PAGE

1–4	1/5
5–8	2/5
9–12	3/5
13–16	4/5
17–20	5/5



HF RADIO PRESET PAGE 1/5
(TYPICAL)

LS1–
LS4: WHEN IDENTIFICATION IS ENTERED IN SCRATCH PAD, PRESSING LS1–LS4 WILL ENTER CHARACTERS IN IDENT FIELD. IF SCRATCH PAD IS BLANK, PRESSING LS1–LS4 WILL TUNE RADIO TO INDICATED PRESET CHANNEL (1–20) AND RETURN TO COMM PAGE.

LS5–
LS8: WHEN FREQUENCY AND/OR MODE (U,L,A, OR C) IS ENTERED IN SCRATCH PAD, PRESSING THIS KEY WILL ENTER INFORMATION IN PRESET FIELD.

U = UPPER SIDE BAND
L = LOWER SIDE BAND
A = AMPLITUDE MODULATION
C = CONTINUOUS WAVE

SLEW SWITCH: UP ACTION ON THE SWITCH WILL CAUSE PRESET PAGE 2/5 THROUGH 5/5 TO BE DISPLAYED. DOWN ACTION WILL CAUSE PREVIOUS PAGES TO BE DISPLAYED.

NA-86-0043-54A

Figure 19-18. COMM Key Flow Chart and Page Displays for HF Radio (Sheet 4 of 4)

19.2.5 KY-75 System. The secure voice processor, KY-75, is located in the forward cargo bay and provides encrypted voice communications to the HF radio set. The KY-75 processor is controlled by the KY-75 control panel located on the pilot's left console. The control panel allows control of the HF Radio KY-75 mode (PLAIN or CIPHER), KY-power, KY-zeroize function, and code filling. When in the cipher text mode, the KY-75 will encode microphone audio and send it to the HF receiver/transmitter (RT) for processing and transmission. When cipher text communication is received by the RT it is sent to the KY-75. The KY deciphers the ciphered-audio and routes this to the ICS system as plain voice. The KY-75 is capable of storing three different codes or net variables and these codes will be maintained once loaded by an internal battery regardless of aircraft power state unless OFF/ZEROIZE is selected with the PWR/FILL switch on the KY-75 control panel. The KY-75 system requires 28-VDC electrical power supplied by the secondary dc bus.

19.2.5.1 KY-75 System Controls. The KY-75 control panel, located on the pilot's left console, provides all the necessary controls for KY and HF radio operation (Figure 19-19). The CMS will display the cipher mode selected on the Comm page and the HF Radio Mode Control page (Figure 19-18). The PWR/FILL switch when set to 1, 2, or 3 applies power to the KY-75 processor and selects the storage location or code variable to be used. The PWR indicator will illuminate white when power is applied to the processor.

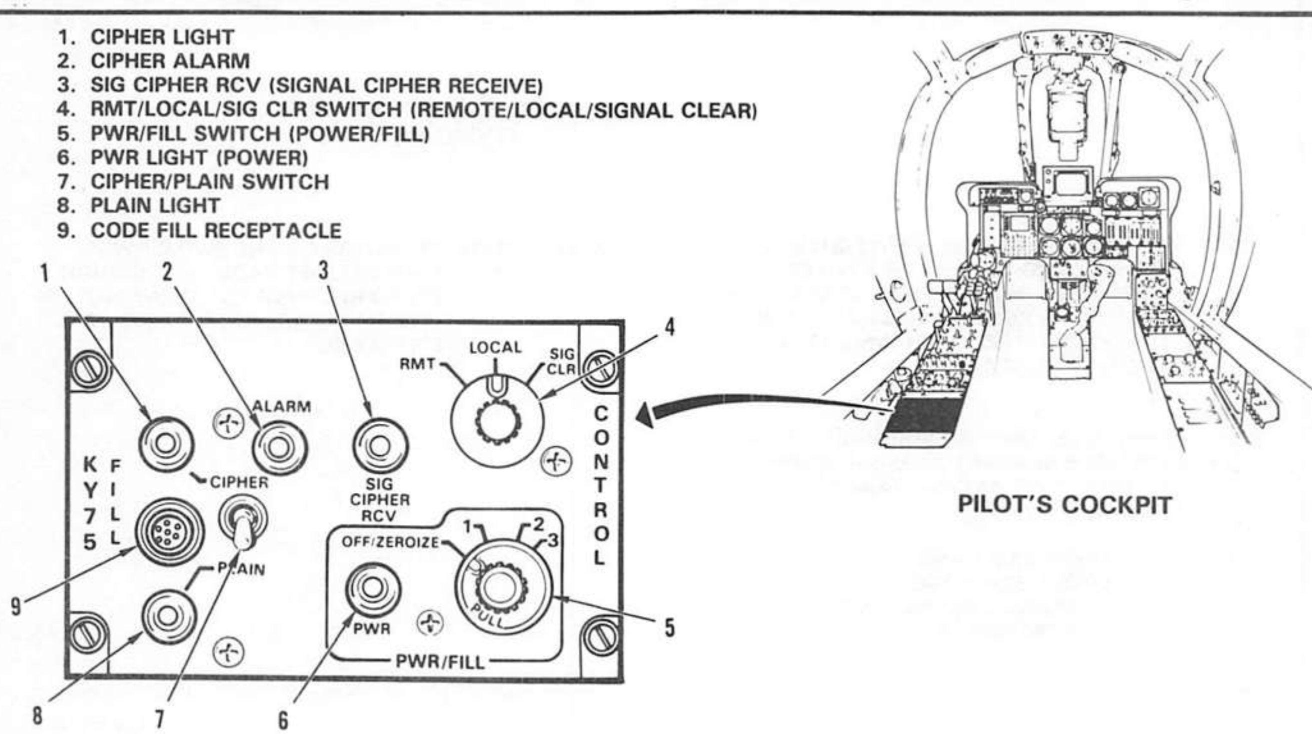
NOTE

With the KY-75 processor installed, the KY-75 control panel must be selected to one of the code positions (1, 2, or 3), the PLAIN/CIPHER switch selected to PLAIN, and LOCAL selected on the RMT/LOCAL/SIG CLR switch for normal plain voice communications. The ALARM, PWR, and PLAIN indicator lights will be illuminated continuously.

When set to OFF/ZEROIZE, power is removed from the KY-75 processor and the codes stored in positions 1, 2, or 3 are zeroed.

The RMT/LOCAL/SIG CLR switch is normally positioned to the LOCAL position to allow control from the KY-75 control panel. The RMT (remote) postion is not used. The signal clear

1. CIPHER LIGHT
2. CIPHER ALARM
3. SIG CIPHER RCV (SIGNAL CIPHER RECEIVE)
4. RMT/LOCAL/SIG CLR SWITCH (REMOTE/LOCAL/SIGNAL CLEAR)
5. PWR/FILL SWITCH (POWER/FILL)
6. PWR LIGHT (POWER)
7. CIPHER/PLAIN SWITCH
8. PLAIN LIGHT
9. CODE FILL RECEPTACLE



KY-75 CONTROL UNIT

PILOT'S COCKPIT

NA-86-0043-232

Figure 19-19. KY-75 Control Panel

(SIG CLR) position is used to clear the code memory for preparation of the fill operation when the coder device is attached. The amber KY-alarm light will illuminate if the KY is selected ON with no codes loaded or the loaded codes are zeroed when SIG CLR is selected.

When the CIPHER-PLAIN switch is in the PLAIN position the amber PLAIN indicator light will illuminate indicating the KY-processor is ready for plain voice transmission and reception. In addition, when the proper code is loaded in the KY-75 processor, all HF cipher transmissions will be received and heard as plain voice. In the CIPHER position, all transmissions will be in cipher and indicated by the green CIPHER light. In either switch position (PLAIN or CIPHER), both plain and cipher messages may be received. To determine which received audio was originally cipher audio, the blue signal cipher receive (SIG CIPHER RCV) indicator light will come on continuously when a plain voice message is received and will flash when a cipher message is received.

19.2.5.2 KY-75 System Operation. To transmit and receive cipher text on the HF radio proceed as follows:

1. Assure CMS and HF Status are GO.

NOTE

If loading of KY-75 is not required proceed to step 6.

2. PWR/FILL switch—Select 1, 2, or 3 as desired, Observe PWR light ON, ALARM light ON, and PLAIN or CIPHER light ON (depending on switch positon).

3. CIPHER-PLAIN switch to CIPHER—ALARM light ON and CMS Comm Page and HF Radio Mode Control page displays C and CIPHER TXT mode respectively.

4. Momentarily select SIG CLR—Code memory cleared, return switch to LOCAL postion.

5. PWR/FILL switch in desired code fill position (1, 2, or 3)—Attach loading device to fill receptacle and load code(s)—ALARM light OFF.

6. Ensure CIPHER/PLAIN switch in CIPHER—CIPHER light ON, ALARM light OFF, PWR light ON.

7. Select CMS COMM key—Comm page displayed.

8. Insert preset or manual secure voice operating HF frequency.

9. HF transmit select switch to ON—Keying of microphone Radio XMIT switch permits cipher transmission, all received audio plain or cipher will be heard.

NOTE

The CMS monitors cipher text mode for all radios. If a radio is selected for transmit in CIPHER TEXT mode and any other radio is selected by the same operator to transmit in the plain text mode, a secure voice violation exists. When a secure voice violation exists the CMS-CDU will display SECURE VOICE annunciator and the ON indication of selected radios on the ICS selector panel will flash. The CMS will send a cipher-off command to the HF bypass relay, which in turn disables cipher operation and permits only plain voice operation. To resume cipher operation, the ICS transmit select switches must be properly set for the radios in conflict, the CDU CLR key pressed, and the PLAIN/CIPHER switch set to PLAIN and back to CIPHER.

10. For plain voice communication, select PLAIN/CIPHER switch to PLAIN—All received audio (plain or cipher) will be heard but transmissions will be in plain voice.

11. To secure KY-75 system and zero codes—Position the PWR/FILL switch to OFF/ZEROIZE.

(a) To retain codes—Shut off aircraft electrical power with the PWR/FILL switch in the present code variable position (1, 2, or 3).

19.3 NAVIGATION SYSTEMS

Airborne navigation information is available from several sources providing the pilot and observer with accurate aircraft bearing, heading, position, and fixed-target/checkpoint navigation data. ADF and TACAN relative bearing information, controlled through the CMS, is displayed on the pilot's and observer's BDHIs. ADF beacon signals are received by the UHF-ADF AN/ARA-50 antenna system, processed by Radio No. 1, and displayed as a bearing point by the No. 1 needle. TACAN range and bearing information from ground or airborne TACAN stations is received by the AN/ARN-118(V) TACAN set and displayed on the No. 2 needle and BDHI range indicator. Compensated magnetic heading information, determined by the AN/ASN-75 compass system, is displayed on the compass card of the BDHI for aircraft heading and provided to the AN/APN-233 doppler navigation system for reference. The doppler system combines the doppler velocity signals, compensated compass heading, and pitch-and-roll rate and mathematically computes and predicts aircraft position, target, and checkpoint data in latitude/ longitude or Universal Transverse Mercator (UTM) coordinates. Radar altitude information from 0 to 5000 feet is a function of the AN/APN-171(V) radar altimeter system.

19.3.1 UHF Automatic Direction Finding System, AN/ARA-50. The UHF direction finder, AN/ARA-50, is a radio direction finder signal sensing and bearing data generating group that works in conjunction with Radio 1, AN/ARC-182 receiver. It is selectable from the Radio 1 Mode Control page. ADF navigation beacon signals are received by the Radio 1 receiver and AN/ ARA-50 direction finder system in the UHF frequency range (from 225.00 to 399.97 MHz) and the direction finder determines the relative bearing of the beacon signals. This bearing data is displayed on both BDHI's No. 1 needle. Radio 1 turns ON the ADF system when commanded by either CMS-CDU. While in the ADF mode, if Radio 1 is used for transmission (Radio 1 transmit select switch ON and microphone switch keyed) a UHF transmit relay will energize and disable ADF operation. When the mic switch is released, ADF operation will resume. Both BDHI needles will point to the received beacon (BDHI No. 2 needle will be slaved to No. 1 needle) if the TACAN system is OFF. If TACAN is ON, BDHI No. 1 needle will provide the only indication of ADF bearing. The BDHI average indicating speed is 60 degrees per second under normal operating conditions. Bearing accuracy is ±5 degrees under service conditions and indication lag should be less than 5 degrees for a standard 2-minute turn. After lock-on the needle should not hunt more than ±1 degree in straight and level flight. If a frequency of less than 88 MHz is selcted for ADF use, an error message "out of ADF range" will be displayed in the CDU scratch pad. Primary 28-VDC electrical power is provided by the primary dc bus, 115 VAC from the primary ac bus, and 26-VAC BDHI needle power from the instrument bus.

19.3.1.1 UHF-ADF Operation. Refer to paragraph 19.2.2.2.2 in this chapter.

19.3.2 TACAN Navigation Set, AN/ARN-118(V). The AN/ARN-118(V) TACAN navigation set is used to determine relative bearing and slant range distance to a TACAN ground station or a similar TACAN-equipped aircraft. The TACAN system operates in the ultra-high frequency (UHF) band from 962 megahertz (MHz) to 1213 MHz. Operation is limited to line of sight, depending on aircraft altitude and ground terrain. Maximum range is 390 nautical miles (nm) when the TACAN station is a surface beacon or 200 nm when the TACAN station is an airborne beacon. There are 126 X-channels and 126 Y-channels spaced at 1-MHz intervals, for a total of 252 channels available. The TACAN system operates at altitudes up to 70,000 feet. The TACAN system is controlled by the CMS Nav page. Bearing and range are indicated on the pilot's and observer's bearing-distance-heading indicator (BDHI). The TACAN system receives 115-VAC electrical power from the primary ac bus, 26-VAC power from the instrument bus and 28 VDC from the NO. 1 monitor bus and the primary dc bus.

The TACAN system operates in five different modes. These are: (1) receive (REC); (2) transmit-receive (T/R); (3) air-to-air receive (A/A REC); (4) air-to-air transmit-receive (A/A T/R); and (5) self-test. When REC is selected, bearing information to the selected ground station will be displayed. When T/R is selected, bearing and distance information to the selected ground station will be displayed. During REC and T/R operation, a three-letter morse code, station-identification, signal is received once every 30 seconds. TACAN audio allows the pilot to verify that the TACAN information received is the proper station. Garbled or unreadable TACAN audio indicates that the TACAN has a poor lock-on and received information may not be valid.

Before the TACAN can be operated in an air-to-air mode, communications with the other aircraft must be established and both TACAN systems set 63 channels apart. For example, if the cooperating aircraft is operating on channel 15Y with A/A T/R selected, the TACAN must be set to channel 78Y with A/A T/R selected. The 63-channel spacing simulates the spacing between transmit and receive frequencies when a ground station is used. Normally only distance information between two aircraft is available for display on the BDHI.

When operating with specially equipped aircraft that are capable of simulating a ground-based TACAN station while airborne (bearing and range information available). The A/A T/R and A/A REC modes may be used. With A/A REC selected, relative bearing to the specially equipped aircraft would be displayed. With A/A T/R selected, relative bearing and range are indicated.

There are two types of self-tests available, manual and automatic. Manual self-test provides the operator with a confidence test of the system. Automatic self-test ensures correct operation if a signal is lost or becomes unreliable.

19.3.2.1 TACAN Controls and Indicators. The controls and indicators for the TACAN system, consist of: CMS Power, Nav, and Nav Test pages; the pilot's and observers BDHI; and the pilot's and observer's ICS monitor panels, TAC control.

19.3.2.1.1 Power Page. The Power page is used to turn TACAN power ON and OFF. Refer to paragraph 19.1.5.1 and see Figure 19-10 in this chapter for Power page access and operation.

19.3.2.1.2 Nav Page. The Nav page is accessed using the NAV function select Key. From the Nav page, the operator selects mode, channel and may also select power ON and OFF. (Figure 19-21).

19.3.2.1.3 Nav Test Page. The Nav Test page is used to initiate a confidence test of the TACAN system. Refer to paragraph 19.1.5.3 and see Figure 19-10 in this chapter for Nav Test page access and operation.

19.3.2.1.4 Bearing-Distance-Heading Indicator (BDHI), ID-663 D/U. There is one BDHI located on the instrument panel in each cockpit. Each BDHI provides a heading card, No. 1 and No. 2 bearing needles, and a digital distance (range) indicator. The No. 1 needle reflects UHF/ADF bearing. The No. 2 needle reflects TACAN bearing. With either ADF or TACAN selected, but not both, the No. 1 and No. 2 needles will be slaved to each other. The distance indicator displays slant range distance to TACAN surface beacons in the REC or T/R modes, or line-of-sight distance to TACAN-equipped aircraft in the A/A modes. An OFF flag will cover the distance indicator if TACAN range is not available or determined invalid by the TACAN system.

19.3.2.1.5 ICS Monitor Panel, TAC Control. The TAC control is located on the ICS monitor panel, in the pilot's left-hand console, and in the observer's lower instrument panel. When pulled out, TACAN station identification audio is sent to the headset. When rotated, it adjusts the volume level of TACAN audio.

19.3.2.2 TACAN Operation. TACAN operation consists of preflight check, normal navigation, and air-to-air operation.

19.3.2.2.1 Preflight Check. To perform a preflight check of the TACAN system, proceed as follows.

NOTE

CMS operational checkout should be performed prior to TACAN operation to ensure GO status of CMS system.

1. On CMS-CDU, select NAV key—Nav page displayed

2. On Nav page, press LS5—ON:PWR displayed.

3. After 90-second warm-up time, select T/R mode (LS2)—TACAN:T/R displayed.

4. On CMS-CDU, press IDX key—Index page displayed.

5. On Index page, press LS5—Test Index page displayed.

6. On Test Index page, Press LS2—Nav Test page displayed.

7. Perform TACAN test as follows:

NOTE

A distance indication 300.0 is equal to a negative 0.01 nm and 399.5 is equal to a negative 0.5 nm. The 300.0 and 399.5 indications are not malfunctions but an indication of negative distances.

(a) Press LS2—TACAN:ON displayed.

(b) On the BDHI, observe the following indications:

(1) During the first 7 seconds, the No. 2 needle slews to 270 degrees and the distance OFF flag is in view.

(2) During the next 15 seconds, the OFF flag goes out of view, the distance indicator reads 000.0 (±0.5), and the No. 2 needle indicates 180 (±3) degrees.

(3) After approximately 15 seconds, the OFF flag will reappear, the No. 2 needle will break lock and start to slew in a clockwise direction.

(c) On the Nav Test page, observe that TACAN:GO is displayed.

19.3.2.2.2 Normal Navigation. To receive TACAN bearing and/or range information to a TACAN ground beacon, proceed as follows:

1. On CMS-CDU, press NAV function key—Nav page displayed.

2. Select mode (LS2)—TACAN: REC or T/R.

3. Using keyboard, enter new channel number (1-126) and channel letter (X or Y) into scratch pad.

NOTE

- If changing from an X-channel to another X-channel, or from a Y-channel to another Y-channel, only the channel number need be entered into the scratch pad.

- If changing from an X-channel to a Y-channel of the same number, only the X or the Y need be entered into the scratch pad.

4. Press LS6—Channel from scratch pad is displayed adjacent to LS6 and bearing and range indications on BDHI break lock-on.

5. Observe bearing and distance indications on BDHI.

(a) Within 2 seconds, OFF flag is removed from distance indicator and distance to selected TACAN station is displayed.

(b) Within 5 seconds, No. 2 needle on BDHI is locked-on to bearing of selected TACAN station ± 1 degree.

6. On ICS monitor panel, pull TAC control and rotate to desired volume level.

(a) After 30 seconds, TACAN identification audio should be heard in headset.

(b) Verify code is that of station selected.

19.3.2.2.3 Air-to-Air Operation. To operate the TACAN system in the A/A mode, with a suitably TACAN equipped aircraft, proceed as follows.

NOTE

- To receive bearing information in the A/A REC or A/A T/R modes requires a cooperating aircraft that is equipped with a TACAN system capable of producing bearing information. The AN/ARN-118(V) TACAN is not capable of producing or transmitting bearing information.
- During A/A modes operation, the ADF function of Radio 1 may be selected and used periodically to determine bearing to cooperating aircraft.
- In all TACAN systems there is the possibility of interference from the IFF transponder and DME signals when operating in the A/A modes. In order to minimize the possibility of interference, it is recommended that Y-channels are used and that channels 1 through 11, 58 through 74, and 121 through 126 should be avoided.

1. On CMS-CDU, press NAV function key—Nav page displayed.

2. Select mode (LS2)—TACAN: A/A REC or A/A T/R

3. Establish communications with cooperating aircraft and choose operating channels. Assure that a 63-channel separation exists between aircraft.

4. Using keyboard, enter new channel number (1–126) and channel letter (X or Y) into scratch pad.

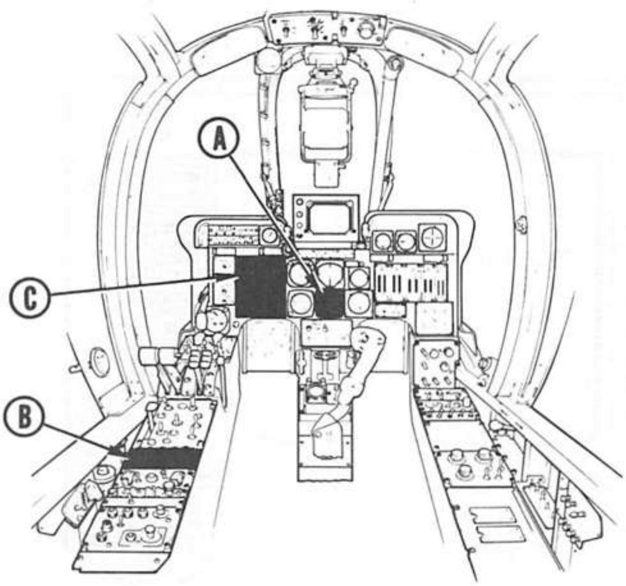
5. Press LS6—channel from scratch pad is displayed adjacent to LS6.

6. Observe bearing and distance indications on BDHI.

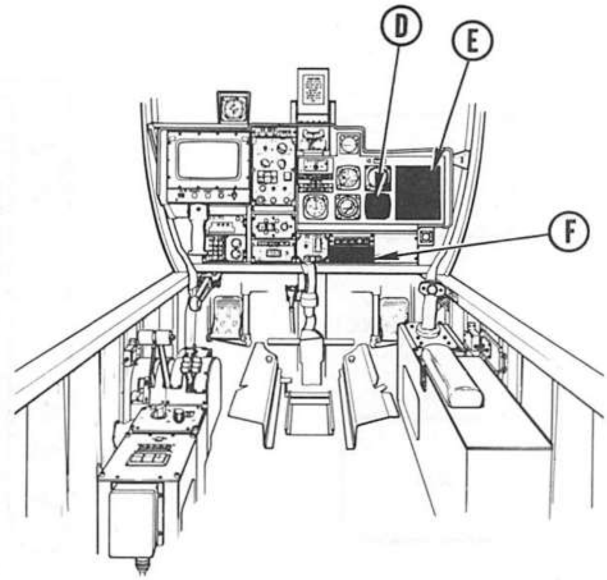
(a) If in A/A T/R, within 2 seconds, OFF flag is removed from distance indicator and distance to cooperating aircraft is displayed.

(b) If cooperating aircraft is producing bearing information, within 5 seconds, No. 2 needle on BDHI is locked-on to bearing of the cooperating aircraft + 1 degree.

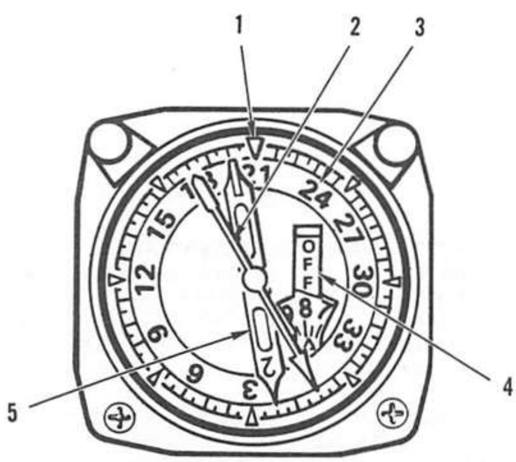
19.3.3 Doppler Navigation System, AN/APN-233. The doppler navigation system (DNS) is a doppler velocity sensor and navigation system. The system consists of a computer display unit (CDU), a multipurpose indicator (MPI), and a receiver-transmitter-antenna (RTA) assembly. See Figure 19-23 for block diagram. Using inputs from the compass system (AN/ASN-75) and the vertical gyro indicating system (MD-1), the DNS provides position information in latitude and longitude (L/L) or universal transverse mercator (UTM) coordinates. Navigation information including bearing, range, steering, and estimated time enroute to preset checkpoints is displayed on the CDU and the MPI (Figure 19-22).



PILOT'S COCKPIT



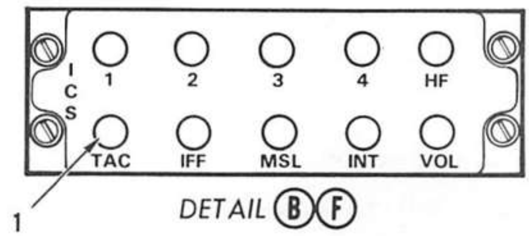
OBSERVER'S COCKPIT



DETAIL (A)(D)

BEARING-DISTANCE-HEADING INDICATOR

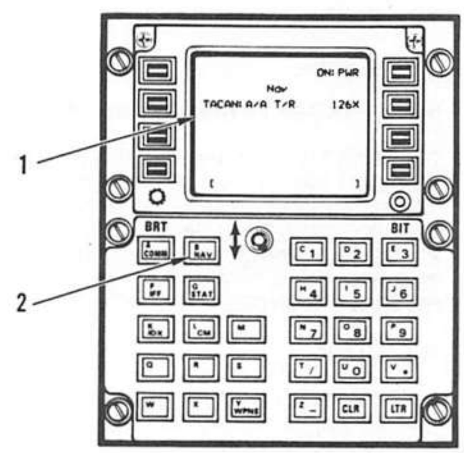
1. TOP (HEADING) INDEX
2. NO. 1 (ADF) POINTER
3. ROTATING COMPASS CARD
4. DISTANCE INDICATOR AND WARNING FLAG
5. NO. 2 (TACAN) POINTER



DETAIL (B)(F)

ICS MONITOR PANEL

1. TAC CONTROL



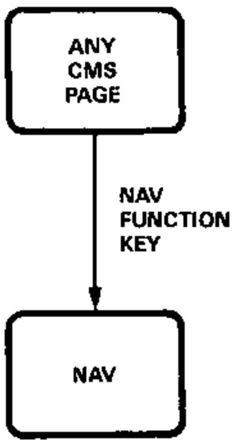
DETAIL (C)(E)

CMS CONTROL DISPLAY UNIT

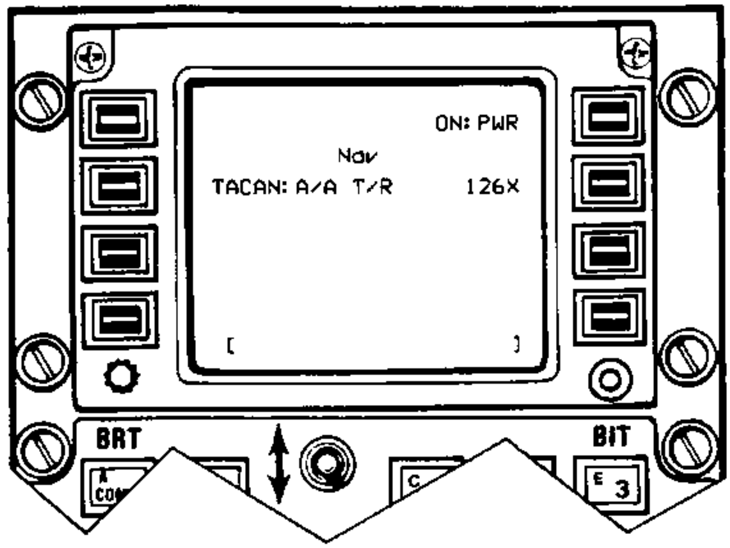
1. NAV PAGE DISPLAY
2. NAV FUNCTION KEY

NA-86-0043-55A

Figure 19-20. TACAN, AN/ARN-118 (V), Controls and Indicators



NAV KEY FLOW CHART



NAV PAGE

LS1: NO ACTION.

LS2: SELECT TACAN MODES
- REC
- T/R
- A/A REC
- A/A T/R

LS3: NO ACTION.

LS4: NO ACTION.

LS5: SELECT TACAN POWER ON AND OFF.

LS6: PRESSING THIS KEY WITH NEW CHANNEL IN SCRATCH PAD (1–126, X OR Y) WILL TUNE TACAN TO NEW CHANNEL. THE REPLACED CHANNEL WILL BE STORED IN MEMORY. PRESSING THIS KEY WITH A BLANK SCRATCH PAD WILL TUNE TACAN TO PREVIOUSLY REPLACED CHANNEL FROM MEMORY.

LS7: NO ACTION.

LS8: NO ACTION.

SLEW SWITCH: NO ACTION.

NOTE

- IF CHANGING FROM AN X CHANNEL TO ANOTHER X CHANNEL, OR FROM A Y CHANNEL TO ANOTHER Y CHANNEL, ONLY THE CHANNEL NUMBER NEED BE ENTERED INTO THE SCRATCH PAD.
- IF CHANGING FROM AN X CHANNEL TO A Y CHANNEL OF THE SAME NUMBER, ONLY THE X OR THE Y NEED BE ENTERED INTO THE SCRATCH PAD.

N-86-0043-56A

Figure 19-21. NAV Key Flow Chart and Page Display

19.3.3.1 Doppler CDU Controls and Displays. All CDU controls and displays are described in the following paragraphs (Figure 19-22).

19.3.3.1.1 CDU Mode Selector Switch. The mode selector switch positions and functions are as follows:

POSITION	FUNCTION
OFF	System inoperative, non-volatile memory powered by an internal battery.
TEST	Permits the operator to perform a display lights test. If a malfunction occurs (MAL indicator comes on) a diagnostic message will appear on the alphanumeric display indicating the nature of the fault. Navigation is not interrupted in this mode.
AD	Radar silence mode, transmitter is inhibited. Navigation data is updated using the last valid doppler information in memory. MEM indicator will be on. Position information continues to update, but will deteriorate over time in this mode.
LAND	Selected for operation over land.
SEA	Selected for operation over water.

19.3.3.1.2 CDU Function/Display Selector Switch. The function/display selector switch positions and functions are as follows:

POSITION	FUNCTION
UTM-L/L	Allows operator to select L/L or one of seven UTM spheroids.
VAR	Displays the magnetic variation of the aircraft present position.
CHKPT	Allows up to ten checkpoints to be displayed or entered in UTM or latitude/longitude coordinates.
POS	Present position is displayed in the selected coordinate system.
BRG-RNG	Displays bearing (magnetic) and range (nautical miles) to the selected checkpoint.
CRS-DOC	Displays true course and distance off course to the selected checkpoint.
TRK-GS	Displays the true ground track angle and ground speed of the aircraft in knots.
ETE	Displays estimated time enroute in hours and minutes from present position to the destination checkpoint.
WIND	Inoperative. True airspeed not available for wind computation.
TGT	Allows storage and display of up to ten targets of opportunity in the computers non-volatile memory. The targets may be displayed in UTM or L/L depending on mode selected. Any one of the targets can be transferred to checkpoint numbers 6, 7, 8, or 9 for navigation purposes.

19.3.3.1.3 CDU Alphanumeric Display Dim Control. The DIM control adjusts the brightness of the alphanumeric display.

19.3.3.1.4 CDU Alphanumeric Display. The alphanumeric display shows all selected or entered data.

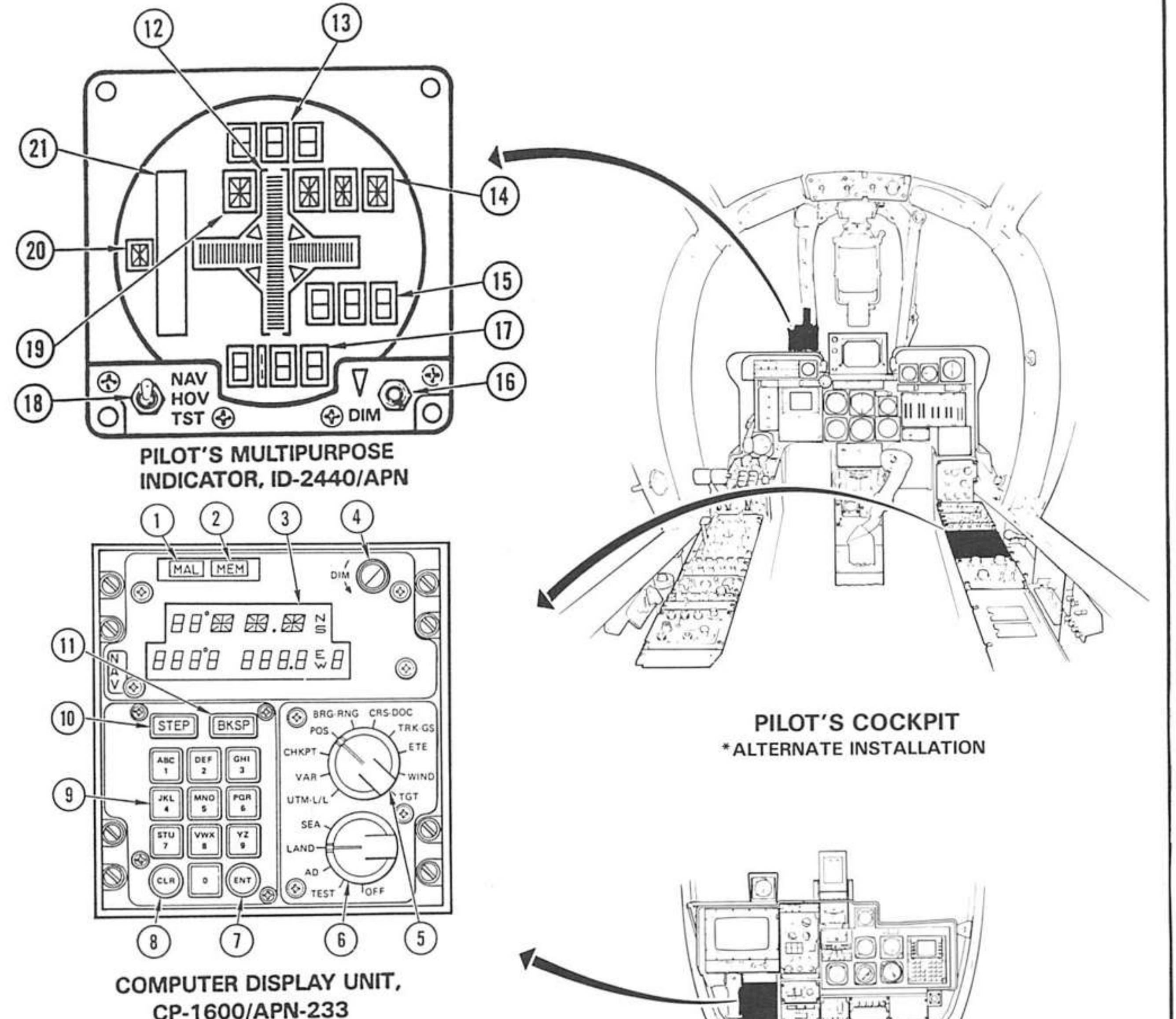
19.3.3.1.5 CDU MEM (Memory) Indicator. The memory (MEM) indicator ON indicates a loss of doppler velocity data. With the MEM indicator ON the computer will continue to compute navigational data using the last valid data in memory. Data will deteriorate over time and should be checked periodically. If the AD mode (radar silence) is selected on the mode selector switch, the MEM indicator will come on due to loss of velocity data from the RTA. When flying over extremely flat surfaces or in unusual attitudes, the MEM indicator may come on due to reduced radar reflections. The MEM indicator will always be ON when the aircraft is on the ground.

19.3.3.1.6 CDU MAL (Malfunction) Indicator. The malfunction (MAL) indicator ON indicates that a failure has been detected. The operator must then select the TEST position on the mode selector switch to determine the nature of the failure. Only one malfunction may be displayed. If more than one fault exists, the fault with the highest priority will be displayed. Selecting the TEST mode results in a diagnostic display in the alphanumeric display which advises the operator of system status and degree of reliability. The malfunction priority displays, and the resulting system status are as follows (see Figure 19-24):

DISPLAY/ PRIORITY	SYSTEM STATUS
1. CD	Navigational data may still be usable, but not reliable. Validity of present position and bearing/ range should be checked periodically.
2. HDG	System inoperative, do not use.
3. DVS	System transfers automatically to the best reversion mode. Computer continues to compute using the part of the RTA data that is still valid.
4. DVB	System transfers automatically to air data mode and accuracy deteriorates over time.
5. P/R	Slight accuracy degradation. Computer substitutes level pitch and roll for missing vertical reference data. May be intermittent.
6. TAS	(Deleted.)
7. TMP	Slight accuracy degradation. Computer substitutes 41 °C for invalid antenna temperature data.
8. AUX	System may be functional but auxiliary output has failed. (MPI display data may be absent or erroneous.)
9. BAT	Normal operation. CDU battery should be replaced after flight.
10. BSC	Antenna boresight data is incorrect. Boresight data is transmitted only during first 2 seconds after power is applied. Operator may recycle power once in an effort to clear failure.
11. DVN	Accuracy degradation dependent upon compass deviation errors. Zero deviation is substituted for all heading octants.

NOTE

This message (DVN) usually indicates that the battery or CDU has been replaced without reprogramming the magnetic compass deviation. Reprogram before flight.



1. MALFUNCTION INDICATOR
2. MEMORY INDICATOR
3. ALPHANUMERIC DISPLAY
4. ALPHANUMERIC DISPLAY DIMMING CONTROL
5. FUNCTION/DISPLAY SELECTOR SWITCH
6. MODE SELECTOR SWITCH
7. CLEAR KEY
8. ENTER KEY
9. ALPHANUMERIC KEYBOARD
10. STEP KEY
11. BKSP (BACKSTEP) KEY
12. X-Y/BULLSEYE GRAPHIC DISPLAY
13. COMMAND HEADING DISPLAY
14. GROUNDSPEED/STATUS/RIGHT TURN DISPLAY
15. RANGE DISPLAY
16. DIM SWITCH
17. ESTIMATED TIME ENROUTE DISPLAY
18. NAV/HOV/TST SWITCH
19. LEFT TURN ARROW DISPLAY
20. VERTICAL VELOCITY BAR
21. VERTICAL VELOCITY CENTER SYMBOL

N10/90
NA-86-0043-21B

Figure 19-22. Doppler Navigation System Computer Display Unit (DOP NAV CDU)

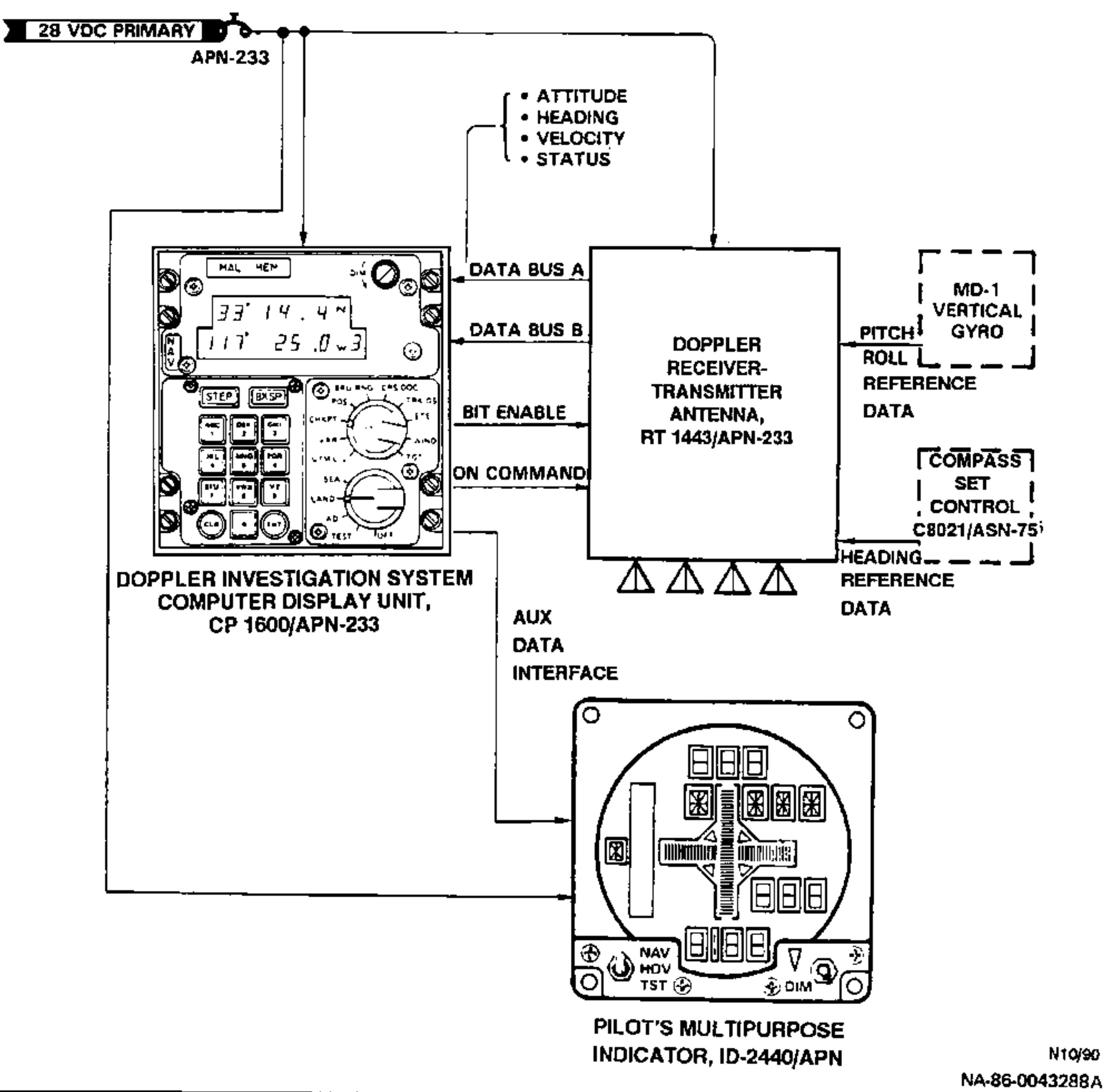
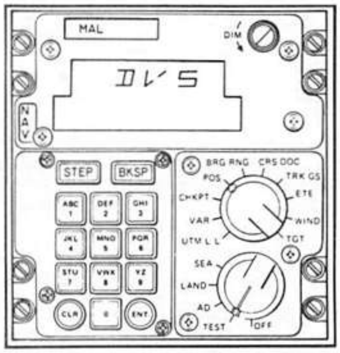
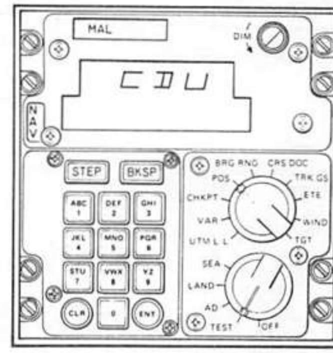


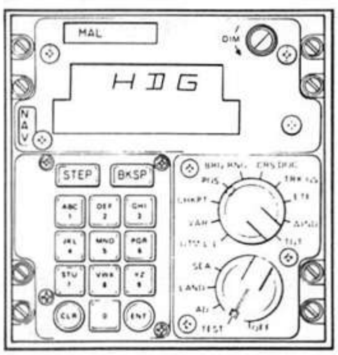
Figure 19-23. Doppler Navigation System Signal Flow



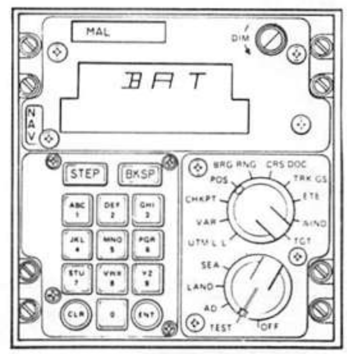
NAV ACCURACY LOSS
DUE TO RTA DATA LOSS



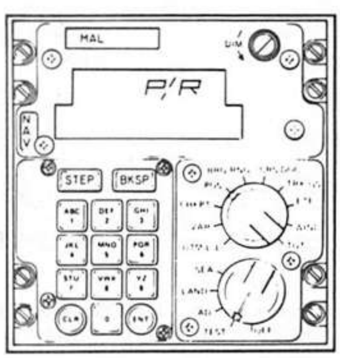
NAV DATA NOT RELIABLE
BUT MAY STILL BE USED



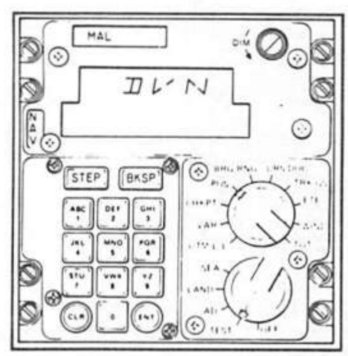
NO NAVIGATION POSSIBLE



NAV NORMAL, BATTERY
SHOULD BE REPLACED



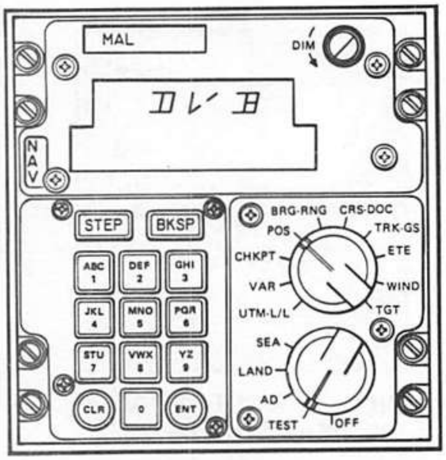
SLIGHT ACCURACY LOSS
DUE TO PITCH/ROLL ERRORS.
COMPUTER SUBSTITUTES
LEVEL PITCH AND ROLL FOR
VERTICAL REFERENCE DATA



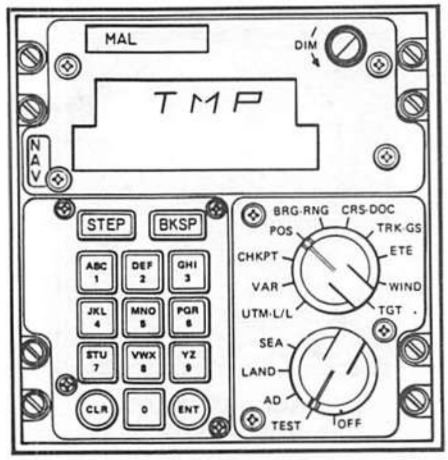
ACCURACY LOSS DUE TO
COMPASS DEVIATION ERRORS.
ZERO DEVIATION FOR ALL
HEADING OCTANTS.
REPROGRAM DEVIATION
TABLE BEFORE FLIGHT.

NA-86-0043-234

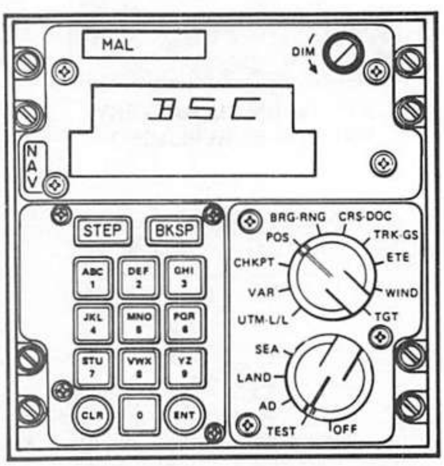
Figure 19-24. Doppler CDU Test Malfunction Displays (Sheet 1 of 2)



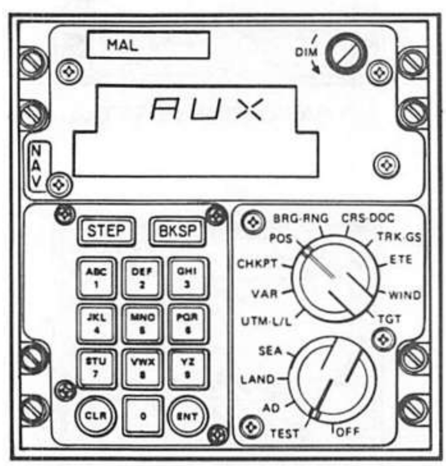
SYSTEM INOPERATIVE.
DO NOT USE



ACCURACY DEGRADED
STANDARD TEMPERATURE
VALUE (41 °C) BEING USED
BY SYSTEM



ANTENNA BORESIGHT DATA
IS INCORRECT. SYSTEM SUBSTITUTES
NOMINAL BORESIGHT CORRECTION
DATA



NORMAL OPERATION MAY BE
POSSIBLE BUT AUXILIARY
OUTPUT HAS FAILED

NA-86-0043-235A

Figure 19-24. Doppler CDU Test Malfunction Displays (Sheet 2 of 2)

19.3.3.1.7 CDU STEP Switch. The STEP switch permits the selection of target number, checkpoint number, L/L, or one of seven UTM spheroids. It is also used to select the desired alphabet character from the set of three on the alphabet keys of the keyboard.

19.3.3.1.8 CDU Backstep (BKSP) Switch. The BKSP switch has the same function as the STEP switch but in a reverse direction. The BKSP switch is also used to erase the last digit of an entry error prior to actuating the enter (ENT) switch light.

19.3.3.1.9 CDU Keyboard. The keyboard has 10 alphanumeric keys. The keys are used in conjunction with the STEP and BKSP switches for data entry.

19.3.3.1.10 CDU Clear (CLR) Switch. Depressing the CLR switch erases an entire message prior to being entered into the computer. The information erased will be replaced with the information previously entered.

19.3.3.1.11 CDU Enter (ENT) Switch Light. The ENT switch light is used to enter data into the computer memory. The switch will not function until armed by the computer (switch light on). In the entry modes, the switch light is not armed until sufficient characters have been entered (except TGT mode, as soon as TGT mode is entered the switch is armed). The ENT switch light is not functional in the following modes; BRG-RNG, TRK-GS, and ETE.

19.3.3.2 Multipurpose Indicator (MPI), ID-2440/APN. The multipurpose indicator (MPI) is an all solid-state navigation display instrument that is third-generation, night-vision goggle compatible (Figure 19-22). The MPI is mounted in the pilot's cockpit on the left instrument panel shroud and provided 28 VDC power by the primary bus. Digital data from the doppler computer display unit (CP-1600/APN-233) auxiliary output provides navigation data to the indicator. For block diagram of signal flow and power distribution, see Figure 19-23. The data stream is comprised of: magnetic bearing and range to checkpoint, heading velocity, drift velocity, and vertical velocity, distance-off-course, ground speed, aircraft heading, and doppler malfunction status. Modes are selected by a three-position switch located in the lower-left corner of the indicator faceplate. Panel and integral lighting control is provided by the pilot's INST lighting control located in the pilot's interior lighting control panel and a dimming switch located on the lower-right corner of the indicator faceplate respectively. Descriptions of modes of operation and controls are detailed in the following paragraphs.

19.3.3.2.1 Multipurpose Indicator Controls

1. NAV/HOV/TST switch. The NAV/HOV/TST switch positions are up, center, and down. The up position (NAV) selects the navigation mode. The MPI will provide the pilot with steering information when the switch is in this position and the doppler navigation system (AN/APN-233) is operating. The center or HOV position is not usable. The down, or TST position, is a momentary position which activates a MPI lamp test.

2. DIM switch. Integral instrument lighting intensity is adjustable with the spring-loaded toggle DIM switch located in the lower-right portion of the indicator faceplate. Up action on the switch will increase brightness and down action is used to decrease from a preset nominal level. Brightness data is stored in a nonvolatile memory for repeatability after power is cycled. The time period for adjustment from a completely blank display to maximum brightness is approximately 6 seconds.

19.3.3.2.2 Multipurpose Indicator Modes of Operation. The MPI modes of operation are selectable with the NAV/HOV/TST mode select switch. Descriptions of the three modes and associated displays are as follows:

1. NAV (Navigation) mode. The following alphanumeric/graphic information will be displayed on the MPI in NAV mode (Figure 19-24A).

   (a) Command Heading Display. Command heading in degrees (magnetic) computed from drift angle and bearing is indicated on a three-digit numeric display located in the upper center of the MPI display screen. The computed heading permits the pilot to fly directly from the aircraft's present position to the next checkpoint.

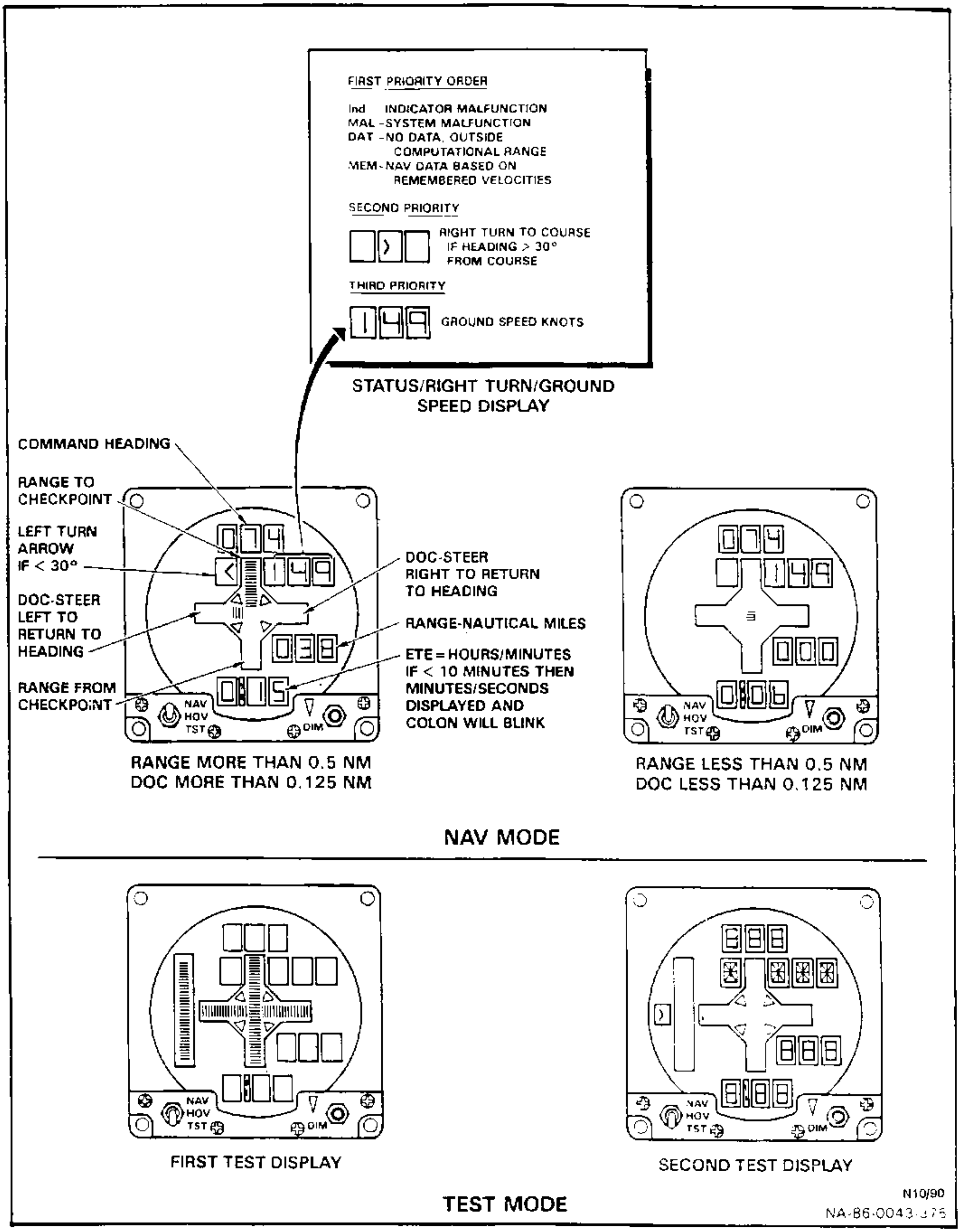


Figure 19-24A. MPI NAV Mode and Test Displays

(b) Ground Speed/Status/Right Turn Display. A three-digit alphanumeric display is located in the upper-right region of the display screen. Under normal circumstances, ground speed (in knots) will be displayed. In the event that the command heading to the selected checkpoint is more than 30 degrees from present heading and the shortest turn to command heading is to the right, the center-most alphanumeric character will display a right turn arrow. In the event of a system error, memory condition in the doppler, an error condition in the MPI, the MPI ground speed/status/ right turn display will indicate one of the following in priority order (Figure 19-24A).

Pilot's MPI Diagnostic Display Information

PRIORITY	DISPLAY	DEFINITION
1	Ind	MPI Malfunction.
2	MAL	Indicates (1) interface failure or (2) lack of navigation system response, or (3) MAL indicator illuminated on the NAV CDU.
3	DAT	No computed data, the course entered is out of the NAV CDU range (greater than 11.25 degrees latitude or longitude) or no valid navigation data available (CDU OFF or no data entered).
4	MEM	Indicates remembered velocity data is being used (AD mode) and accuracy may degrade over time. Will also be displayed when CDU is ON, navigation data entered, and aircraft is on the ground.

(c) Range Display. Range information (nautical miles) to the next selected checkpoint is displayed by three alphanumeric digits located in the lower-right region of the display screen.

(d) ETE Display. ETE is displayed on a three-digit numeric display located in the bottom-center region of the screen indicating the estimated time enroute from the present position directly to the destination checkpoint. Time is displayed in hours/ minutes, with the left digit indicating hours and the right two digits indicating minutes. When the ETE is less than 10 minutes, the display is scaled in minutes and seconds. The left digit indicating minutes and the right two digits indicating seconds. The left digit is separated from the two right digits by a colon. When in the hours/minutes mode (ETE of 10 minutes or greater), the colon is continuously illuminated; when in the minutes/seconds mode (ETE of less than 10 minutes), the colon will blink at 3 to 5 cycles per second.

(e) X-Y Coordinate Graphic Display. The X-Y coordinate graphic display provides the direction and distance-off-course (DOC) and to-from range information. The display is made up of four bars each consisting of 16 segments that illuminate in pairs, such that each bar has eight discretly scaled positions. Four segments make up the center bull's-eye. Triangles in the display corners are turned on when any of the four bars are on. When none of the four bars are on, the center bull's-eye is on.

(1) Vertical Bars. The vertical bar (Y-axis) indicates range-to information in the upper bar (utilized when range to the next checkpoint is decreasing) and range-from information in the lower bar (utilized when range from the checkpoint is increasing). Each segment pair in the vertical bar is scaled to 1 nautical mile (NM). All segments in the upper bar will be turned ON when the range to the next selected checkpoint is equal to or greater than 7.5 nautical miles.

(2) Horizontal Bar. Distance-Off-Course (DOC) information is displayed by way of a horizontal bar (X-axis) located in the center of the display screen. Each segment pair in the horizontal bar is scaled to 0.250 nautical mile. All segments in a given bar will be illuminated ON when DOC is equal to or greater than 1.875 nautical miles. When DOC is less than 0.125 mile, the bar is OFF.

NOTE

The MPI is a fly-to instrument; that is, in normal flying configuration (aircraft flying from the FROM checkpoint to the TO checkpoint), the pilot steers the aircraft in the direction indicated by the horizontally illuminated segments. For example, bars on the left are sequentially illuminated ON when the specified course is to the left of the aircraft as viewed from normal flight orientation. In this situation if the aircraft and the doppler computed course line could be looked down on (or viewed from above) the aircraft would be flying right of the doppler course. To correct and fly to the course line, the pilot would steer the aircraft to the left as indicated by the MPI.

(3) Center Bull's-Eye Display. The center bull's-eye will be turned on when the range from the selected checkpoint is less than 0.500 NM and the DOC is less than 0.125 NM (all vertical and horizontal segments off).

(f) Vertical Velocity Graphic Display. The vertical velocity graphic display is a vertical bar located in the left portion of the display screen and is not utilized in this installation.

(g) Left Turn Display. A left turn arrow is displayed by a single-digit alphanumeric display and is located in the upper-left center region of the display screen. The arrow will appear when the command heading to the selected checkpoint is greater than 30 degrees from the present heading and the shortest turn to return to command heading is to the left.

NOTE

The 30-degree turn limitation does not include magnetic variation.

2. Hover (HOV) mode. HOV mode is not used in this installation.

3. Test (TST) mode. When the NAV/HOV/TST switch is pressed down momentarily, a MPI lamp test will be initiated consisting of: an alternating display of the vertical bar and X-Y graphic displays, and then all five alphanumeric displays on the MPI screen (Figure 19-24A).

19.3.3.3 Doppler Navigation System Operation. The operating instructions consist of preflight checks, normal operation, and MPI light test.

19.3.3.3.1 Preflight Checks. The following steps are performed for preflight checks (Figure 19-25).

1. Electrical power on aircraft—MPI displays DAT indicating no navigation data has been computed.

NOTE

- During system test, observe that there are no unlighted alphanumeric segments, degree signs or decimal points and that the MAL, MEM, and ENT indicators come on.
- Ensure that L/L mode selected prior to test.

2. Set the mode selector switch to TEST and observe the following sequence (Figure 19-25):

(a) 1st Test Display: N/S, MAL, ENT, and MEM Indicators ON.

(b) 2nd Test Display: E/W, ENT, MEM Indicators ON, MAL Indicator OFF.

(c) Final Test Display: MEM and ENT lights off. Display indicates GO.

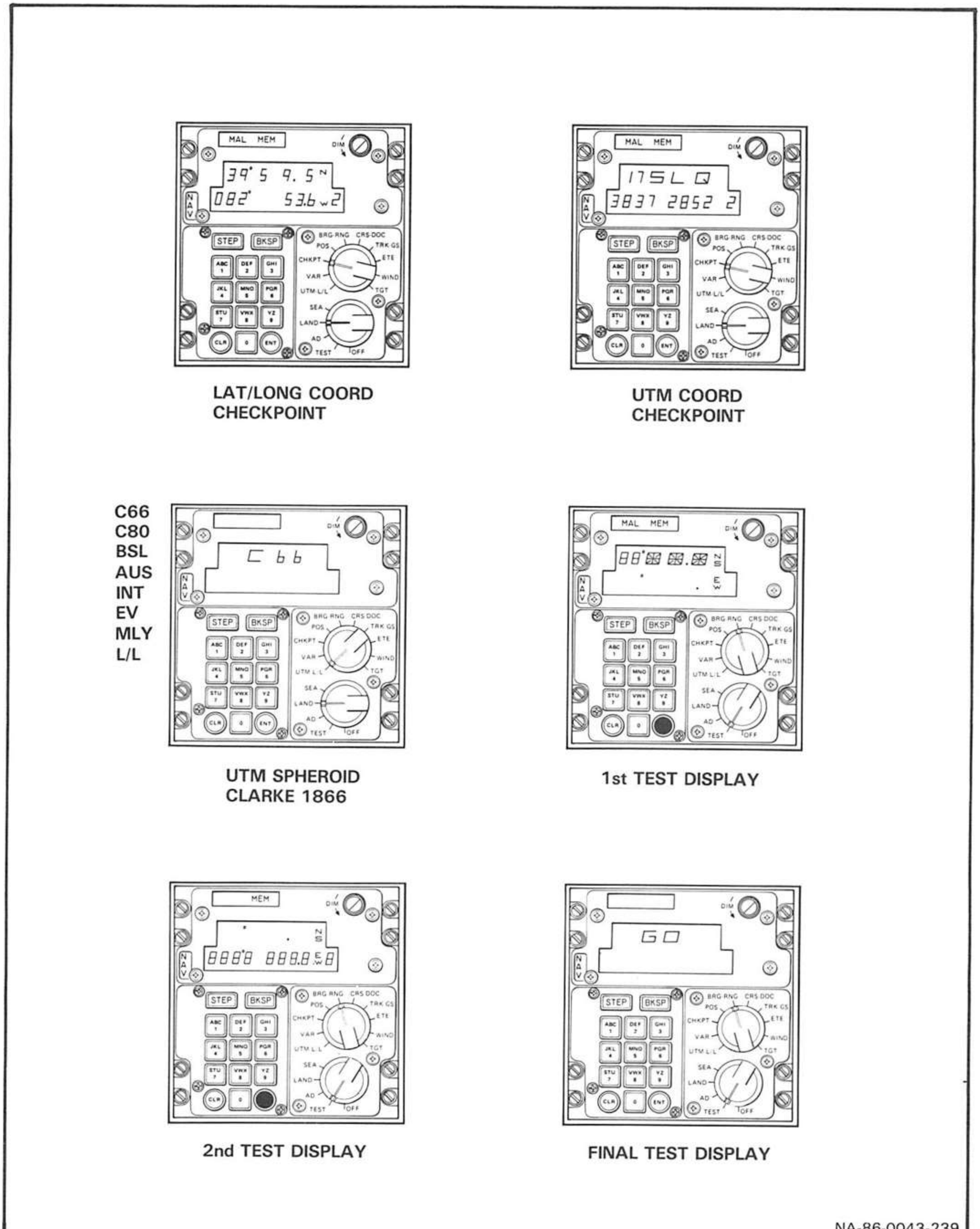


Figure 19-25. Doppler CDU Coordinate Selection and Test Displays

2A. On MPI, select NAV/HOV/TST switch to TST momentarily and observe the following sequence:

(a) 1st Test Display: Vertical bar and X-Y graphic come ON, then go OFF.

(b) 2nd Test Display: Five alphanumeric displays come ON, then go OFF.

(c) Ensure switch positioned to NAV.

3. If DVN message displayed instead of GO during TEST, use the following procedure to enter compass deviations (Figure 19-22, Sheet 2):

(a) Select VAR position with function/ display selector switch.

(b) Select LAND on mode selctor switch.

(c) Using the keyboard, enter 9999.

(d) Depress ENT switchlight and verify the following;

(1) Lower left line of display shows one of eight compass points (one every 45 degrees starting at 000 degrees) and lower right displays a deviation table identifier number, 0 to 7, for these compass points.

(2) Upper line of display shows assigned deviation for indicated compass points.

NOTE

If the same deviation is to be entered for all eight compass points, for fast entry proceed to step (i) in this procedure.

(e) Using the keyboard and information from aircraft compass deviation tables, enter deviation for displayed heading (example: 01° 05′ E).

(f) Press ENT key to enter data into the computer. Verify deviation is entered on upper line of display.

(g) Use STEP or BKSP Key to access remaining compass points to enter deviations. Repeat steps (e) through (g) as required.

(h) Press CLR key to return to VAR (magnetic variation display) and continue checkout.

(i) To enter a compass deviation that is the same for all eight compass points, proceed as follows;

(1) Using the keyboard and information from aircraft compass deviation chart, enter a four digit deviation (ex. 01° 05′ E).

(2) Press No. 1 key if deviation is EAST or the No. 9 key if the deviation is WEST.

(3) Press ENT key to enter data into the computer. Verify deviation is entered on upper line of display.

(4) Press CLR key to return to VAR (magnetic variation display) and continue checkout.

4. Set function/display selector switch to VAR and mode selector switch to LAND. Check date of variation, if date is within the last 3 months proceed to step 5. If not proceed as follows:

(a) Enter date (year and month). (Example: for September 1987, enter 8709.)

(b) Depress ENT switch light.

5. Set mode selector switch to LAND and set function/display selector switch to UTM-L/L. This step allows operator to select L/L or one of seven UTM spheroids.

(a) Actuate the STEP and/or BKSP keys to change the display until the desired code is displayed on the top line of the alphanumeric display.

Code displays are as follows:

C66	for CLARKE 1866
BLS	for BESSEL
INT	for INTERNATIONAL
MLY	for MALAYAN
C80	for CLARKE 1880
AUS	for AUSTRALIA
EV	for EVEREST
L/L	for LATITUDE/ LONGITUDE

(b) Depress ENT switch light.

6. Entering checkpoints. Use the following procedures to enter checkpoints:

(a) Set function/display selector switch to CHKPT.

(b) Using the STEP or BKSP switches, select desired checkpoint.

(c) Enter all 13 characters (ENT switch light will come on).

(d) Depress ENT switch light.

(e) Using the STEP or BKSP switches, select the next checkpoint and enter data as in steps (c) and (d) above.

19.3.3.3.2 **Normal Operation.** Normal operation consists of updating present position, selecting course line, bearing-range check, ground track-ground speed check, transferring target coordinates to checkpoint, changing course, changing L/L to UTM and UTM to L/L selecting radar silence (AD) mode, and selecting estimated time enroute display (Figure 19-26).

1. Updating present position—To update present position proceed as follows:

NOTE

Present position must be updated at beginning of flight.

(a) Set function/display selector switch to POS.

(b) Depress key representing the checkpoint to be used for updating. (ENT switch light will come on.)

(c) Depress ENT switch light when aircraft is directly over checkpoint. (ENT light will go off when coordinates are stored in computer.)

NOTE

BRG-RNG and CRS-DOC displays are blanked if computed range is greater than 11.25 degrees of latitude or longitude.

2. Selecting course line—To select course line, proceed as follows:

(a) Set function/display selector switch to CRS-DOC.

(b) Depress key for number of departure position checkpoint, followed by the number of the destination checkpoint. The course line from departure to destination checkpoint will be displayed in the upper line as either right (R) or left (L) of course. The bottom line of the display indicates course line in degrees between the selected checkpoints and distance off course in nautical miles.

NOTE

Selecting a course line starting with "O" causes the automatic transfer of present position into checkpoint "O".

3. Bearing-Range check—To check bearing-range, proceed as follows:

(a) Set function/display selector switch to BRG-RNG. Check bearing and range displayed.

(b) Upper line of display shows the same checkpoint for destination as selected in CRS-DOC. This indicates bearing and range is being computed from present position to destination checkpoint.

NOTE

When range to destination reaches three nautical miles, the arrow on the top row changes from ↗ to *.

4. Ground track-ground speed check—To check ground track-ground speed, set function/display selector switch to TRK-GS and observe the display:

(a) KNT is shown on upper line of display.

(b) On lower line, track angle (in degrees) is shown on left side and ground speed (nautical miles per hour) is displayed on the right in flight. On the ground, the ground speed is not accurate.

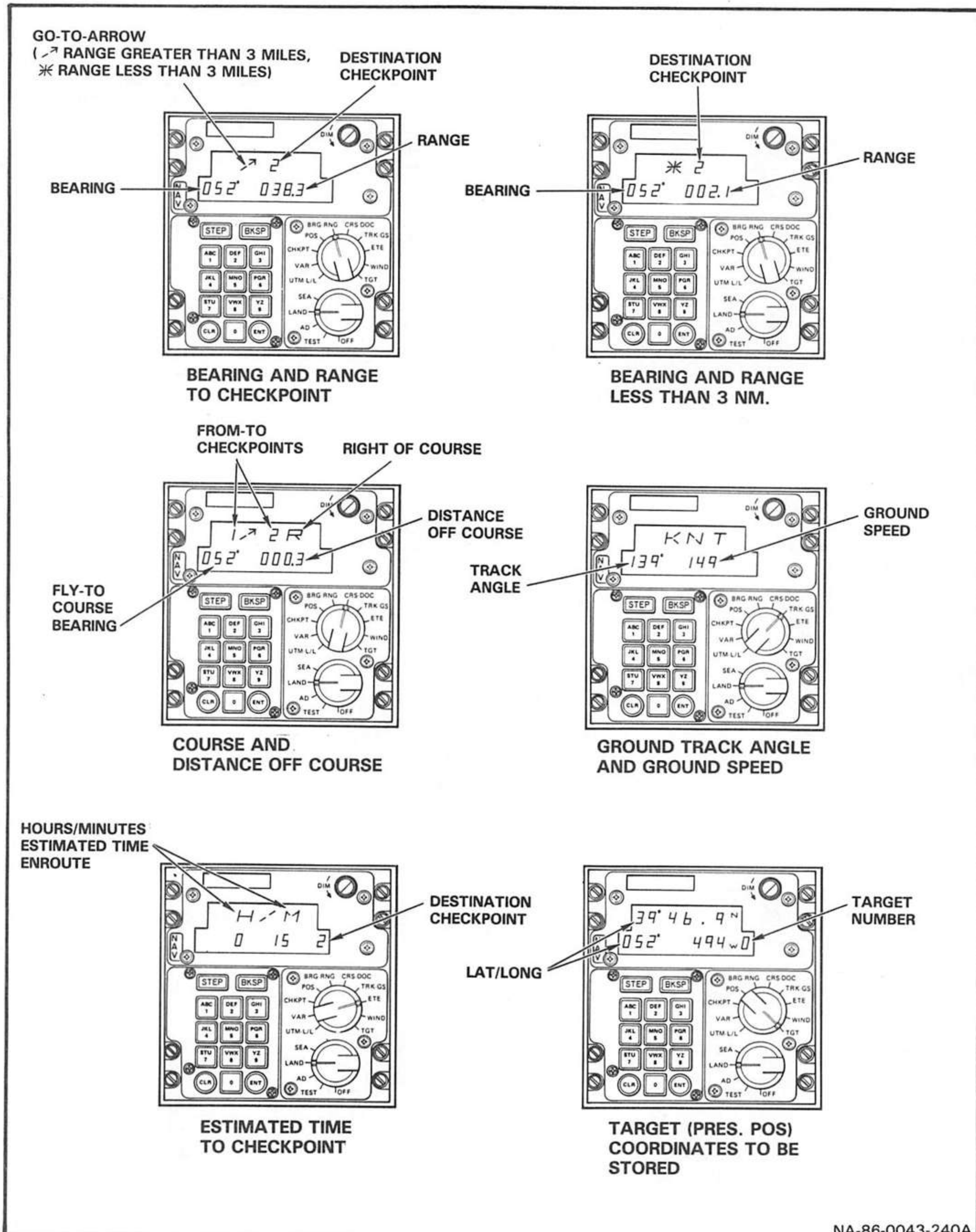


Figure 19-26. Doppler Data Displays (Sheet 1 of 2)

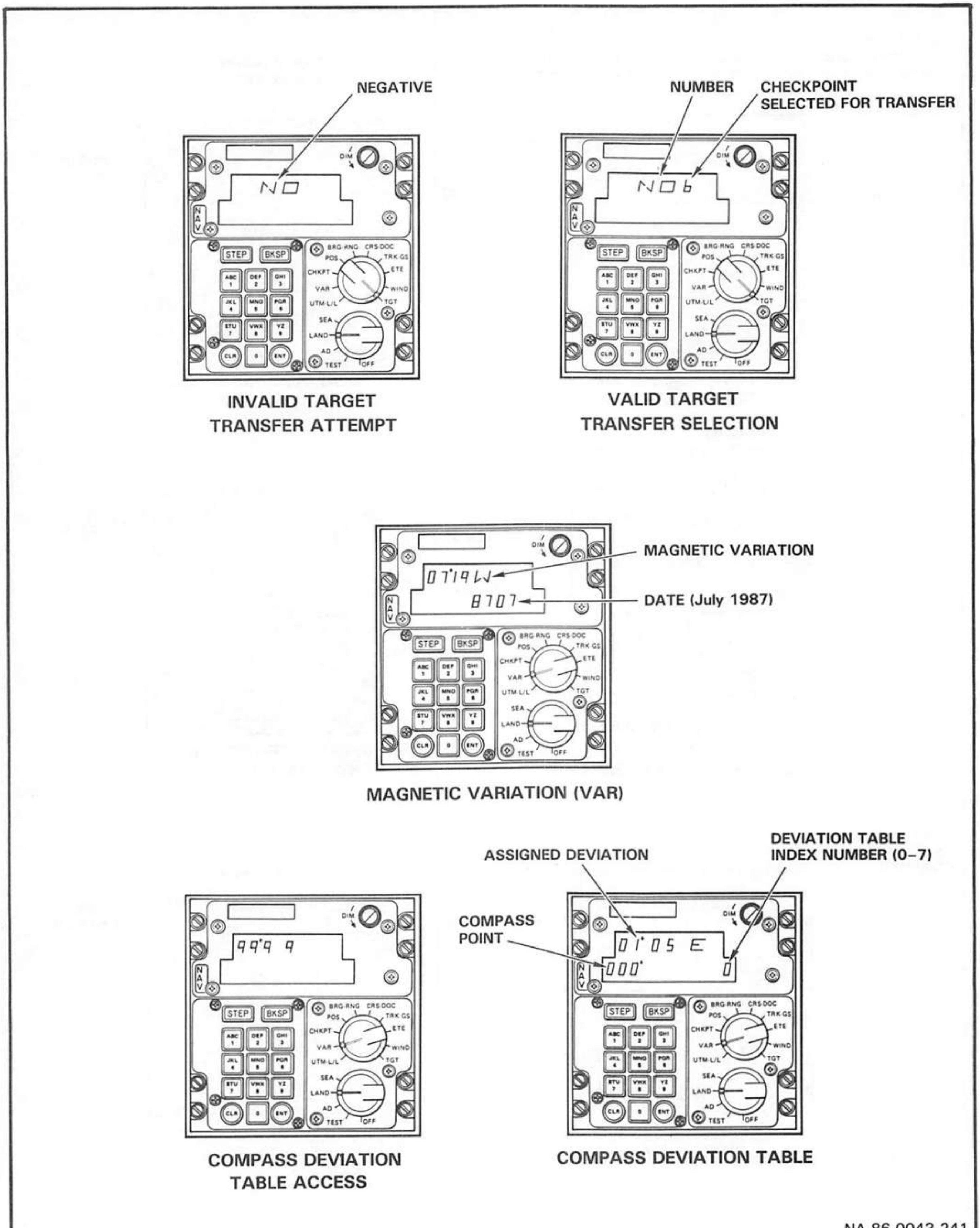


Figure 19-26. Doppler Data Displays (Sheet 2 of 2)

5. Storing target of opportunity coordinates—To store target coordinates, perform the following steps:

(a) Set function/display selector switch to TGT and select target number with STEP or BKSP keys. (ENT light will come on and coordinates previously entered will be displayed.)

(b) Depress ENT switch light when aircraft is over target of opportunity. Present position coordinates are stored in next target number.

NOTE

- If ENT key is pressed when in TGT mode, present position coordinates will be displayed in next target number. If target 0 is selected and displayed with the STEP or BKSP keys and the ENT switch is pressed, the present coordinates will be displayed in target 1.
- Target number shown in lower right of display will indicate number of targets stored since power was first applied, if power is interrupted target 0 will be displayed
- Up to ten targets can be entered.

6. Transferring target of opportunity coordinates to checkpoint—To transfer target coordinates to checkpoint, perform the following steps:

NOTE

Only checkpoints can be used to provide navigational information.

(a) Set function/display selector switch to TGT. (ENT light comes on.)

(b) Using the STEP or BKSP keys, select desired target coordinates.

NOTE

Target data cannot be entered in checkpoints numbered 0 through 5, if transfer is attempted to those checkpoints NO will be displayed

(c) Select storage checkpoint number by entering 6, 7, 8, or 9 from keyboard.

(d) Depress ENT switch light.

(e) Set function/display selector switch to CHKPT.

(f) Actuate STEP key until desired checkpoint number is displayed (6, 7, 8, or 9). Display should be the same coordinates as entered in step c above.

7. To change course—To change course, perform the following steps:

(a) Set function/display selector switch to CRS-DOC.

NOTE

Selecting checkpoint 0 causes the automatic transfer of present position into checkpoint 0.

(b) Enter 0 and then destination checkpoint number.

(c) Depress ENT switchlight.

8. Changing L/L to UTM or UTM to L/L format—To change L/L or UTM format, perform the following steps:

(a) Set function/display selector switch to UTM-LL.

(b) Actuate STEP or BKSP keys to select desired UTM or L/L.

(c) Depress ENT switch light.

NOTE

Changing the display from UTM to L/L or L/L to UTM will not affect navigation. Placing the function/display selector switch to CHKPT, POS, or TGT will display the selected format.

9. Air data mode (AD)—To attenuate the doppler transmitter signal for radar silence or emission control (EMCON), perform the following step:

(a) Set mode switch to AD. The system will automatically enter the memory mode and the MEM indicator will be displayed. Navigation will be based on the last valid data in memory. Navigational accuracy will deteriorate over time in this mode.

10. Estimated time enroute—To display estimated time enroute, perform the following step:

(a) Set function/display selector switch to ETE. Display will show estimated time enroute (ETE) to selected destination checkpoint in hours and minutes (H/M).

NOTE

If ETE exceeds 8 hours, the bottom of the display will be blank.

19.3.4 Compass System, AN/ASN-75. The compass system consists of a directional gyro-controller remote compensator unit in the left boom, a remote compass transmitter in the horizontal stabilizer, and a compass control panel. Compass heading is indicated by the heading ring of the bearing-distance-heading indicator (BDHI). The compass operates in either a SLAVED or a FREE mode at latitudes up to 60 degrees. The SLAVED mode of operation orientates the system in relation to the earth's magnetic field as determined by the transmitter. When used in the FREE mode, where magnetic sensing is not reliable, the compass system references some predetermined fixed point with a known directional heading.

19.3.4.1 Compass Controls. The compass control panel (Figure 19-27) is installed on the right console in the pilot's cockpit.

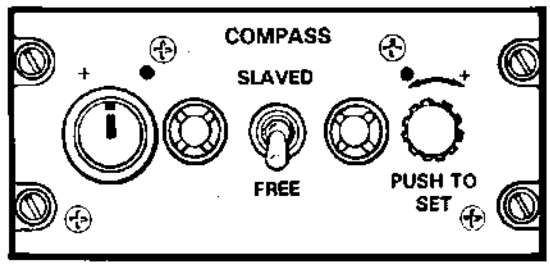


Figure 19-27 Compass Controls

19.3.4.1.1 SLAVED-FREE Switch. The SLAVED-FREE switch selects compass mode of operation. In the FREE mode, BDHI heading indication must be periodically corrected for gyro drift and apparent precession.

19.3.4.1.2 Annunciator. The annunciator (+, •), operative only in SLAVED mode, shows agreement or disagreement between the compass gyro and the magnetic compass transmitter. A plus (+) indication reflects clockwise error and a minus (•) indication reflects counterclockwise heading error. Annunciator oscillation during SLAVED mode operation is normal, indicating continuous corrective synchronization.

19.3.4.1.3 PUSH TO SET Knob. The PUSH TO SET knob is used in the SLAVED mode to set annunciator indication as required and to set the desired aircraft heading while operating in a FREE mode.

19.3.4.2 Compass Operation. With ac primary and instrument bus power available (either inverter on) and SLAVED mode selected, compass normal operation is automatic. If an error between BDHI and standby compass indication is noted, or if heading indication does not agree with known aircraft heading, momentarily select FREE, then return to SLAVED. If the error is not corrected, select FREE, correct the error with the PUSH TO SET knob, and reselect SLAVED. When operating in areas of high latitude the gyro should be unslaved to prevent unreliable readings.

NOTE

> When the slaved mode is selected, AN/ASN-75 will automatically slave to the correct heading at a rate of 2.5 (±1.25) degrees per minute. The correct heading may be immediately selected with the PUSH TO SET knob.

19.3.5 Radar Altimeter, AN/APN-171(V). The radar altimeter system consists of a receiver-transmitter and two antennas mounted in the right wing tip and two remote indicators located on the pilot's and observer's instrument panels. The transistorized receiver-transmitter generates high-resolution pulse radar that automatically locates the closest terrain and performs continuous, selective, precision range track of this signal. The computing circuitry is mechanized to allow absolute altitude measurement from zero to 5000 (±5) feet. The system is immune to false readings or accuracy degradation in very heavy rain fall. In addition to altitude indication, the system provides for presetting desired minimum altitude and display of a LOW warning light and sounding of a low altitude audio warning tone in the crewmember's headsets when below preset minimum. The indicator displays an OFF flag to indicate improper or out-of-operating-range radar altimeter system operation. The system requires a 3- to 5-minute warm-up and is powered from the primary ac bus except for the OFF flag, LOW level light and low-altitude warning tone which are powered from the primary dc bus.

19.3.5.1 Radar Altimeter Indicator and Controls. All controls for the radar altimeter (pilot's and observer's) are located on the face of the indicator case. The indicator is a null-balance servo device with a pointer and nonlinear dial marking from zero to 5000 feet. A mask, located in the lower right corner of the dial face, covers the pointer tip when above the maximum radar altitude range or when the altimeter is not tracking. An OFF flag will appear in the low center of the dial if the set malfunctions (Figure 19-28).

19.3.5.1.1 OFF-SET-PUSH TO TEST knob. Each indicator has an OFF, SET, and PUSH TO TEST knurled knob, located on the lower left of the indicator case, that functions to control the system power ON and OFF, to perform self-test, and set low-altitude index. Turning either knob clockwise from OFF provides power to the system and moves the low-altitude indexer clockwise as desired. After 3- to 5-minute warm-up time, press the knurled knob to perform self-test and observe reading of 100 (±15) feet. Return of the knob to the OFF position will return the low-altitude indexer to less than zero feet.

19.3.5.1.2 Low-Altitude Light. A yellow, low-altitude warning light is located on the lower right corner of the indicator case. This light functions to indicate LOW when altitude above terrain is less than indexer selected minimum altitude and maybe set independently on each indicator.

19.3.5.1.3 Low-Altitude Warning Tone. A 700- to 1700-Hz swept audio tone with a repetition rate of 2 Hz is initiated by the TIT/low-altitude warning aural tone generator and is heard once in both crewmembers' headsets for 4.5 (±0.5) seconds when descending to or below the pilot's indexer selected minimum altitude. The tone will be disabled if the low-altitude situation is corrected immediately. In addition to the tone, the pilot's LOW warning light will illuminate and remain on when at or below the selected minimum altitude.

NOTE

The TIT/low-altitude warning aural tone generator will assign first priority to a low-altitude warning command signal and second priority to the TIT warning command signal. If a TIT and low-altitude warning occur simultaneously, the aural tone generator will sound the low-altitude warning for 5 seconds followed by the TIT warning if the TIT command signal is still present. If the TIT warning sounds and a low-altitude warning occurs, the TIT warning will be interrupted and replaced by the low-altitude warning. Upon completion of the low-altitude warning, the TIT warning will resume providing the TIT command signal is still present.

19.3.5.2 Radar Altimeter Operation

1. Radar Altimeter PUSH TO TEST knob—ON, set index at 50 feet (P,O).

2. Allow at least 3-minute warm-up or wait for disappearance of barber pole and pointer-indicator repositioned at zero altitude. When pointer passes the low-altitude indexer (50 feet), the LOW altitude light should illuminate and the low-altitude warning tone will sound for 5 seconds.

NOTE

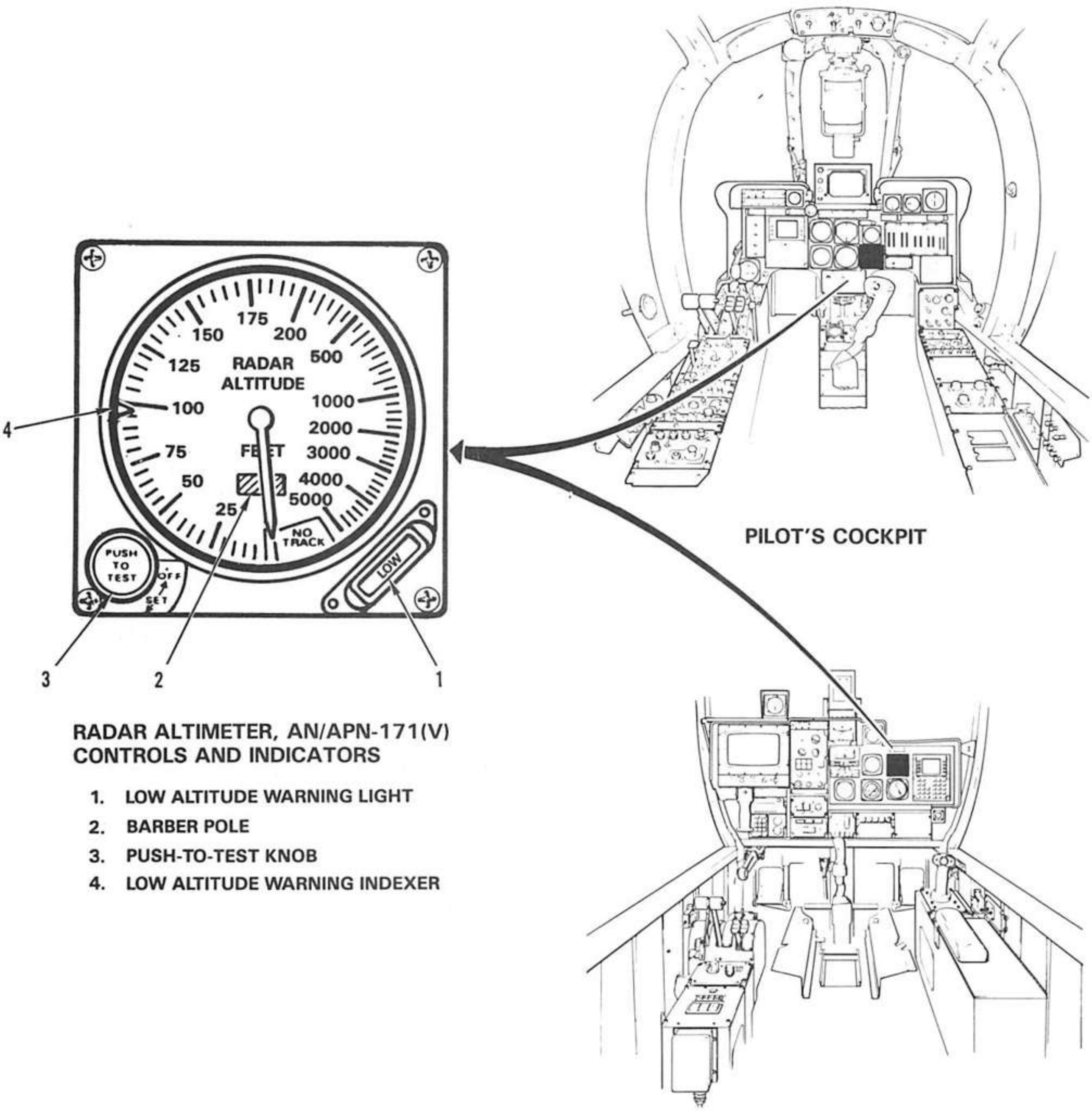
The low-altitude warning tone is only initiated when the pilot's pointer-indicator descends below the low-altitude indexer. When the pointer descends below low-altitude indexer on the observer's indicator only the low-altitude warning light will come on.

3. PUSH TO TEST knob depressed—Altitude 100 (±15) feet, LOW altitude warning light out (pilot's and observer's).

4. Release Press To Test—When pointer-indicator passes the low altitude indexer (50 feet), the LOW altitude light should illuminate and the low-altitude warning tone should sound (pilot's indicator) for 4.5 (±0.5) seconds as the pointer returns to zero feet indication.

5. Reset low-altitude warning index to setting desired.

6. To secure system, set indexer at 0 feet.



RADAR ALTIMETER, AN/APN-171(V) CONTROLS AND INDICATORS

1. LOW ALTITUDE WARNING LIGHT
2. BARBER POLE
3. PUSH-TO-TEST KNOB
4. LOW ALTITUDE WARNING INDEXER

NA-86-0043-57A

Figure 19-28. Radar Altimeter, AN/APN-171(V), Controls and Indicators

19.4 IDENTIFICATION SYSTEMS

19.4.1 IFF Transponder Set, AN/APX-100(V). The AN/APX-100(V) IFF set provides automatic identification of the aircraft in reply to challenge signals (interrogations), from an air traffic control (ATC) interrogator. When interrogations are received, the IFF system determines correct mode and code of challenge and automatically transmits a coded reply. The IFF system operates in modes 1, 2, and 3/A, which are selective identification feature (SIF) modes, and in mode C, the altitude reporting mode. Mode 4, the secure mode, is available when the computer-transponder, KIT-1A/TSEC is installed. These modes are selected from the CMS IFF page. SIF mode replies can be modified by actuating the identification (IDENT) function or by actuating emergency operation. These are selected from the pilot's emergency radio control panel. The observer may initiate emergency operation using the IFF EMER switch, located on the video recorder and emergency IFF switch panel. Emergency operation will be initiated automatically upon pilot's ejection when the pilot's seat leaves the aircraft. During normal operation, electrical 28-VDC power is supplied from the primary dc bus and 115-VAC power is supplied from the primary ac bus. During emergency operation, 28 VDC is provided by the battery bus. During normal operation, power is turned ON and OFF from the CMS Power page. Power may also be turned ON, but not OFF, from the IFF page. All other control for normal operation is from the IFF page. During emergency operation, power is automatically turned ON by activating any of the emergency IFF switches. The IFF operates in altitudes up to 70,000 feet.

19.4.1.1 IFF Transponder Set Controls and Indicators. Controls and indicators for the IFF system consist of: CMS Power, IFF, and IFF Test pages; the emergency radio control panel IFF EMER, IFF IDENT-MIC and ZEROIZE switches and IFF REPLY light; ICS monitor panel IFF control switch; pilot's altimeter, AAU-21/A CODE OFF flag; pilot's caution light panel IFF caution light; pilot's eject sensing switch; and the video recorder and emergency IFF switch panel EMER IFF switch. See Figure 19-29 for component locations.

19.4.1.1.1 Power Page. The Power page is used to turn IFF power ON and OFF. When turned ON, the IFF is placed in the standby mode. Refer to paragraph 19.1.5.1 and see Figure 19-10 in this chapter for Power page access and operation.

19.4.1.1.2 IFF Page. The IFF page is accessed using the IFF function select key. From the IFF page, the operator selects power (OFF to standby to normal but not to OFF), mode, modes 1 and 3/A codes, antenna operation, mode 4 reply monitoring and mode 4 code hold. See Figure 19-30 for specific key functions and displays.

19.4.1.1.3 IFF Test Page. The IFF Test page is used to initiate a confidence test of the IFF system. Refer to paragraph 19.1.5.3 and see Figure 19-10 for IFF Test page access and operation.

19.4.1.1.4 IFF EMER Switch. The IFF EMER switch is located on the emergency radio control panel in the pilot's cockpit, left-hand console. When enabled, turns the IFF system ON, enables modes 1, 2, and 3/A to reply to interrogations in the emergency mode, and zeroizes mode 4 code. The IFF EMER switch is a guarded switch to prevent accidental enabling of the emergency mode (Figure 19-29).

19.4.1.1.5 IFF IDENT-MIC Switch. The IFF IDENT-MIC switch is located on the emergency radio control panel in the pilot's cockpit, left-hand console. When positioned momentarily to IDENT, (switch has spring-loaded return) enables IFF system to reply identification of position information for 15 to 30 seconds. When positioned to MIC, allows the pilot's microphone selector (XMIT) switch to remotely enable IDENT. Only one radio (Radio 1, 2, or 3) is required to be ON and selected to transmit for MIC IDENT operation (Figure 19-29).

19.4.1.1.6 ZEROIZE Switch. The ZEROIZE switch is located on the emergency radio control panel in the pilot's cockpit, left-hand console. When enabled, zeroizes the mode 4 code stored in the computer-transponder, KIT-1A/TSEC and the KY-58 secure voice codes. The ZEROIZE switch is a guarded switch to prevent accidental zeroizing of codes (Figure 19-29).

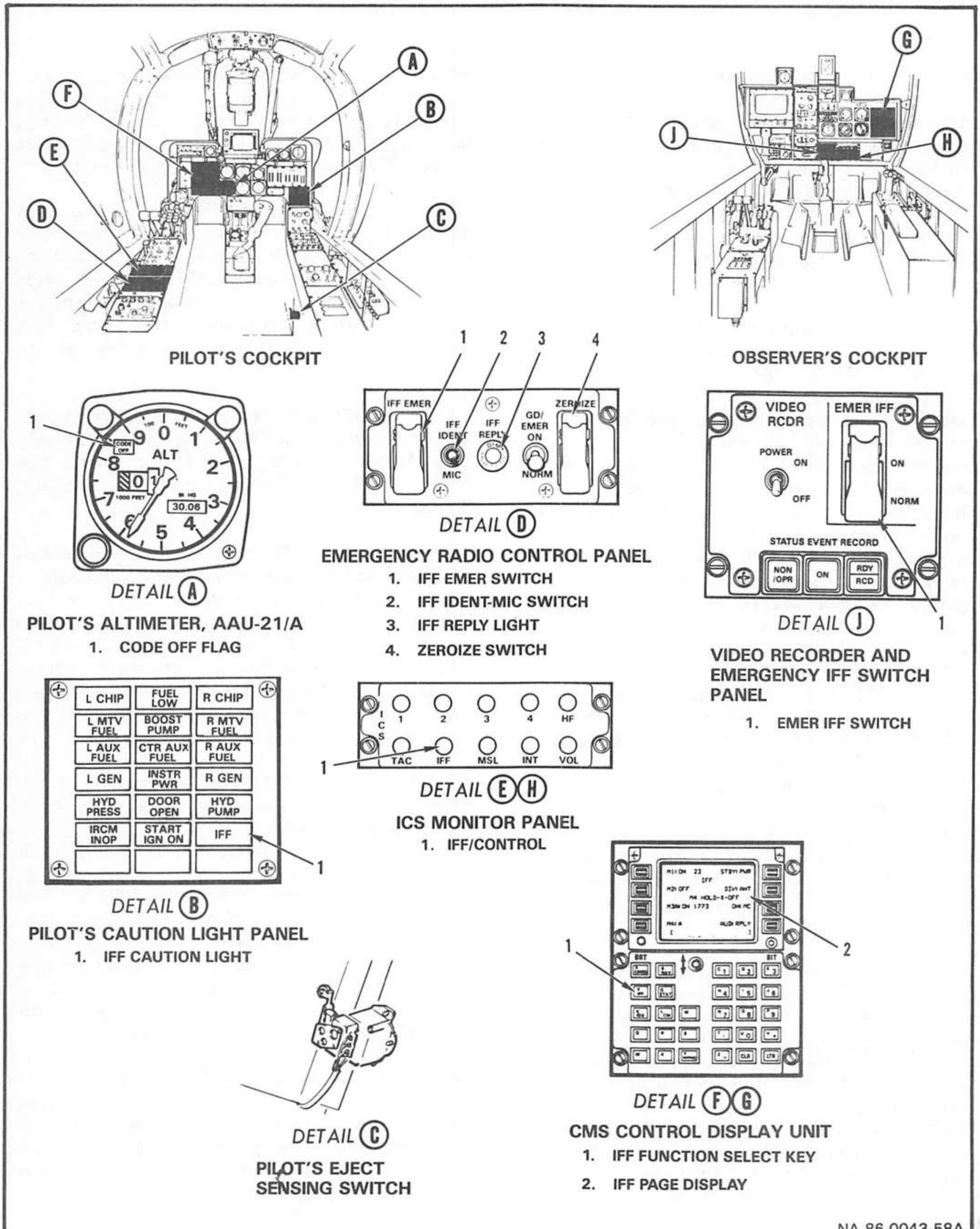
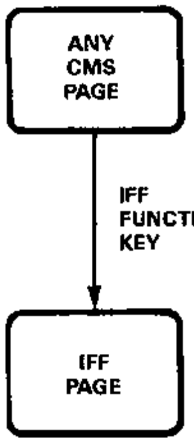
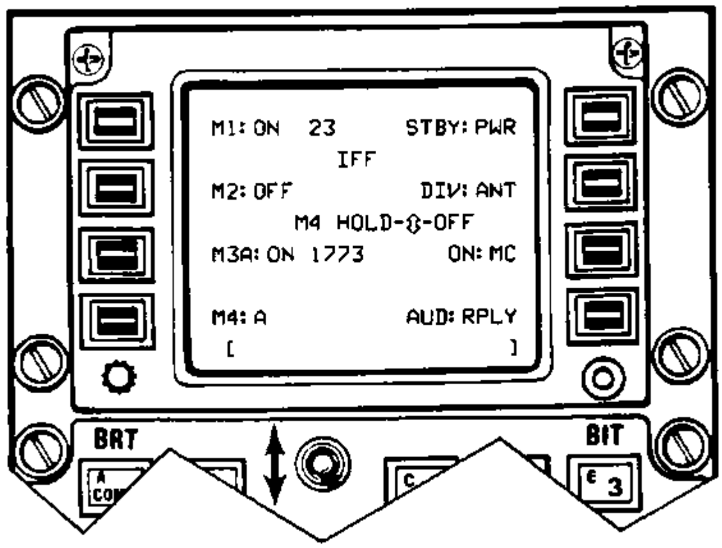


Figure 19-29. IFF, AN/APX-100(V), Controls and Indicators



IFF KEY FLOW CHART



IFF PAGE

LS1: WHEN SCRATCH PAD IS EMPTY, PRESSING THIS KEY WILL TOGGLE MODE 1 ON AND OFF. IF SCRATCH PAD CONTAINS A NEW MODE 1 CODE (00–73), PRESSING THIS KEY WILL ENTER NEW CODE FOR MODE 1 REPLY.

LS2: PRESSING THIS KEY WILL TOGGLE MODE 2 ON AND OFF.

LS3: WHEN SCRATCH PAD IS EMPTY, PRESSING THIS KEY WILL TOGGLE MODE 3/A ON AND OFF. IF SCRATCH PAD CONTAINS A NEW CODE (0000–7777), PRESSING THIS KEY WILL ENTER NEW CODE FOR MODE 3/A REPLY.

LS4: PRESSING THIS KEY WILL TOGGLE MODE 4 FROM OFF TO SUBMODES 4A and 4B.

LS5: WHEN IFF POWER IS OFF, PRESSING THIS KEY WILL TOGGLE POWER TO STANDBY. WHEN IFF POWER IS ON, PRESSING THIS KEY WILL TOGGLE POWER BETWEEN STANDBY AND NORMAL.

LS6: PRESSING THIS KEY WILL TOGGLE ANTENNA SELECTION BETWEEN DIVERSITY OPERATION, TOP ANTENNA ONLY, AND BOTTOM ANTENNA ONLY.

LS7: PRESSING THIS KEY WITH MODE 3/A ON, WILL TOGGLE MODE C ON AND OFF. IF MODE 3/A IS NOT ON, PRESSING THIS KEY WILL HAVE NO ACTION.

LS8: PRESSING THIS KEY WILL TOGGLE THE MODE 4 REPLY INDICATIONS BETWEEN AUD (BOTH AUDIO AND LIGHT INDICATIONS), LIT (LIGHT INDICATIONS ONLY), AND OUT (NO INDICATIONS).

SLEW SWITCH: WHEN POSITIONED UP OR DOWN PRIOR TO TURNING IFF OFF, KEEPS MODE 4 CODE FROM AUTOMATICALLY ZEROIZING. INFORMATION LINE WILL DISPLAY M4 HOLD-⇕-ON FOR APPROXIMATELY 15 SECONDS FROM SELECTION, THEN WILL CHANGE TO M4-HELD-⇕-OFF.

NOTE

IFF POWER MAY BE TURNED OFF FROM THE POWER PAGE ONLY.

NA-86-0043-59B

Figure 19-30. IFF Key Flow Chart and Page Display

19.4.1.1.7 IFF REPLY Light. The IFF REPLY light is located on the emergency radio control panel in the pilot's cockpit, left-hand console. When turned on, indicates presence of valid mode 4 reply. When pressed, turns light ON to test bulb (Figure 19-29).

19.4.1.1.8 ICS Monitor Panel, IFF Control. The IFF control is located on the ICS monitor panel, in the pilot's cockpit, left-hand console, and in the observer's cockpit, lower instrument panel. When pulled out, allows IFF mode 4 reply audio to be sent to headset. When rotated, adjusts volume level of mode 4 reply audio (Figure 19-29).

19.4.1.1.9 CODE OFF Flag. The CODE OFF flag is located in the upper left corner of the pilot's altimeter, AAU-21/A. The flag will appear when the altimeter is not capable of providing coded altitude information to the IFF system. When altimeter is operating correctly, flag will remain out of view (Figure 19-29).

19.4.1.1.10 IFF Caution Light. The IFF caution light, located on the pilot's caution light panel on the pilot's instrument panel, turns ON when the IFF is not replying to valid mode 4 interrogations or when the mode 4 code is zeroized. The IFF light is inhibited when the computer-transponder KIT-1A/TSEC is not installed (Figure 19-29).

19.4.1.1.11 Pilot's Eject Sensing Switch. The pilot's eject sensing switch is located in the pilot's cockpit at fuselage station 91, behind the pilot's ejection seat. The switch will actuate when the ejection seat leaves the aircraft during ejection. Upon ejection, the switch enables modes 1, 2, and 3/A for reply in the emergency mode, and zeroize the mode 4 code (Figure 19-29).

19.4.1.1.12 EMER IFF Switch. The EMER IFF switch is located on the video recorder and emergency IFF switch panel in the observer's lower instrument panel. When positioned to NORM, allows the IFF system to operate normally from the CMS-CDU. When positioned to ON, turns the IFF system ON, enables modes 1, 2, and 3/A to reply to interrogations in the emergency mode, and zeroizes mode 4 code. The EMER IFF switch is a guarded switch to prevent accidental enabling of the emergency mode (Figure 19-29).

19.4.1.2 IFF Operation. IFF operation consists of a preflight check, normal operation and emergency operation.

19.4.1.2.1 Preflight Check. To perform a preflight check of the IFF system, proceed as follows:

NOTE

- CMS operational checkout should be performed prior to IFF operation to ensure GO status of CMS system.
- During the 2-minute warm-up time of the IFF system, a √ STATUS annunciator will appear on the CMS-CDU and the IFF status will be NOGO regardless of operating mode (STBY or NORM).
- After the warm-up time if the IFF is placed in STBY from NORM, a √ STATUS annunciator will appear on the CMS-CDU and the IFF status will be NOGO until the IFF is placed into NORM.

1. On CDU, select IFF key—IFF page displayed.
2. On IFF page, press LS5—STBY:PWR displayed.
3. After 2-minute warm-up time, press LS5—NORM:PWR displayed.
4. Press STAT key—WRA Status page 1/2 displayed. (If page 2/2 displayed, use slew switch to select page 1/2.)
5. On WRA Status Page 1/2, press LS8—√ marks cleared from display.
6. Press IDX key—Index page displayed.
7. On Index page, press LS5—Test Index page displayed.
8. On Test Index page, press LS6—IFF Test page displayed.

9. Perform IFF test as follows:

(a) Press LS1- * displayed to left of M1 and TEST displayed to right. TEST changes to GO after mode test complete.

(b) Press LS2- * displayed to left of M2 and TEST displayed to right. TEST changes to GO after mode test complete.

(c) Press LS3- * displayed to left of M3A and TEST displayed to right. TEST changes to GO after mode test complete.

(d) Press LS4- * displayed to left of MC and TEST displayed to right. TEST changes to GO after mode test complete.

(e) Ensure GO is displayed next to ANT on the information line.

(f) Ensure GO is displayed next to ALT on information line.

10. If aircraft is mode 4 equipped (KIT-1A/TSEC installed), proceed to mode 4 preflight check.

19.4.1.2.2 Normal Operation. For normal operation of the IFF system, proceed as follows:

1. On CMS-CDU, press IFF key—IFF page displayed.

2. With empty scratch pad, press LS1—M1:ON displayed.

3. Using keyboard, enter mode 1 code (00–73) into scratch pad.

4. With code in scratch pad, press LS1—code moves from scratch pad to right of M1:ON displayed.

5. Press LS2—M2:ON displayed.

6. Press LS3—M3A:ON displayed.

7. Using keyboard, enter mode 3/A code (0000–7777) into scratch pad.

8. With code in scratch pad, press LS3—code moves from scratch pad to right of M3A:ON.

9. Check antenna selection (LS6)—DIV:ANT displayed.

10. If directed, hold IDENT—MIC switch (located on the emergency radio control panel) momentarily to IDENT, or select MIC and momentarily hold microphone switch to XMIT (Radio 1 or 2, or 3 must be ON and selected to transmit to MIC—IDENT operation).

11. For altitude reporting, on CMS IFF page, press LS7 (mode 3/A must be ON)—ON:MC displayed.

19.4.1.2.3 Emergency Operation. To operate the IFF in emergency proceed as follows:

NOTE

- Selection of IFF emergency will automatically zeroize mode 4 codes if the aircraft is so equipped.
- Selection of IFF emergency will automatically turn the IFF system ON and enable modes 1, 2, 3/A to reply to interrogations in the emergency mode. The mode 3/A code will be changed to the distress code 7700.

1. To select emergency from the pilot's cockpit:

(a) On the emergency radio control panel, lift guard to expose the IFF EMER switch.

(b) Position IFF EMER switch forward.

2. To select emergency from the observer's cockpit:

(a) On the video recorder and emergency IFF switch panel, lift guard to expose the EMER IFF switch.

(b) Position EMER IFF switch to ON.

19.4.1.3 Altimeter-Encoder, AAU-21/A. The AAU-21/A altimeter-encoder combines a conventional pneumatic altimeter and an altitude reporting encoder in one self-contained unit (Figure 19-29). Altitude readout is displayed by a counter-drum-pointer system. The counters display by direct digital output 10,000- and 1,000-foot increments while the drum displays 100-foot increments. Direct digital readout can be made from minus 1,000 to 38,000 feet. The single pointer repeats the indications of the 100-foot drum and provides a quick indication of the rate of altitude changes. The digital readout is referenced to 29.92 inches Hg and is not affected by changes of barometric setting. The encoder provides coded altitude information in 100-foot increments for automatic transmission when the transponder is interrogated on mode C and the mode select switch M-C is in the ON position. A code OFF flag will appear in the upper left portion of the instrument face if power to the encoder is lost. The code OFF flag only monitors the encoder function of the altimeter. It does not indicate transponder condition. Altitude reporting may be inoperative without the code OFF flag showing if the transponder fails or controls are improperly set. If the code OFF flag appears, check that ac power is available and circuit breakers are in. If the flag is still visible, contact a ground radar to determine altitude reporting operation and proceed accordingly. In the event of encoder failure, the instrument continues to function as a normal barometric altimeter. The altimeter is set by turning the barometric setting knob on the lower left, front side of the case until the proper setting is visible in the Kollsman dial on the lower right side of the instrument display (range 28.1 to 31.0 inches Hg). The instrument also contains an internal vibrator which operates whenever dc power is on. The vibrator provides for smooth display changes by minimizing mechanical friction effect. If the vibrator fails, the instrument will continue to function pneumatically, but a less smooth movement of the instrument display will be evident. The 100-foot pointer may stick when passing the 12-o'clock position. This effect can be lessened by tapping the instrument case.

19.4.1.4 MODE 4. Mode 4 is a Military secure mode. It will operate only when the cryptographic computer-transponder (KIT-1A/TSEC) is installed and coded. Mode 4 codes are inserted mechanically, with a special coding tool, into the KIT-1A/TSEC. Mode 4 is controlled from the CMS IFF page (Figure 19-30). To operate mode 4, the IFF must be on and in the normal mode.

19.4.1.4.1 Preflight Check. To perform a preflight check of mode 4 IFF, proceed as follows:

1. Perform preflight check of IFF system

2. On IFF Test page, press LS5 — * appears to right of M4 and TEST is displayed to the left. TEST changes to GO when mode test is complete.

3. Ensure GO is displayed next to KIT on data line 3.

19.4.1.4.2 Mode 4 Operation. To operate the IFF system in mode 4 proceed as follows:

1. On CMS-CDU, press IFF key—IFF page displayed.

2. Select mode 4 submode for current time period (LS4)—M4:A or M4:B.

3. Select method of mode 4 reply monitoring (LS8)—AUD:RPLY, LIT:RPLY, or OUT:RPLY.

4. If AUD:RPLY selected:

   a. Connect headset to ICS disconnect.

   b. Pull and turn IFF monitor control mid-range.

   c. Turn VOL control to mid-range.

5. Press IFF REPLY light—light is ON while pressed.

6. Check IFF caution light—light is OFF.

NOTE

The IFF caution light will illuminate when the IFF system fails to reply to a valid mode 4 interrogation. The IFF caution light circuitry monitors for: (1) mode 4 codes zeroized, (2) transponder failure to reply to proper interrogation, and (3) automatic self-test function of the computer revealing a computer malfunction.

7. Should the IFF caution light illuminate, proceed as follows.

(a) On CMS-CDU, press IFF key—IFF page selected.

(b) Check IFF power—NORM:PWR displayed.

(c) Check mode 4 submode—4A or 4B selected for current time period of operation.

(d) If the IFF caution light remains on, avoid operation in a known mode 4 interrogating environment or if already in one, take appropriate corrective action as operationally directed for this condition (inoperative mode 4).

NOTE

The mode 4 codes will automatically zeroize when power to the IFF is turned OFF with the landing gear down. If a second flight is anticipated during the installed code time period, the code setting may be retained by selecting HOLD ON with weight on the landing gear at least 15 seconds before IFF power is turned OFF.

8. If the need to zeroize mode 4 codes inflight exists, proceed as follows:

(a) On emergency radio control panel, lift guard on ZEROIZE switch.

(b) Move switch to ZEROIZE position-IFF caution light illuminates.

9. To retain mode 4 codes:

(a) On CMS-CDU, press IFF key—IFF page displayed.

(b) Position slew switch up or down and hold momentarily (2 to 3 seconds)—M4 HOLD-↕-ON displayed on information line for approximately 15 seconds, then is replaced by M4 HELD ↕:OFF.

(c) Wait at least 15 seconds before turning the IFF to OFF.

CHAPTER 20

Communications

20.1 GENERAL

Communications and associated electronic equipment are described in Chapter 19 of this Part. The installed radio equipment requires various times for warm-up prior to operation. For specific warm-up periods, see Figure 19-1.

20.2 OPERATION

The mission requirements dictate that pilots and observers adhere to proper voice procedures and strict radio discipline as standardized by the current editions of NWPs. Guard frequency must be continuously monitored but transmissions will be made only in an emergency situation. Ground-to-air signals, including aircraft maneuvers as acknowledgments, will be in accordance with NWP 50-2. CMS preset pages for installed radios will be in accordance with the appropriate communication plan.

20.3 VISUAL COMMUNICATIONS

Communications between aircraft within a formation will be conducted visually whenever practicable, provided no sacrifice in operational efficiency is involved. Flight leaders will ensure that all aircraft in the formation receive and acknowledge signals when given. Visual signals as set forth in NWP 50-2 will be used. For emergency signaling, the FAA standard HEFOE system should be used:

1 finger	H	Hydraulic
2 finger	E	Electrical
3 fingers	F	Fuel
4 fingers	O	Oxygen
5 fingers	E	Engine

PART VIII

Weapons Systems

CHAPTER 21

Armament

21.1 ARMAMENT EQUIPMENT

The aircraft is capable of carrying a variety of conventional weapons loads, including gun pods, bombs, missiles, rocket pods, CBUs, and napalm. Weapons display and control functions are selected from the CMS control display unit via the WPNS key. Only those stores listed in the NWP 55-6-OV10A/D (OV-10A/D Tactical Manual) are authorized to be carried and released or fired within the specified limits.

21.2 SPONSON GUNS

Two M60C 7.62mm machine guns are integrally installed in each sponson. The M60C is an electrically charged, gas-operated weapon which was adapted from the M60 NATO automatic rifle. Each pair of guns (left and right) may be charged separately on the ground or in flight, through the CMS Internal Guns page selected READY/SAFE and will be displayed on annunciator line (Figure 21-3). Ground use of the sponson-mounted charging switches requires application of external power or that the BATTERY switch be placed to ON to energize the primary dc bus; the MASTER ARM switch must be moved to ON.

21.3 BOMBING EQUIPMENT

A variety of conventional weapons may be carried on five external store stations. Two pylons may be installed on each sponson and one pylon may be installed at centerline on the fuselage. The centerline station will carry a single store weighing up to 1200 pounds at design G-limits and may be adapted for stores requiring 30-inch suspension spacing. The remaining stations are designed for 14-inch suspension spacing and will carry stores weighing up to 600 pounds at design G-limits. The external store station pylons are bolted on and cannot be dropped.

21.3.1 Optical Sight and Sight Controls. An illuminating, reflecting, noncomputing optical sight (Figure 21-1) is installed in the pilot's cockpit. The reticle may be depressed up to 270 mils through tilting of the reflecting glass to provide proper sight angles for release of weapons. The reticle image consists of a 2-mil pipper and quadrantial markings at 25 and 50 mils. A slip indicator is mounted above the mil-depression knob.

21.3.1.1 Inclinometer Light. A post light, mounted on the optical sight inclinometer, provides improved illumination of the mil-setting index and the slip indicator. This light is controlled by the STBY COMPASS switch and intensity is controlled by the INSTRUMENTS rheostat (Figure 21-1).

21.3.1.2 Sight Reticle Brightness Knob. The sight reticle brightness knob (Figure 21-1) allows selection of sight reticle illumination and brightness.

21.3.1.3 Filament Select Switch. The FIL SEL switch (Figure 21-1) allows selection of the No.1 or No. 2 sight reticle illuminator filament when the monitor dc bus is powered.

NOTE

Select NO. 1 filament to prevent top filament, if burned out, from shorting out bottom filament. To prolong filament life, the brightness knob should be kept at full low until brightness is required. Use NO. 2 filament after failure of NO. 1 filament.

21.3.2 MASTER ARM Switch. The ON position of the MASTER ARM switch (Figure 21-1) applies power to the armament bus when the landing gear handle is in the UP position and the monitor dc bus is powered. All armament selection, release, and firing power is provided through the master arm circuit. The ARMT SAFETY DISABLE switch in the left main landing gear well bypasses the landing gear handle safety switch allowing the armament bus to be powered for ground checks and maintenance.

21.3.3 Drop Button. The drop button is located on the pilot's stick grip. This button is used to drop any bomb rack mounted store selected on the CMS Weapons Select pages and for selective stores jettison via the CMS (Figure 21-1).

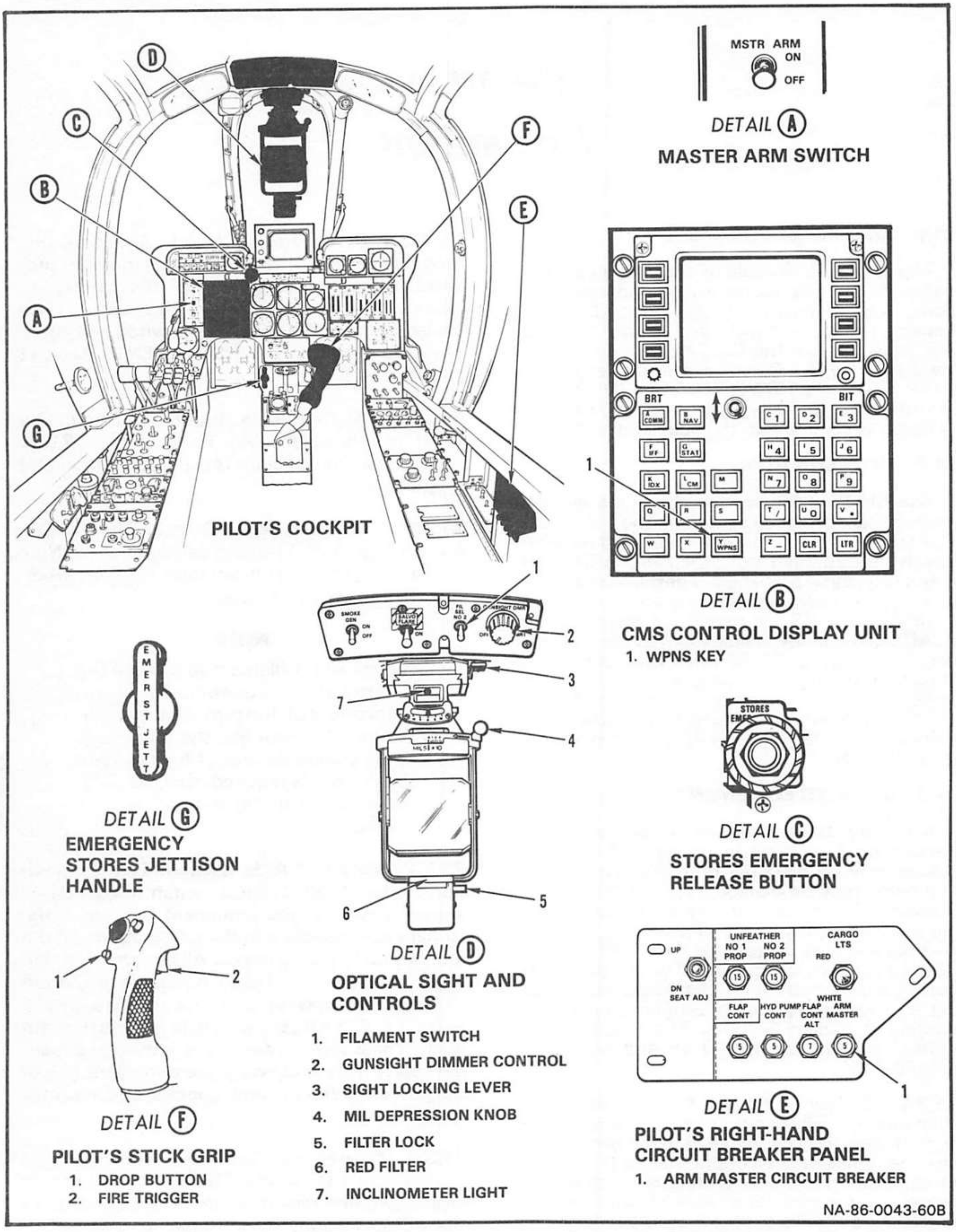


Figure 21-1. Optical Sight and Armament Controls

21.3.4 Fire Trigger. Used to fire any internally or externally carried, forward-firing ordnance as selected on the CMS Weapons Select pages and to drop flares when the SUU-44A dispenser is installed (Figure 21-1).

21.3.5 Stores Emergency Release Button. The STORES EMER REL button (Figure 21-1) when depressed releases all external stores. The stores emergency release system, powered by the battery bus, is deactivated by the ground safety switch with weight on the gear and is operative only with the aircraft airborne. The emergency release system is independent of the MASTER ARM switch.

21.3.6 Emergency Stores Jettison Handle. The EMER ST JETT handle (Figure 21-1) is located on the left side of the pilot's center pedestal. Stores on stations 1, 2, 4, and 5 may be jettisoned manually by pulling this handle outward approximately 3 inches.

21.3.7 Missile Monitor Control. The 1200-Hz AIM-9 missile audio tone may be monitored by pulling up and turning the MSL monitor control to mid-range. The control is located on the ICS monitor panel. Clockwise rotation will increase the audio level and counterclockwise rotation will decrease the audio level. Activation of the tone indicates the missile has acquired and locked onto an IR target. The tone will be heard in the crew's headsets until the missile is fired or the target is lost (Figure 19-11).

21.4 CMS CONTROL AND DISPLAY FOR WEAPONS EQUIPMENT

The CMS system provides an operator interface for weapon station selection, bomb arming and drop, internal gun firing, rocket and flare firing, and selective store jettisoning. Control and display of weapons status is selected by pressing the WPNS key on either CMS-CDU. Upon initial display of the Weapons Select pages; all weapons stations will be OFF, bombs will indicate SAFE, and GPU-2 gun rate of fire will be HIGH. If GPU-2 or bombs are not mounted, the functions will be disabled. Any station selected for drop or fire on the Weapons Select pages will be displayed on the annunciator line as a station select annunciator on all CMS pages until deselected. The flight crew must ensure that the stores configuration matches the CMS display information, the CMS does not have the capability to cross-check for unauthorized stores configurations (Figures 21-1 and 21-3).

21.4.1 CMS Power Control ON/OFF Switch. The CMS PWR switch, located on the CMS AND RADIO PWR CONTROL panel, provides electrical power to the CMS system for weapons control and display operation (Figure 19-2).

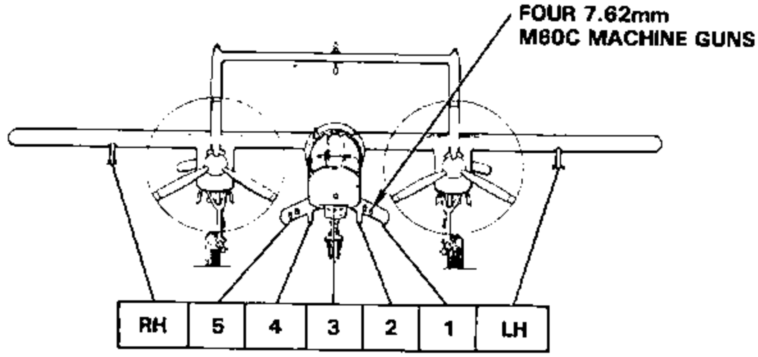
21.4.2 Weapons Select Pages. Two Weapon Select pages display the current aircraft weapons configuration for the left and right wing stations and store stations 1 through 5. Options on these pages allow the crew to review weapons configuration, select stores for drop or firing, select gun fire rate, or the arming of bombs. Access to the jettison and internal guns pages is also provided. Weapons loaded on store stations will be identified by mnemonics. See Figure 21-2 for mnemonic, store-type, station mode, and arming function. See Figure 21-3 for page description.

21.4.3 Weapons Configuration Pages. Aircraft weapons load information is programmed for display on the Weapons Select pages by the aircrew or ground personnel by using the Weapons Configuration page and associated Bomb, Missile, Rocket, PMBR, and Special Configuration List pages. When the landing gear is down, these pages may be accessed and weapon information inserted by pressing UP on the slew switch when viewing Weapon Select page 2/2. Rotary operation of LS1 on the Weapon Configurations page will sequentially display the desired store station (L, 1, 2, 3, 4, 5, or R) and its present load. The present store station load may be changed by selecting the desired weapon Configuration List page from the options displayed (LS2 through LS8). On the Weapons Configuration List pages, LS key action will insert weapon choice from the list to the selected store station. When the desired weapon choice has been inserted, it will be displayed on the Weapon Select pages and the Weapon Configuration page (when selected) for the applicable store station. Auxiliary fuel and GPU-2 gun pod store station configurations can be entered directly from the Weapons Configuration page. See Figure 21-3 for detailed CDU key operation.

21.4.4 Jettison Page. The pilot may select the Jettison page (from the Weapons Select page 1/2) when he desires to override the weapons delivery mode and selectively jettison the indicated stores. CMS-CDU programing will not permit the GPU-2/A gun pod to be jettisoned from stations 2 and 4 or PMBR ordnance from any station. The AIM-9 Sidewinder missile will also be inhibited from jettison. To jettison, the pilot must select READY with applicable LS key and push the drop button to release the selected store. Arming and firing functions are automatically disabled (safe) when the Jettison page is selected by the pilot. When the pilot exits the Jettison page, all stations return to their original state (prior to entry). The observer has access to this page for monitor purposes only. See Figure 21-3 for detailed operation.

21.4.5 Internal Guns Page. Arming of the left and right internal guns may be selected by selecting INT GUNS on the Weapons Select page 1/2 and selecting LS2 (left guns) and/or LS6 (right guns) on the Internal Guns page. The guns can be fired by pressing the fire trigger on the pilot's stick grip (Figure 21-1).

21.4.6 Station Select Annunciator Messages. See Figure 19-7.



STORE NAME/TYPE	MNEMONIC	STATION MODE FIRE	DROP	ARMING N & T	FUNCTION TAIL	SEE NOTE
MK 81 GP BOMB	MK 81		X	X	X	2
MK 82 GP BOMB	MK 82		X	X	X	2
MK 83 GP BOMB	MK 83		X	X	X	3
MK 77 FIRE BOMB	FIRE		X	X	X	2
CBU-55 FAE BOMB	FAE		X	X		2
SIDEWINDER MISSILE	AIM-9	X				4
2.75 ROCKETS	2.75	X				5
5.0 ROCKETS	ZUNI	X				5
FUEL TANKS	FUEL					6
GPU-2 GUN POD	GPU-2	X				7
PMBR—PRACTICE BOMBS	MBRPB		X			8
PMBR—FLARES	MBRFL		X			8
PMBR—SMOKE	MBRSM		X			8
PMBR—ADSID-III	MBRAD		X			8
SUU-25F/A FLARES	FL-25	X				2
SUU-44/A FLARES	FL-44	X				9
SUU-44	ASDTS		X			10
CAPTIVE SIDEWINDER	AIMTR	X				11
TELEMETRY POD	ACMR	X				11

NOTE

1. IT IS THE CREWS RESPONSIBILITY TO CROSS CHECK FOR CONFIGURATION
2. STATIONS 1 THROUGH 5 ONLY
3. STATION 3 ONLY
4. LEFT WING AND RIGHT WING ONLY–NO JETTISON FUNCTION
5. ALL STATIONS EXCEPT 3
6. STATION 3, LEFT WING AND RIGHT WING ONLY
7. RATE OF FIRE AND GUN CLEAR (STATIONS 2 AND/OR 4)
8. NO ARMING FUNCTION FOR MULTIPLE BOMB RACKS
9. LEFT WING AND RIGHT WING ONLY
10. STATIONS 1, 2, 4, AND 5 ONLY
11. LEFT AND RIGHT WING ONLY–NOT FIRED OR DROPPED. WITH THIS COMBINATION ON LEFT AND RIGHT WING STATIONS THE SIDEWINDER INTERLOCK WILL BE DISABLED.

NA-86-0043-61A

Figure 21-2. Selected Stores and Store Stations

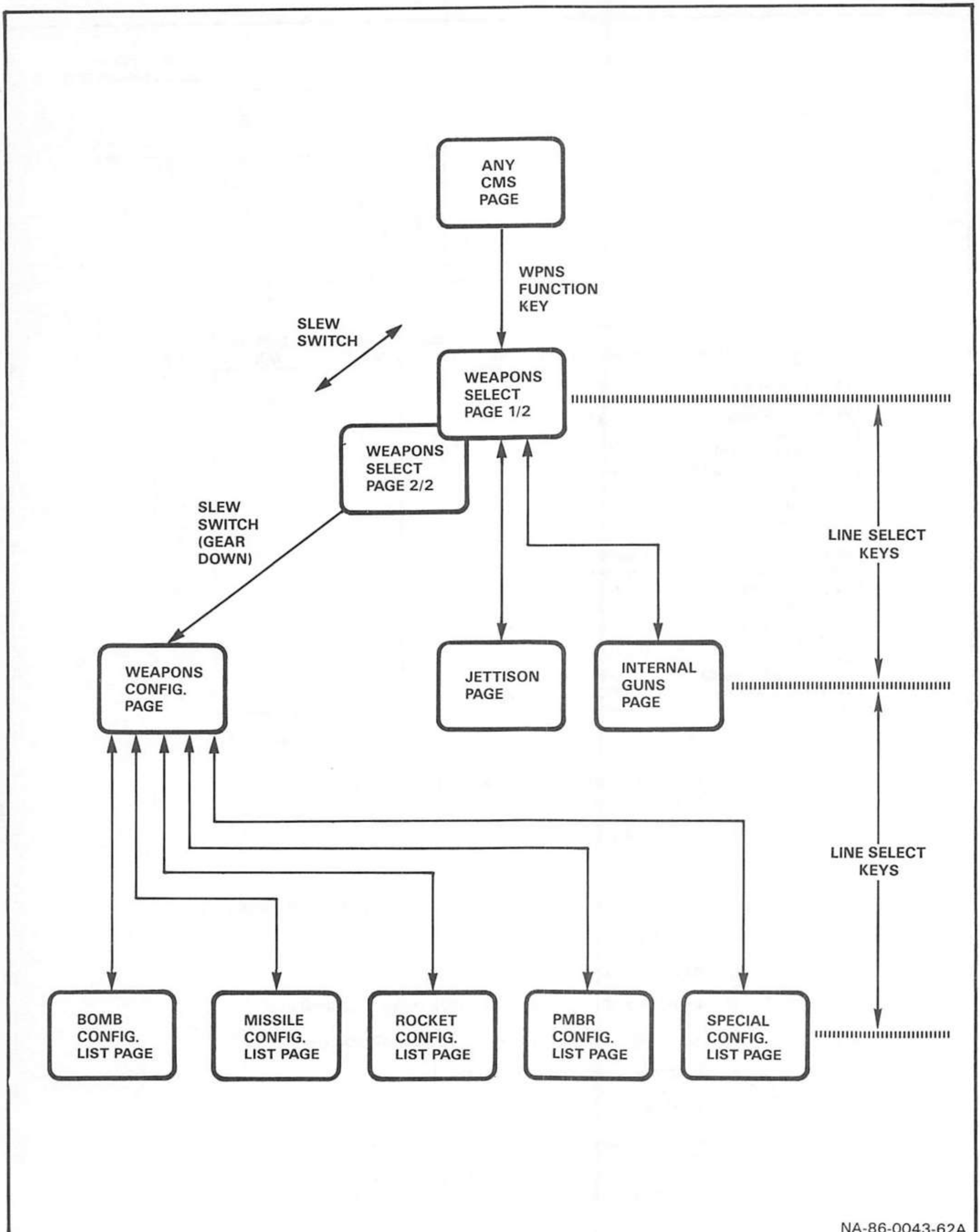
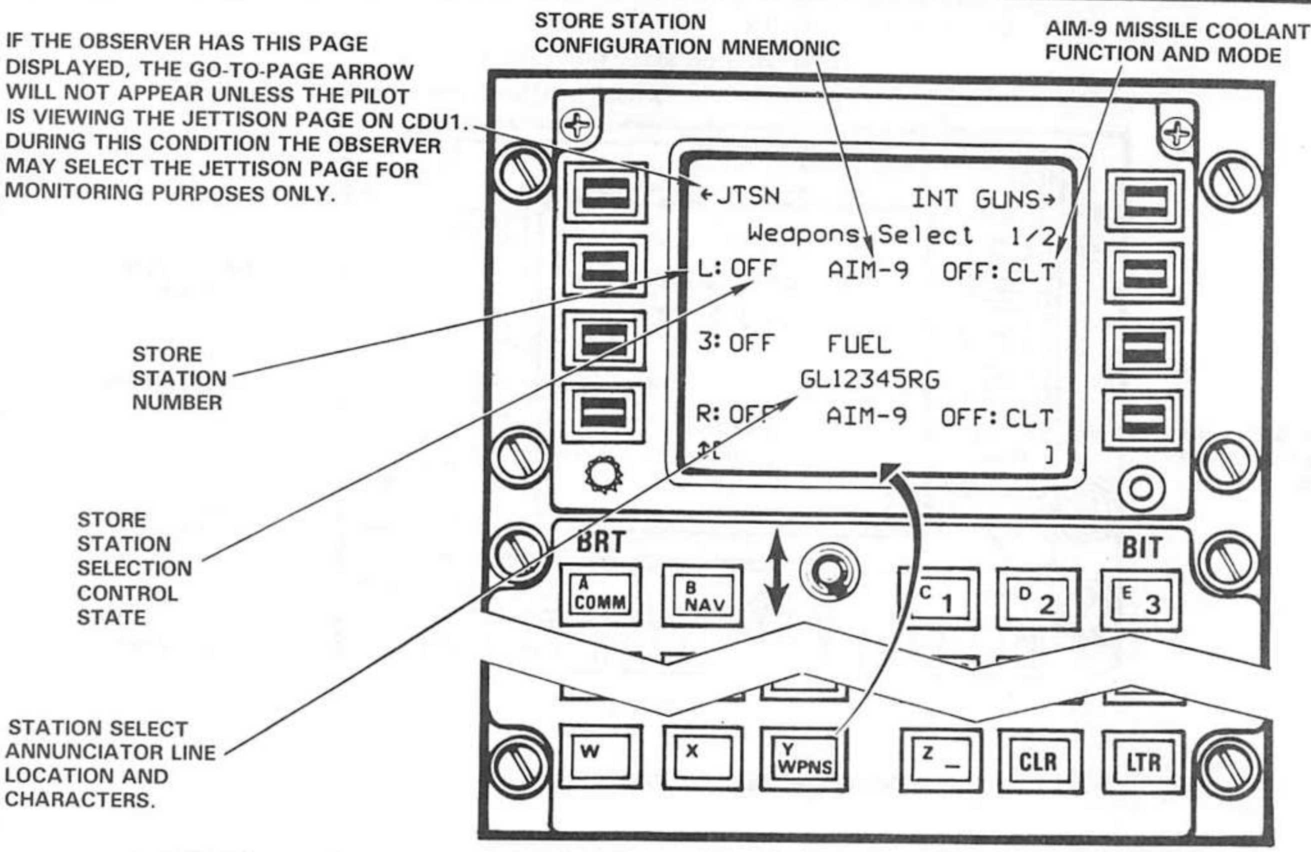


Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 1 of 11)



WEAPONS SELECT PAGE 1/2

LS1: GO TO THE JETTISON PAGE.

LS2: LEFT WING STORE STATION CONFIGURATION AND SELECTION CONTROL (OFF/FIRE OR OFF/DROP).

LS3: STORE STATION 3 CONFIGURATION AND SELECTION CONTROL (OFF/DROP, OFF/FIRE OR OFF/HI/LOW WITH GPU-2/A CONFIGURED).

LS4: RIGHT WING STORE STATION CONFIGURATION AND SELECTION CONTROL (OFF/FIRE OR OFF/DROP).

LS5: GO TO THE INTERNAL GUNS PAGE.

LS6: BOMB ARMING FUNCTION FOR THE LEFT WING STORE STATION.

(A) IF STATION SELECTED AND BOMB CONFIGURED ARMING OPTIONS ARE;

SAFE = NOT ARMED
TAIL = TAIL ARMING
N + T = NOSE AND TAIL ARMING

(B) IF STATION SELECTED AND AIM-9 MISSILE CONFIGURED; COOLANT CONTROL (ON/OFF) IS DISPLAYED.

LS7: BOMB ARMING FUNCTION FOR STORE STATION 3 (SEE LS6, PART A) OR GUN CLEAR MOMENTARY FUNCTION (ON/OFF).

NOTE

GUN RATE OF FIRE (LS3) AND GUN CLEAR FUNCTION (LS7) ARE NOT USED. GPU-2/A GUN POD IS NOT AUTHORIZED FOR STORE STATION 3.

LS8: BOMB ARMING FUNCTION FOR THE RIGHT WING STORE STATION (SEE LS6, PART A AND B).

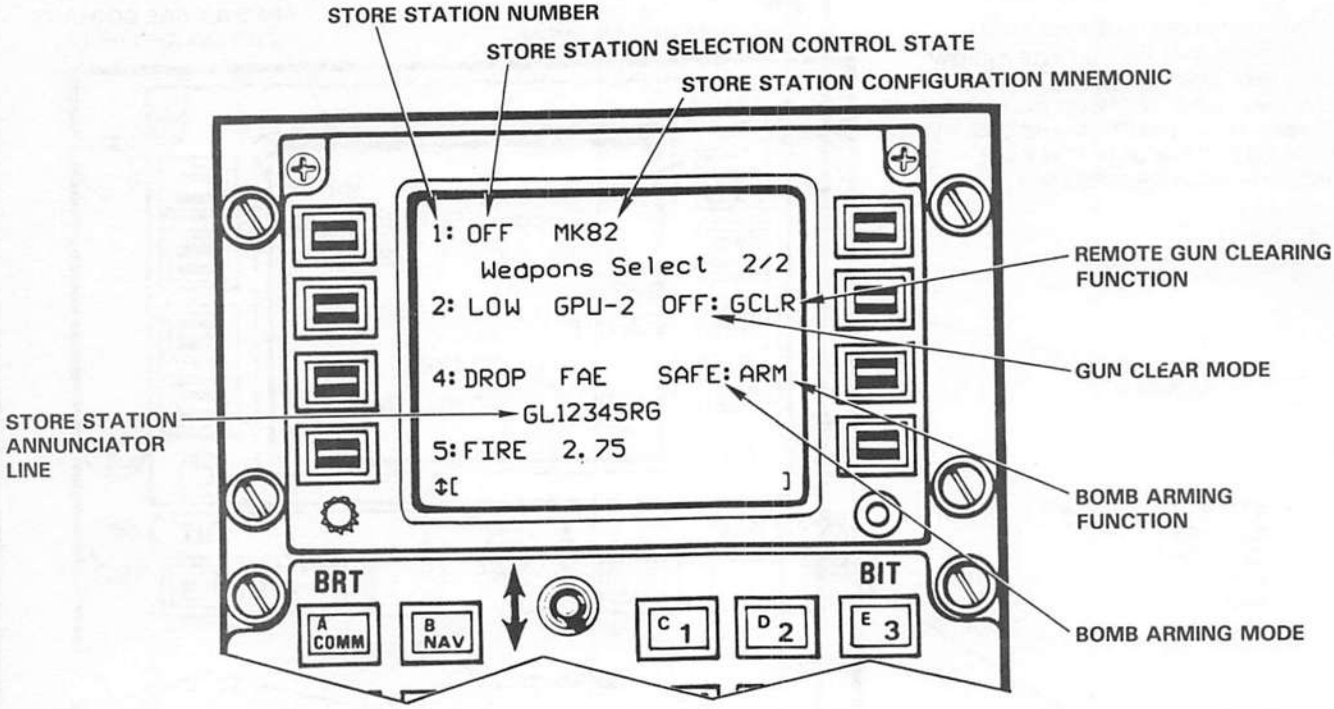
SLEW UP/DOWN–GO TO THE WEAPONS SELECT PAGE 2/2.

NOTE

- STORE STATIONS THAT HAVE FUEL CONFIGURED (L,3,R) WILL HAVE NO WEAPONS STATION SELECT FUNCTION EXCEPT FOR JETTISON (FROM JTSN PAGE).
- WHEN AIM-9 IS CONFIGURED THE COOLANT CONTROL FUNCTION SHALL PROVIDE BOTH MISSILES WITH COOLANT, THEREFORE, SELECTION OF EITHER TURNS BOTH ON OR OFF.
- OFF/FIRE WILL BE DISPLAYED FOR FORWARD FIRING WEAPONS (MISSILES, ROCKETS, AND FLARES). OFF/DROP WILL BE DISPLAYED FOR GRAVITY WEAPONS (BOMBS, PMBR, ORDNANCE AND DETECTORS).

NA-86-0043-63A

Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 2 of 11)



WEAPONS SELECT PAGE 2/2

LS1: STORE STATION 1 CONFIGURATION AND SELECTION CONTROL (OFF/DROP OR OFF/FIRE).

LS2: STORE STATION 2 CONFIGURATION AND SELECTION CONTROL (OFF/DROP, OFF/FIRE OR OFF/HI/LOW WITH GPU-2/A CONFIGURED).

LS3: STORE STATION 4 CONFIGURATION AND SELECTION CONTROL (OFF/DROP, OFF/FIRE OR OFF/HI/LOW WITH GPU-2/A CONFIGURED).

LS4: STORE STATION 5 CONFIGURATION AND SELECTION CONTROL (OFF/DROP OR OFF/FIRE).

LS5: BOMB ARMING FUNCTION FOR STORE STATION 1, IF STATION SELECTED FOR DROP AND BOMB CONFIGURED:

SAFE = NOT ARMED
TAIL = TAIL ARMING
N + T = NOSE AND TAIL ARMING

LS6: BOMB ARMING FUNCTION FOR STORE STATION 2. SEE LS5 AND NOTE.

LS7: BOMB ARMING FUNCTION FOR STORE STATION 4. SEE LS5 AND NOTE.

LS8: BOMB ARMING FUNCTION FOR STORE STATION 5. SEE LS5.

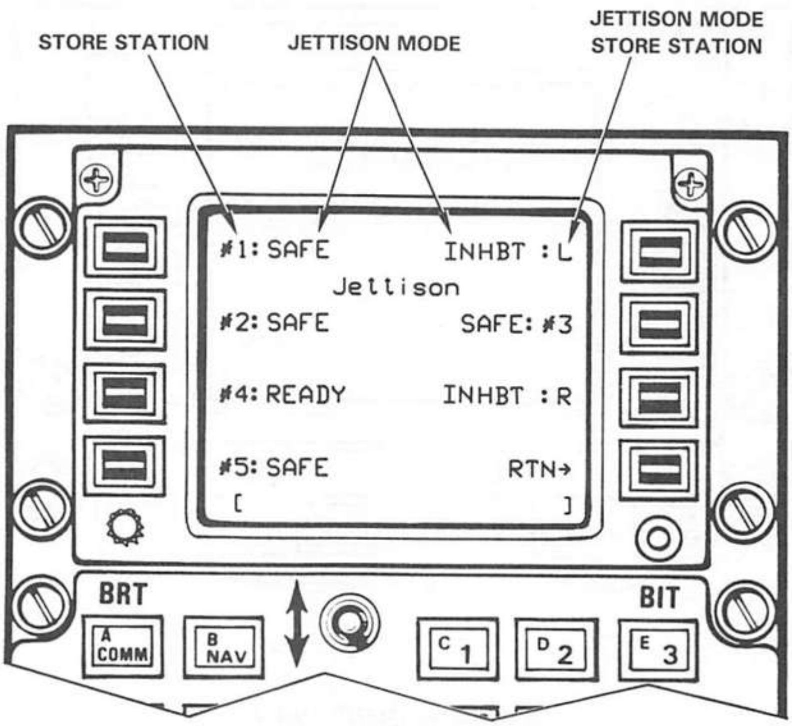
SLEW UP/DOWN–GO TO THE WEAPONS SELECT PAGE 1/2. (WITH LANDING GEAR DOWN, SLEW UP WILL GO TO THE WEAPONS CONFIGURATION PAGE FROM 2/2).

NOTE

- THE BOMB ARMING FUNCTION WILL NOT BE DISPLAYED UNTIL THE CORRESPONDING WEAPON STATION IS SELECTED FOR DROP.
- STATIONS 2 AND 4 MAY CARRY THE GPU-2/A GUN POD. STATION SELECT SELECTION CONTROL (LS2 OR LS3) SHALL TOGGLE OFF, HI OR LOW AND THE OPPOSITE LINE SELECT KEYS (LS6 OR LS7) SHALL PROVIDE THE REMOTE CLEARING FUNCTION (ON/OFF: GLCR).
- ONLY LOW RATE OF FIRE IS AUTHORIZED FOR GPU-2/A GUN POD WITHOUT AAC 716.
- OFF/FIRE WILL BE DISPLAYED FOR FORWARD FIRING WEAPONS (ROCKETS, MISSILES AND FLARES). OFF/DROP WILL BE DISPLAYED FOR GRAVITY WEAPONS (BOMBS, PMBR ORDNANCE, AND DETECTORS).

NA-86-0043-64A

Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 3 of 11)



JETTISON PAGE

LS1: TOGGLE STATION 1 JETTISON MODE (SAFE, READY, INHBT).

LS2: TOGGLE STATION 2 JETTISON MODE (SAFE, READY, INHBT).

LS3: TOGGLE STATION 4 JETTISON MODE (SAFE, READY, INHBT).

LS4: TOGGLE STATION 5 JETTISON MODE (SAFE, READY, INHBT).

LS5: TOGGLE STATION 3 JETTISON MODE (SAFE, READY, INHBT).

LS6: TOGGLE LEFT WING STATION JETTISON MODE (SAFE, READY, INHBT).

LS7: TOGGLE RIGHT WING STATION JETTISON MODE (SAFE, READY, INHBT).

LS8: RETURN TO THE WEAPON SELECT PAGE 1/2.

NOTE

- THIS SCREEN MAY ONLY BE USED ON THE PILOT'S CDU. OBSERVER MAY ONLY VIEW IT WHEN THE PILOT HAS IT DISPLAYED ON CDU 1.
- STATIONS CONFIGURED WITH AIM-9 MISSILES OR PMBR ORDNANCE WILL DISPLAY (INHBT), INHIBITED FOR JETTISON.
- AFTER STORE STATIONS ARE SELECTED TO "READY", PUSHING THE DROP BUTTON ON THE PILOT'S CONTROL STICK GRIP WILL JETTISON SELECTED STORE.
- ARMING AND FIRE/DROP FUNCTIONS ARE DISABLED WHEN THIS SCREEN IS DISPLAYED. UPON EXITING THIS SCREEN THE PREVIOUS WEAPON ARMING CONDITION WILL BE RESTORED.

NA-86-0043-65B

Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 4 of 11)

INTERNAL GUNS PAGE

LS1–NO ACTION.

LS2–TOGGLE LEFT INTERNAL GUN MODE (SAFE/READY).

LS3–NO ACTION.

LS4–NO ACTION.

LS5–NO ACTION.

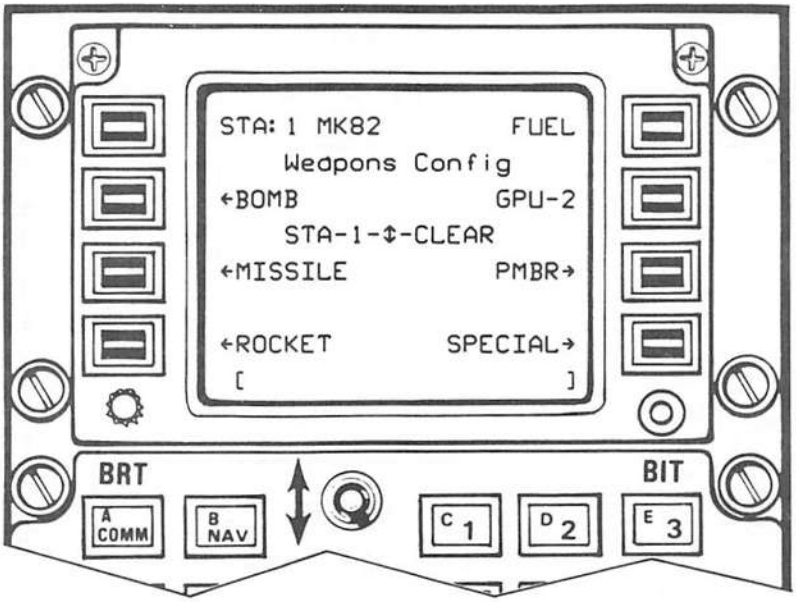
LS6–TOGGLE RIGHT INTERNAL GUN MODE (SAFE/READY).

LS7–NO ACTION.

LS8–RETURN TO THE WEAPONS SELECT PAGE 1/2.

NA-86-0043-66A

Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 5 of 11)



*** WEAPONS CONFIGURATIONS PAGE**

LS1 - SEQUENCES THROUGH STATION LOCATIONS (L, 1, 2, 3, 4, 5, R), OR THE STATION CAN BE ENTERED VIA THE SCRATCH PAD. DISPLAYS DASHES IF NO WEAPON LOADED.

LS2 - GO TO THE BOMB CONFIGURATION LIST PAGE.

LS3 - GO TO THE MISSILE CONFIGURATION LIST PAGE.

LS4 - GO TO THE ROCKET CONFIGURATION LIST PAGE.

LS5 - CONFIGURE AUXILIARY FUEL TANK AT CURRENT STATION (FUEL).

LS6 - CONFIGURE GUN POD AT CURRENT STATION (GPU-2/A).

LS7 - GO TO THE PMBR CONFIGURATION LIST PAGE.

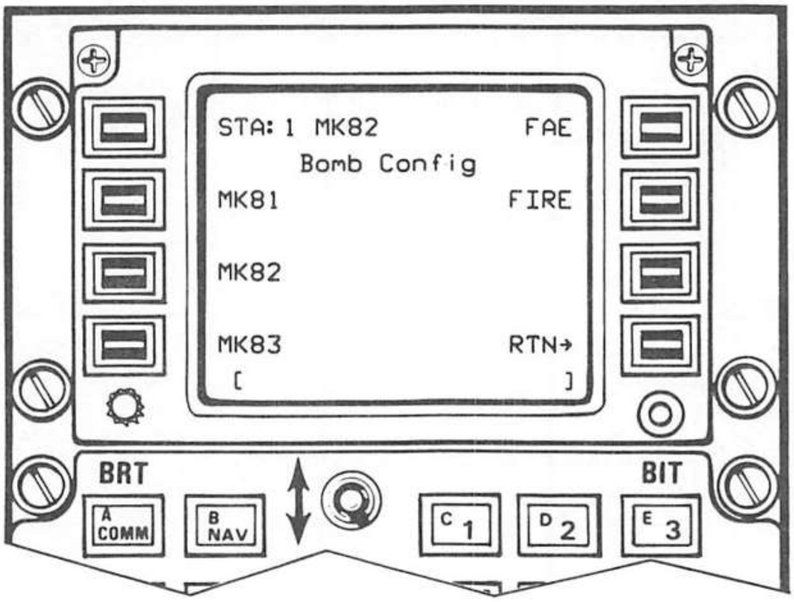
LS8 - GO TO THE SPECIAL CONFIGURATION LIST PAGE.

SLEW UP/DOWN - CLEARS CURRENT STATION.

* ACCESSIBLE ONLY WHEN GEAR DOWN.

NA-86-0043-67A

Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 6 of 11)



BOMB CONFIGURATION LIST PAGE

LS1 – SEQUENCES THROUGH STATION LOCATIONS (L, 1, 2, 3, 4, 5, R), OR THE STATION CAN BE ENTERED VIA THE SCRATCH PAD.

LS2 – CONFIGURE A MK 81 BOMB AT THE CURRENT STATION.

LS3 – CONFIGURE A MK 82 BOMB AT THE CURRENT STATION.

LS4 – CONFIGURE A MK 83 BOMB AT THE CURRENT STATION.

LS5 – CONFIGURE A FAE BOMB AT THE CURRENT STATION.

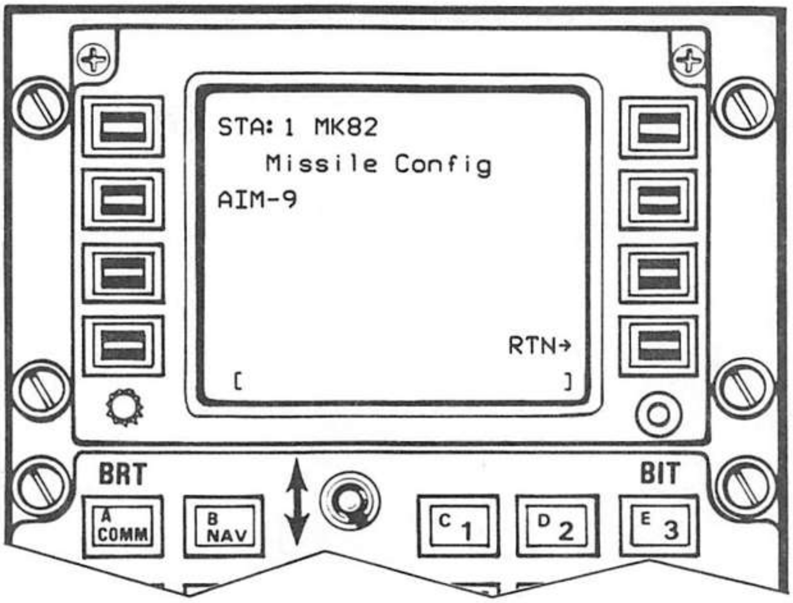
LS6 – CONFIGURE A FIRE BOMB AT THE CURRENT STATION.

LS7 – NO ACTION.

LS8 – RETURN TO THE WEAPONS CONFIGURATION PAGE.

NA-86-0043-68A

Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 7 of 11)



MISSILE CONFIGURATION LIST PAGE

LS1 — SEQUENCES THROUGH STATION LOCATIONS (L, 1, 2, 3, 4, 5, R), OR THE STATION CAN BE ENTERED VIA THE SCRATCH PAD.

LS2 — CONFIGURE AN AIM-9 MISSILE AT THE CURRENT STATION.

LS3 — NO ACTION.

LS4 — NO ACTION.

LS5 — NO ACTION.

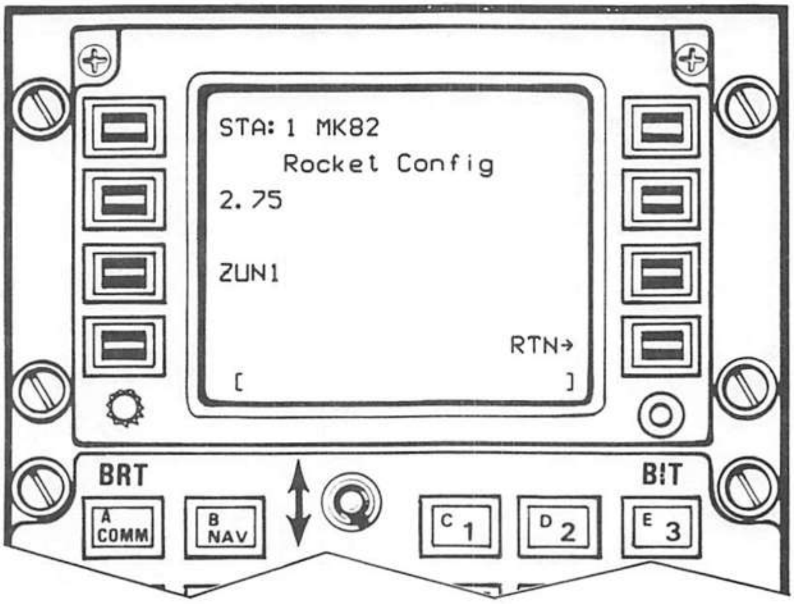
LS6 — NO ACTION.

LS7 — NO ACTION.

LS8 — RETURN TO THE WEAPONS CONFIGURATION PAGE.

NA-86-0043-69A

Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 8 of 11)



ROCKET CONFIGURATION LIST PAGE

LS1 — SEQUENCES THROUGH STATION LOCATIONS (L, 1, 2, 3, 4, 5, R), OR THE STATION CAN BE ENTERED VIA THE SCRATCH PAD.

LS2 — CONFIGURE A 2.75 ROCKET AT THE CURRENT STATION.

LS3 — CONFIGURE A ZUNI ROCKET AT THE CURRENT STATION.

LS4 — NO ACTION.

LS5 — NO ACTION.

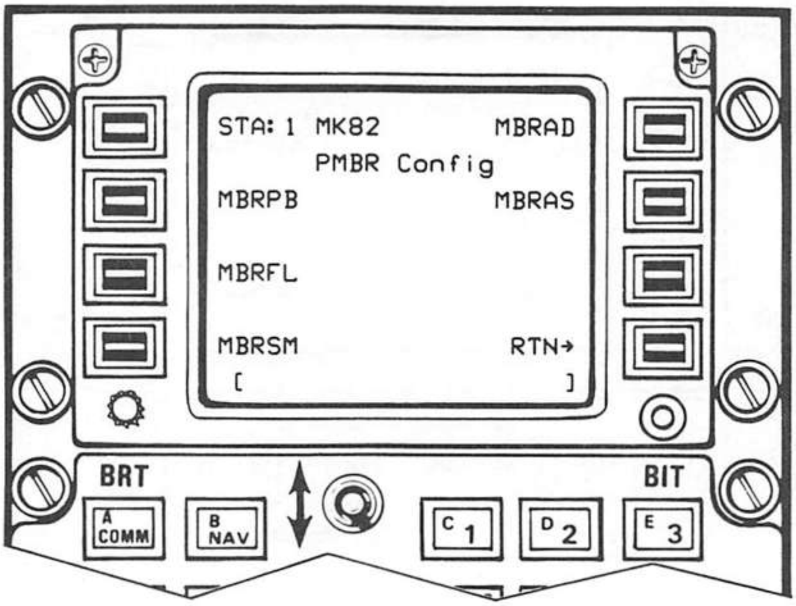
LS6 — NO ACTION.

LS7 — NO ACTION.

LS8 — RETURN TO THE WEAPONS CONFIGURATION PAGE.

NA-86-0043-70A

Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 9 of 11)



PMBR CONFIGURATION LIST PAGE

LS1 – SEQUENCES THROUGH STATION LOCATIONS (L, 1, 2, 3, 4, 5, R), OR THE STATION CAN BE ENTERED VIA THE SCRATCH PAD.

LS2 – CONFIGURE A MBRPB PMBR AT THE CURRENT STATION.

LS3 – CONFIGURE A MBRFL PMBR AT THE CURRENT STATION.

LS4 – CONFIGURE MBRSM PMBR AT THE CURRENT STATION.

LS5 – CONFIGURE MBRAD PMBR AT THE CURRENT STATION.

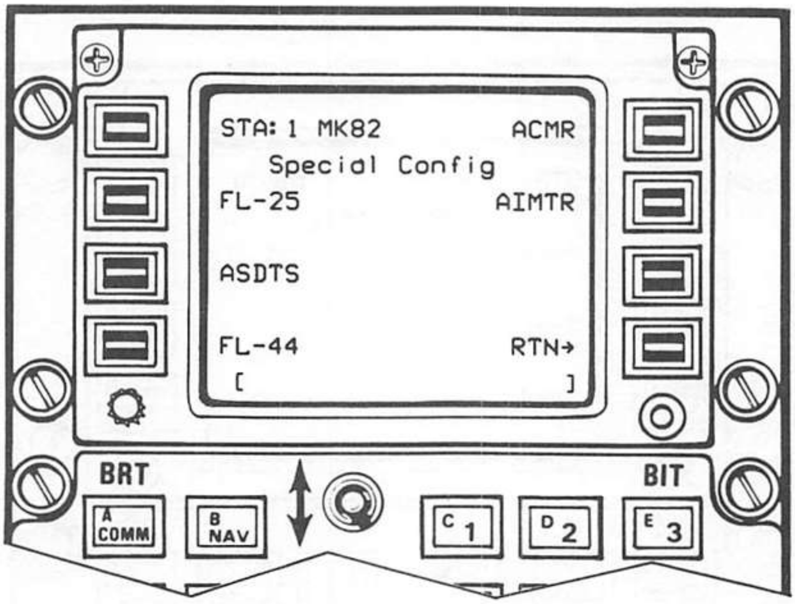
LS6 – CONFIGURE MBRAS PMBR AT THE CURRENT STATION.

LS7 – NO ACTION.

LS8 – RETURN TO THE WEAPONS CONFIGURATION PAGE.

NA-86-0043-71A

Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 10 of 11)



SPECIAL CONFIGURATION LIST PAGE

LS1: SEQUENCES THROUGH STATION LOCATIONS (L, 1, 2, 3, 4, 5, R), OR THE STATION CAN BE ENTERED VIA THE SCRATCH PAD.

LS2: CONFIGURE FL-25 (FLARES) AT THE CURRENT STATION.

LS3: CONFIGURE ASDTS (SUU-44) AT THE CURRENT STATION.

LS4: CONFIGURE FL-44 (FLARES) AT THE CURRENT STATION.

LS5: CONFIGURE ACMR (TELEMETRY POD) AT THE CURRENT STATION.

LS6: CONFIGURE AIMTR (CAPTIVE SIDEWINDER) AT THE CURRENT STATION.

LS7: NO ACTION.

LS8: RETURN TO THE WEAPONS CONFIGURATION PAGE.

NA-86-0043-72B

Figure 21-3. WPNS Key Flow Chart and Page Displays (Sheet 11 of 11)

CHAPTER 22

Avionics

22.1 TARGET DETECTION SYSTEMS

The infrared laser detecting-ranging set and mission (video) recorder comprise the target detection system.

22.2 INFRARED LASER DETECTING-RANGING SET, AN/AAS-37

The infrared laser detecting-ranging set, AN/AAS-37 consists of a forward looking infrared (FLIR) detection set subsystem, a laser rangefinder-designator (LRD) subsystem, and an automatic video tracking (AVT) computer subsystem. The FLIR views the terrain in the vicinity of the aircraft. Infrared energy is converted into electrical signals and is displayed on a CRT indicator in the pilot's and observer's cockpits. The displayed video enables both crewmembers to recognize, identify, and classify targets which would otherwise go undetected because of darkness or camouflage. The LRD transmits time-coded pulses to a specific target selected by the observer. Target laser reflections are processed into range information and displayed on the laser control panel located on the observer's instrument panel. The FLIR/LRD controls and indicators available to the pilot are the FLIR CMD and LASER ENABLE switches, located on the left-hand side of the instrument panel, and the pilot's video indicator located above the instrument panel. All other system controls and indicators are in the observer's cockpit (Figure 22-1).

WARNING

Laser radiation from infrared laser detecting-ranging set, AN/AAS-37, is invisible and can cause permanent blindness at a range of several miles. The same degree of care should be afforded operation of the LRD as is afforded gun systems. Aircrew members shall be provided, and use, eye protection equipment to guard against reflections of LASER energy.

22.2.1 Forward Looking Infrared Detecting Set (FLIR). The forward looking infrared detecting set (FLIR) utilizes the receiver/transmitter-converter (FLIR turret), located in the nose of the aircraft, to scan the terrain and sense thermal energy differences between objects on the ground and convert those differences into voltage differences. The voltage differences are converted into visible light images for viewing by the television camera. The AVT evaluates position, size, and movement of the operator-selected targets. The AVT controls the FLIR/LRD turret line of sight (LOS), causing the target to be continuously centered on the video display. Camera video is routed to the power supply-video converter (in the cargo bay door) where it is changed into composite video and added to gimbal angle indicator symbology, then routed to video indicators in each cockpit. Control of the FLIR turret is accomplished by mode comands, position inputs, and rate signals from the infrared detecting set control (FLIR control), the target tracking sight control, or the receiver/transmitter-converter control (all located in the observer's cockpit). The system line of sight is adjustable from 200 degrees left to 200 degrees right in azimuth and from 15 degrees up to 84 degrees down in elevation, relative to the aircraft.

In the manual (MANTRK) mode of operation, the system line of sight is controlled by rate outputs from the target tracking sight control, proportional to thumb pressure on the control button. In this mode, the automatic video tracker (AVT), located in the cargo bay door can provide automatic target tracking commands to the FLIR turret. Target lock-on and tracking is accomplished by squeezing and releasing the trigger of the target tracking sight control after the target has been centered within the tracking gate on the video indicator. Target offset tracking is accomplished by depressing the OFFSET COMD pushbutton on the video tracking control panel and slewing the locked-on target to desired offset distance from the center reticle with the target tracking sight control thumb button. Target lock-on will be maintained. OFFSET COMD pushbutton illumination will be blue while in the offset mode. To return to normal automatic tracking, depressing the OFFSET COMD pushbutton will automatically slew the offset locked-on target to the center reticle and the pushbutton illumination will change to white.

The FLIR detecting set also incorporates a "coast" feature. After target lock-on in MAN TRK, rotating the mode switch to CPTR TRK will initiate this rate-aided function and will remain locked on. If lock-on is broken due to obstruction or loss of contrast, the turret will coast in the same direction and at the same tracking rate for approximately 5 seconds with the four gate dots blinking. Automatic relock should occur within this time interval if former tracking conditions are restored. If relock does not occur, the four dots will be replaced with the tracking gate square and the turret will cease tracking. In the computer track (CPTRTRK) mode, all advisory indications and video displays remain the same as in the MAN TRK mode and the system line of sight is controlled by the thumb button, but is also responsive to aircraft altitude, acceleration, pitch, and roll angles. Attempting to slew the FLIR/LRD turret in CPTR TRK after lock-on is broken may produce large, difficult to control turret movements. After lock-on is broken, rotate MODE switch to MAN TRK, switch field of view to WFOV, reacquire target, return field of view to NFOV, and rotate MODE switch to CPTR TRK.

In the POS mode of operation the system line of sight is controlled by the AZIMUTH and ELEVATION controls on the FLIR control panel.

When the FWD mode is selected, the FLIR turret is positioned to zero degrees azimuth. In this mode elevation can be varied between 0 and −57 degrees by rotating the FLIR GIMBAL ANGLE DEPRESSION knob on the receiver/transmitter-converter control located in the observer's cockpit, left-hand side.

When the FLIR CMD switch in the pilot's cockpit is placed to the OPERATOR position, all system control is accomplished from the observer's cockpit. When the pilot selects WIDE or NARROW on the FLIR CMD switch, the observer's controls are overridden, an advisory light (PILOTS FLIR) above the observer's FLIR control panel illuminates, the FLIR turret goes to zero degrees azimuth and elevation, and the field of view is wide or narrow, as selected. With the system in this condition, the pilot's video indicator can be used as a gunsight for firing the sponson guns. The reticle however is not in boresight with the aircraft.

The FLIR system is equipped with built-in-test provisions which detect, isolate, and indicate system malfunctions and which inhibit operation prior to system readiness. A NOT READY light on the FLIR control panel indicates that (1) gyros are not up to operational speed or (2) the FLIR turret has not reached operating temperature. The FLIR control panel COOLING light indicates that the infrared detectors are not cooled to the proper operating temperature.

After the NOT READY and COOLING lights have gone out, the FLIR built-in-test sequence may be initiated by depressing the BIT ON button on the FLIR control panel. A BIT ON button light will come on and remain on during the test sequence. If the test is completed without a malfunction, the SYS GO light will come on and BIT ON light will go out. Pressing the SYS GO indicator will cause that light to go out. Malfunctioning of the major functions of the FLIR system will be indicated by RCVR CONV FAIL, POWER SUPPLY FAIL, or CONTROL SERVO FAIL lights. A RCVR O TEMP light, also located on the FLIR control panel will illuminate if an overtemperature condition exists in the FLIR turret. The automatic video tracker is also equipped with built-in-test provisions. Test initiation and indication are accomplished on the video tracking control located on the observer's instrument panel. A BIT ABA button on the control panel initiates the test sequence and GO or NOGO lights indicate test results. A blue backlight will illuminate when the BIT ABA pushbutton is depressed to the BIT mode. Always deselect BIT ABA after test.

22.2.2 Laser Rangefinder Designator (LRD). The laser rangefinder designator (LRD) transmitter and receiver components are an integral part of the FLIR turret and are boresighted to the same target point. The LRD transmits time coded pulses to a specific target selected by the observer. Returning laser reflections from the selected target area are picked up by the laser receiver and compared in time with the original laser transmission. The time differential is processed into range information and displayed on the laser control panel located on the observer's instrument panel.

The pulse coder generator, located in the left-hand observer's cockpit, provides the coding logic and controls that permit the observer to encode the transmitted laser pulses. The pulse coder generator generates the laser code pulse at the rate selected by the four thumbwheel CODE switches on the front panel. This laser code pulse determines the laser firing rate.

A backlighted TEST/ON/OFF/GO pushbutton and fail indicators are also located on the pulse coder generator panel, which allows the operator to enable and interpret the LRD BIT functions.

Indicator lights on the pulse coder generator illuminate if faults are detected, during test operations or during normal operation, in the pulse coder generator (CODE FAIL), and laser designator (DES FAIL), and during test operations, in the laser rangefinder (RNG FAIL). A LOW PWR indicator light comes on if power output drops to 70 percent of normal during test or normal operation.

With the LRD coder generator test button ON light illuminated and the LRD fire button depressed, the BIT indicators on the LRD coder generator panel indicate failures and the range readout on the LASER control panel should read 9985. With the LRD coder generator test button OFF light illuminated and the LRD fire button depressed, actual laser range is displayed on the LASER control panel, and the BIT indicators and associated BIT circuits are also enabled in this mode, except the RANGE FAIL indicator.

The laser control panel (on the observer's instrument panel), the LASER switch on the fire control grip (observer's left-hand cockpit), and the LASER ENABLE switch (on the pilot's left-hand instrument panel), provide the primary controls and indications required for the laser rangefinder designator. Firing of the laser is accomplished by depressing the LASER switch on the fire control grip with the LASER switch on the laser control panel in the ARM position and LASER ENABLE switch in the pilot's cockpit in the ON position. A LASING indicator on the laser control panel illuminates to verify laser firing. Laser range is displayed in meters on the control panel.

The laser cannot be fired from the pilot's cockpit however, the LASER ENABLE switch (in the pilot's cockpit), when placed to OFF disables firing circuit control by the observer. The firing circuit is also disabled if an overtemperature condition exists in the laser resonator or if the FLIR gimbals are positioned in an inhibited region. Either of these conditions cause the LRD INHB light on the control panel to come on. The LRD FAIL light indicates a malfunction in the laser rangefinder designator.

22.2.3 Infrared Laser Detecting-Ranging Set, Controls and Indicators

22.2.3.1 PILOTS FLIR Advisory Light. An advisory light, located on the observer's instrument panel, will illuminate when the pilot has selected WIDE or NARROW with the FLIR CMD switch indicating the pilot has command of the system. When the pilot selects OPERATOR, the light will extinguish (Figure 22-1).

22.2.3.2 FLIR Control Panel. The FLIR control panel (Figure 22-1) is located on the observer's instrument panel. Controls and indicators found on the FLIR control panel are as follows:

22.2.3.2.1 GRAYSCALE Switch. The GRAYSCALE switch is a two-position (ON—OFF) toggle switch which, when placed to ON, presents stepped shades of gray across the bottom of the video indicators.

22.2.3.2.2 MODE Switch. The MODE switch is a six-position (OFF–STBY–MANTRK–CPTRTRK–POS–FWD) rotary switch. The function of each position is as follows:

OFF – Disables all functions of the infrared detecting set.

STBY – Establishes and maintains system operational readiness by providing air conditioning and cryogenic cooling of the detectors. Also drives receiver to stow position.

MANTRK – Receiver servo control and gimbals respond to slew signals from the target tracking sight control.

CPTRTRK – Receiver servo control and gimbals respond to slew signals from the target tracking sight control with compensation for aircraft maneuvering.

POS – Receiver servo control and gimbals respond to signals from AZIMUTH and ELEVATION POS CONTROL potentiometers on the FLIR control panel.

FWD – Receiver line of sight is slewed to zero degrees in azimuth and the elevation depression angle is selected from the FLIR GIMBAL ANGLE DEPRESSION knob on the receiver/transmitter-converter control.

22.2.3.2.3 Position Control Knobs. There are two POS CONTROL knobs (potentiometers); AZIMUTH and ELEVATION. The AZIMUTH potentiometer controls the receiver line-of-sight position in azimuth when the MODE switch is in the POS position. The ELEVATION potentiometer controls the receiver line-of-sight position in elevation in the POS position. Markings of each of the potentiometers are in degrees (AZIMUTH: 0° to 200° left and right: ELEVATION: 15° up to 84° down).

22.2.3.2.4 Polarity Switch. The polarity (POL) switch is a two-position (WHT HOT—BLK HOT) toggle switch which selects the polarity of the video signal to be displayed. Hot targets appear white on the video indicators in the WHT HOT position. In the BLK HOT position hot targets appear black.

22.2.3.2.5 Field-of-View Switch. The field-of-view (FOV) switch is a two-position (WIDE–NAR) toggle switch that changes lenses in and out of the receiver optical path to obtain a wide or narrow field of view.

22.2.3.2.6 GAIN Knob. The GAIN knob (potentiometer) when rotated clockwise increases the contrast of the target displayed on the video indicators.

22.2.3.2.7 LEVEL Knob. The LEVEL knob (potentiometer) controls the brightness of the background video lever displayed on the video indicators.

22.2.3.2.8 Reticle Bright Knob. The RTCL BRT knob (potentiometer) controls the intensity of the reticle brightness. The reticle marks the center of the displayed field of view as well as the LRD line of sight.

22.2.3.2.9 FOCUS Switch. The FOCUS switch is a five position (300′–700′–2000′–5000′–∞) rotary switch which selects focusing range. Targets within the range selected will be in focus when NAR is selected on the field-of-view FOV switch.

22.2.3.2.10 Built-In-Test Switch/Indicator. The BIT ON switch/indicator is a backlighted momentary pushbutton switch which is depressed, after the COOLING and NOT READY have gone out, to initiate the built-in-test sequence. The BIT ON indicator will come on while the test is in progress. Satisfactory completion of the test sequence will cause the BIT ON indicator to go out and the SYS GO indicator to come on.

22.2.3.2.11 System Go Switch/Indicator. The SYS GO switch indicator is a backlighted momentary pushbutton switch which lights to indicate successful completion of the built-in-test function. Momentarily pressing the SYS GO button will cause the light to go out.

22.2.3.2.12 POWER SUPPLY FAIL Indicator. Illumination of the POWER SUPPLY FAIL indicator light during BIT, indicates the most probable cause for failure of the built-in-test is malfunction or failure of the power supply-video converter (WRA2).

22.2.3.2.13 Receiver Converter Fail Indicator. Illumination of the RCVR CONV FAIL indicator light during BIT, indicates the most probable cause for failure of the built-in-test is malfunction or failure of the FLIR turret (WRA1).

22.2.3.2.14 CONTROL SERVO FAIL Indicator. Illumination of the CONTROL SERVO FAIL indicator light indicates the most probable cause for failure of the built-in-test is malfunction or failure of the control servo (WRA3).

22.2.3.2.15 COOLING Indicator. The COOLING indicator lights will come on when system is energized and will remain on until the infrared detectors have reached operating temperature.

22.2.3.2.16 NOT READY Indicator. The NOT READY indicator light will come on when the system is energized and will remain on until the FLIR turret reaches operating temperature and the gyros come up to speed. Built-in-testing cannot be initiated until the NOT READY light goes out.

22.2.3.2.17 Receiver Overtemperature Indicator. The RCVR O TEMP indicator light will come on if excessive temperature is sensed within the FLIR turret.

22.2.3.3 Target Tracking Sight Control. The target tracking sight control (Figure 22-1), located on the observer's right-hand forward console is equipped with an electromechanical transducer (thumb control) and a trigger switch. In the MANTRK and CPTRTRK modes of operation, the thumb control provides a slew rate signal to control the FLIR turret line of sight in azimuth and elevation. The line of sight moves in the direction pressure is applied. Line-of-sight movement stops when pressure is removed from the thumb control. Once a target has been centered within the tracking gate on the video indicator, by using the thumb control, target lock-on and automatic tracking is achieved by squeezing and releasing the trigger switch. The square box representing the gate is replaced by four dots, one at each corner of the original box. The gate size will automatically adjust to the optimum size. If lock-on is broken due to obstruction or loss of contrast, the FLIR turret will coast for several seconds, with the four dots blinking until automatic relock occurs or the four dots are replaced with the tracking gate box if relock does not occur. To break automatic tracking of an unwanted target or to update tracking of a desired target, the trigger is squeezed again and released.

22.2.3.4 Receiver/Transmitter-Converter Control. The receiver/transmitter-converter control (Figure 22-1), located in the observer's cockpit aft of the power control quadrant contains the following controls and indicators.

22.2.3.4.1 FLIR GIMBAL ANGLE DEPRESSION Control. The FLIR GIMBAL ANGLE DEPRESSION control is a gearbox and resolver which provides a servo error signal to establish the depression angle (0 to − 57 degrees) of the FLIR turret when the system is in the forward mode.

22.2.3.4.2 MILS Counter. The MILS counter, located on the FLIR GIMBLE ANGLE DEPRESSION control, is a mechanical counter which is manually set to the desired FLIR turret elevation gimbal depression (from horizontal) in milliradians.

22.2.3.4.3 TRACKING SENSITIVITY Control. The TRACKING SENSITIVITY control is a ten-position (0–4–5–6–7–8–9–10–11–12) rotary switch which is used to adjust the sensitivity of the target tracking sight thumb control to suit the tactical situation and the preference of the observer. The FLIR turret will move slower as the switch position numbers increase.

22.2.3.5 Video Tracking Control. The video tracking control panel (Figure 22-1) is located on the observer's instrument panel. Video tracking control panel controls and indicators includes the following.

22.2.3.5.1 INITIAL GATE SIZE Knob. The INITIAL GATE SIZE knob (potentiometer) is used to adjust the size of the target gate displayed on the video indicator.

22.2.3.5.2 Offset Command Switch/ Indicator. The OFFSET COMD switch/indicator is a backlighted momentary pushbutton switch which is used to initiate the target offset function. With target lock-on, in either MANTRK or CPTRTRK modes, offset tracking is initiated by momentarily depressing the OFFSET COMD pushbutton switch. Backlighting of the pushbutton switch will change from white to blue. To return to automatic tracking, depress the OFFSET COMD pushbutton switch. Backlighting of the pushbutton will change from blue to white.

22.2.3.5.3 Built-In-Test Switch/Indicator. The BIT ABA switch/indicator is a backlighted momentary pushbutton switch that when depressed momentarily, initiates a built-in-test sequence of the automatic video tracking computer. The BIT ABA pushbutton indicator will illuminate blue. An artificially generated video target will appear and move about on both displays. At completion of the test sequence within 3 minutes, the GO light will illuminate green if the computer is functioning in a satisfactory manner. Depressing the BIT ABA pushbutton switch will extinguish the GO light and the BIT ABA light will illuminate white.

NOTE

> With power outage or interruption, the laser boresighting information stored in the video tracker may be dumped. BIT ABA self-test must be initiated to update boresighting.

During the test sequence, 16 small dots also appear on the upper left-hand side of the video indicators to indicate the computer is functioning in a satisfactory manner. If a malfunction is detected, a dash will replace any one or several of the dots. Depressing the BIT ABA pushbutton to white will return video tracking to normal mode.

22.2.3.6 Observer's Video Indicator. The observer's video indicator (Figure 22-1), located on the observer's instrument panel, is equipped with a power switch, brightness and contrast controls, status indicator, and an elapsed-time meter.

22.2.3.6.1 Power Switches. The PWR switch is a two-position (ON–OFF) toggle switch which, when placed to ON, applies power to the observer's video indicator.

22.2.3.6.2 BRIGHTNESS Control. The BRIGHTNESS control is a potentiometer used to vary the brightness of the observer's CRT display according to the preference of the observer.

22.2.3.6.3 CONTRAST Control. The CONTRAST control is a potentiometer used to vary the contrast of the observer's CRT display according to the preference of the observer.

22.2.3.6.4 STATUS Indicator. The green STATUS indicator light is illuminated whenever power and composite video are applied to the video indicator.

22.2.3.6.5 Elapsed-Time Meter. The ETM meter indicates total time the video indicator has been operated.

22.2.3.7 Pilot's Video Indicator. A brightness control, contrast control, status indicator, and elapsed-time meter are found on the front of the pilot's video indicator. The indicator (Figure 22-1) is located above the pilot's instrument panel.

22.2.3.7.1 Brightness Control. The BRT control is a potentiometer which varies the brightness of the CRT display according to the preference of the pilot.

22.2.3.7.2 Contrast Control. The CTRS control is a potentiometer which varies the contrast of the CRT display according to the preference of the pilot.

22.2.3.7.3 STATUS Indicator. The green STATUS indicator light is illuminated whenever power and composite video are applied to the video indicator.

22.2.3.7.4 Elapsed-Time Meter. The ETM indicates the total time the video indicator has been operated.

22.2.3.8 Pilot's FLIR/WEAPONS Control Panel. The pilot's FLIR/WEAPONS control panel (Figure 22-1), located on left side of instrument panel, includes the FLIR command (CMD) switch and the LASER ENABLE switch.

22.2.3.8.1 FLIR Command Switch. The FLIR CMD switch (Figure 22-1) is a three-position (OPERATOR–NARROW–WIDE) lever-lock toggle switch located on the pilot's left-hand instrument panel. System control is maintained by the observer when the switch is in the OPERATOR position. Placing the switch to the NARROW or WIDE position will override the observer's control of the system and will drive the FLIR turret to zero degrees azimuth and elevation. A wide or narrow field of view, corresponding to the switch position selected will be displayed. When selected to NARROW or WIDE position, the PILOTS FLIR light will be illuminated on the observer's caution/warning panel.

22.2.3.8.2 LASER ENABLE Switch. The LASER ENABLE switch (Figure 22-1) is a two-position (ON–OFF) lever lock toggle switch located on the pilot's left-hand instrument panel. The switch must be in the ON position before the observer can fire the laser.

WARNING

Laser radiation from infrared laser detecting-ranging set, AN/AAS-37, is invisible and can cause permanent blindness at a range of several miles. The same degree of care should be afforded operation of the LRD as is afforded gun systems. Aircrew members will be provided, and use, eye protection equipment to guard against reflections of LASER energy.

22.2.3.9 Laser Control Panel. The laser control panel (Figure 22-1), located on the observer's instrument panel, has provisions for arming the laser circuits, displaying laser range, and indicating system status.

22.2.3.9.1 Laser Arming Switch. The laser arming switch is a two position (OFF–ARM) lever-lock-type switch which, when placed to ARM, arms the laser firing circuits if the laser safety plug is installed on the ground safety panel LASER FIRE POWER DISC, and (1) the pilot's LASER ENABLE switch is ON, (2) gimbal angles are within the operating envelope, (3) correct system-operating temperature prevails, and (4) either the gear is up and locked; or during ground operations, the laser window covers are installed or the LASER FIRE SAFETY DISABLE switch on the ground safety panel is depressed.

22.2.3.9.2 LASER RANGE Indicator. Elapsed time between the laser transmittal pulse and the return pulse is converted in range and displayed in meters on the LASER RANGE indicator. With the LRD code generator TST switch in ON mode and LASER FIRE switch depressed the range will read 9985.

22.2.3.9.3 RANGE DISPLAY Knob. The RANGE DISPLAY knob (potentiometer) varies the lighting intensity of the LASER RANGE indicator between dim (DIM) and bright (BRT).

22.2.3.9.4 Laser Status Indicators. Three laser status indicator lights are found on the laser control panel: LRD FAIL, LRD INHIB, and LASING. The LRD FAIL indicator illuminates if a malfunction is detected in the laser rangefinder designator circuitry. The LRD INHIB indicator comes on if an overtemperature condition is detected in the laser resonator or if turret gimbal angles are outside the allowable operating envelope. Either condition will inhibit the laser fire command. The LASING indicator comes on to verify proper command is present for laser firing. The LASING indicator will come on even if the safety jumper plug is not installed on the ground airborne and actual firing missions and ground testing of the laser.

22.2.3.10 Fire Control Grip. The fire control grip (Figure 22-8), located on the left-hand, forward side of the observer's cockpit, contains the LASER fire button. The LASER button when depressed completes the laser firing circuit when all system conditions are proper.

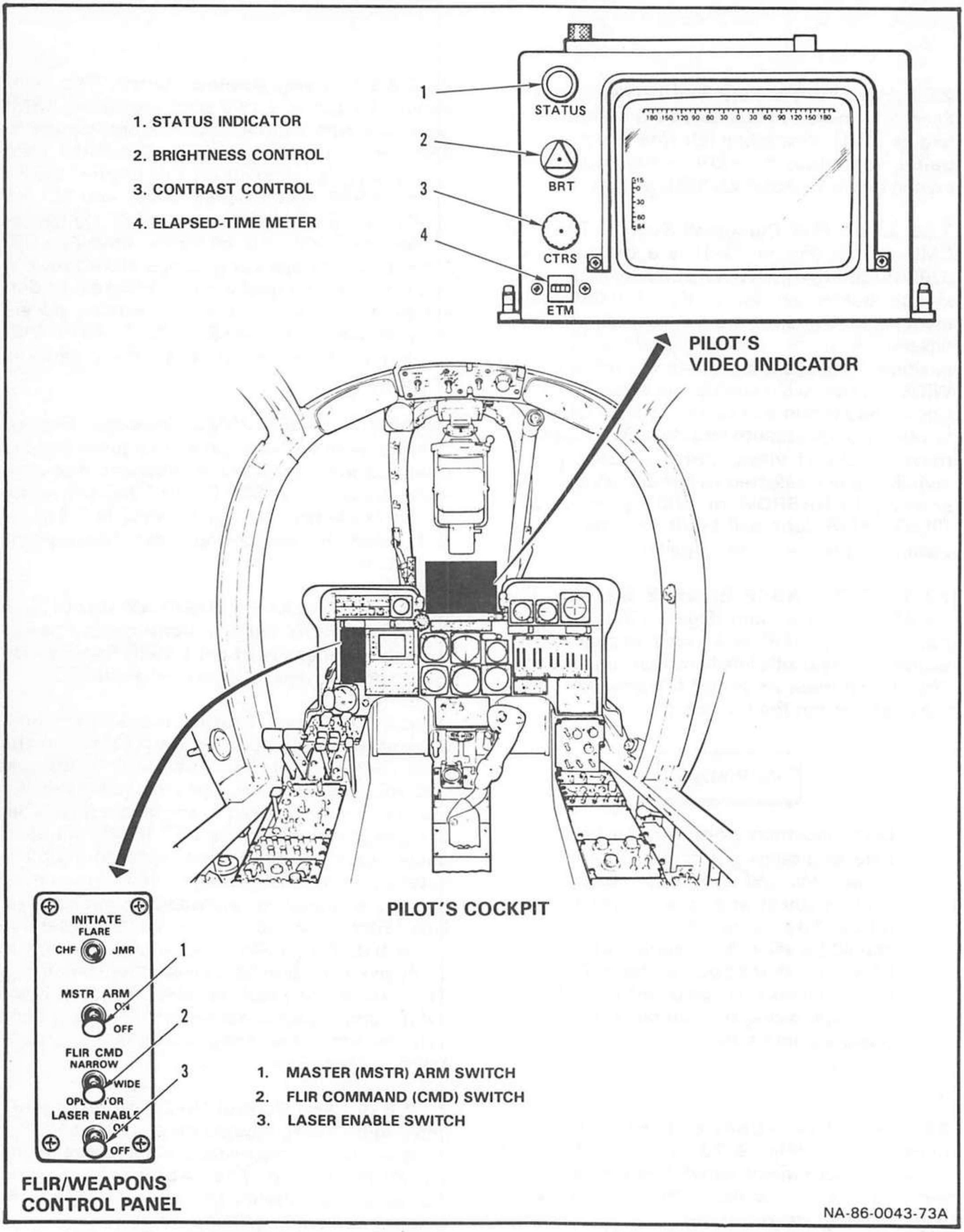


Figure 22-1. Infrared Laser Detecting-Ranging Set, AN-AAS-37, Controls and Indicators (Sheet 1 of 3)

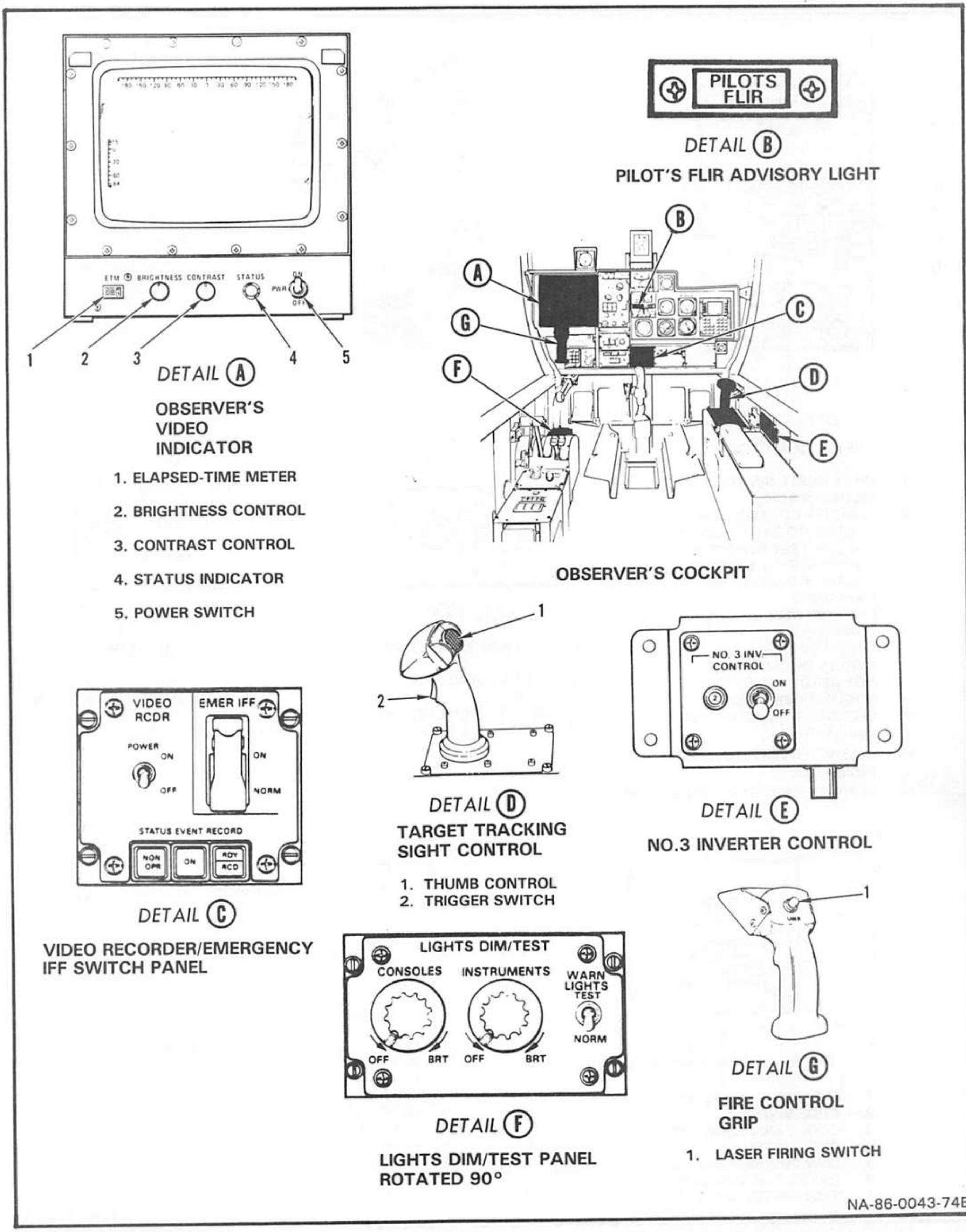
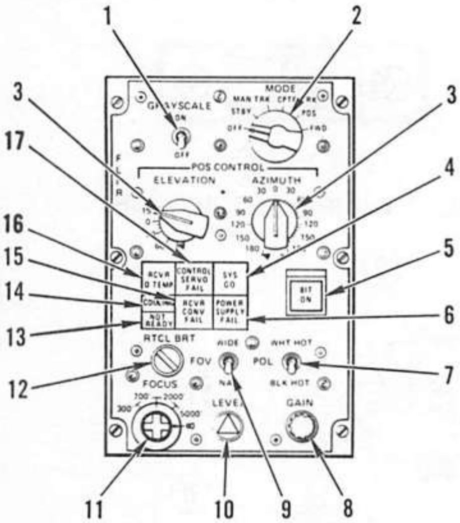


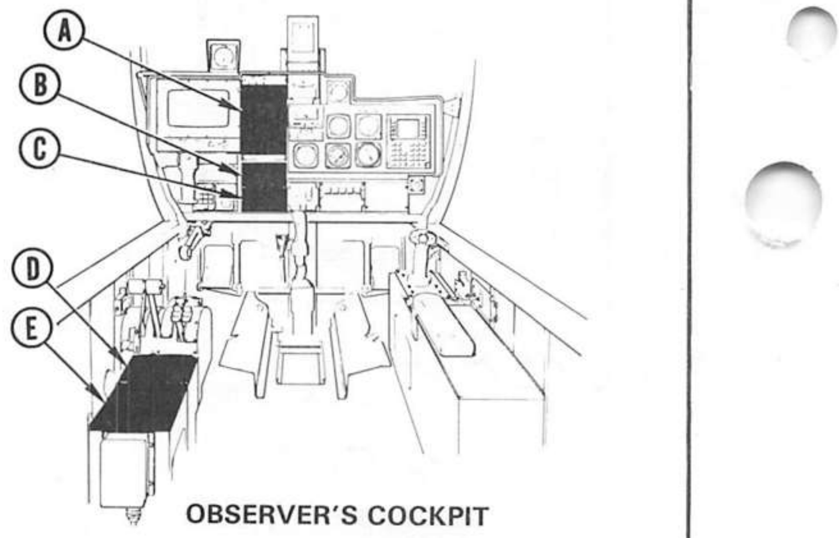
Figure 22-1. Infrared Laser Detecting-Ranging Set, AN-AAS-37, Controls and Indicators (Sheet 2 of 3)



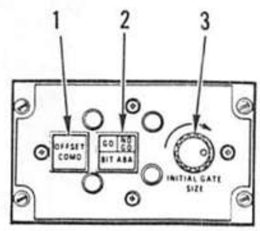
DETAIL (A)

FLIR CONTROL

1. GRAY SCALE SWITCH
2. MODE SWITCH
3. POSITION CONTROL KNOBS
4. SYSTEM GO SWITCH/INDICATOR
5. BUILT-IN-TEST SWITCH/INDICATOR
6. POWER SUPPLY FAIL INDICATOR
7. POLARITY SWITCH
8. GAIN KNOB
9. FIELD OF VIEW SWITCH
10. LEVEL KNOB
11. FOCUS SWITCH
12. RETICLE BRIGHT KNOB
13. NOT READY INDICATOR
14. COOLING INDICATOR
15. RECEIVER-CONVERTER FAIL INDICATOR
16. RECEIVER-OVERTEMPERATURE INDICATOR
17. CONTROL SERVO FAIL INDICATOR



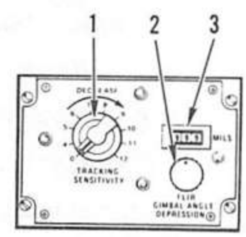
OBSERVER'S COCKPIT



DETAIL (B)

VIDEO TRACKING CONTROL

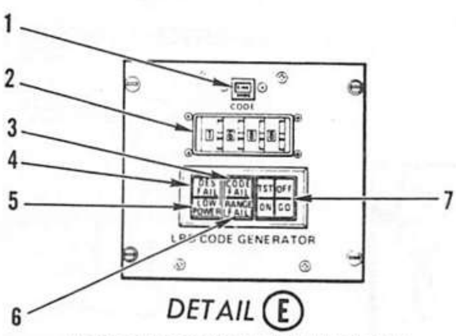
1. OFFSET COMMAND SWITCH/ INDICATOR
2. BUILT-IN-TEST SWITCH/INDICATOR
3. INITIAL GATE SIZE KNOB



DETAIL (D)

RTC CONTROL

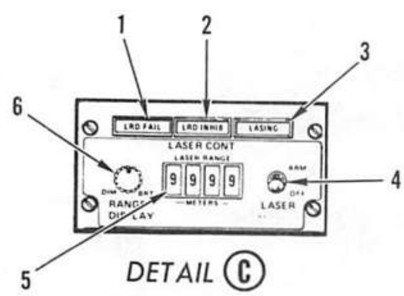
1. TRACKING SENSITIVITY CONTROL
2. FLIR GIMBAL ANGLE DEPRESSION CONTROL
3. MILS COUNTER



DETAIL (E)

PULSE-CODER GENERATOR

1. ELAPSED-TIME METER
2. CODE SWITCHES
3. CODE FAIL INDICATOR
4. DESIGNATOR FAIL INDICATOR
5. LOW POWER INDICATOR
6. RANGE FAIL INDICATOR
7. TEST/GO/ON/OFF SWITCH–INDICATOR



DETAIL (C)

LASER CONTROL

1. LASER RANGEFINDER DESIGNATOR FAIL INDICATOR
2. LASER RANGE FINDER DESIGNATOR INHIBIT INDICATOR
3. LASING (FIRE VERIFY) INDICATOR
4. LASER ARMING SWITCH
5. LASER RANGE INDICATOR
6. RANGE DISPLAY BRIGHTNESS KNOB

NA-86-0043-245A

Figure 22-1. Infrared Laser Detecting-Ranging Set, AN-AAS-37, Controls and Indicators (Sheet 3 of 3)

22.2.3.11 Pulse Coder-Generator. The pulse coder-generator (Figure 22-1), located at the left-hand rear side of the observer's cockpit, provides the means of encoding the laser designator, initiating built-in-test sequence of the laser rangefinder designator and indicating system failures in various areas.

22.2.3.11.1 CODE Switches. A set of four self-illuminating octal thumbwheel switches (CODE) provide the means of encoding the laser designator.

22.2.3.11.2 TST/GO/ON/OFF Indicator Switches. The TST pushbutton switch has individually backlighted sections for the TST, GO, ON and OFF indications. With the ON indicator illuminated and the laser fire button depressed, the GO indicator should illuminate and the LRD control panel range readout shall read 9985, indicating a satisfactory system. Depressing the TST pushbutton with the GO indicator illuminated will extinguish the GO light and illuminate the OFF light, returning the laser to normal operating mode.

22.2.3.11.3 CODE FAIL Indicator. The CODE FAIL indicator light will come on if, during built-in-testing, a malfunction is detected in the pulse coder-generator. The light will also come on to indicate a failure during normal operation.

22.2.3.11.4 Designator Fail Indicator. The DES FAIL indicator light will illuminate during built-in-testing if a failure is noted in the laser designator. The light will also come on to indicate a malfunction during normal operation.

22.2.3.11.5 RANGE FAIL Indicator. The RANGE FAIL indicator light will illuminate during built-in-testing if a failure is detected in the laser rangefinder.

22.2.3.11.6 LOW POWER Indicator. The LOW POWER indicator light comes on if laser output power, during built-in-testing or system operation, drops below 70 percent of normal.

22.2.3.11.7 Elapsed-Time Meter. The elapsed-time meter records the total time the pulse coder-generator has been operating.

22.2.4 Infrared Laser Detecting-Ranging Set Operation. The following paragraphs provide instructions for operating the infrared detecting set (FLIR) and the laser rangefinder designator (LRD).

NOTE

All applicable system circuit breakers must be closed prior to proceeding with the following paragraphs.

22.2.4.1 FLIR Operation

CAUTION

Do not operate FLIR system or fire laser at altitudes above 15,000 feet.

Before applying power to aircraft, ensure switches/controls are as follows:

LASER ENABLE to OFF
FLIR CMD to OPERATOR
LASER switch to OFF (O)
FLIR MODE switch to OFF (O)
RTCL BRT control to mid-range (O)
LEVEL control to mid-range (O)
GAIN control to mid-range (O)
Video indicator PWR switch to ON (O)
Video indicator BRIGHTNESS and CONTRAST to mid-range (P, O)

Apply external electrical power to aircraft or ensure at least one generator is providing power to aircraft bus system during ground operation of the infrared laser detecting-ranging set.

Ensure both generators are providing power to aircraft bus system during flight operations.

1. Place WARN LIGHTS switch (LIGHTS DIM/TEST) panel on observer's left console to TEST and verify that all indicator lights on FLIR control panel, video tracking control panel, laser control panel, pulse-coder generator panel and the pilot's FLIR light next to the observer's Caution/Warning Light panel. (O)

2. Ensure No. 3 inverter switch is ON. (O)

3. Set MODE switch on FLIR control panel to STBY position. (O) The NOT READY and COOLING lights on the FLIR control panel will illuminate.

CAUTION

To preclude foreign object damage, the FLIR turret should be pointing forward before taking the propellers off the start locks, and during taxi, take-off, and landing.

NOTE

The NOT READY indicator light should extinguish within 2 minutes and the COOLING indicator light within 10 minutes after the MODE switch is placed in STBY.

4. Set MODE switch on FLIR control panel to POS and rotate the turret to forward (0°) azimuth position. (O) The video green status lights will illuminate and the gimble angle indicators will appear on the top and left side of each display. FLIR video will appear on each display.

NOTE

On SOLO flights, place NO. 3 INV switch ON and place FLIR CMD switch on pilot's left-hand instrument panel to WIDE position. The FLIR turret will drive to approximately zero degrees azimuth and elevation. Placing FLIR CMD switch to OPERATOR position will turn FLIR system off with turret locked in forward pointing position.

5. Place GRAYSCALE switch to ON. (O)

6. Adjust BRIGHTNESS and CONTRAST controls on the observer's video indicator to optimize the grayscale displayed across the bottom of the indicator screen. (O)

7. Adjust BRT and CTRS controls on the pilot's video indicator to optimize the grayscale displayed across the bottom of the indicator screen.

8. Place GRAYSCALE switch OFF. (O)

9. When NOT READY indicator light extinguishes, place MODE switch to MANTRK position. (O)

10. On FLIR control panel, press BIT ON switch and verify that SYS GO indicator light comes on within 1 minute. Press SYS GO switch to extinguish light. (O)

11. Adjust RTCL BRT control on the FLIR control panel to set the desired reticle brightness level on the observer's and pilot's video indicators. (O)

12. Rotate GAIN control to adjust contrast of the target displayed on the video indicators. (O)

13. Rotate LEVEL control to adjust the brightness of the background of the displayed image on the video indicators. (O)

14. Select a wide or narrow field of view by placing the FOV switch to WIDE or NAR. The WIDE position of the FOV switch is best for search operations. The NAR position of the FOV switch is best for tracking a target. (O)

15. Using FOCUS switch select the range in which a target appears in focus on the video indicators. The FOCUS control is operational only when the narrow (NAR) field of view is selected. (O)

16. Place polarity switch (POL) to WHT HOT or BLK HOT. (O) In the WHT HOT position, hot targets will appear white on the video indicators. In the BLK HOT position, hot target will appear black on the video indicators.

17. With the system in the MANTRK mode of operation, the FLIR turret line of sight is controlled by applying pressure to thumb control on the target tracking sight control (right-hand forward side of observer's cockpit). (O) Sensitivity of the thumb control can be adjusted by adjusting the TRACKING SENSITIVITY control on the receiver/ transmitter-converter control (observer's cockpit forward of power control quadrant).

18. Depress BIT ABA switch on video tracking control panel and observe blue background lighting on BIT ABA indicator. An artificially generated display program will appear on both video indicators. The GO light should illuminate green within 3 minutes. (O)

19. Depress BIT ABA switch and observe white background lighting on BIT ABA indicator and GO light to extinguish. (O)

20. With the system in MANTRK mode of operation, slew the turret until a target is centered at the reticle. (O) Adjust the INITIAL GATE SIZE knob on the video tracking control panel until the gate is slightly larger than the target. Squeeze and release the trigger switch on the target tracking sight control. Target lock-on and automatic tracking will be indicated by four small dots replacing the square tracking gate.

21. With the system in MANTRK mode of operation and a firm lock established on a clearly defined target, depress the OFFSET COMD pushbutton on the video tracking control panel. The pushbutton indicator will illuminate blue. (O) Use the hand sight control thumb button to slew the locked on target approximately 1-1/2 inches from the reticle. Target lock-on and offset tracking will be maintained.

22. Depress OFFSET COMD pushbutton switch. (O) The offset target will automatically slew back to the video indicator center reticle and the pushbutton illumination will change from blue to white.

23. Squeeze and release the trigger switch on the target tracking sight control to return to manual tracking. (O)

24. Place MODE switch to CPTRTRK. Slew FLIR turret until a target is centered at the reticle. (O) Adjust INITIAL GATE SIZE on the AVT control panel until the gate is slightly larger than the target. Squeeze and release the trigger switch on the target tracking sight control. Target lock-on and automatic tracking will be indicated by four small dots replacing the square tracking gate.

25. With the system in CPTRTRK mode of operation and a firm lock established on a clearly defined target, depress the OFFSET COMD pushbutton on the AVT control panel. The pushbutton indicator will illuminate blue (O) Use the hand sight control thumb button to slew the target approximately 1-1/2 inches from the reticle. Target lock-on and offset tracking will be maintained.

26. Depress OFFSET COMD pushbutton switch. (O) The offset target will automatically slew back to the video indicator center reticle and the pushbutton illumination will change from blue to white.

27. Squeeze and release the trigger switch on the target tracking sight control to return to manual tracking. (O)

28. When MODE switch is placed in the POS (position) mode, the observer can vary the line of sight of the FLIR turret by rotating the AZIMUTH and ELEVATION position controls on the FLIR control panel. (O) The tracking gate will disappear.

29. The forward mode of operation is selected by placing the MODE switch to the FWD position. (O) In this mode, the FLIR turret line of sight is positioned to 0 degrees in azimuth and the elevation angle (0 to −57 degrees) is selected by the FLIR GIMBLE DEPRESSION ANGLE control on the receiver/transmitter-converter control. The tracking gate will not appear.

30. Place FLIR CMD switch (pilot's left-hand instrument panel) to WIDE or NARROW position. FLIR turret line of sight will go to 0 degrees azimuth and elevation in the field of view selected. The PILOTS FLIR light on the observer's instrument panel will come on indicating that the pilot has assumed system control. The system will remain in this mode even with the system turned off on the observer's FLIR control panel.

31. Place FLIR CMD switch to the OPERATOR position. The PILOTS FLIR light will go out.

32. Prior to engine shutdown at completion of flight, place MODE switch to STBY (FLIR control panel) and observe via the video indicator that the FLIR turret gimbals go to the stowed position (CCW and up limits). (O) The video image should be lost when this occurs.

33. Place MODE switch to OFF. (O)

NOTE

In case of emergency, place MODE switch directly to OFF. This removes power and locks the gimbals in the operating position.

22.2.4.2 Flight Operation

1. NO. 3 INV switch—ON. (O)

2. FLIR MODE switch—STBY. (O)

NOTE

The NOT READY indicator light should extinguish within 2 minutes and the COOLING light within 10 minutes after the MODE switch is placed in STBY.

3. Video indicator power switch—ON. (O)

4. When NOT READY indicator lights go out, MODE switch—Select operating position. (O)

5. GRAYSCALE switch—ON. (O)

6. Brightness and contrast controls—adjust video. (P, O) Indicators will display black, ten shades of gray, and white across the bottom of indicator screen.

7. GRAYSCALE switch—OFF. (O)

22.2.4.3 Laser Operation

WARNING

- Laser radiation from infrared laser detecting-ranging set, AN/AAS-37, is invisible and can cause permanent blindness at a range of several miles. The same degree of care should be afforded operation of the LRD as is afforded gun systems. It is recommended that aircrew members be provided, and use eye protection equipment to guard against reflections of LASER energy.
- LRD BIT will fire laser. Observe all laser safety precautions prior to initiating LRD BIT.

During ground operation requiring laser operation, the LRD and FLIR window covers shall be installed.

The FLIR system must be in an operating mode in order to operate the LRD.

22.2.4.4 LRD BIT (Built-in-Test)

1. Set MODE switch on FLIR control panel to FWD. (O)

2. On receiver/transmitter-converter control, set the FLIR GIMBAL ANGLE DEPRESSION to 400 MILS. (O)

3. Set code 1688 On LRD CODE GENERATOR. (O)

4. Set LASER ENABLE switch to ON.

5. Set LASER switch to ARM. (O) Observe that LASER RANGE indicates 0000.

6. Adjust RANGE DISPLAY lighting to desired level. (O)

7. Depress TST switch on LRD CODE GENERATOR panel and observe that ON indicator light illuminates (O).

8. On laser control handgrip, depress LASER firing trigger and hold for 20 seconds minimum.

9. Observe the following if the laser fire ground safety jumper plug is installed on the ground safety panel:

Laser Control Panel . . . . . Lasing light, ON
Laser Control Panel . LASER RANGE, 9985
LRD code Generator Panel . . GO light, ON

10. Release LASER firing trigger. (O) Observe lasing light extinguishes and LASER RANGE indicates 0000.

CAUTION

After each laser firing, leave FLIR system ON, the LASER ENABLE switch ON, and the LASER switch at ARM for at least 20 seconds to allow laser cooldown.

11. Push TST switch on LRD code generator panel to end test mode. (O) Observe the ON and GO indicator lights extinguish and the OFF indicator light illuminates.

NOTE

BIT is continuously enabled during normal laser operation with the LRD code generator panel TST switch OFF. The range display on the LRD control panel indicates actual range to target and the DES FAIL, CODE FAIL and LOW POWER indicators on the LRD CODE GENERATOR panel will indicate failures if present.

12. Secure LRD by placing LASER switch to OFF (O) and LASER ENABLE switch to OFF.

13. LRD operation will be disabled if LRD BIT test switch is not deselected OFF.

22.2.4.5 Inhibited Region Test. The laser cannot be fired throughout the entire FLIR pointing envelope to prevent impingement of the laser beam on the aircraft structure (Figure 22-2). A qualitative test of this function may be made during ground or flight operations as follows:

1. During ground test, ensure that the LRD and FLIR window covers are installed.

2. Set mode switch to MANTRK and drive the turret to full up elevation and pointing aft in azimuth. (O)

3. Set LASER ENABLE switch to ON.

4. Set LASER switch to ARM. (O)

CAUTION

After laser firing, leave the FLIR system ON, the LASER ENABLE switch ON and the LASER switch to ARM for at least 20 seconds to allow laser cooldown.

5. Depress LASER firing trigger and hold (O). Observe:

LASING light . . . . OFF
INHIBIT light . . . . ON

Disregard other advisory lights.

6. Slowly decrease the elevation angle to approximately 10 degrees down and observe:

LASING light . . . . ON
INHIBIT light . . . . OFF

7. Release LASER firing trigger.

8. Secure LRD by placing LASER switch to OFF (O) and LASER ENABLE switch to OFF.

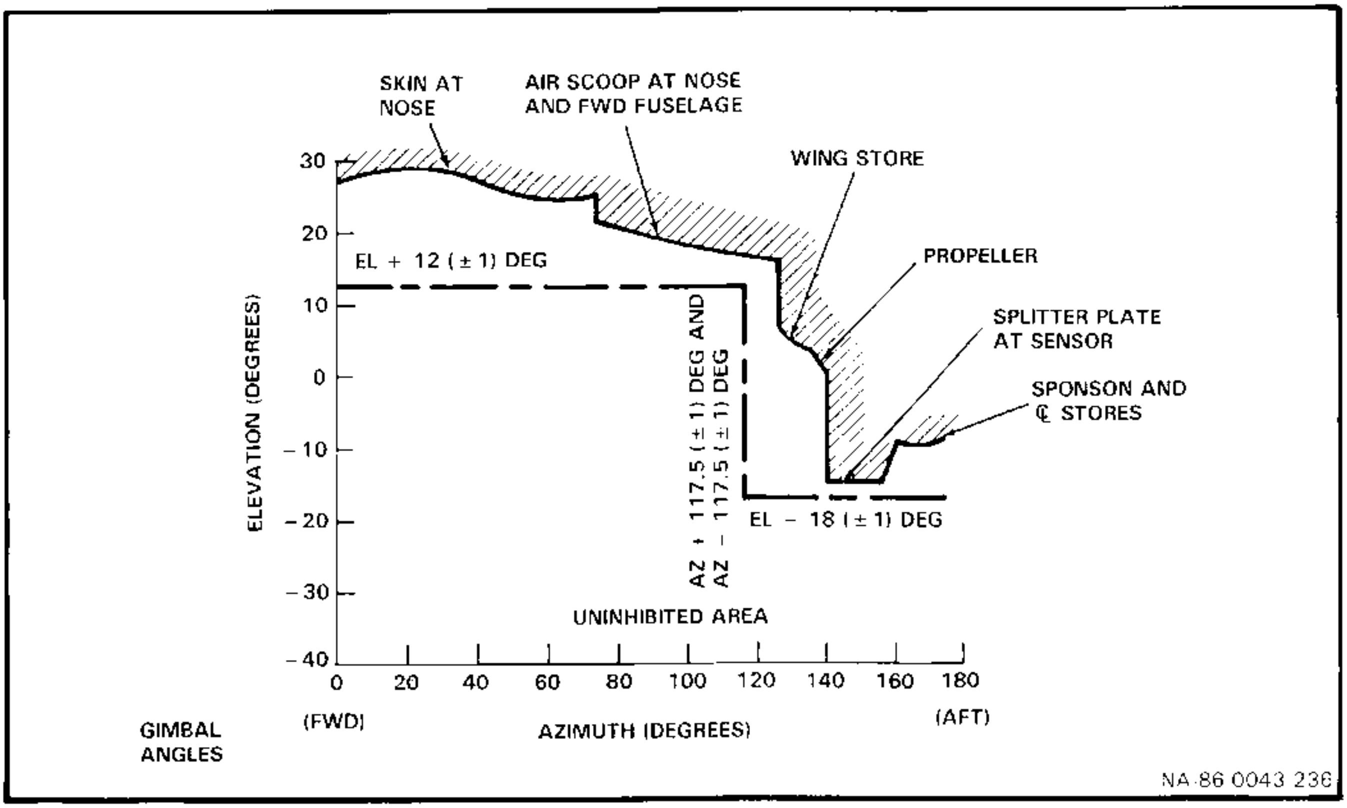


Figure 22-2. LRD Inhibited Gimbal Angle Envelope

22.2.4.6 Flight Operation

CAUTION

LRD and FLIR widow covers must be removed before take-off.

1. Set assigned code on LRD CODE GENERATOR panel. (O)

2. BIT ABA—Depress.

NOTE

BIT ABA must be initiated prior to laser usage in order to ensure boresight. It must also be initiated after any occurrence that removes electrical power from the FLIR system, as boresight will be lost.

3. Deselect BIT ABA test switch after successful test sequence. Tracking computer operation will be disabled if BIT ABA test switch is not deselected OFF.

4. Select narrow FOV on FLIR control panel.

NOTE

Ensure laser is fired only in the narrow FOV. The laser may not be boresighted in the wide FOV.

5. Place LASER ENABLE switch to ON.

6. Place LASER switch to ARM. (O)

7. Depress LASER firing trigger. Firing continues until trigger is released or the turret is driven into the inhibited region.

8. To secure LASER system, place LASER switch to OFF (O) and LASER ENABLE switch to OFF.

22.3 MISSION (VIDEO) RECORDER, RD-548/AXQ

The aircraft is equipped with a rotary, two-head, helical scan, video recorder for recording black and white FLIR video. The recorder is located in the cargo bay door (Figure 22-3). Horizontal resolution available on the FLIR display screens is 300 lines. The tape moves at 1.37 inches per second (30 frames) and provides 120 minutes of recording time on a VHS-type-format 1/2-inch video tape cassette. A heater within the video recorder protects against condensation of dew on the tape head and prevents hardening of the magnetic tape at low temperatures. The VIDEO RCDR-EMER IFF control panel for the video recorder is located on the observer's instrument panel. Two audio channels, line (channel 1) and microphone (channel 2) are available however only line is utilized. While in the record mode; FLIR video, event marking, and headset audio from the observer and aft maintenance ICS disconnect will be recorded. Electrical power (115 VAC) for heater circuits in the recorder is provided by the No. 2 monitor ac bus. No. 1 monitor dc bus provides 28 VDC for recorder control and operation.

22.3.1 Mission (Video) Recorder Controls. The video recorder and emergency IFF control panel, located on the observer's instrument panel, is used for remote operation of the video recorder. The panel indicates the operational status of the recorder (STATUS light) and provides START/STOP control of recording (RECORD switch). The EVENT switch allows for event marking of the audio portion of the tape, and the POWER switch provides for ON/OFF power control to the recorder. A CLOSE-OPEN EJECT knob for loading and removing the video tape is located on the video recorder (Figure 22-3).

22.3.1.1 POWER Switch. Electrical (ON/OFF) power is controlled by a two-position toggle switch (Figure 22-3).

22.3.1.2 STATUS Light. The STATUS light when illuminated NON/OPR indicates a malfunction in the video recorder and/or tape (Figure 22-3).

22.3.1.3 EVENT Switch. When the EVENT switch is pressed illuminating ON, it will mark the audio portion of the tape with a 1-second, 1000-Hz tone on line channel 1 (Figure 22-3).

22.3.1.4 RECORD Switch. The RECORD switch is a pushbutton/double indicator switch (RDY and RCD). When selected to the ready (RDY) position, the recorder is ready for operation. RDY is also selected to stop recorder operation.

When record (RCD) is selected, recording will begin. Approximately 2 seconds will elapse after RDY is selected to stop recording before the RCD light will extinguish (Figure 22-3).

22.3.2 Mission (Video) Recorder Tape Loading and Preflight Check. To load tape and operate recorder, proceed as follows:

CAUTION

- When loading or unloading video recorder, do not touch tape surface. Dust, fingerprints, or foreign materials will degrade recording ability and may damage the recorder.
- The video tape may become brittle and crack during cold temperatures. The recorder heater is not operational when power is removed from the aircraft or the VIDEO RCDR/EMER IFF PWR switch is OFF. Remove tape cassette from recorder during cold temperatures to prevent damage to the tape and store above 15 °F (−9 °C).

NOTE

Check tape cassette for the presence of the small plastic prong before loading. This prong may have been removed to prevent accidental erasure of the tape. It must be present on the tape for recording.

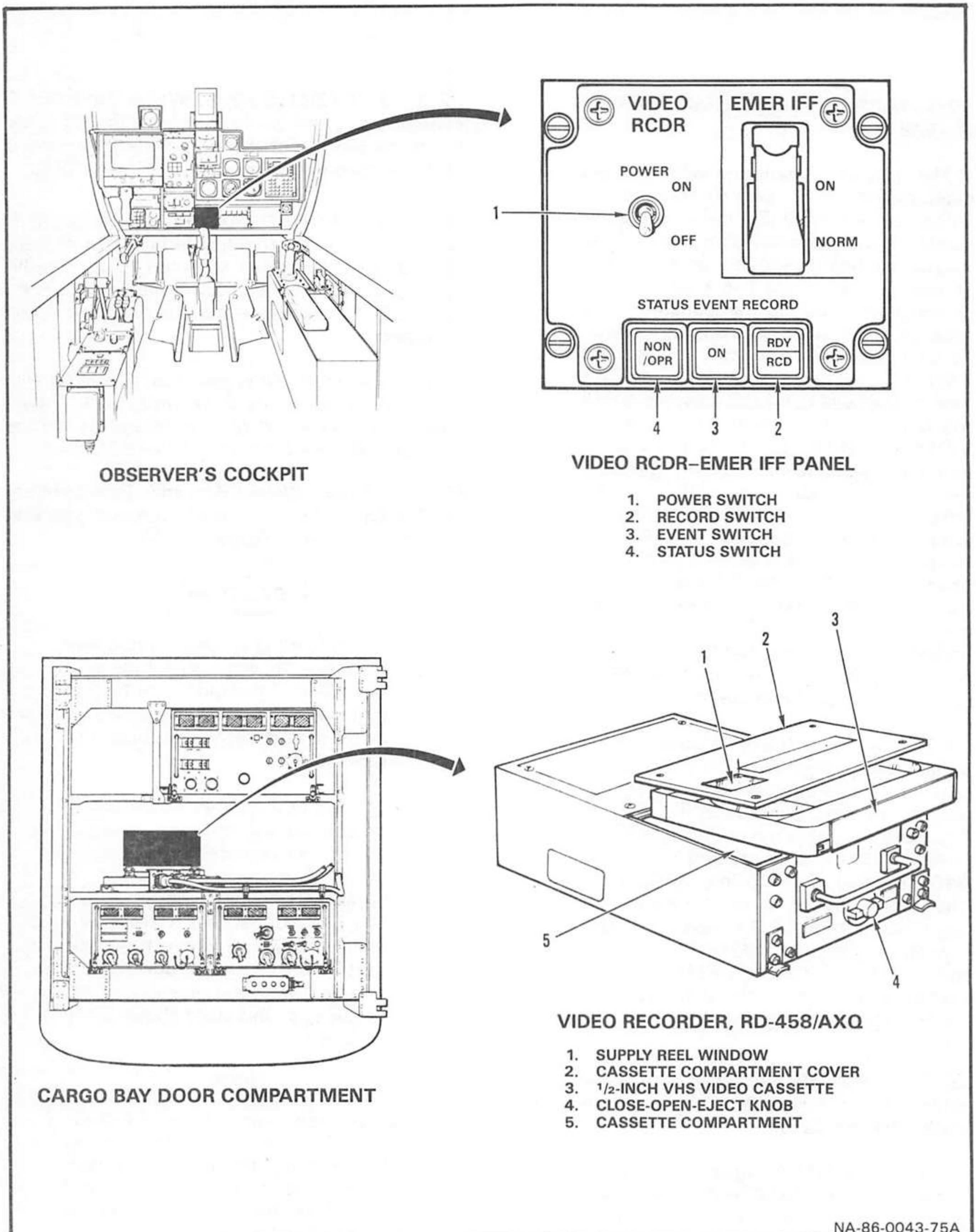


Figure 22-3. Video Tape Recorder, RD-458/AXQ, Controls and Indicators

1. Turn CLOSE-OPEN EJECT knob counterclockwise to OPEN EJECT and push knob—cassette compartment raises.

2. Insert tape and push cassette compartment down.

3. Turn CLOSE-OPEN EJECT knob clockwise to CLOSE—cassette compartment locked.

4. Apply electrical power to aircraft.

5. Select VIDEO RCDR PWR switch—ON, verify NON/OPR light is OFF and RDY light is ON. (O)

6. Push RECORD switch—after 2 seconds verify NON/OPR light is OFF and RCD light is ON. (O)

7. Momentarily push EVENT switch—verify EVENT light comes ON. (O)

8. Push RECORD switch—verify RCD light goes OFF, RDY light comes ON, and NON/OPR light is OFF. (O)

NOTE

The recorder has no playback mode, to verify that recorder has recorded FLIR video during FLIR system operation, the tape must be removed, rewound, and viewed on equipment with playback capability.

9. To secure video recorder—select VIDEO RCDR switch OFF. (O)

10. Turn CLOSE-OPEN EJECT knob counterclockwise and push knob—cassette compartment raises.

11. Remove tape and push cassette compartment down.

12. Turn CLOSE-OPEN EJECT knob clockwise to CLOSE—cassette compartment locked.

22.3.3 Mission (Video) Recorder Operation. To record FLIR video proceed as follows;

CAUTION

On missions where FLIR video is to be recorded, ensure mission recorder power switch is ON prior to take-off to energized heater circuits in the tape head. Condensation may develop on the tape head that may damage tape and mission recorder.

NOTE

Total FLIR video recording time is 120 minutes. If recording time exceeds tape capacity the NON/OPR indicator will illuminate. It is advised that a recording time log be kept to ensure adequate tape supply for mission requirements.

1. Aim FLIR turret at desired target and adjust FLIR system for best presentation and target detail.

2. Ensure VIDEO RCDR PWR switch—ON, verify NON/OPR light is OFF and RDY light is ON.

3. Push the RECORD switch—after 2 seconds verify NON/OPR light is OFF and RCD light is ON.

4. After desired video has been recorded, push RECORD switch—verify RCD light goes OFF, RDY light comes ON, and NON/OPR light is OFF.

5. To secure video recorder—select VIDEO RCDR switch OFF.

22.4 ELECTRONIC COUNTERMEASURES SYSTEMS

The electronic countermeasures systems are comprised of the countermeasures dispensing set, the infrared countermeasures system, and the radar warning system.

22.5 COUNTERMEASURES DISPENSING SET, AN/ALE-39

The countermeasures dispensing set, AN/ALE-39, is installed and is used to dispense countermeasures materials (metallic chaff, flares, and jammers) aft of the aircraft (Figure 22-4). The ejected countermeasures materials deceive enemy radars and infrared sensors, and jam communications frequencies, which enables the aircraft to evade air-to-air and surface-to-air attacks. A sequencer switch and dispenser module are located in each of the tail booms of the aircraft. Each dispenser has 30 cylindrical discharge tubes, electrically partitioned into sections of 10 and 20 discharge tubes. The dispenser module sections are identified as L10 (left 10), L20 (left 20), R10 (right 10), and R20 (right 20) to distinguish payload locations and controlling circuits. The cartridges containing the countermeasures materials are carried in the discharge tubes of the two dispensers. After loading the dispensers, the ground personnel set the programmer LOAD switches to indicate which type of load is in each of the four sections. The countermeasurers materials are ejected from the dispenser tubes by electrical signals controlled by the pilot and indicated on the CMS countermeasures page. The programmer search and fire circuitry automatically senses the location of the selected type of payload in the dispensing sections. If the desired type of payload is not loaded or has been expended from one section, the system cascades to the next loaded dispenser section from which the dispensing sequence is completed.

Manual (single) dispensing or multiple programmed dispensing sequences of countermeasures materials can be selected on the pilot's and observer's CMS-CDUs and dispensing initiated by either the pilot or observer, by depressing the INITIATE switch. Manual dispensing can be performed during a programmed dispensing sequence without disrupting the program. Flare salvo dispensing can also be initiated by placing the POWER/SALVO FLARE switch on the pilot's cockpit control panel to the SALVO FLARE position. All remaining flares, regardless of loaded location, are dispensed in rapid-fire sequence.

The MX-9254/ALE-39 programmer is located in the right-hand wheel well. Programmed dispensing routines for chaff, flares, and jammers are set into the programmer and LOAD switches set to indicate which type of load is in each of the dispenser sections. Programmer controls for the programmed dispensing of countermeasures materials can be set to control the number of bursts (single firings) and the time lapse between bursts. In addition to burst quantity and interval control, the chaff programmed payload dispensing control includes the number of chaff salvos and the time lapse between chaff salvos in a programmed sequence.

22.5.1 Countermeasures Dispensing Set Controls and Indicators. All controls and indicators for the countermeasures dispensing set are on the programmer control panel (located in the right-hand wheel well), the CMS Countermeasures page, the SALVO FLARE ON/OFF switch (located on the smoke generator-gunsight dimmer panel in the pilot's upper cockpit), and two INITIATE switches located on the pilot's instrument panel and the observer's instrument panel (Figure 22-4).

22.5.1.1 Countermeasures Page. The CMS Countermeasures page, selected by pressing the CM key on either CMS CDU, displays; power status (ON/OFF), mode selection (program, single, multiple, or group) and payload remaining indications for chaff, flare, and jammer countermeasures stores. Initial countermeasures payload may be programmed into the CMS from the keypad and as each store is dispensed, the counters will incrementally decrease. Indicators are limited to a maximum of 60 for each type of countermeasure store. All modes will indicate OFF when the page is initially displayed prior to programming. LS key action will have no effect if the SALVO FLARE ON/OFF switch is OFF (Figure 22-5).

22.5.1.1.1 Countermeasures Mode Selection. The chaff and jammer modes have four selections possible; OFF, SINGLE, PROGRAM, and RWR. The flare mode selections are: OFF, SINGLE, MULTIPLE, OFF, PROGRAM, GROUP, RWR, and OFF (Figure 22-5).

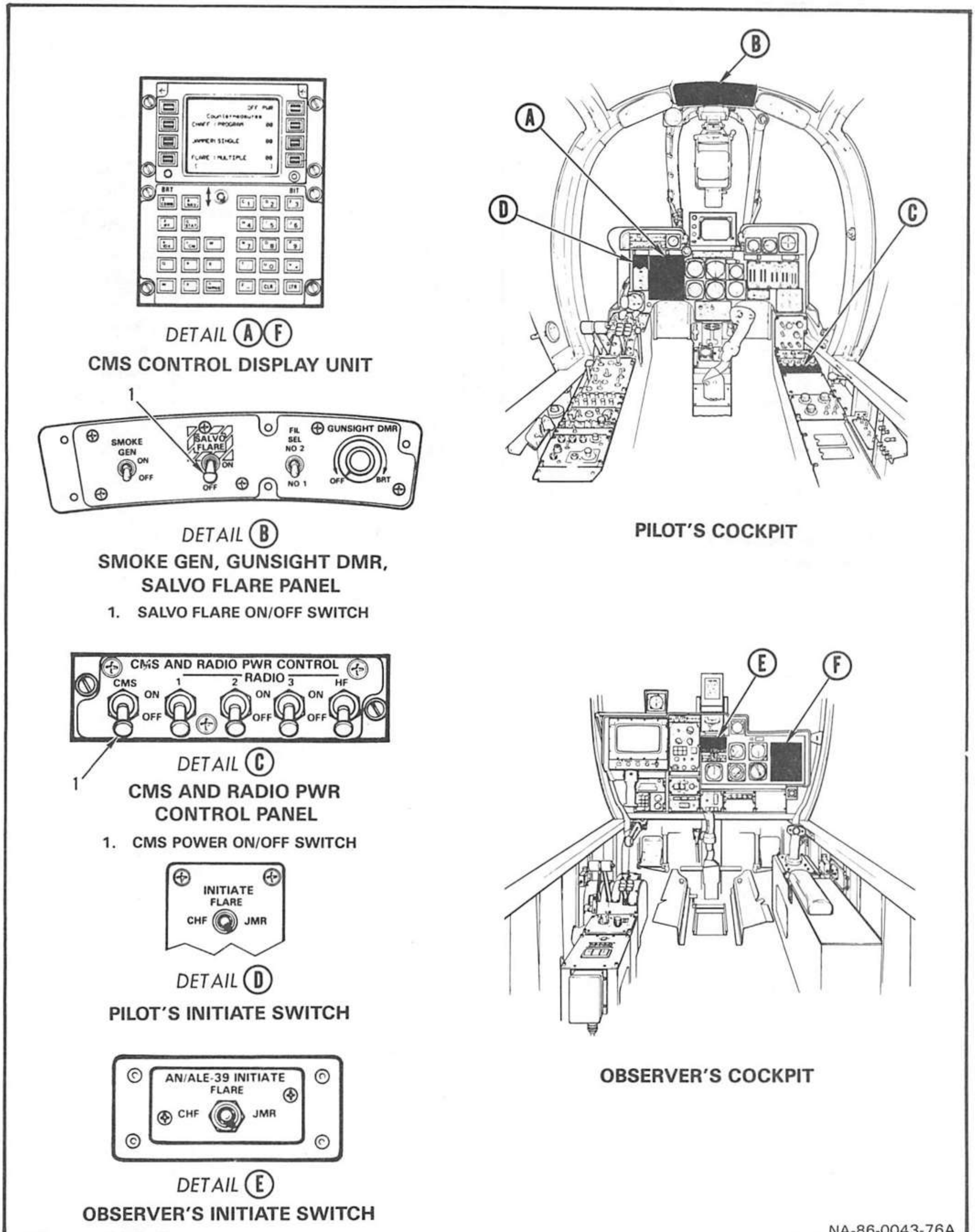
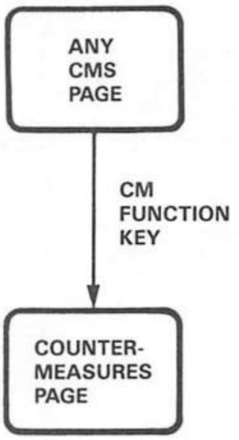
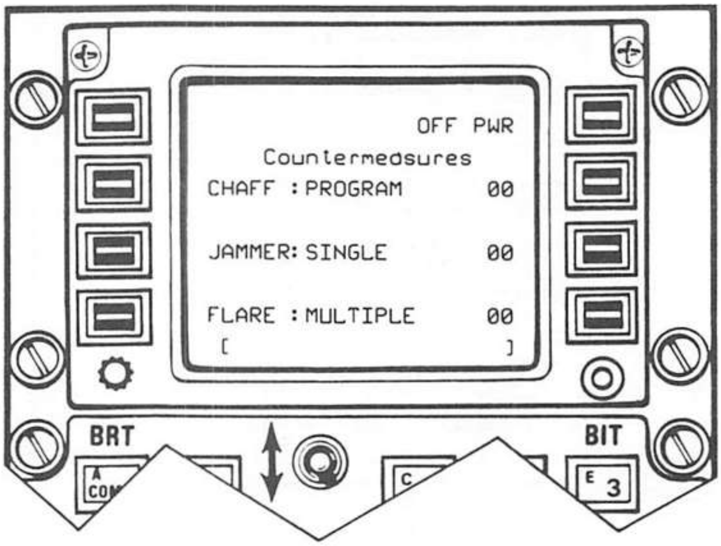


Figure 22-4. Countermeasures Dispensing Set, AN/ALE-39, Controls and Indicators



COUNTERMEASURES PAGE FLOW CHART



COUNTERMEASURES PAGE

LS1: NO ACTION.

LS2: TOGGLE CHAFF MODE SELECT (OFF, SINGLE, PROGRAM, RWR).

LS3: TOGGLE JAMMER MODE SELECT (OFF, SINGLE, PROGRAM, RWR).

LS4: TOGGLE FLARE MODE SELECT (OFF, SINGLE, MULTIPLE, OFF, PROGRAM, GROUP, OFF, RWR).

LS5: NO ACTION. DISPLAY CM POWER STATE.

LS6: ENTER PAYLOAD COUNT FROM SCRATCH PAD.

LS7: ENTER PAYLOAD COUNT FROM SCRATCH PAD.

LS8: ENTER PAYLOAD COUNT FROM SCRATCH PAD.

NOTE

PAYLOAD COUNTERS WILL DECREASE WITH EVERY INITIATE SWITCH ACTIVATION. HOWEVER, THE CMS DOES NOT HAVE THE CAPABILITY TO CROSS-CHECK FOR MISFIRES OR DUD COUNTERMEASURE MATERIALS.

NA-86-0043-77B

Figure 22-5. CM Key Flow Chart and Page Display

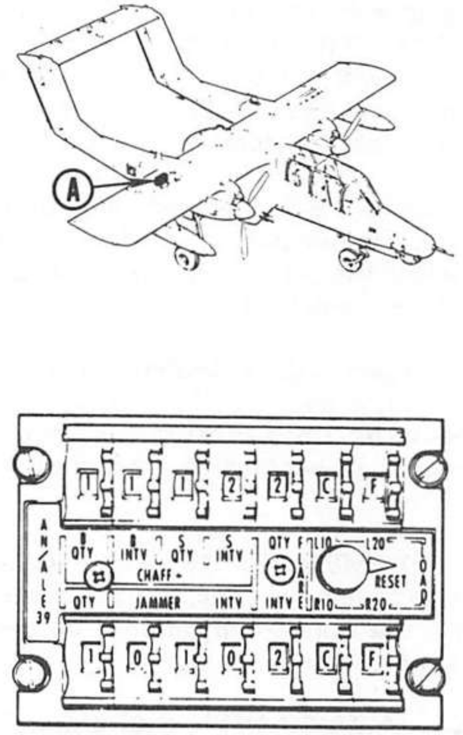
CMS-CM MODE	FUNCTION
OFF	Initiation of dispensing is not possible.
SINGLE	Causes a single dispense command to the programmer for each actuation of the dispense INITIATE switch.
PROGRAM	Causes a programmed dispense command to be sent to the programmer for each activation of the dispense INITIATE switch.
RWR	Not used.
MULTIPLE	A command to the programmer to cause it to dispense flare payloads in parallel if available, and is initiated by activation of the flare dispense INITIATE switch.
GROUP	A combination command of PROGRAM and MULTIPLE modes, which causes the programmer to expand flare payloads from all available sections in parallel in the quantity and time interval selected by the programmer.

NOTE

Radar Warning Receiver (RWR) mode may be displayed but is not functional in this configuration.

22.5.1.1.2 Load Remaining Indications. Load remaining subtractive counters are provided on the Countermeasures page (Figure 22-5) to indicate the number of unfired chaff, flare, and jammer cartridges remaining in the dispensers. The CMS does not have the capability to cross-check between actual and indicated countermeasure materials. When the Countermeasures page is displayed, entry into the scratch pad from the keypad and LS key selection will insert the quantity adjacent to the selected countermeasures store. The display is limited to 60 loads (Figure 22-5).

22.5.1.2 Programmer Control Panel. The programmer control panel (Figure 22-6) is located in the right-hand wheel well. The programmer unit accepts command signals from the cockpit control unit and provides the two sequencer switches with stepping pulses for dispensing countermeasures payloads from the dispensers. The programmer controls are set prior to flight and cannot be changed during flight.



DETAIL (A)

PROGRAMMER CONTROL PANEL

NA-86-0043-237

Figure 22-6. Programmer Control Panel

22.5.1.2.1 CHAFF B QTY Switch. The CHAFF B QTY switch has positions 1, 2, 3, 4, C, and R which select the number of chaff bursts in one salvo. The C position permits continuous dispensing of individual bursts at the rate selected on the CHAFF B INTV switch. Dispensing continues until all chaff have been expended or until the dispenser control POWER/SALVO FLARE switch is positioned to OFF. The R position permits a random number of bursts in one salvo (4 minimum or 6 maximum).

22.5.1.2.2 CHAFF B INTV Switch. The CHAFF B INTV switch has positions .1 (0.125 second), .2 (0.250 second), .5 (.500 second), .7 (0.750 second), 1.0 (1.0 second), and R (Random) which select the time interval in seconds between each chaff burst in a salvo. With the CHAFF B INTV switch in RANDOM, the first three bursts of the first salvo are 0.125 second apart. Additional bursts of 1, 2, or 3 are fired at random time intervals of either 0.25, 0.50, 0.75, 1.00, 1.50, 2.00, 3.00, or 4.00 seconds when CHAFF B QTY switch is at R or C. If CHAFF B INTV switch is on R and CHAFF B QTY is not on R or C, a single chaff payload is dispensed.

22.5.1.2.3 CHAFF S QTY Switch. The CHAFF S QTY switch has positions 2, 4, 6, 8, 10, and 15 which select the number of chaff salvos in one programmed sequence.

22.5.1.2.4 CHAFF S INTV Switch. The CHAFF S INTV switch has positions 2, 4, 6, 8, and 10 which select the time interval in seconds between ejection of each salvo in an automatic sequence.

22.5.1.2.5 JAMMER QTY Switch. The JAMMER QTY switch has positions of 1, 2, 3, and 4 which select the number of jammer bursts in one programmed sequence.

22.5.1.2.6 JAMMER INTV Switches. The three JAMMER INTV switches provide for selection of time interval between jammer bursts from 001 to 299 seconds.

22.5.1.2.7 FLARE QTY Switch. The FLARE QTY switch has positions 2, 3, 4, 6, 8, and 10 which select the number of flare bursts in one flare programmed sequence.

22.5.1.2.8 FLARE INTV Switch. The FLARE INTV switch has positions of 2, 4, 6, 8, and 10 which select the time interval in seconds between flare bursts during flare programmed sequence.

22.5.1.2.9 L10, L20, R10, R20 LOAD Switches. The four LOAD switches have positions of chaff (C), flares (F), and jammers (J) which are set by ground personnel to indicate which type of load is in each of the four dispenser sections.

22.5.1.2.10 RESET Switch. The RESET switch is used to clear all registers in the programmer and resets the sequencer switches (cancels remainder of a program).

22.5.1.3 AN/ALE-39 Override Switch Panel. The AN/ALE-39 override switch panel (Figure 22-6) is attached to the programmer housing in the right-hand wheel well. The AN/ALE-39 override switch provides a signal to a relay in the power and light dimming control panel which overrides the aircraft main landing gear ground safety circuit. This function permits ground testing of the AN/ALE-39 dispensing system.

22.5.1.4 AN/ALE-39 Safety Switch. An AN/ALE-39 safety switch (Figure 22-7) is provided for each dispenser (left and right). The switches are located in the left- and right-hand booms. The safety switch is a plunger-actuated sealed switch. When a disarm pin is inserted, 28-VDC operating power to the sequencer switch is interrupted, preventing dispensing of payloads. The switch can be opened only by a disarm pin.

22.5.1.5 INITIATE Switches. An INITIATE switch is located on the pilot's and observer's instrument panel. The multiposition, momentary toggle switch has positions for CHF, FLARE and JMR with center position OFF. Momentarily depressing the switch to CHF, FLARE, and JMR will initiate a dispense function to the programmer as selected on the CMS Countermeasures page (Figure 22-4).

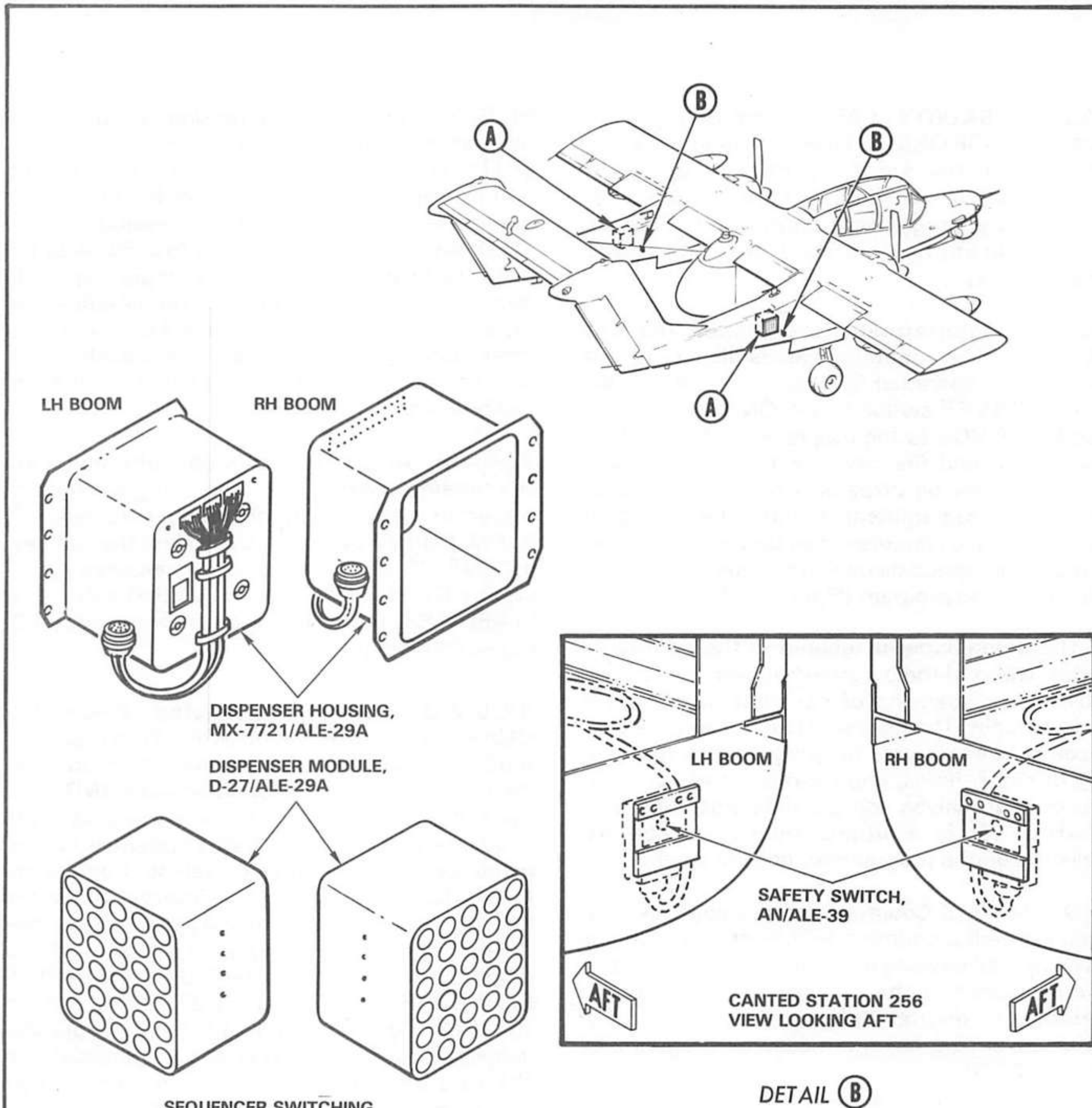


Figure 22-7. AN/ALE-39 Countermeasures Dispensing Set Controls

22.5.1.6 SALVO FLARE ON/OFF Switch. The SALVO FLARE ON/OFF lever-lock toggle switch, located on the smoke generator-gunsight dimmer-salvo flare panel, provides 28 VDC power to the programmer control and to initiate the programmer salvo flare sequence (Figure 22-4).

22.5.2 Countermeasures Dispensing Set Operation. The countermeasures dispensing set is placed in operation by positioning the SALVO FLARE ON/OFF switch to the ON position. This applies 28 VDC to the programmer and enables the search and fire circuitry. Countermeasures materials may be dispensed manually or automatically (programmed). Manual dispensing of chaff, flares, or jammers can be performed during a programmed dispensing sequence without disturbing the program (Figure 22-4).

The programmer is located in the right-hand wheel well and the programmer controls for programmed dispensing of payloads must be set prior to flight. The number of bursts and the time lapse between bursts for programmed dispensing of chaff, flares, and jammers, and the number of chaff salvos and the time lapse between chaff salvos in a programmed sequence are selected on the programmer control panel.

On the CMS Countermeasures page, set the load remaining counters to indicate the number of each type payload material (chaff, flares, jammers) loaded in the dispensers. In addition, select and display the programmer modes selected on the Countermeasures programmer (Figure 22-5).

Flares may be salvoed at any time (in flight) by placing the SALVO FLARE ON/OFF switch to the SALVO FLARE position. All remaining flares, regardless of loaded location are dispensed in a rapid fire sequence.

22.5.2.1 Manual Operation. After the dispensing system is placed in operation by positioning the SALVO FLARE ON/OFF switch to ON, select the CM key on CMS-CDU. On the Countermeasures page, select CHAFF (LS2), JAMMER (LS3), and FLARE (LS3) to SINGLE with rotary LS key action. When the modes are selected to SINGLE, momentarily depressing the pilot's or observer's INITIATE switch to either CHF, JMR, or FLR will dispense one payload of selected countermeasures material. With the FLARE mode selected to MULTIPLE, depressing the INITIATE switch will cause one to four flares to be dispensed simultaneously as a single dispense, depending on how the four dispensers are loaded. If three sections have flares loaded, three flares can be fired simultaneously, or if only one section has flares loaded, a single flare will be fired.

22.5.2.2 Automatic Operation (Programmed Dispensing). After the dispensing system is placed in operation by positioning the SALVO FLARE ON/OFF switch to ON, select the CM key on CMS-CDU. On the Countermeasures page, select CHAFF (LS2), JAMMER (LS3), and FLARE (LS3) to desired position with rotary LS key action (Figure 22-5).

22.5.2.2.1 Chaff Dispensing. Place the CHAFF mode to PROGRAM (LS2). When the mode is selected to PROGRAM, momentarily depressing the pilot's or observer's INITIATE switch to CHF will initiate a programmed sequence of dispensing chaff payloads from the dispensers. The number of salvos, number of bursts for each salvo, time interval between bursts, and time interval between salvos are determined by the setting (prior to flight) of the programmer switches (CHAFF B QTY, CHAFF B INTV, CHAFF S QTY, and CHAFF S INTV). With the CHAFF B QTY switch in C (continuous) the individual bursts are dispensed continuously at the rate determined by the position of the CHAFF B INTV switch (Figure 22-6).

NOTE

Continuous dispensing can only be terminated by positioning the SALVO FLARE ON/OFF switch to OFF.

The positions of the CHAFF S QTY and CHAFF S INTV switches are meaningless when the CHAFF B QTY switch is in C.

22.5.2.2.2 Jammer Dispensing. Place the JAMMER mode to PROGRAM (LS3). When the mode is selected to PROGRAM, momentarily depressing the pilot or observer's INITIATE switch to JMR will initiate a programmed sequence of dispensing jammer payloads from the dispensers. The number of jammer bursts in one programmed sequence and the time interval between jammer bursts, are determined by the setting (prior to flight) of the programmer switches (JAMMER QTY and JAMMER INTV).

22.5.2.2.3 Flare Dispensing. Place the FLARE mode to PROGRAM (LS4). When the mode is selected to PROGRAM, momentarily depressing the pilot's or observer's INITIATE switch to FLARE will initiate a programmed sequence of dispensing flare payloads from the dispensers. The number of flare bursts in one programmed sequence and the time interval between flare bursts, are determined by the setting (prior to flight) of the programmer switches (FLARE QTY and FLARE INTV).

Place the FLARE mode to GROUP (LS4). When the mode is selected to GROUP, momentarily depressing the pilot's or observer's INITIATE switch to FLARE will initiate a programmed sequence of dispensing multiple flare payloads (up to four flares dispensed simultaneously) from the dispensers. The number of multiple flare bursts in one programmed sequence and the time interval between flare bursts, are determined by the setting (prior to flight) of the programmer switches (FLARE QTY and FLARE INTV).

22.6 INFRARED (IR) COUNTERMEASURES SYSTEM, AN/ALQ-144(V)

The AN/ALQ-144(V) is installed to provide protection to the aircraft from infrared-guided missile systems. Protection is provided by emitting large amounts of modulated radial energy from an electrically heated source which emits frequencies throughout the spectral band of the seeker missile receiver, this causes the missile guidance system to steer the missile away from a direct path toward its target. The system can be operated in all weather and climatic conditions. A system failure is indicated by the IRCM INOP indicator light on the pilot's caution light panel. If the IRCM INOP light does not illuminate in approximately 60 seconds after power application, the system is operational. Two modes of operation are available, FIXED or SWEPT, the modes are preselected prior to flight depending on mission threat.

22.6.1 Infrared Countermeasures System Controls and System Failure Indicator. All controls for the IR countermeasures system are located in the pilot's cockpit on the control unit in the left console and on the transmitter located on the upper AFT fuselage. The IRCM INOP indicator light is located on the pilot's caution light panel (Figure 22-8).

22.6.1.1 Control Unit. The control unit, located in the pilot's left-hand console provides ON/OFF control (Figure 22-8).

22.6.1.1.1 ON/OFF Power Switch. The ON/OFF power switch is a positive locking-type switch and must be pulled outward and then up or down to change positions. The ON/OFF power switch has two positions; ON, which provides 28-VDC control signal to the transmitter to energize the power-up cycle, and OFF which secures the system.

NOTE

If system is turned on, it should remain on for a minimum of 15 minutes (if no fault condition exists) to extend the transmitter life.

22.6.1.2 Transmitter. The transmitter is located on the upper AFT fuselage above the HF antenna coupler (Figure 22-8).

22.6.1.2.1 RESET/FIXED/SWEEP (RST/FXD/SWP) Switch. The RST/FXD/SWP switch, located behind the Built-In-Test (BIT) indicator access panel on the base of the transmitter, has three positions: RST which allows the BIT indicators to be reset, FXD which allows for fixed frequency modulation, and SWP which allows for sweep frequency modulation.

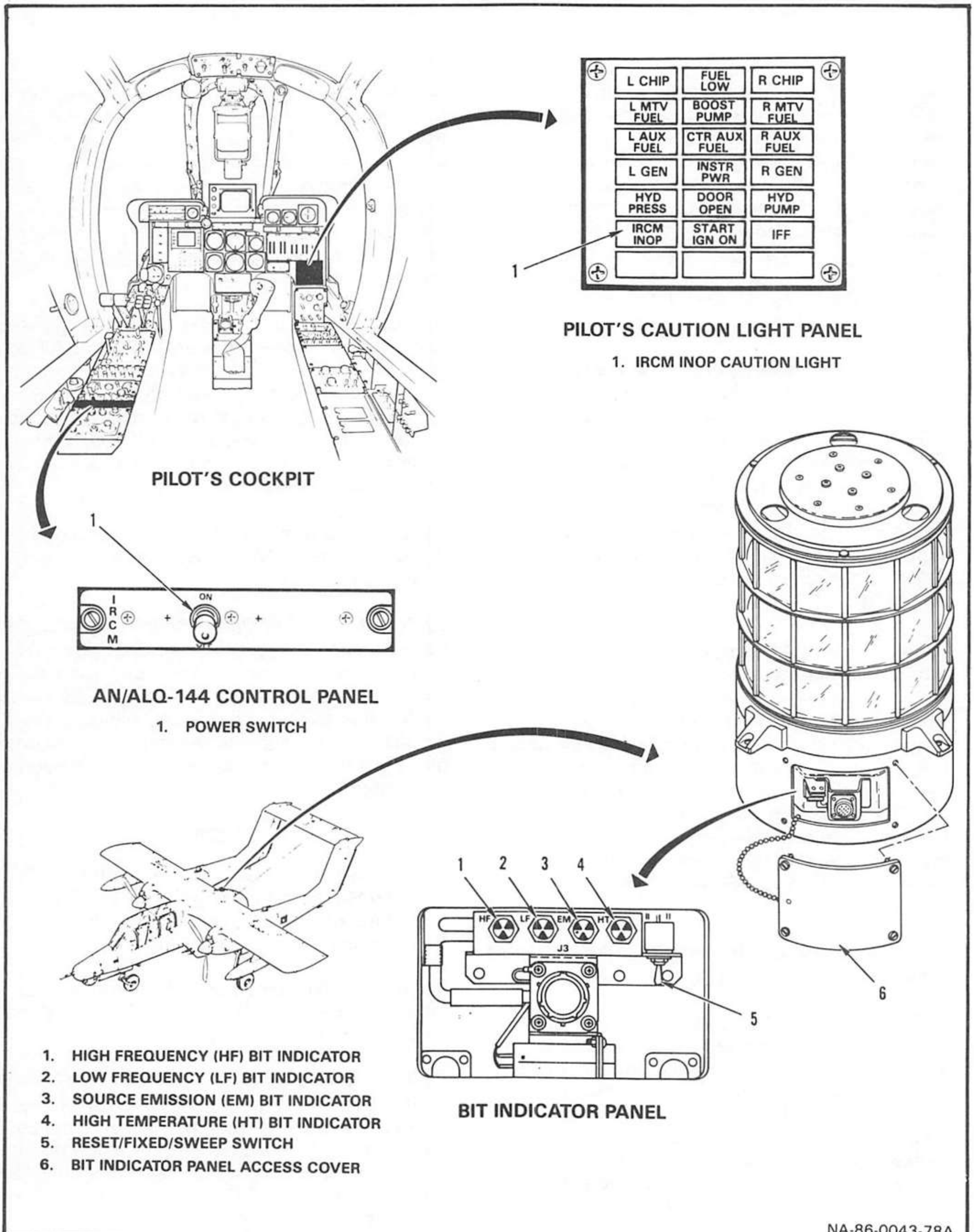


Figure 22-8. Infrared (IR) Countermeasures, AN/ALQ-144, Controls and Indicators

22.6.1.3 System Failure Indicator. The system failure indicator (IRCM INOP), located on the pilot's caution light panel, will illuminate for the following reasons:

1. When the system is shut down, the IRCM INOP light will illuminate for approximately 1 minute while the cool-down cycle is in progress. When the cool-down cycle is complete, the light will extinguish.

2. If a fault condition exists after the completion of the system power-up cycle (approximately 1 minute) the IRCM INOP caution light will illuminate and the system will automatically shut down. After the cool-down cycle (approximately 1 minute) the IRCM INOP caution light will extinguish.

3. If a fault condition occurs during normal operation, the IRCM INOP caution light will illuminate and automatically shut the system down after the BIT fault indicators are initiated. The cool-down cycle (approximately 1 minute) will start and the IRCM INOP caution light will extinguish after the cool-down cycle is completed.

22.6.2 Infrared Countermeasures System Operation. The IR countermeasures system is energized by placing the ON/OFF switch to the ON position. This supplies a 28-VDC voltage to the transmitter to energize the power-up cycle. After approximately 1 minute, the system is operational. If the IRCM INOP caution light illuminates do the following:

1. Place control unit ON/OFF switch in the OFF position.

2. Wait until the IRCM INOP caution light extinguishes (approximately 1 minute); then place control unit ON/OFF switch to the ON position.

3. If after approximately 1 minute, the IRCM INOP caution light does not illuminate, the system is operating properly. If the IRCM INOP caution light illuminates again, place the ON/OFF switch to OFF (internal system failure).

22.7 RADAR WARNING SYSTEM, AN/APR-39(V)

The AN/APR-39(V) is a passive omnidirectional radar warning system receiving and displaying information to the pilot and observer concerning the radar environment surrounding the aircraft. The system accepts and responds to radar tracking signals in the E, F, G, H, I, and J (wide band) and radar missile guidance signals in the C and D (low band) frequency bands. The system provides visual and aural indications of received radar signals. The system indicator provides a radial strobe display for each processed signal received by the wide-band antennas. This radial strobe shows the presence of and direction to emitting source. The length of the strobe is an indication of signal strength only and not to be used as a measure of range or distance. Radar signals which are not hostile are generally excluded. Aural indications are heard in the headsets through the ICS system. There are two signal-types of aural indications. The first aural indication is representative of the amplitude and pulse repetition frequency (PRF) of the processed wide-band signals. The second aural indication is developed when a low-band guidance signal is received by the low-band antenna and is correlated with a wide-band tracking signal. When this occurs, the equipment identifies the signal combination as an activated SAM radar complex and sends a warbling tone superimposed on top of the first tone to warn the pilot and observer of an immediate threat.

22.7.1 Radar Warning System Controls and Indicators. All the controls for the radar warning system are on the control unit, located in the pilot's left-hand console, and on the indicators, one in each cockpit (Figure 22-9).

22.7.1.1 Control Unit. The control unit is located in the pilot's left-hand console (Figure 22-9).

22.7.1.1.1 Power (PWR) Switch. The PWR switch has two positions; ON which energizes the system, and OFF which secures the system.

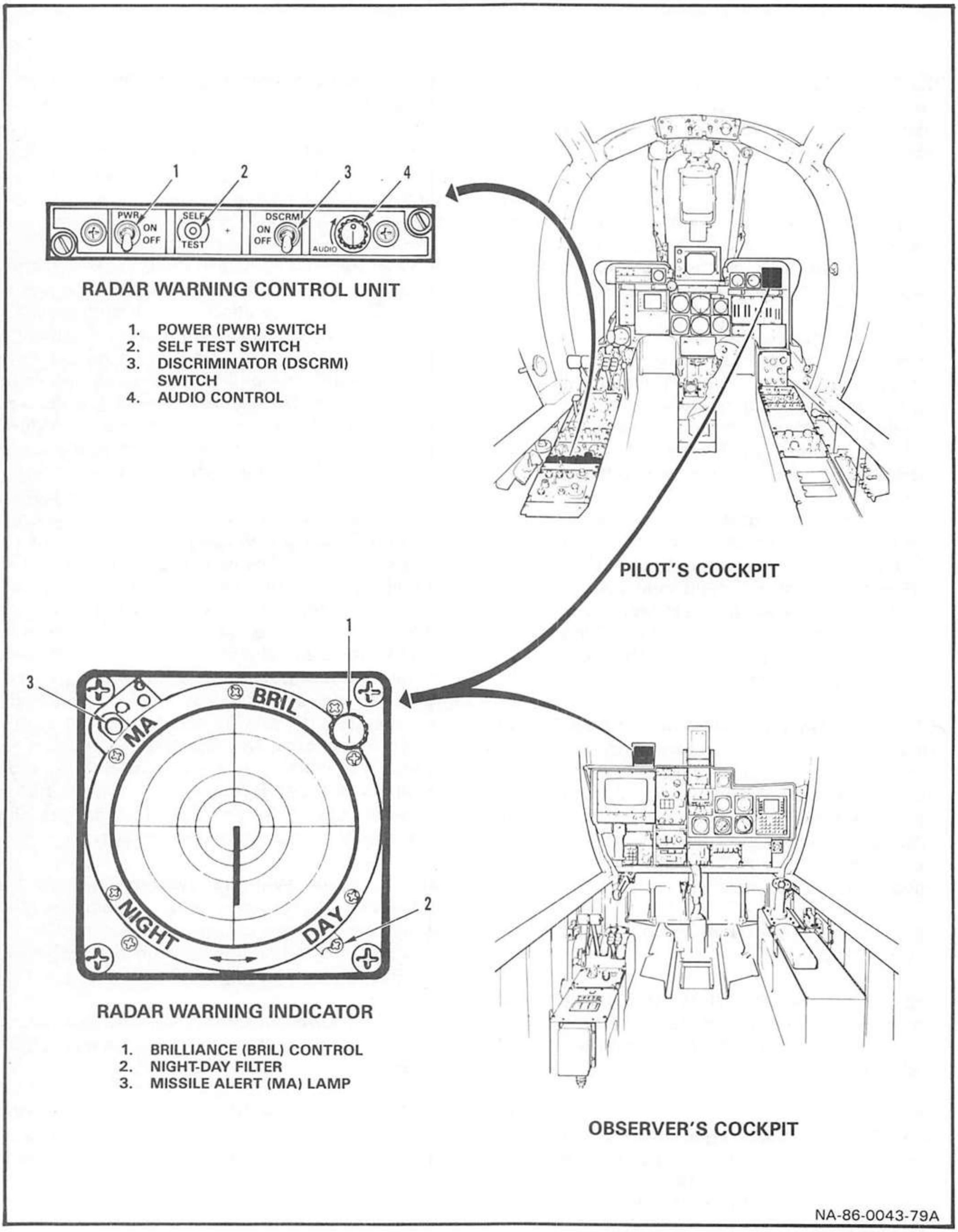


Figure 22-9. Radar Warning System, AN/APR-39, Controls and Indicators

22.7.1.1.2 SELF TEST Switch. The SELF TEST switch is a push-button switch which when pushed in and held performs a self-test of the radar warning system.

22.7.1.1.3 Discriminator (DSCRM) Switch. The DSCRM switch has two positions; the ON position, which energizes the discriminator circuit and allows only the received signals which meet known threat requirements to be displayed. The OFF position, which allows all signals received within the frequency range of the system to be displayed.

22.7.1.1.4 AUDIO Control. The AUDIO control adjusts the volume of the aural tone output of the radar warning system which is integrated through the intercommunications system (ICS) and routed to the pilot's and observer's headsets.

22.7.1.2 Indicator. There are two indicators, one located in each cockpit (Figure 22-9). The pilot's indicator is located on the upper right portion of the pilot's instrument panel. The observer's indicator is located above the FLIR indicator on the left side of the cockpit.

22.7.1.2.1 Brilliance (BRIL) Control. The BRIL control adjusts the brightness of the strobes which are generated by the system to show direction of the threat.

22.7.1.2.2 NIGHT-DAY Filter. The NIGHT-DAY filter varies the density of the red polarizing faceplate for day or night operation. When used in conjunction with the BRIL control, it produces a highly visible and clear display under most lighting conditions.

22.7.1.2.3 Missile Alert (MA) lamp. The MA lamp indicates the presence of low-band radar frequencies (C and D bands). With the DSCRM switch on the control unit in the ON position, the MA lamp will flash on and off when received signals are processed and there is a correlation between the high- and low-band frequencies which indicate an immediate threat. With the DSCRM switch in the OFF position, the MA lamp will flash when any intercepted low-band signals are processed.

22.7.1.2.4 MA Lamp Shield. The MA lamp shield can be placed over the MA lamp to reduce the brightness of the MA lamp when the pilot or observer is using a night vision system.

CAUTION

To prevent damage to the system, assure that the system antennas are at least 60 yards from active ground-based radar antennas or 6 yards from active airborne radar antennas. Allow an extra margin for new, unusual, or high-powered emitters.

22.7.2 Radar Warning System Operation

1. On the control unit, set power ON/OFF switch to the ON position and allow 60 seconds for equipment to become fully operational.

2. On control unit, set DSCRM switch to the OFF position.

3. Perform a SELF TEST of the system.

4. On the control unit, set DSCRM switch in accordance with mission requirements.

NOTE

System sensitivity is slightly reduced when the DSCRM switch is in the ON position. Weak signals which may be beneficial could be blocked out.

22.7.3 Radar Warning System Self-Test Procedure

1. On pilot's interior lights control panel, adjust the console lights control to bright and check that control unit panel lights are lit.

2. On control unit, set DSCRM switch to the OFF position and the power ON/OFF switch to ON. Allow 1 minute for system to warm up.

3. On control unit, press the SELF TEST button and hold.

(a) A PRF representative audio signal (missile tracking) should be heard immediately in the headset. After 6 seconds, a whooping missile guidance alert (MA) signal is added.

(b) Immediately observe the indicator screen. Forward and AFT strobes appear, radiating outward from the center to approximately the third circle on the screen.

(c) The MA lamp on the indicator starts flashing after 6 seconds.

4. On indicator, turn the BRIL control left or right and observe the strobes on the indicator screen brighten and dim as the control is turned. Set control for desired display brilliance and color (maximum red for night).

NOTE

Strobes brighten as the control is turned clockwise.

5. On control unit, adjust the audio control. Set control for desired audio level in headset.

NOTE

Audio increases as the control is turned clockwise.

6. Release SELF TEST button. All indications should stop.

7. On control unit, set DSCRM switch to the ON position and press and hold the SELF TEST button.

(a) The PRF audio signal (missile tracking) is heard after 4 seconds. After a few more seconds this frequency will double. Within another few seconds the missile guidance alert (MA) signal will be heard.

(b) Within 4 seconds, the forward or aft strobe appears, followed by the opposite strobe within the next few seconds.

NOTE

Occasionally after pushing in SELF TEST button and before the appearance of the first strobe, a distorted dot on the indicator screen and off-and-on audio will be present. This is not a fault indication. Hold SELF TEST button in long enough for strobes to appear.

(c) Six seconds after pressing in the SELF TEST button, the MA lamp will start flashing.

8. Release SELF TEST button, all indications should cease.

PART IX

Flight Crew Coordination

CHAPTER 23

Flight Crew Coordination

23.1 INTRODUCTION

This section provides information on pilot/observer coordination. Observer is defined as any aircrewmember occupying the rear cockpit in the performance of the assigned mission. The mission assigned to the aircraft will dictate the qualifications required for the observer.

23.2 AIRCREW POSITIONS

The duties of the pilot and observer are often integrated. Each must support and contribute to the completion of the assigned mission. Although specific responsibilities are delineated, cooperation and initiative would become paramount in the event of aircraft system malfunction, emergency or unfamiliar circumstances where assistance is desired. The pilot is the Aircraft Commander and is ultimately responsible for the safe completion of any mission assigned to his aircraft. The pilot and observer shall perform as a team in the completion of the mission. By intercommunications, the pilot and observer should anticipate rather await developments.

23.3 FLIGHT PLANNING

- PILOT—The pilot will be responsible for the preparation of required charts, flight logs, navigation computation including fuel planning, checking weather and NOTAMS, and for filing required flight plans.

- OBSERVER—The observer will provide any mission requirements such as special maps, air threat, ground threat, photography, tactical briefs, or assist the pilot with any of his duties necessary for mission completion.

23.4 BRIEFING/MISSION PLANNING

- PILOT—The pilot/flight leader is responsible for briefing all crewmembers on all aspects of the mission to be flown.

- OBSERVER—The observer will assist the pilot/flight leader in preparing required flight or briefing forms. If NATOPS qualified, the observer may brief the entire mission with guidance from the pilot or flight leader. The observer may plan and brief the tactical aspects of the flight.

23.5 PREFLIGHT

- PILOT—The pilot is responsible for accepting and preflighting the aircraft assigned in accordance with this manual and appropriate preflight checklist contained in the NATOPS Pilot's Pocket Checklist (A1-O10DA-NFM-500), referred hereafter as NATOPS Pilot's PCL.

- OBSERVER—The observer shall conduct that portion of the exterior inspection checklist which is related to the rear cockpit and if NATOPS qualified, assist with the preflight as directed by the pilot.

23.6 PRESTART

- PILOT—The pilot will execute the prestart checks described in the NATOPS Pilot's PCL and will inform the observer PRESTART CHECKS COMPLETE—READY TO START.

- OBSERVER—The observer will execute the prestart checks applicable to the observer's cockpit described in the NATOPS Pilot's PCL and will inform the pilot PRESTART CHECKS COMPLETE—READY TO START.

23.7 STARTING

- PILOT—The pilot will start engines as described in Part III, Chapter 7 and will keep the observer informed of any unusual occurrences.

- OBSERVER—The observer will watch for any unusual engine developments and remain alert for any emergency signals from the ground crew and will inform the pilot if such signals are observed.

23.8 POSTSTART

- PILOT—The pilot will complete all poststart checks described in the NATOPS Pilot's PCL.

- OBSERVER—The observer will ensure all before taxi checks are complete as described in the NATOPS Pilot's PCL.

23.9 PRETAKE-OFF

- PILOT—The pilot will execute pretake-off checklists described in the NATOPS Pilot's PCL. The pilot will report completion of each of the take-off checklist items to the observer and upon completion advise the observer TAKE-OFF CHECKLISTS COMPLETE—READY FOR TAKE-OFF.

- OBSERVER—The observer will report READY FOR TAKE-OFF upon satisfactory completion of his checklist. The observer should be alert to challenge the pilot if any item on the take-off checklist is not reported as completed. The observer will assist in communications as directed by the pilot.

23.10 TAKE-OFF/DEPARTURE

- PILOT—The pilot will request, copy, and acknowledge all clearances. He should, however, afford the observer the opportunity to practice requesting and copying flight clearances in addition to his normal tactical clearances.

- OBSERVER—The observer will keep a constant lookout and advise the pilot of any traffic within close proximity of the aircraft, and perform other such duties as the pilot may request.

23.11 EN ROUTE

- PILOT—The pilot will inform the observer of any unusual occurrences and will ensure that the aircraft is operated within prescribed operating limitations at all times. The operation of the radios will be delineated by the pilot in command/mission commander. Monitor and manage fuel.

- OBSERVER—The observer will assist the pilot in changing communication frequencies and will request, copy, and acknowledge flight and tactical clearances or make position reports when directed by the pilot. Additionally, the observer will ensure that he is familiar with the emergency procedures section of the NATOPS Pilot's PCL to enable him to assist the pilot when requested.

23.12 INSTRUMENT PROCEDURES

- PILOT—Transitioning from VFR to IFR conditions the pilot should shift completely to instruments prior to entering IMC and inform the observer. Remain on instruments any time the aircraft is climbing or descending through cloud layers. If experiencing vertigo/disorientation notify the observer immediately, stay on the instruments and refrain from making any unnecessary communication, navigation, or IFF changes. Refrain from making any communication or control changes which could be completed by the observer.

- OBSERVER—Assume all lookout responsibilities any time the pilot is on the instruments, monitor the flight instruments and advise the pilot while in IMC. Assist the pilot if he experiences vertigo and advise if vertigo is experienced by the observer. If the pilot experiences vertigo/disorientation, carefully monitor instruments informing pilot of attitude, altitude, and airspeed.

23.13 MISSIONS

- PILOT—Maintain a good lookout doctrine, report fuel switchology, transfer, and fuel state to observer periodically. Inform observer when going from visual to instruments or vice versa. Inform observer when changing radio/TACAN/IFF frequencies. Be constantly aware of attitude, altitude, and geographical position.

- OBSERVER—Maintain a good lookout doctrine and scan pattern. Be aware of attitude, altitude, and geographic position. Copy all clearances and headings/altitude changes. If pilot is occupied, be prepared to make any radio calls to affect mission success, which includes advising the pilot concerning aircraft positioning.

23.14 RETURN

- PILOT—Exercise control of aircraft to return as planned. Monitor and manage fuel.
- OBSERVER—Provide navigation assistance as requested to pilot. Perform communications duties commensurate with mission responsibilities.

23.15 DESCENT/APPROACH

- PILOT—Before commencing any penetration, the pilot will report the completion of the instrument checklist to the observer.
- OBSERVER—The observer will assist the pilot as directed during the instrument approach.

23.16 LANDING

- PILOT—The pilot will utilize the landing checklist and will report each item to the observer. The pilot will receive a TWO DOWN VISUAL/READY TO LAND report from the observer.
- OBSERVER—The observer will complete the landing checklist; visually check that main gear are down and will report TWO DOWN VISUAL/READY TO LAND to the pilot.

23.17 POSTLANDING/TAXI/SHUTDOWN

- PILOT—Complete appropriate checklist preparatory to securing engines. Report the ejection seat safety pin inserted, shut down engines, and secure aircraft as described in Part III, Chapter 7, NATOPS flight manual and the NATOPS Pilot's PCL.
- OBSERVER—The observer will challenge the pilot on the insertion of the ejection seat safety pin if the report is not received.

WARNING

The front and rear seats are interconnected so that pilot-initiated ejection will eject the rear even with rear seat pins installed. Complete checklist items described in the NATOPS Pilot's PCL. Advise pilot when completed.

23.18 POSTFLIGHT

- PILOT—The pilot will conduct a post flight inspection of the aircraft.
- OBSERVER—The observer will conduct a post flight inspection of those items covered during preflight.

23.19 DEBRIEFING

The pilot and observer will complete the yellow sheet and all required debriefing forms.

23.20 FUNCTIONAL CHECKFLIGHTS

- PILOT—The pilot will conduct a running commentary on aircraft flight performance and parameters for each item on profile.
- OBSERVER—The observer will assist the pilot by recording all data on the FCF check card as reported by the pilot. the observer will augment lookout doctrine and be aware of attitude, altitude, airspeed, and geographical position at all times.

23.21 FORMATION

- PILOT—Maintain a good lookout doctrine. Advise observer of any signals received from other aircraft or when passing signals.
- OBSERVER—Maintain a good lookout doctrine. Advise pilot of any signals received from other aircraft. Monitor closure rate, airspeed, and altitude separation.

23.22 TRAINING

The pilot and observer will receive and conduct training commensurate with the assigned mission. Each is responsible to the other to impart special knowledge of systems and or evaluations that enhance the overall combat readiness of the aircrew.

23.23 SAR

- PILOT—Maintain good lookout doctrine. Advise observer on survivors and their location while assuming on-scene commander.
- OBSERVER—Pilot survivors' exact location. Attempt radio contact with survivors. Request launch or SAR forces and ETA. Assist pilot with on-scene commander's checklist until properly relieved.

23.24 EMERGENCIES

- PILOT—Inform observer of nature of emergency. Inform observer of action taken, action required.
- OBSERVER—Inform pilot of any emergency situation as soon as noticed. Follow pilot through checklist answering questions or stating steps when requested by pilot.

PART X

NATOPS Evaluation

CHAPTER 24

NATOPS Evaluation Program

24.1 CONCEPT

The standard operating procedures described in this manual represent the optimum method of operating the OV-10D aircraft. The NATOPS evaluation is intended to evaluate compliance with NATOPS procedures by observing and grading individuals and units. This evaluation is tailored for compatibility with various operational commitments and missions of both Navy and Marine Corps units. The prime objective of the NATOPS evaluation program is to assist the Unit Commanding Officer in improving unit readiness and safety through constructive comment. Maximum benefit from the NATOPS evaluation program is achieved only through the vigorous support of the program by commanding officers as well as flight crewmembers.

24.2 IMPLEMENTATION

The NATOPS evaluation program shall be carried out in every unit operating naval aircraft. The various categories of flight crewmembers desiring to attain/retain qualification in the OV10D shall be evaluated initially in accordance with OPNAVINST 3710.7 series, and at least once during the 12 months following initial and subsequent evaluations. Individual and unit NATOPS evaluations will be conducted annually. However, instruction in and observation of adherence to NATOPS procedures must be on a daily basis within each unit to obtain maximum benefits from the program. The NATOPS Coordinators, Evaluators, and Instructors shall administer the program as outlined in OPNAVINST 3710.7 series. Evaluees who receive a grade of unqualified on a ground or flight evaluation shall be allowed 30 days in which to complete a re-evaluation. A maximum of 60 days may elapse between the date the initial ground evaluation was commenced and the date the flight evaluation is satisfactorily completed.

24.3 DEFINITIONS

The following terms, used throughout this section, are defined as to their specific meaning within the NATOPS evaluation program.

24.3.1 NATOPS Evaluation. A periodic evaluation of individual flight crewmember standardization consists of an open book examination, a closed book examination, an oral examination, and a flight evaluation.

24.3.2 NATOPS Re-Evaluation. A partial NATOPS evaluation administered to a flight crewmember who has been placed in an unqualified status by receiving an unqualified grade for any of his ground examinations or the flight evaluation. Only those areas in which an unsatisfactory level was noted need be observed during a re-evaluation.

24.3.3 Qualified. That degree of standardization demonstrated by a reliable flight crewmember who has a good knowledge of standard operating procedures and a thorough understanding of aircraft capabilities and limitations.

24.3.4 Conditionally Qualified. That degree of standardization demonstrated by a flight crewmember who meets the minimum acceptable standards. He is considered safe enough to fly as a pilot in command or to perform normal duties without supervision, but more practice is needed to become qualified.

24.3.5 Unqualified. That degree of standardization demonstrated by a flight crewmember who fails to meet minimum acceptable criteria. He should receive supervised instruction until he has achieved a grade of qualified or conditionally qualified.

24.3.6 Area. A routine of preflight, flight, or postflight procedures which are observed and graded during a flight evaluation.

24.3.7 Subarea. A performance subdivision within an area, which is observed and evaluated during a flight evaluation.

24.3.8 Critical Area/Subarea. Any area or subarea which covers items of significant importance to the overall mission requirements, the marginal performance of which would jeopardize safe conduct of the flight.

24.3.9 Emergency. An aircraft component failure, system failure, or a condition which requires instantaneous recognition, analysis, and proper action.

24.3.10 Malfunction. An aircraft component failure, system failure, or a condition which requires recognition and analysis, but which permits more deliberate action than that required for an emergency.

24.4 GROUND EVALUATION

Prior to commencing the flight evaluation, an evaluee must achieve a minimum grade of qualified on the open book and closed book examinations. The oral examination is also part of the ground evaluation but may be conducted as part of the flight evaluation. To assure a degree of standardization between units, the NATOPS Instructors may use the bank of questions contained in this chapter in preparing portions of the written examinations.

24.4.1 Open Book Examination. The purpose of the open book examination portion of the written examination is to evaluate pilot knowledge of appropriate NATOPS publications and of the aircraft. The open book examination should consist of, but is not limited to, questions from the question bank.

24.4.2 Closed Book Examination. Up to 50 percent of the closed book examination may be taken from the question bank and shall include questions concerning normal procedures and aircraft limitations. The number of questions in the examination will not exceed 50 or be less than 25. Questions designated critical will be so marked. An incorrect answer to any question in the critical category will result in a grade of unqualified being assigned to the examination.

24.4.3 Oral Examination. The questions may be taken from this manual and drawn from the experience of the Instructor/Evaluator. Such questions should be direct and positive and should in no way be opinionated.

24.4.4 OFT/WST Procedures Evaluation. An OFT may be used to assist in measuring the crewmember's efficiency in the execution of normal operating procedures and his reaction to emergencies and malfunctions. In areas not served by OFT facilities, this may be done by placing the crewmember in an aircraft and administering appropriate questions.

24.4.5 Grading Instructions. Examination grades shall be computed on a 4.0 scale and converted to an adjective grade of qualified or unqualified.

24.4.5.1 Open Book Examination. To obtain a grade of qualified, an evaluee must obtain a minimum score of 3.5.

24.4.5.2 Closed Book Examination. To obtain a grade of qualified, an evaluee must obtain a minimum score of 3.3.

24.4.5.3 Oral Examination and OFT Procedure Check (If Conducted). A grade of qualified or unqualified shall be assigned by the Instructor/Evaluator.

24.5 FLIGHT EVALUATION

The number of flights required to complete the flight evaluation should be kept to a minimum, normally one flight. The areas and subareas to be observed and graded on a flight evaluation are outlined in the grading criteria with critical areas marked by an asterisk (*). Subarea grades will be assigned in accordance with the grading criteria. These subareas shall be combined to arrive at the overall grade for the flight. Area grades, if desired, shall also be determined in this manner.

24.5.1 Flight Evaluation Grade Determination. The following procedure shall be used in determining the flight evaluation grade. A grade of unqualified in any critical area/subarea will result in an overall grade of unqualified for the flight.

Otherwise, flight evaluation (or area) grades shall be determined by assigning the following numerical equivalents to the adjective grade for each subarea. Only the numeral 0, 2, or 4 will be assigned in subareas. No interpolation is allowed.

Unqualified—0.0
Conditionally Qualified—2.0
Qualified—4.0

To determine the numerical grade for each area and the overall grade for the flight, add all the points assigned to the subareas and divide this sum by the number of subareas graded. The adjective grade shall then be determined on the basis of the following scale:

Unqualified—0.0 to 2.19
Conditionally Qualified—2.2 to 2.99
Qualified—3.0 to 4.0

Example: Add subarea numerical equivalents:

$$\frac{4 + 2 + 4 + 2 + 4}{5} = \frac{16}{5} = 3.20 \text{ Qualified}$$

24.5.2 Flight Evaluation Grading Criteria. Only those subareas provided or required will be graded. The grades assigned for a subarea shall be determined by comparing the degree of adherence to standard operating procedures with adjectival ratings. Momentary deviations from standard operating procedures should not be considered as unqualifying provided such deviations do not jeopardize flight safety and the evaluee applies prompt corrective action.

24.5.2.1 Qualified. Well standardized; evaluee demonstrated highly professional knowledge of and compliance with NATOPS standards and procedures; momentary deviations from or minor omissions in noncritical areas are permitted if prompt and timely remedial action is initiated by the evaluee.

24.5.2.2 Conditionally Qualified. Satisfactorily standardized; one or more significant deviations from NATOPS standards and procedures, but no errors jeopardizing mission accomplishment or flight safety.

24.5.2.3 Unqualified. Not acceptably standardized; evaluee fails to meet minimum acceptable standards regarding knowledge of and/or ability to apply NATOPS procedures; one or more significant deviations from NATOPS standards and procedures which could jeopardize mission accomplishment or flight safety.

24.6 FINAL GRADE DETERMINATION

The final NATOPS evaluation grade shall be the same as the grade assigned to the flight evaluation. An evaluee who receives an unqualified on any ground examination or the flight evaluation shall be placed in an unqualified status until he achieves a grade of conditionally qualified or qualified on a re-evaluation.

24.7 RECORDS AND REPORTS

A NATOPS Evaluation Report (OPNAV Form 3610/8) (Figure 24-1) shall be completed for each evaluation and forwarded to the evaluee's Commanding Officer. This report shall be filed in the individual flight training record and retained therein for 5 years. In addition, an entry shall be made to the crewmember's flight logbook under "Qualifications and Achievements" as follows:

QUALIFICATION	DATE	SIGNATURE
NATOPS EVAL: OV-10D PILOT-IN-COMMAND	DATE OF FLIGHT EVAL	SIGNATURE OF C.O. OR DESIG- NATED REPRE- SENTATIVE UNIT WHICH ADMINISTERED EVAL

NA-86-0043-243

NATOPS EVALUATION REPORT
OPNAV 3510/8 (REV. 7-78) S/N 0107-LF-036-1040 — **REPORT SYMBOL OPNAV 3510-3**

NAME (Last, first, initial)		GRADE	SSN
SQUADRON/UNIT	AIRCRAFT MODEL	CREW POSITION	
TOTAL PILOT/FLIGHT HOURS	TOTAL HOURS IN MODEL	DATE OF LAST EVALUATION	

NATOPS EVALUATION

REQUIREMENT	DATE COMPLETED	GRADE		
		Q	CQ	U
OPEN BOOK EXAMINATION				
CLOSED BOOK EXAMINATION				
ORAL EXAMINATION				
*EVALUATION FLIGHT				
FLIGHT DURATION	AIRCRAFT BUNO	OVERALL FINAL GRADE		

REMARKS OF EVALUATOR/INSTRUCTOR

☐ CHECK IF CONTINUED ON REVERSE SIDE

GRADE, NAME OF EVALUATOR/INSTRUCTOR	SIGNATURE	DATE
GRADE, NAME OF EVALUEE	SIGNATURE	DATE

REMARKS OF UNIT COMMANDER

EXPIRATION DATE

RANK, NAME OF UNIT COMMANDER	SIGNATURE	DATE

*WST, OFT, COT, or cockpit check in accordance with OPNAVINST 3710.7

Figure 24-1. NATOPS Evaluation Report (OPNAV Form 3610/8)

In the case of enlisted crewmembers, an entry shall be made in the administrative remarks of his personnel record upon satisfactory completion of the NATOPS evaluation.

(Date) Completed a NATOPS evaluation in (aircraft designation) as (flight crew position) with an overall grade of (qualified or conditionally qualified).

24.7.1 NATOPS Evaluation Question Bank. The question bank is intended to assist the unit NATOPS Instructor/Evaluator in the preparation of ground examinations and to provide an abbreviated study guide. The questions from the bank should be combined with locally originated questions as well as questions obtained from the Model Manager in the preparation of ground examinations.

24.7.2 NATOPS Evaluation Forms. In addition to the NATOPS Evaluation Report, a NATOPS Flight Evaluation Worksheet (OPNAV FORM 3510/10) (Figure 24-2) and other forms are provided for use by the Evaluator/Instructor during the evaluation flight. All of the flight areas and subareas are listed on the worksheet with space allowed for related notes. Applicable forms in this section may be reproduced locally as required.

24.8 QUESTION BANK

1. The secondary bus is powered from the primary bus when: ____________ .

(a) The landing gear handle is down.

(b) Either generator is operating.

(c) When BATTERY switch is selected to EMERG.

(d) All of the above.

2. The No. 2 inverter is powered by: ____ .

(a) Primary bus.

(b) Battery bus.

(c) Monitor bus.

(d) Secondary bus.

3. With both engines running, the voltmeter shows which voltage? ____________ .

(a) Battery.

(b) Right generator.

(c) Generator with highest output.

(d) Left generator.

4. The ailerons are similar to the elevator in that both have aerodynamic boost provided by ____________ .

5. A red light glowing in the landing gear handle knob means ____________ .

6. The procedure for setting the wheel brakes for parking is to: ____________ .

7. Give the air start procedures: ________ .

8. What are the procedures in the event of engine fire in flight? ____________ .

9. What are the warning and caution lights installed on both the pilot's and observer's warning/caution light panels? ______ , ______ , ______ , ______ , ______ .

10. How may the pilot determine if the fuel system is gravity transferring? ____________ .

11. By what means is the drop tank fuel transferred? ____________ .

12. With SUPPLY lever ON, diluter lever either NORMAL OXYGEN or 100% OXYGEN, and emergency lever NORMAL on the OXYGEN REGULATOR panel, the FLOW indicator will blink white on inhalation and black on exhalation.
True ____________ ; False ____________ .

13. With the SUPPLY lever OFF, diluter lever 100% OXYGEN, and emergency lever NORMAL on the OXYGEN REGULATOR panel; it would be impossible to breathe wearing an oxygen mask.
True ____________ ; False ____________ .

14. If the FLOW indicator is blinking, it is a positive indication that oxygen is flowing to the mask.
True ____________ ; False ____________ .

15. On a solo flight, the oxygen gage indicated 900 psi at 10,000 feet. With 100% OXYGEN selected, the pilot could expect sufficient oxygen for: ____________ .

(a) 1 hour.

(b) 2 hours.

(c) 4.9 hours.

(d) 9.8 hours

16. The gunsight filament switch is located: ____________ .

(a) On right-hand instrument shroud.

(b) On left-hand instrument shroud.

(c) Top center of canopy bow.

(d) Center pedestal.

17. The stores loading limit of the centerline station is: ______________ .

(a) 1200.

(b) 600.

(c) 2250.

(d) 500.

18. Initiation of the escape system is accomplished by a: ______________ .

(a) Lower ejection handle.

(b) Face curtain.

(c) Squeeze grip.

19. The seat is adjustable both vertically and fore and aft.
True ______________ ; False ______________ .

20. On a parachute descent, the survival kit cannot be released.
True ______________ ; False ______________ .

21. On a zero altitude and zero airspeed ejection, collision of the two seats is prevented by the time delay of the forward catapult rocket and parachute location.
True ______________ ; False ______________ .

22. Failure of the seat, or seats, to eject is very remote because of the dual system to the catapult rocket.
True ______________ ; False ______________ .

23. Flight at zero or negative "g" is limited to ______ seconds.

24. The INST PWR caution light illuminates on failure of primary ac bus power regardless of inverter selection.
True ______________ ; False ______________ .

25. How much time may be required to fully extend the flaps using the alternate method?
______________ .

26. Either MIL-L-7808 or MIL-L-23699 is acceptable oil for the OV-10D.
True ______________ ; False ______________ .

27. Optimum glide gear up is ______ nautical miles for every 5000 feet of altitude.

28. When will the fuel BOOST PUMP caution light illuminate? ______________ .

29. In the event of runaway nose-up trim that cannot be moved by either the normal or alternate trim system, a no-flap landing is recommended.
True ______________ ; False ______________ .

30. If light-off is not indicated within ______ seconds, abort start. How long must the starter cool before attempting a relight?
______________ .

31. When fuel quantity falls below ______ to ______ pounds in the center wing tank, the FUEL LOW caution light will illuminate.
______________ .

(a) 200 to 225.

(b) 205 to 235.

(c) 210 to 250.

(d) 280 to 285.

32. Reverse thrust above 70 knots should be used cautiously to preclude engine rpm decay and engine overtemperature.
True ______________ ; False ______________ .

33. If ejector pump action should fail (wing and center tanks) fuel will continue to flow into the feed tank by: ______________ .

(a) Operating the wobble tank.

(b) Engine-driven boost pump.

(c) Gravity.

34. What are the four positions of the condition levers? ______ , ______ , ______ , ______ .

35. What is the total usable internal fuel quantity?
JP-4 __________ and JP-5 __________ .

36. Selection of full heat will reduce engine torque approximately 150 foot-pounds at Military power.
True __________ ; False __________ .

37. Operating with the temperature control full out, ram-air control full in, and cockpit air/defrost control full in may result in overheat damage to windshield panels.
True __________ ; False __________ .

38. If selection of heat (pulling temperature control out) fails to increase temperature, the pilot should ______________________ .

39. If the temperature control failed to shut off the flow of hot air, the pilot should ____ .

40. What two indications can the pilot observe to show that the elevator trim system is working? ______________________ .

41. During BEFORE TAXI check, the stick grip trim switch does not work, the first thing to check is ______________________ .

42. The FLAP handle should be in the ______ position, when the ALT FLAPS switch is checked.

43. The emergency parachute release handle is located on the left side of the headrest on both forward and aft seats.
True __________ ; False __________ .

44. In the event of a malfunction of the hydraulic system, the landing gear can be extended and locked down by ______ , ______ , ______ .

45. To arm the seats, the total safety pins to remove and stow on each seat is: ______ .

(a) 1.

(b) 2.

(c) 3.

(d) 4.

46. Ejection initiation by the pilot with the EJECTION SELECTION handles positioned FORWARD will: ______________________ .

(a) Eject only the pilot.

(b) Eject both pilot and observer in that sequence.

(c) Eject both observer and pilot in that sequence.

(d) Eject both the observer and the pilot at the same instant.

47. On a pilot-initiated ejection, the pilot should expect ______ delay.

(a) 0.4 second.

(b) 0.75 second.

(c) 1.15 seconds.

(d) 0.9 second.

48. On an observer-initiated ejection with the EJECTION SELECTION handle FORWARD, the pilot should expect: ________ .

(a) The observer to eject in approximately 1.15 seconds.

(b) The observer to eject in approximately 0.75 second.

(c) The observer to eject 0.75 second after he (pilot) ejected.

(d) No ejection for himself.

49. One capability not possible with the LW-3B ejection seat and the OV-10D is: ______________________ .

(a) Zero altitude and zero airspeed ejection.

(b) High-speed ejection.

(c) Low-speed, low-altitude ejection.

(d) Over-the-side bail-out.

50. Both the pilot and observer can eject in the shortest interval of time if: __________ .

(a) The pilot initiates the ejection.

(b) The observer initiates the ejection.

(c) The observer initiates his ejection and the pilot initiates his own ejection.

(d) Any of the above initiations is accomplished.

51. Ejection is always through the top glass of the cockpit enclosures.
True ____________ ; False ____________ .

52. On a high-altitude and/or high-speed ejection, a 2-second delay in parachute opening after ejection is normal.
True ____________ ; False ____________ .

53. The shoulder-harness ballistic inertia reel is actuated automatically on ejection.
True ____________ ; False ____________ .

54. With generators operating and external power applied, the generator caution lights will not extinguish until external power plug is disconnected.
True ____________ ; False ____________ .

55. The battery bus is powered: ________ .

(a) As long as the batteries are connected and have an adequate charge.

(b) When the BATTERY switch is positioned to ON.

(c) When the BATTERY switch is positioned to OFF.

(d) All of the above.

56. The primary dc bus: ______________ .

(a) Provides power to all normal mission powered equipment when a battery start is used.

(b) Supplies power directly to the No. 2 inverter.

(c) Is powered from the generators or external ac power.

(d) May receive battery, generator, or external dc power from the main dc bus.

57. To dim the cockpit caution lights: ____ .

(a) The CONSOLES lights rheostat must be positioned away from OFF.

(b) The pilot positions the caution lights dimming switch to DIM position.

(c) The INSTRUMENTS lights rheostat is positioned away from OFF.

58. The No. 1 inverter: ______________ .

(a) Powers the No. 2 monitor ac bus if the INST PWR switch is at INV NO. 1 and either generator operating or utility external power is applied.

(b) Powers the primary ac bus when the INST PWR switch selected to INV NO. 1.

(c) Operates from the monitor dc bus.

(d) None of the above.

59. When does the WHEELS warning light illuminate? ______________________ .

60. Manual jettison of stores will release: ______________________.

(a) All stations.

(b) Stations 1 and 2.

(c) Stations 1, 2, 3, and 4.

(d) Stations 1, 2, 4, and 5.

61. What monitor controls on the ICS monitor panel must be pulled up and turned to mid-range for paratroop-observer ICS operations?

(a) Observer's ICS monitor panel INT control.

(b) PILOT'S master volume control.

(c) Paratroop panel, PUSH-TO-TALK switch.

(d) No. 4 monitor control—observer's ICS panel.

62. What switches must be positioned to transmit over RADIO 1 and monitor RADIO 3 and HF radio? ______________.

(a) RADIO 1, 2, 3 monitor controls pulled up, XMIT: SELECT R1 toggled on CMS Radio 1 mode control panel.

(b) Radio 1 transmit select switch ON, RADIO 3 and HF monitor controls pulled and set to mid-range.

(c) Observer selects HF transmit SELECT switch as pilot monitors and simultaneously selects Radio 1 and 3 transmit select switches.

(d) RADIO 1, 3 and HF monitor controls pulled up and set to mid-range, Radio 1 transmit select switch ON and power lever MIC switch pushed down.

63. What are the engine ignition limits? __ .

64. What is the maximum permissible airspeed for extending the landing gear? ____ .

65. Describe the procedures for unlocking the propellers. ______________ .

66. During preflight of the ejection seat at sea level, the speed/altitude sensor window shows red. The aircraft is still up, but a yellow sheet entry must be made.
True ________ ; False ________ .

67. When testing the fire detection warning lights systems without the inverter on, you are testing the ______ side of the system.

68. Prior to starting the second engine, rpm on the engine already running must be ______ rpm.

69. If light-off does not occur within ______ during start sequence, place the appropriate condition lever to ______ and the engine START switch to ABORT.

70. The OV-10D is currently limited to landings on ______ with sink rates of ______ maximum.

71. Use of reverse thrust on landing rollouts above 100 knots is prohibited.
True ________ ; False ________ .

72. Minimum speed for take-off at gross weights of 12,180 pounds or less is ______ knots for 20 degrees flaps and ______ knots for no flaps.

73. Maximum allowable EGT on start is ______ transient for ______ .

74. A clogged oil filter usually will not be noted by the pilot in the air, but can always be discovered during preflight.
True ________ ; False ________ .

75. At GROUND IDLE rpm, minimum oil pressure is ______________ .

76. The minimum airspeed for normal landings (flaps 20 degrees) is ______ knots for gross weights up to 12,000 pounds.

77. For jettison of the external wing and ℄ fuel tanks, maximum airspeed is ______ knots in 1.0-g level flight.

78. The OV-10D uses a closed center, intermittent duty hydraulic system. If the hydraulic pressure caution light iluminates, it indicates that system pressure is less than ______ and gear and flaps will ________ .

79. Normal pressure for the hydraulic system when operating is ______ psi.

80. Sufficient dc power is available with a single generator operational to supply all required electrical loads.
True ____________ ; False ____________ .

81. In the event of a dual-generator failure, all equipment on the primary dc bus will continue to function, and equipment on the secondary dc bus can be used by placing the gear handle in the down position.
True ____________ ; False ____________ .

82. If, during an engine air start, the START IGN ON advisory light fails to go out above 53% rpm, you should check which of the following?

(a) Condition lever on appropriate engine in NORMAL FLIGHT.

(b) AIR START switch back to the AUTO position.

(c) Battery off.

(d) Power levers forward of FLIGHT IDLE.

83. The main purpose of the NTS (negative torque system) is to prevent the propeller from driving the engine.
True ____________ ; False ____________ .

84. The engine and propeller control oil is supplied from which of the following per engine: ____________________ .

(a) A single 3.0-gallon tank.

(b) Two 3.0-gallon tanks.

(c) One 1.5-gallon tank.

(d) Two 1.5-gallon tanks.

85. To fire the fixed M60 machine guns, put the MASTER ARM ______ , on Internal Guns CMS page select ______ and depress the ____________________ .

86. When firing AIM-9 Sidewinder Missiles, place the MASTER ARM switch ON, on Weapon Select page 1/2, set store station L or R to ______ , set coolant to ______ , and depress the ____________________ .

87. In the event of a sudden and complete engine failure immediately after take-off, and altitude or terrain does not permit safe recovery, you should ______________ .

88. During single-engine emergencies in the dirty configuration, flaps should not be raised above 20 degrees until: ________ .

(a) Above 110 knots.

(b) 90 knots.

(c) Not to be raised at all.

(d) None of the above.

89. In the event an air start is unsuccessful, place the condition levers to ______ and AIR START switches to ______________ .

90. During aborted take-offs, jettisoning of the external stores should be considered as a last resort.
True ____________ ; False ____________ .

91. If a nose tire fails on take-off and you cannot abort, the gear should be left down after becoming airborne.
True ___________ ; False ___________ .

92. The normal position for the IGNITION & UNFEATHER switch on a ground start is ___ .

93. The propellers should be in the _____ position prior to starting the engines.

94. The main gear oleo extension while on the ground should be: _______________ .

(a) 3.66 inches.

(b) Three fingers.

(c) 8 inches from the oleo flange to connector nut.

(d) Approximately 5 inches.

95. The proper procedure for starting the engine with no external power, and the propellers on the start locks is power lever _____ , condition levers to _____ , AIR START switches in _____ , START switch to _____ , and at _____ , condition levers to ___________________________ .

96. If light-off does not occur after 15 seconds of start cycle, the sequence may be continued with close monitor of EGT.
True ___________ ; False ___________ .

97. Maximum engine oil pressure at 100% rpm is: ___________________________ .

(a) 115 psi.

(b) 50 to 120 psi.

(c) 120 psi.

(d) 48 psi.

98. Reverse thrust torque in the range of 0 to 2300 pounds is limited to how many seconds? ___________________________ .

(a) No limit.

(b) 5 seconds.

(c) 1 minute.

(d) 5 seconds if below 98% rpm.

99. The brake systems obtain hydraulic boost pressure from the main hydraulic system during brake actuation.
True ___________ ; False ___________ .

100. The _____ may be used to operate the hydraulic pump at any time, to provide operation of normal hydraulic systems in the event of normal control circuit failure.

101. If the primary ac bus power is lost, you will lose which of the following equipment?
___________________________ .

(a) IFF, instruments lights, No. 1 engine ignition, No. 1 engine TIT.

(b) Attitude gyro, pilot console lights, IFF, No. 1 engine ignition.

(c) No. 1 engine FIRE DET, No. 1 engine ignition, attitude gyro, and No. 1 engine TIT.

(d) IFF, attitude gyro, No. 1 engine TIT, No. 1 engine FIRE DET.

102. If the No. 2 inverter is lost during straight and level flight, with the No. 1 inverter selected, the pilot will be aware of the loss through the loss of which of the following item(s) of equipment? __________ .

(a) Observer's attitude gyro, APX-100 IFF, TACAN.

(b) All engine instruments AIM-9.

(c) ALE-39, missile power, mission (video) recorder.

(d) BDHI No. 1 and No. 2 needle.

103. With a "packed" centerline station external fuel tank, and auxiliary wing tanks, total fuel load is ______ using JP-4; using JP-5, it is ______________________.

104. When transferring external fuel, the EXT FUEL TRANS switches should be placed to OFF when external tanks are empty to prevent ________________.

105. Control force trim on flight control systems is achieved by electrically operated trim ______________________.

106. The rudders are not tab-boosted, and are displaced by direct mechanical action through the rudder pedals.
True __________ ; False __________ .

107. In the event of a normal trim system failure, alternate power will be provided through the primary dc bus, and the system will be operated through the alternate trim control switches.
True __________ ; False __________ .

108. The shaft horsepower rating of the T76-G-420/-421 engine is __________ .

109. The T76 uses a ______ turbine _____ .

110. A function of the fuel control is: ____ .

(a) Modifies fuel flow for changes in engine compressor inlet temperature.

(b) Modifies fuel flow for changes in compressor inlet pressure.

(c) Provides manual fuel metering as a function of the cockpit power lever position.

(d) All of the above.

111. Placement of the power levers at the FLIGHT IDLE position provides in flight minimum fuel flow and torque, dependent on __ .

112. During starts, TEMP instrument displays EGT only below ______ , then monitors ______ when the inverter is on.

113. The start ignition on light should illuminate when either engine START switch is held momentarily in START, and go out at ______________________.

114. In the range of 0 to 2625 pounds of torque, the time limit for this torque is: ____ .

115. The maximum allowable TIT excluding start is: ______________________.

(a) 1040 °C for 1 second.

(b) 990 °C, no time limit.

(c) 1108 °C for 30 minutes.

(d) 1129 °C for 1 minute.

116. Maximum underfuselage store loading for design "g" limits is ______________ .

117. The VHF-UHF RADIO 1, 2, or 3 has a frequency range of 30.00 to 399.97 MHz.
True __________ ; False __________ .

118. When transmitting on more than one radio, it is necessary to have a 10 MHz split in the two operating frequencies.
True __________ ; False __________ .

119. To transmit on a particular radio and hear yourself transmit, you must have the desired radio ON, and the Radio transmit select switch ON.
True __________ ; False __________ .

120. To augment weak audio signals due to distance, the squelch function should be ______________________.

121. The Drag Index of a LAU-61A/A rocket pod, fired, single, is: ______________ .

(a) 9.0.

(b) 18.0.

(c) 12.0.

(d) 15.0.

122. Runway heading is 040 degrees. The wind is 080 degrees at 15 knots, what is the crosswing component? What is the headwind component? ________________ .

(a) 9.5 knots; 11.5 knots.

(b) 9 knots; 7.5 knots.

(c) 10 knots; 10 knots.

(d) 15 knots; 15 knots.

123. In the event of a landing with both main gear down, but nose gear up, the brakes should not be used.
True ____________ ; False ____________ .

124. During operation of the ejection seat, if the arming key is inserted the speed/altitude sensor will provide a 2.0-second delay in firing the thruster above ______ altitude or at speeds in excess of ______ knots.

125. If, during ejection sequence, chute deployment fails to occur, chute deployment and seat separation can be obtained by ___ .

126. A rule of thumb to rapidly determine which engine has failed is ____________ .

127. On engine failure immediately after take-off, after all previous steps have been taken, flaps should be raised when safely ________________________________ .

128. With a dual-engine failure, propellers feathered, clean aircraft configuration, an airspeed of 130 knots, and an altitude of 15,000 feet AGL, you can expect to have a straight-ahead glide distance of _________ .

129. In the event of a complete electrical failure, including the battery, the centerline stores can be released by pulling the emergency stores jettison handle.
True ____________ ; False ____________ .

130. The pilot's hydraulic pressure light will illuminate on system demand if pressure is less than ____________________________ .

131. If primary dc bus power is lost, you will be able to trim the aircraft by going to alternate trim control.
True ____________ ; False ____________ .

132. With a failure of both No. 1 and No. 2 inverters, engine TIT will be impossible to determine.
True ____________ ; False ____________ .

133. The pilot may cross-check the TIT system reading by turning the ______ switch on and reading EGT.

134. The pilot can override the yaw damper action by exerting approximately ______ force on the rudder pedals.

135. ______ minutes are required for warm-up of the AN/ARC-199 HF radio prior to ________________________________ .

136. The AN/APX-100(V) IFF transponder requires ______ minutes warm-up prior to interrogation-response.

137. Limit airspeed for extension of full flaps is ________________________________ .

138. Describe the flame-out approach pattern. ____________________________ .

139. If the engine has been "cold-soaked" at temperatures below 0 °F, a ______ warm-up at ______ is recommended.

140. Selection of frequencies below 88.00 MHz with the UHF-ADF function selected on the CMS will cause the "out of ADF range" annunciator to be displayed on both CMS-CDUs.
True ____________ ; False ____________ .

141. Maximum continuous TIT is _______ .

142. With gross weight 13,800 pounds, what is take-off speed for normal operation with 20 degrees flaps? ______________ .

143. (a) For normal take-off, 0 degrees flaps, what is uncorrected take-off ground run for OAT 24 °C, pressure altitude 4000 feet, gross weight 11,500 pounds, 10 knots wind? ____ .

(b) What is the refusal speed? ____ .

(c) What is the corrected ground run with a wind speed of 10 knots, actual torque reading 1800? ____________ .

(d) What will be the ground run required to clear a 50-foot obstacle on a normal take-off, flaps 0 degrees? ______________________________ .

144. (a) What is the time required to climb to 10,000 feet, gross weight 11,500 pounds, Drag Index 60, average temperature 20 °C, wind 0? __________ .

(b) What is distance covered? _____ .

(c) How much fuel is used? _______ .

145. Compute landing distance for gross weight 10,000 pounds, flap setting 20 degrees, 10 knots headwind, pressure altitude 3000 feet, temperature 25 °C:

(a) Full reverse distance. __________ .

(b) Idle power distance. __________ .

(c) Landing at 101 knots, full reverse thrust. ________________________ .

146. Maximum TIT for start is __________ .

147. Maximum TIT for acceleration is ____ .

148. Maximum allowable torque split on the ground is ______ . In the air is __________ .

149. Symmetrical "g" limits are minus ______ to plus ______ up to 13,142 pounds.

150. Rolling pullout "g" limits are minus ______ to plus ____________________ .

151. Maximum gross weight for take-off is ______________________________ .

152. Maximum wing pylon load is _______ .

153. If the total ampere load per generator with all electrical equipment on is in excess of ______ amps, secure the ______ to see if it is the cause of the high load.

154. Single engine approach should be made ______ flaps with the following minimum airspeeds:

Gross Weight	KIAS
12,000 pounds	______
13,000 pounds	______

155. The auxiliary fuel transfer pumps shut OFF automatically (illuminating the respective AUX FUEL caution light) when fuel flow has stopped for 10 seconds. The transfer switch(es) must be turned OFF and allow ______ seconds minimum to reprime the pump prior to fuel transfer.

156. If the fuel boost pump caution light illuminates, ______ rpm should be maintained to ensure motive flow pressure is retained.

157. In the event that the pilot's cockpit management system control display unit (CDU no. 1) fails, the Observer's CDU will assume command of the data bus.
True ____________ ; False ____________ .

158. The CMS warm-up time is __________ .

(a) 0.5 minutes.

(b) 1.5 minutes.

(c) 5 minutes.

159. The CMS provides control and display functions for the following systems; _____ .

(a) TACAN, IFF, Weapons, Communications, Coutermeasures

(b) IRCM, TACAN, IFF, Navigation, Communications

(c) Radar Warning System, IRCM, NAV and COMM

and provides the following features ______ for crew use.

(a) BIT testing (automatic and operator initiated), Power Control, Checklists and Trim indications

(b) An electronic note pad, way-point navigation and a dopply back-up display

(c) FLIR Target Indexing, fuel useage, and mission status display

160. Loss of the primary dc bus will cause a total failure of CMS.
True ____________ ; False ____________ .

161. Radio 1 is assigned KY ______ when CIPNER-TXT mode is selected. Radio 2 and 3 use KY ______ which is selected. Radio 2 and 3 use KY ______ which is selected for use on the RADIO ______ mode control page(s).

162. On CMS-CDU, annunciator messages are displayed on ______ line and error messages are alternately flashed with incorrect data on the ______ line.

163. Radio power switches should be turned ON before the CMS power switch.
True ____________ ; False ____________ .

164. Which of the following units are directly coupled to the CMS data bus?

(a) KY 2, KY 1, SA 2157.

(b) BSIUs, 1, 2, 3 and RADIOS 1, 2, 3 and HF.

(c) TACAN, IFF, Trim System and BSIU 1, 2, 3, and CDUs.

(d) CDU 1, CDU 2, BSIUs 1, 2, 3, RADIOS 1, 2, 3 and HF.

165. During external fuel transfer, if the outboard wing tanks fill to capacity and the fuel float shut-off switches close, the selected auxillary transfer pumps will ______ and the AUX FUEL caution lights will ______ . When normal fuel consumption causes the shut-off switches to open the transfer pump(s) will ________________ .

166. The lights on pilot's caution/warning light panel will activate the master caution light system.
True ____________ ; False ____________ .

167. The observer's master caution light, if pressed, will stop the pilot's and observer's light from flashing and re-arm the system for subsequent use.
True ____________ ; False ____________ .

168. An illuminated IRCM caution light indicates ________________________ .

169. With the battery bus (energized during engine starts). The following engine instruments will be ON and indicating.

(a) TEMP, RPM, FUEL FLOW, and TORQUE.

(b) RPM, TEMP, OIL PRESSURE, and TORQUE.

(c) FUEL FLOW, RPM, TEMP, OIL PRESSURE, and TORQUE.

(d) FUEL QUANTITY, FUEL FLOW, RPM, TEMP, OIL PRESSURE, and TORQUE.

170. The INST TEST switch when selected to TEST and released, results in _________ .

171. The observer's trim switch is operable when the pilot has alternate trim selected.
True ____________ ; False ____________ .

172. On the ARU-50/A pilot's remote attitude indicator, the attitude warning flag will appear when:

(a) Loss of 115 VAC indicator power.

(b) Failure of roll and/or pitch displays to track signal inputs within ±6 degrees.

(c) Loss of attitude data from MD-1 gyro.

(d) All of the above.

173. Chronometer alarm audio is heard in both the pilot's and observers's headsets.
True ____________ ; False ____________ .

174. In the event that power is lost to the standby gyro, it will coast for ______ minutes, and the pitch-and-roll information will not change by more than ______ degrees.

175. The Ejection Selection handle will be illuminated when ____________________ .

176. The doppler computer display unit has ______ modes of operation and they are __ .

177. With the Ejection Selection handle in the aft position, ejection initiation by either crewmember will result in ____________ .

178. There are provisions to carry up to ______ paratroops in the cargo bay or up to ______ pounds of cargo.

179. When energized, the AN/ALQ-144 IRCM transmitter should remain ON a minimum of ______ minutes.

180. Anti-flameout continuous engine ignition is available during icing conditions by placing the ______ switch to _______ . During this condition the TEMP instrument will indicate ______ .

181. The CMS Aircraft Trim page may be accessed from ____________________ .

(a) Index page only.

(b) Take-Off Checklist page and Index page.

(c) Landing Checklist (Pilot) page, Landing Checklist (Observer) Index page.

(d) The slew switch.

182. On the Comm Test 1/2 page, an R3:GO display at LS3 indicates ______________ .

(a) Power has been applied to Radio 3 and it is operational.

(b) Radio has passed a manually initiated BIT test.

(c) LS3 will go to Radio 3 mode control page.

(d) CMS automatic BIT has verified Radio 3 is operational.

183. Flashing transmit select switches and a SEC voice annunciator displayed on the CMS-CDU indicates __________________ .

184. Which of the following ICS aural tone warnings would have priority if the emergencies occurred simultaneously:

(a) TIT exceeding 1125 °C or;

(b) Aircraft below pilot's radar altimeter index setting.

185. When the GD-EMER switch is placed to ON, all VHF-UHF radios selected for transmit will automatically tune to ______ MHz, and ______ will be displayed on the CMS Comm page next to the Radio title.

186. The AN/ARC-199 HF radio transmitter power output is selectable to ______ watts (LO), ______ watts (MED), and ______ watts (HIGH).

187. HF Radio operating modes are:

(a) BFO, CW, USB, and LSB.

(b) AM, FM, USB, LSB, and CW.

(c) OFF, TUNE, USB, LSB, and SW.

(d) USB, LSB, AM, and CW.

188. The AN/ARN-118(V) TACAN will transmit bearing and range information when A/A T/R is selected:
True ____________ ; False ____________ .

189. The Nav page is accessed by the NAV function select key.
True ____________ ; False ____________ .

190. The AN/APN-133 doppler navigation system displays A/C position in either latitude/longitude coordinates or ________ .

191. The function/display selector switch located on the doppler CDU will provide a WIND readout when selected to the WIND function.
True ____________ ; False ____________ .

192. On the doppler CDU, the MEM indicator is ON continously when the aircraft is on the ground.
True ____________ ; False ____________ .

193. Up to ten targets and ten checkpoints are provided for navigation purposes on the doppler CDU display.
True ____________ ; False ____________ .

194. The doppler navigation system will allow target data to be transferred to checkpoints ____________________________ .

195. When the pilot's EMER IFF switch is selected ON, the following events occur;

(a) Mode 4 is zeroized.

(b) Mode 1, 2, 3A squawk emergency IFF codes.

(c) Power is selected ON for the AN/APX-100(V) system.

(d) b and c only.

(e) all of the above.

196. When the IFF reply light is illuminated it indicates a ________________________ .

(a) A valid Mode 4 reply.

(b) Mode 2 interrogation.

(c) Faulty IFF transponder.

(d) Indicates to the pilot to MIC IDENT.

197. Altitude information is provided to the IFF system by:

(a) The AN/APN-171(V) radar altimeter system.

(b) The pilot's AAU-21/A barometric altimeter.

(c) The doppler navigation system.

(d) None of the above.

198. The IFF caution light when illuminated indicates ________________________ .

(a) Mode 4 interrogation is being replied to.

(b) Mode 4 code is zeroized, IFF is not replying to a valid Mode 4 interrogation, or automatic self-test circuitry in the KIT-1A detects a failure.

(c) Observer's EMER IFF switch selected ON.

(d) KIT-1A/TSEC not installed.

199. The AIM-9 Sidewinder missile tone indicates ________________________ .

200. The Weapons Configuration page may only be viewed when the landing gear is down.
True ____________ ; False ____________ .

201. Arming and firing functions are disabled when the pilot has the ______ CMS page displayed.

(a) Weapon Select pages.

(b) Configuration page(s).

(c) Jettison.

(d) Internal Guns page.

202.As weapons are fired or dropped, the CMS will automatically disable the station select annunciator for that station.
True ____________ ; False ____________ .

203. ______ minutes recording time is available with the RD-548/AXQ Mission (video) Recorder.

204.On the video recorder/emergency IFF panel, the EVENT switch will ______ when passed.

205.On the CMS countermeasures page, the payload counters are limited to displaying ______ loads.

(a) 60.

(b) 99.

(c) 30.

(a) None of the above.

206.The AN/ALQ-144 IR countermeasures system has two primary modes of operation which are ______ . The mode is preset according to mission requirements prior to flight.

(a) ON/OFF.

(b) Fixed and swept.

(c) Radiate and modulate.

(d) Scramble and retransmit.

207.The DSCRM (discriminator) switch on the AN/APR-39(V) radar warning system control panel allows only received signals which meet known threat requirements to be displayed.
True ____________ ; False ____________ .

VT NATOPS EVALUATION WORKSHEET

OPNAV FORM 3510/10 (11/65)

Asterisk (*) denotes a critical area

NAME	GRADE	SERVICE NUMBER
SQUADRON/UNIT	AIRCRAFT MODEL	CREW POSITION
TOTAL PILOT/FLIGHT HOURS	TOTAL HOURS IN MODEL	DATE OF LAST EVALUATION

NATOPS EVALUATION

REQUIREMENT	DATE COMPLETED	GRADE		
		Q	CQ	U
OPEN BOOK EXAMINATION				
CLOSED BOOK EXAMINATION				
ORAL EXAMINATION				
FLIGHT EVALUATION				

FLIGHT DURATION	AIRCRAFT BUNO	OVERALL FINAL GRADE
GRADE, NAME OF EVALUATOR/INSTRUCTOR		DATE

REMARKS

PAGE 1

S/N-0107-723-1500

A-20966

NA-86-0043-246A

Figure 24-2. NATOPS Flight Evaluation Worksheet (Sheet 1 of 4)

OPNAV FORM 3510/10 (11/65)

Asterisk (*) denotes a critical area

1. MISSION PLANNING		ADJECTIVE AREA GRADE				REMARKS
SUB-AREAS		Q	CQ	U	POINTS	
A. PERSONAL FLYING EQUIP						
B. FLIGHT PREPARATION						
*C. CREW/PASSENGER BRIEFING						
*D. AIRCRAFT TAKEOFF DATA						
NUMERICAL AREA GRADE		TOTAL POINTS				
2. PREFLIGHT		ADJECTIVE AREA GRADE				
SUB-AREAS		Q	CQ	U	POINTS	
A. AIRCRAFT INSPECTION						
B. CHECKLISTS						
NUMERICAL AREA GRADE		TOTAL POINTS				
3. PRE-TAKEOFF		ADJECTIVE AREA GRADE				
SUB-AREAS		Q	CQ	U	POINTS	
A. START						
B. CHECKLISTS						
C. TAXI						
*D. ENGINE RUNUP						
NUMERICAL AREA GRADE		TOTAL POINTS				
4. TAKEOFF		ADJECTIVE AREA GRADE				
SUB-AREAS		Q	CQ	U	POINTS	
*A. TAKEOFF PROCEDURES						
*B. TRANSITION						
NUMERICAL AREA GRADE		TOTAL POINTS				

PAGE 2

NA-86-0043-247

Figure 24-2. NATOPS Flight Evaluation Worksheet (Sheet 2 of 4)

OPNAV FORM 3510/10 (11/65)

Asterisk (*) denotes critical area

5. BASIC AIRWORK		ADJECTIVE AREA GRADE				REMARKS
SUB-AREAS		Q	CQ	U	POINTS	
A.						
B.						
C.						
D.						
NUMERICAL AREA GRADE		TOTAL POINTS				

*6. EMERGENCIES		ADJECTIVE AREA GRADE			
SUB-AREAS		Q	CQ	U	POINTS
*A. ENGINE FAILURE					
*B. FIRE INFLIGHT					
*C. SYSTEM FAILURE					
NUMERICAL AREA GRADE		TOTAL POINTS			

7. INSTRUMENT PROCEDURES		ADJECTIVE AREA GRADE			
SUB-AREAS		Q	CQ	U	POINTS
A. HOLDING					
B. APPROACH/PENETRATION					
C. PRECISION RADAR APPROACH					
NUMERICAL AREA GRADE		TOTAL POINTS			

8. LANDING		ADJECTIVE AREA GRADE			
SUB-AREAS		Q	CQ	U	POINTS
*A. CHECKLISTS					
*B. DESCENT					
*C. PATTERN					
*D. LANDING AND ROLLOUT					
NUMERICAL AREA GRADE		TOTAL POINTS			

PAGE 3

NA-86-0043-248

Figure 24-2. NATOPS Flight Evaluation Worksheet (Sheet 3 of 4)

OPNAV FORM 3510/10 (11/65)

Asterisk (*) denotes a critical area

9. POSTFLIGHT	ADJECTIVE AREA GRADE				REMARKS
SUB-AREAS	Q	CQ	U	POINTS	
A. ENGINE SHUTDOWN					
B. CHECKLIST (NA TO JETS)					
C. POSTFLIGHT INSPECTION					
D. MISSION DEBRIEF					
NUMERICAL AREA GRADE		TOTAL POINTS			

A. TOTAL ALL SUB-AREA POINTS	
B. TOTAL NO. SUB-AREAS GRADED	
C. FLT. EVAL. NUMERICAL GRADE $\frac{A}{B}$	
**EVALUATION ADJECTIVE GRADE	

***See OPNAVINST 3510.9 Series.*

PAGE 4

NA-86-0043-249

Figure 24-2. NATOPS Flight Evaluation Worksheet (Sheet 4 of 4)

PART XI

Performance Data

CHAPTER 25

Standard Data

25.1 AIRCRAFT OPERATING WEIGHT

Each aircraft has a Weight and Balance Data Manual (NAVAIR 01-1B-40) containing detailed weight and balance information. When computing aircraft weights, pilots shall use the basic weight as listed in that manual. To obtain the weight, drag and carriage clearances of an external store, see Figure 25-1. The following weights are provided only for use in the example problems which follow.

NOTE

> Only those stores and operating limitations shown in Figure 25-1 are authorized to be carried and released or fired to the limits indicated.

To obtain operating weight, add:

- Basic weight (from NAVAIR 01-1B-40) 9,194

Ballast	61
Centerline pylon	52
Two Wing pylons	132
Two Sponsons with racks	272
Two Crewmembers	400

- Operating weight . . . . 10,111 pounds

To compute take-off gross weight, add:

Fuel-usable internal (FULL) (JP-5)	1,622
Two Auxiliary fuel tanks	232
External fuel (JP-5)	1,306
Two Mk-77 Mod 4 fire bombs	1,040

- Take-off Gross Weight . . . . 14,311 pounds

To compute expected landing weight, subtract:

Expected fuel consumption	2,200
Ordnance expended (anticipated)	1,040

- Expected Landing Weight . . . . 11,071 pounds

25.1.1 Weight Chart

• Operating Weight	10,111			
Fuel Usable-Internal (JP-5) . .	1,622	11,733		11,733
Auxiliary Fuel Tanks (2) . . .	232	11,965		
External Fuel (JP-5)	1,306	13,271		
Centerline Tank	135	13,406	135	11,868
Centerline Fuel . . . . (Normal Attitude)	830	14,236	830	12,698
Centerline Fuel . . . . (Packed)	190	14,426	190	12,888

25.1.2 Gross Weight Example. AIRCRAFT CONFIGURATION: Ballast, two wing pylons, crew, sponsons, centerline pylon, plus one Aero 1C external fuel tank and two LAU-68 B/A D/A with cones.

- Operating Weight . . . . 10,111 pounds

Fuel-usable, internal (JP-5)	1,622
Aero 1C external fuel tank (full) (JP-5) . . .	1,155
LAU-68 B/A, D/A (two) with cones . . .	434

- Take-Off Gross Weight . . . . . 13,322 pounds

25.2 AIRCRAFT CONFIGURATION DRAG INDEX SYSTEM (FIGURE 25-1)

Climb, range, and endurance data are presented in a drag index format to provide maximum flexibility, while requiring minimum interpolation. With this system, basic aircraft drag (with FLIR turret, sponsons and centerline pylon installed) is assigned a value of 50 and a store drag number is assigned to each external store including the wing pylons and drop tanks.

By adding the individual drag numbers, a configuration drag number (called Drag Index) is obtained.This Drag Index is used with aircraft gross weight in performance data computation. The Drag Index obtained can be rounded off for convenience without losing significant accuracy. The only interpolation then required is that used to determine data point placement between drag index reflector curves provided on the charts.

25.2.1 Drag Index Example. AIRCRAFT CONFIGURATION: Sponsons and centerline pylon plus two wing pylons and two Mk 81 GP bombs.

Basic aircraft drag number	50.0
Two wing pylons	15.0
Two Mk 81 GP bombs (conical fins, adjacent)	10.0
Drag Index (loaded for take-off) (Total)	75.0

25.3 STANDARD UNITS CONVERSION CHART (FIGURE 25-2)

The Standard Units Conversion chart presents commonly used temperature, distance, and speed data for conversion to alternate measurement forms. To use this chart locate the known value on the appropriate vertical scale and move horizontally left or right to the desired conversion scale.

25.4 FUEL WEIGHT VERSUS TEMPERATURE (FIGURE 25-3)

Pertinent performance data are based on the use of JP-5 fuel at a specific weight of 6.8 pounds per gallon (Standard Day). Variations in fuel weight for nonstandard temperatures and/or the use of alternate or emergency fuels can be determined by using Figure 25-3.

NOTE

Fuel which has been stored in aircraft tanks for more than approximately 4 hours can be assumed to be at the same temperature as ambient air.

25.5 STANDARD ATMOSPHERE TABLE (FIGURE 25-4)

The Standard Atmosphere Table (Figure 25-4) provides various atmospheric parameters under ICAO Standard Day conditions from sea level through 39,000 feet.

25.6 TEMPERATURE DEVIATION FROM STANDARD CHART (FIGURE 25-5)

The temperature deviation from standard chart provides the temperature deviation from ambient air (°C) as plotted against pressure altitude from 0 to 30,000 feet.

25.7 COMPRESSIBILITY CORRECTION TO CALIBRATED AIRSPEED (FIGURE 25-6)

The airspeed compressibility correction that must be subtracted from the calibrated airspeed to obtain equivalent airspeed is shown in Figure 25-6. Equivalent airspeed is the term normally used when making aerodynamic calculations and aircraft performance checks, and in determining true airspeed. True airspeed equals equivalent airspeed.

25.7.1 Airspeed Compressibility Correction Example. Calibrated airspeed is 250 knots at 20,000-foot pressure altitude. Figure 25-6 shows that 5 knots must be subtracted to obtain the correct equivalent airspeed of 245 knots.

25.8 AIRSPEED CONVERSION (FIGURE 25-7)

The Airspeed Conversion chart (Figure 25-7) is used to determine calibrated airspeed (CAS), true airspeed (TAS), and Mach number. Indicated airspeed (IAS) must first be converted to CAS before entering the chart to determine TAS.

25.8.1 Airspeed Conversion Example Problem. Determine true airspeed:

- Altitude–10,000 feet
- CAS–130 knots
- Temperature–20 °C

1. True Mach number = 0.235
2. Standard Day TAS = 151 knots
3. Corrected TAS = 158 knots

25.9 OUTSIDE AIR TEMPERATURE (OAT) COMPRESSIBILITY CORRECTION CHART (FIGURE 25-8)

The Outside Air Temperature Compressibility Correction chart is a plot of indicated OAT versus true ambient air temperature with parameters of mach number.

25.10 SPEED-ALTITUDE CORRECTION (FIGURE 25-9)

The Speed-Altitude Correction chart (Figure 25-9) is used to determine indicated airspeed (IAS) when desired calibrated airspeed (CAS) is known, and to obtain corrections for converting indicated altitude to true pressure altitude. Airspeed corrections are generally small enough to be considered negligible. Altimeter corrections for low-altitude, high-speed flight are sufficient to warrant preplanning for low-level missions.

25.11 WIND COMPONENT (FIGURE 25-10)

The Wind Component chart is used to obtain headwind, tailwind, or crosswind components for winds from 0 to 60 knots at angles up to 90 degrees from aircraft heading. Tailwind components may be determined by entering the chart with wind direction taken from the reciprocal of aircraft heading (Figure 25-10).

NOTE

Crosswind component limit is 20 knots for take-off and landing.

25.11.1 Wind Component Example Problem.

- Runway Heading–040 degrees
- Reported Wind–090 degrees, 12 knots

1. Headwind component = 7.5 knots
2. Crosswind component = 9 knots

25.12 STALL SPEEDS (FIGURE 25-11)

The Two-Engine Stall Speeds chart (Figure 25-11) determines minimum safe operating speeds with Military power on and power off both engines. Indicated airspeeds may be determined for any of three flap positions with gross weights up to 15,000 pounds.

25.12.1 Stall Speeds Example Problem. Find stall speed with the following conditions:

- Flaps–20 degrees
- Gross Weight–13,000 pounds
- Power Setting–Military power
- Landing Gear–down

1. Stall speed = 69 KIAS (POWER ON).
2. Stall speed = 94 KIAS (POWER OFF).

25.13 ANGLE-OF-ATTACK RELATIONSHIP (FIGURE 25-12)

The relationship of aircraft angle of attack at the fuselage reference line (in degrees) and indicated angle of attack (in units) to gross weight, dive angle, and calibrated airspeed may be determined on the Angle-of-Attack Relationship chart (Figure 25-12).

25.13.1 Angle-of-Attack Relationship Example Problem. Find indicated angle of attack and fuselage reference line angle of attack for the following conditions:

- Gross Weight–13,000 pounds
- Dive Angle–30 degrees
- Power Setting–Military power
- Airspeed–240 knots CAS

1. Fuselage reference line = – 1.8 degrees
2. Angle of attack = 9.2 units

25.14 MINIMUM SINGLE-ENGINE SPEEDS (FIGURES 25-13 AND 25-14)

The minimum Single-Engine Speed charts (Figures 25-13 and 25-12) provide the pilot with the minimum single-engine control speed for various gross weights and maximum weight fly-away curves as a function of temperature and speed. If the aircraft gross weight is to the right of the appropriate temperature line, single-engine fly-away is not possible. Gross weight must be reduced to a value that falls left of the applicable temperature line.

25.14.1 Minimum Single-Engine Speed Example Problem. Find minimum single-engine control speed and minimum safe (maintaining level flight) speed, gears down and up, if engine fails with following conditions:

- Flap Position–20 degrees
- Gross Weight–13,000 pounds.
- Temperature–30 °C

1. Enter weight scale at 13,000 pounds on 20-degree flaps (gear down) chart.

2. Move vertically to minimum single-engine control speed line and note speed of 94 KIAS (gear down).

3. Note that gross weight is right of the temperature line. Under these conditions, wings-level climb is not possible at any airspeed.

4. Enter weight scale at 13,000 pounds on 20-degree flaps (gear up) chart.

5. Move vertically to minimum single-engine control speed line and note that speed is 79 KIAS (gear up).

6. Move vertically to applicable temperature line and note minimum flyaway speed of 104 KIAS. Level flight at 100 fpm rate of climb is possible if airspeed is not reduced below this level.

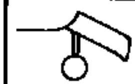
NOTE: IN CASE OF MIXED STORES, USE HIGHEST DRAG INDEX

CLEAN AIRCRAFT (SPONSONS, ℄ PYLON, AND FLIR TURRET) DRAG = 50*

ITEM	STATION 1	2	3	4	5	WEIGHT-LBS FULL	EMPTY	DRAG NUMBER SINGLE	ADJACENT	MULTIPLE
AIRCRAFT OPERATING WEIGHT							10,111			
INCLUDES:										
SPONSONS (TWO) WITH RACKS						272		21.0*		
CENTERLINE PYLON			X			52		4.5*		
WING STATION PYLONS (TWO)							132	15.0		
GENERAL ITEMS										
USABLE INTERNAL FUEL (JP-5)						1,622				
AUXILIARY FUEL TANKS (TWO) (JP-5)	WING PYLONS					1,538	232	27.0		
AERO 1C OR FPU-3/A FUEL TANK (JP-5)			X			1,155	135	14.0		24.0
M60C GUNS (FOUR) COMPLETE							150			
AMMUNITION 2000 ROUNDS						130				
GENERAL-PURPOSE BOMBS										
MK-81 (CONICAL FINS)	X	X	X	X	X	260		4.0	5.0	6.0
MK-81 (SNAKEYE FIN)	X	X	X	X	X	305		6.5	7.5	8.0
MK-82 CONICAL FIN	X	X	X	X	X	531		5.0	6.0	7.0
MK-82 SNAKEYE (RETARDED/UNRETARDED)	X	X	X	X	X	565		9.0	10.0	11.0
MK-83 CONICAL FIN			X			985		9.0	10.5	12.0
FIRE BOMBS										
MK-77 MOD 4	X	X	X	X	X	520		8.0	10.0	12.0
CLUSTER BOMBS										
CBU-55/B (FAE) OR CBU-55 A/B (FAE)	X	X	X	X	X	519		13.0	20	27.0
	AND WING PYLONS									

NA-86-0043-250A

Figure 25-1. Aircraft Configuration Table–Stores Capability (Sheet 1 of 3)

ITEM	STATION 1	2	3	4	5	WEIGHT-LBS FULL	EMPTY	DRAG NUMBER SINGLE	ADJACENT	MULTIPLE
										
PRACTICE BOMBS										
BDU-45/B CONICAL FIN	X	X	X	X	X	531		5.0	6.0	7.0
BDU-45/B SNAKEYE (RETARDED/UNRETARDED)	X	X	X	X	X	565		9.0	10.0	11.0
A/A37B-3 (PMBR)							87.0	10.0	12.0	14.0
SIX MK-76, BDU-33 D/B	X	X	X	X	X	237	–	18.5	25.0	32.0
SIX MK-106, BDU-48/B	X	X	X	X	X	117/147	–	25.0	34.0	45.0
ROCKET LAUNCHERS (2.75 INCH FFAR)										
LAU-61 A/A, B/A, C/A, (CONES ON)	X	X		X	X	542		10.0	17.0	22.0
W/O CONES (FULL)						529		29.0	35.0	40.0
W/O CONES (FIRED)							133	12.0	18.0	23.0
LAU-68 B/A, D/A (CONES ON)	X	X		X	X	217		4.0	5.0	6.0
W/O CONES (FULL)	AND					204		15.0	16.0	17.0
W/O CONES (FIRED)	WING PYLONS						67	5.0	6.0	7.0
ROCKET LAUNCHERS (5.0 INCH FFAR)										
LAU-10 SERIES (CONES ON)	X	X		X	X	533		7.0	11.0	15.0
W/O CONES (FULL)	AND					500		26.0	30.0	34.0
W/O CONES (FIRED)	WING PYLONS						105	9.0	13.0	17.0
GUN PODS										
GPU-2/A (M-197 GUN)		X		X		586	417	20.0		33.0

NA-86-0043-251A

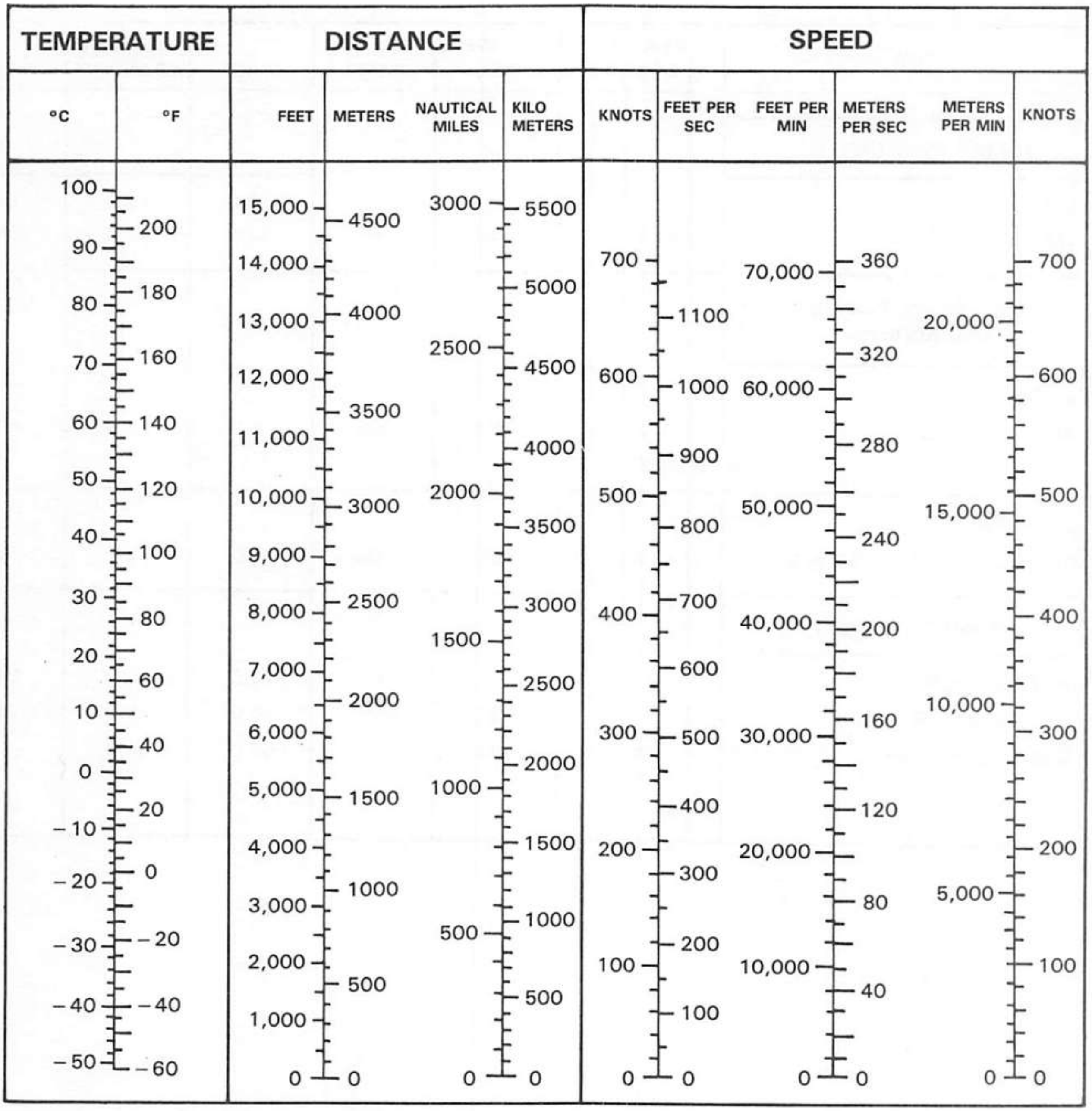
Figure 25-1. Aircraft Configuration Table–Stores Capability (Sheet 2 of 3)

ITEM	STATION 1	2	3	4	5	WEIGHT-LBS FULL	EMPTY	DRAG NUMBER SINGLE	ADJACENT	MULTIPLE
										
FLARES (PARACHUTE)										
A/A37B-3 (PMBR)							87	10.0	12.0	14.0
SIX MK-45 MOD 0	X	X	X	X	X	249	—	32.0	43.0	55.0
DISPENSERS, FLARES (PARACHUTE)										
SUU-44A										
EIGHT MK-45/LUU-2 A/B, -B/B	X	X	X	X	X	350	135	8.0	13.0	17.0
	AND WING PYLONS									
SUU-25 F/A										
EIGHT LUU-2 B/B, LUU-2 A/B	X	X	X	X	X	485	260	8.0	13.0	17.0
SENSORS (SEISMIC)										
A/A37B-3 (PMBR)							87	10.0	12.0	14.0
SIX ADSID III (S)	X				X	237	—	70.0	96.0	112.0
THREE ADSID III (N)	X		X		X	162	—	50.0	80.0	
	OR									
		X		X						

NA-86-0043-252A

Figure 25-1. Aircraft Configuration Table–Stores Capability (Sheet 3 of 3)

STANDARD UNITS CONVERSION CHART



NOTE

- TO OBTAIN US GALLONS MULTIPLY LITERS BY 0.264
- TO OBTAIN IMPERIAL GALLONS MULTIPLY LITERS 0.220
- TO OBTAIN INCHES OF MERCURY MULTIPLY MILLIBARS BY 0.0295
- TO OBTAIN POUNDS MULTIPLY KILOGRAMS BY 2.20

NA-86-0043-253

Figure 25-2. Standard Units Conversion Chart

FUEL WT

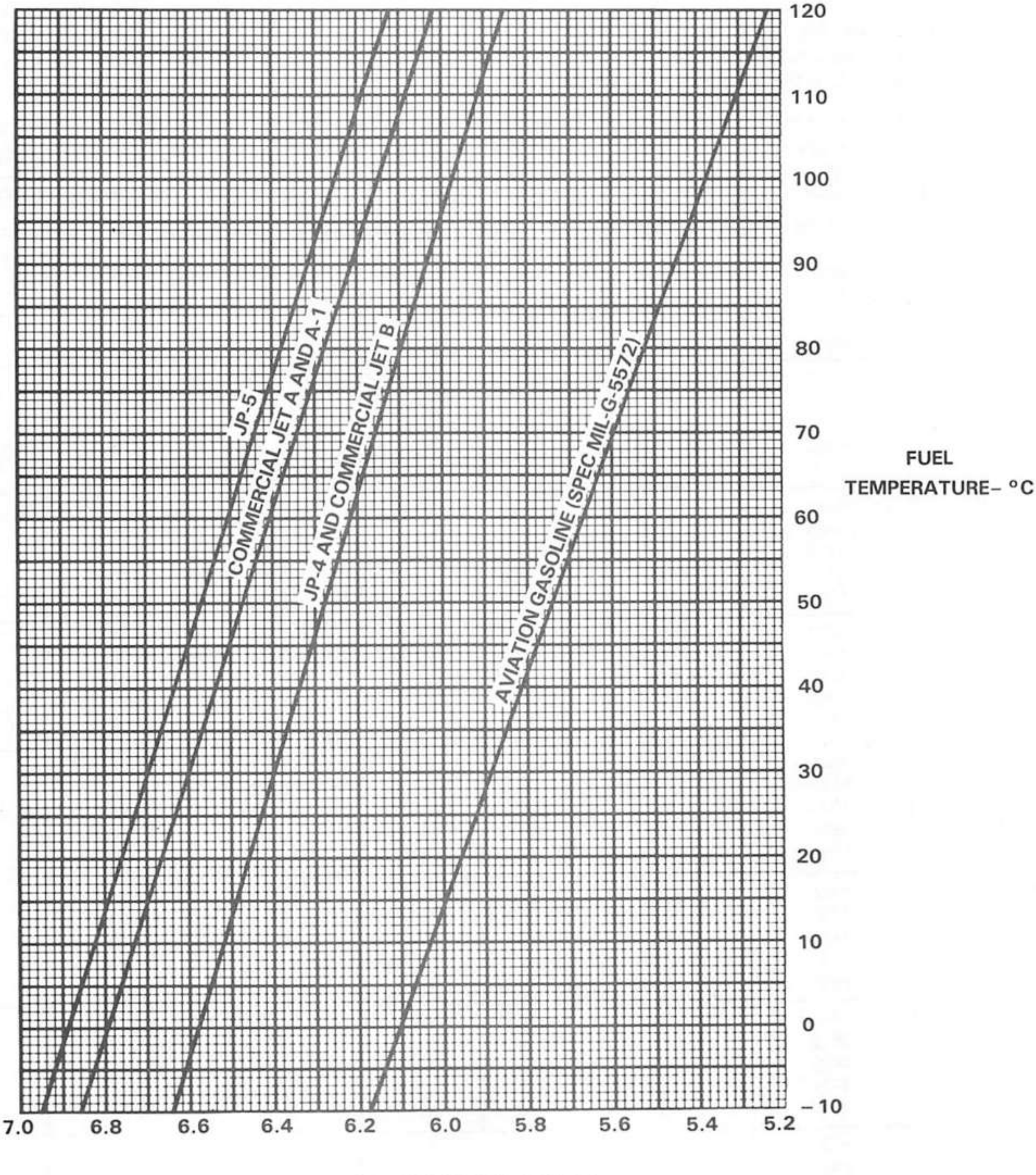


Figure 25-3. Fuel Weight vs. Temperature

STANDARD ATMOSPHERE TABLE

STANDARD S L CONDITIONS:

TEMPERATURE 15°C (59°F)
PRESSURE 29-921 IN. Hg 2116.216 LB/SQ FT
DENSITY .0023769 SLUGS/CU FT
SPEED OF SOUND 1116.89 FT/SEC 661.7 KNOTS

CONVERSION FACTORS:

1 IN. Hg 70.727 LB/SQ FT
1 IN. Hg 0.49116 LB/SQ IN.
1 KNOT 1.151 M.P.H.
1 KNOT 1.688 FT/SEC

ALTITUDE FEET	DENSITY RATIO σ	$\frac{1}{\sqrt{\sigma}}$	TEMPERATURE		SPEED OF SOUND (KNOTS)	PRESSURE	
			DEG. C	DEG. F		IN. OF Hg	RATIO P/PO
0	1.0000	1.000	15.0	59.0	661.7	29.92	1.0000
1000	.9711	1.015	13.0	55.4	659.5	28.86	.9644
2000	.9428	1.030	11.0	51.9	657.2	27.82	.9298
3000	.9151	1.045	9.0	48.3	654.9	26.82	.8963
4000	.8881	1.061	7.1	44.7	652.6	25.84	.8637
5000	.8617	1.077	5.1	41.2	650.3	24.90	.8321
6000	.8359	1.094	3.1	37.6	648.7	23.98	.8014
7000	.8107	1.111	1.1	34.1	645.6	23.09	.7717
8000	.7860	1.128	-0.8	30.5	643.3	22.23	.7429
9000	.7620	1.146	-2.8	26.9	640.9	21.39	.7149
10000	.7385	1.164	-4.8	23.4	638.6	20.58	.6878
11000	.7156	1.182	-6.8	19.8	636.2	19.80	.6616
12000	.6933	1.201	-8.8	16.3	633.9	19.04	.6362
13000	.6715	1.220	-10.8	12.7	631.5	18.30	.6115
14000	.6502	1.240	-12.7	9.1	629.0	17.58	.5877
15000	.6294	1.260	-14.7	5.6	626.6	16.89	.5646
16000	.6092	1.281	-16.7	2.0	624.2	16.23	.5423
17000	.5894	1.303	-18.6	-1.5	621.8	15.58	.5206
18000	.5702	1.324	-20.6	-5.1	619.4	14.95	.4997
19000	.5514	1.347	-22.6	-8.7	617.0	14.35	.4795
20000	.5331	1.370	-24.6	-12.2	614.6	13.76	.4599
21000	.5153	1.393	-26.6	-15.8	612.1	13.20	.4410
22000	.4980	1.417	-28.5	-19.3	609.6	12.65	.4228
23000	.4811	1.442	-30.5	-22.9	607.1	12.12	.4051
24000	.4646	1.467	-32.5	-26.5	604.6	11.61	.3881
25000	.4486	1.493	-34.5	-30.0	602.1	11.12	.3716
26000	.4330	1.520	-36.5	-33.6	599.6	10.64	.3557
27000	.4178	1.547	-38.4	-37.1	597.1	10.18	.3404
28000	.4031	1.575	-40.4	-40.7	594.6	9.742	.3256
29000	.3887	1.604	-42.4	-44.3	592.1	9.315	.3113
30000	.3747	1.634	-44.4	-47.8	589.5	8.904	.2976
31000	.3612	1.664	-46.4	-51.4	586.9	8.507	.2843
32000	.3480	1.695	-48.3	-54.9	584.4	8.125	.2715
33000	.3351	1.727	-50.3	-58.5	581.8	7.757	.2592
34000	.3227	1.760	-52.4	-62.1	579.2	7.402	.2474
35000	.3106	1.794	-54.3	-65.6	576.6	7.061	.2360
36000	.2989	1.829	-56.2	-69.2	574.0	6.733	.2250
37000	.2853	1.872	-56.5	-69.7	573.7	6.418	.2145
38000	.2719	1.918	-56.5	-69.7	573.7	6.118	.2045
39000	.2592	1.964	-56.5	-69.7	573.7	5.832	.1949

NA-86-0043-255

Figure 25-4. Standard Atmosphere Table

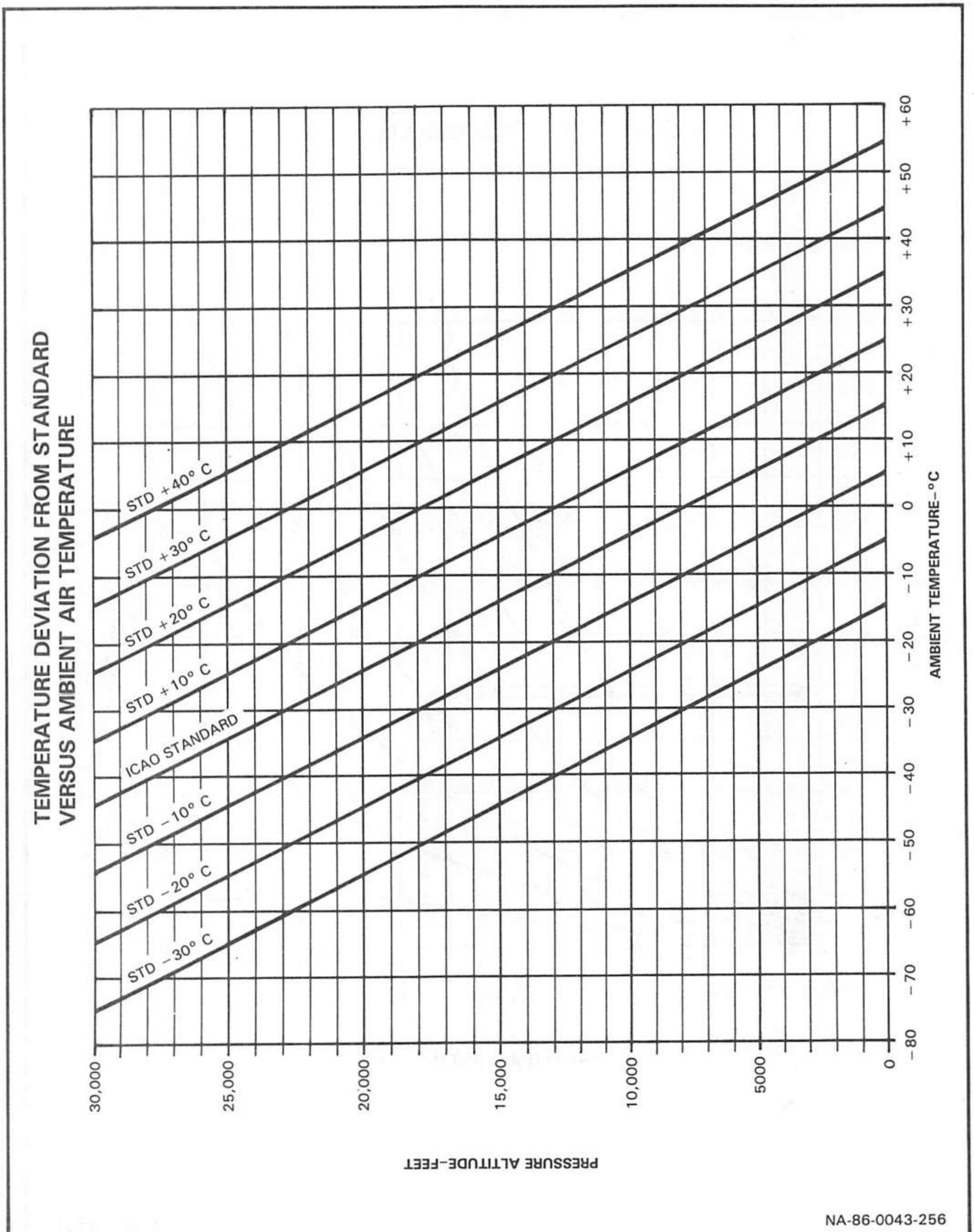


Figure 25-5. Temperature Deviation from Standard Chart

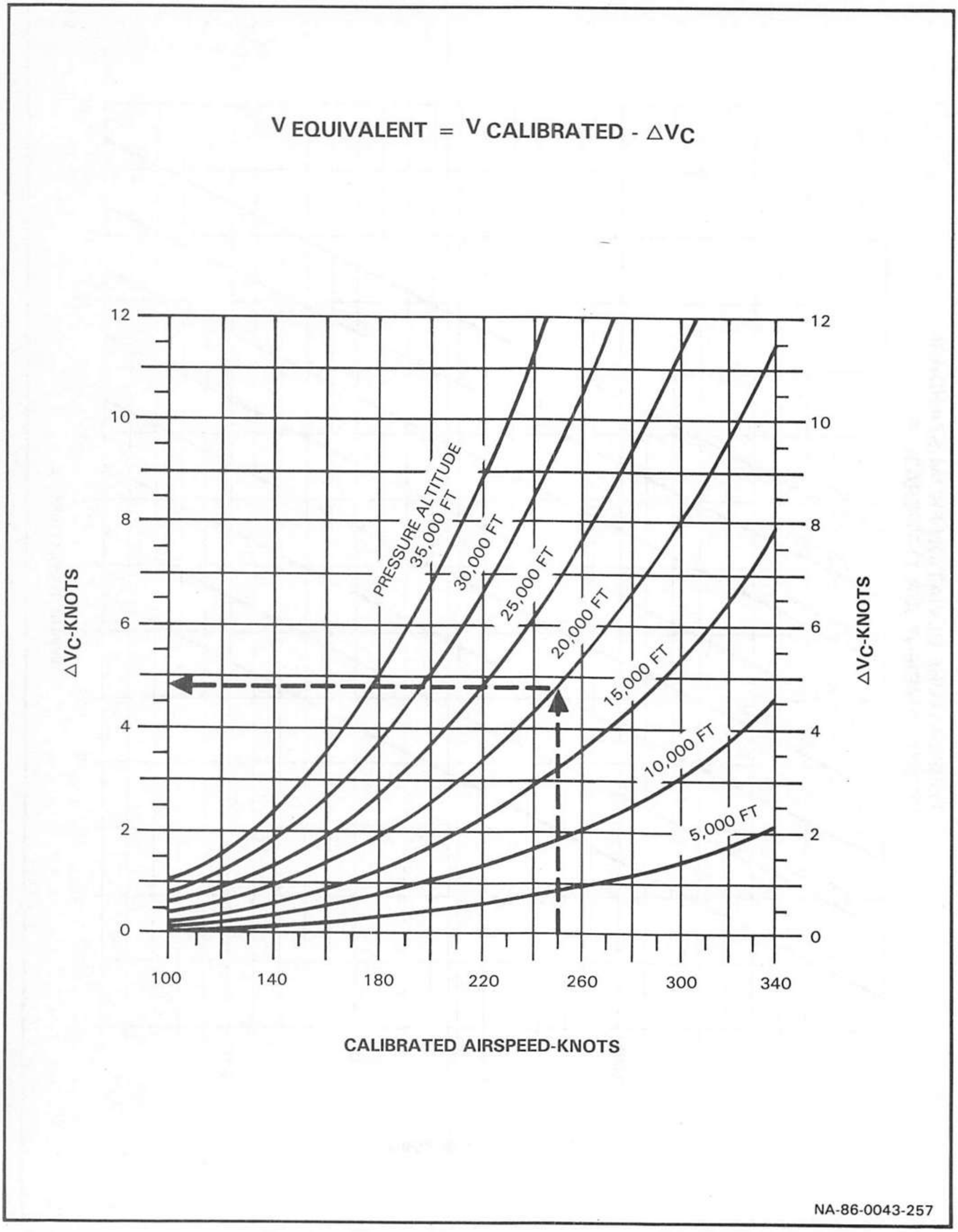


Figure 25-6. Compressibility Correction to Calibrated Airspeed Chart

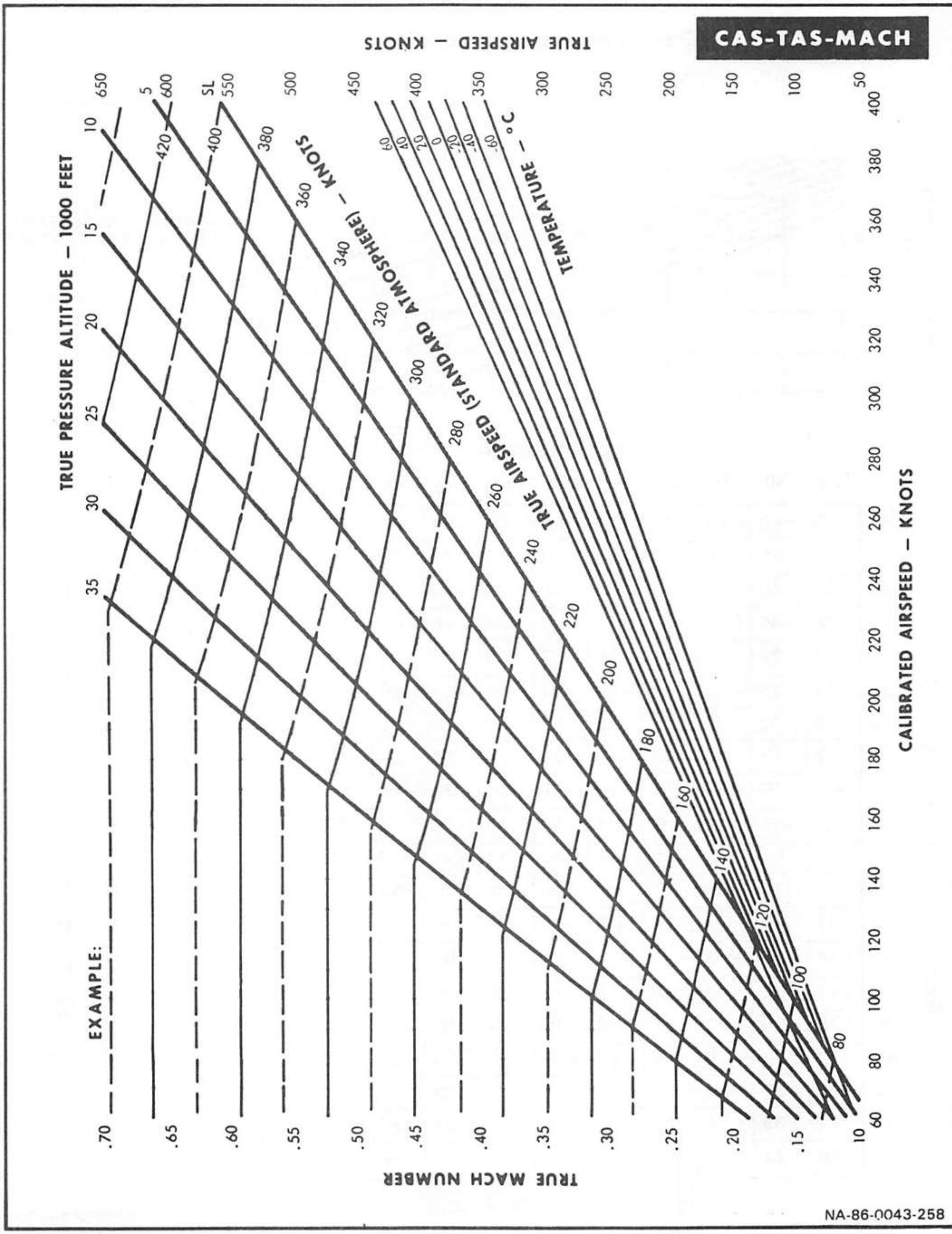
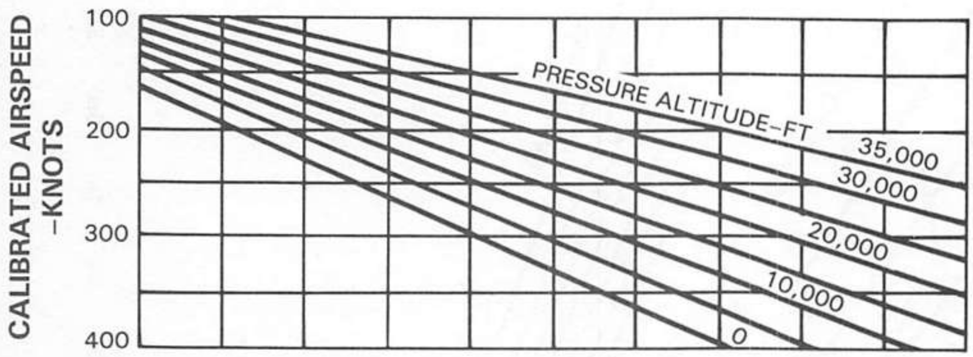


Figure 25-7. Airspeed Conversion

TEMPERATURE COMPRESSIBILITY CORRECTION

NOTE: TEMPERATURE CORRECTION BASED ON 100% ADIABATIC RISE



MACH NUMBER

INDICATED AIR TEMPERATURE– °C	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75
−45	−47	−49	−51	−52	−54	−56	−59	−61	−63	−65	−67
−40	−42	−44	−46	−47	−49	−51	−53	−56	−58	−61	−64
−35	−37	−40	−41	−42	−44	−46	−49	−51	−54	−56	−59
−30	−32	−34	−36	−38	−40	−42	−44	−46	−49	−52	−55
−25	−28	−29	−31	−33	−35	−37	−39	−42	−44	−47	−51
−20	−23	−25	−26	−28	−30	−32	−35	−37	−40	−43	−46
−15	−18	−20	−21	−23	−25	−27	−30	−32	−35	−38	−41
−10	−13	−15	−16	−18	−20	−23	−25	−28	−31	−34	−37
−5	−8	−10	−12	−13	−16	−18	−20	−23	−26	−29	−32
0	−3	−5	−7	−9	−11	−13	−16	−18	−21	−24	−28
+5	+2	0	−2	−4	−6	−8	−11	−14	−17	−20	−23
+10	+7	+5	+3	+1	−1	−4	−6	−9	−12	−15	−19
+15	+12	+10	+8	+6	+4	+1	−2	−4	−8	−11	−14
+20	+16	+15	+13	+11	+8	+6	+3	0	−3	−6	−10
+25	+21	+20	+18	+16	+13	+11	+8	+5	+2	−2	−5
+30	+26	+25	+23	+21	+18	+16	+13	+10	+6	+3	−1
+35	+31	+30	+28	+25	+23	+20	+17	+14	+11	+8	+3
+40	+36	+35	+32	+30	+28	+25	+22	+19	+16	+12	+7
+45	+41	+39	+37	+35	+33	+30	+27	+24	+20	+17	+12
+50	+46	+44	+42	+40	+37	+35	+31	+28	+25	+21	+16

AMBIENT AIR TEMPERATURE – °C

PRESSURE ALTITUDE (1000 FT)	STANDARD TEMPERATURE (°C)
0	+15
2	+11
4	+7
6	+3
8	−1
10	−5
12	−9
14	−13
16	−17
18	−21
20	−25
22	−29
24	−33
26	−37
28	−41
30	−44
32	−48
34	−52
35	−54

NA-86-0043-259

Figure 25-8. Temperature Compressibility Correction Chart

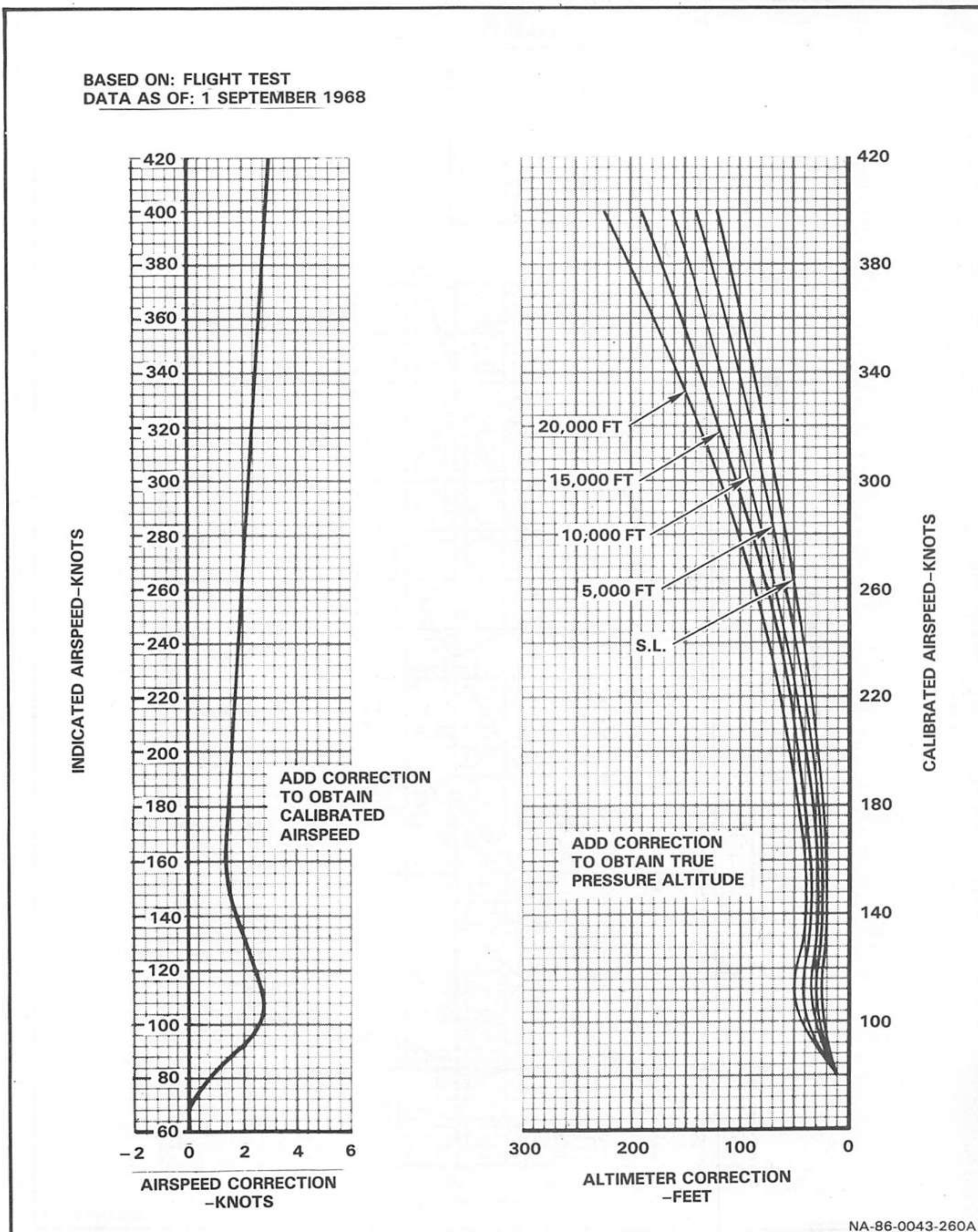


Figure 25-9. Speed-Altitude Correction

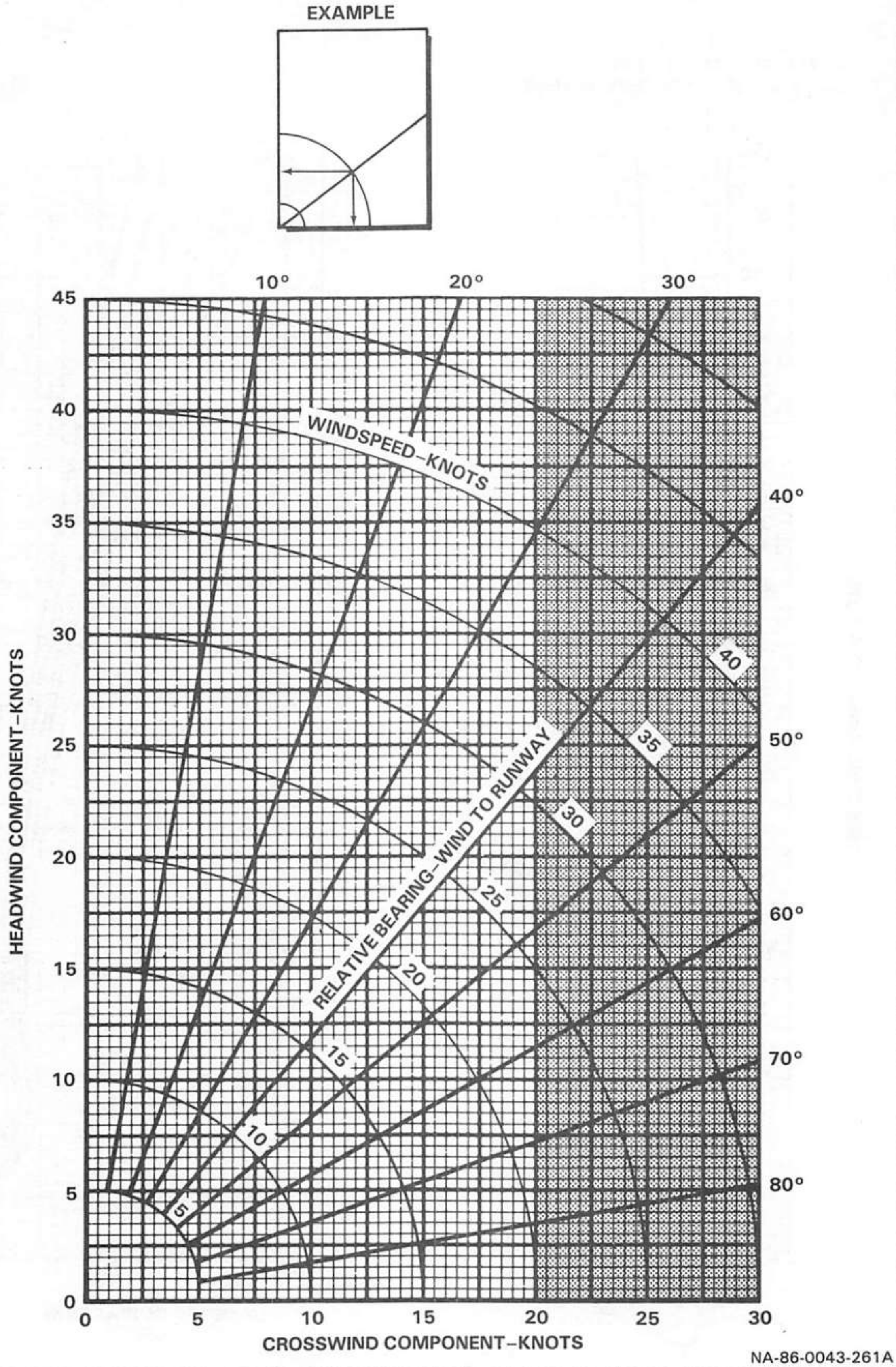


Figure 25-10. Wind Component

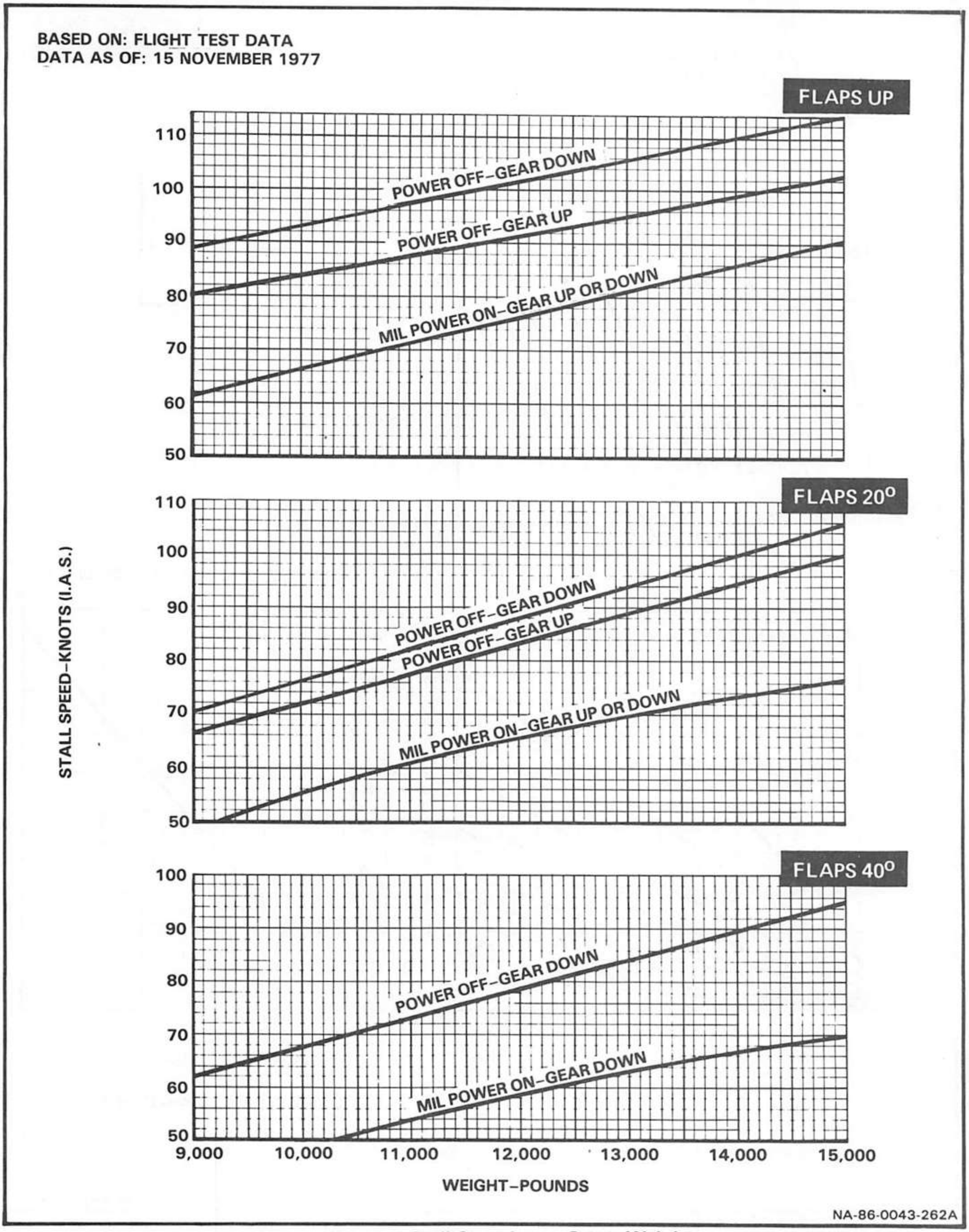


Figure 25-11. Stall Speeds vs. Gross Weight

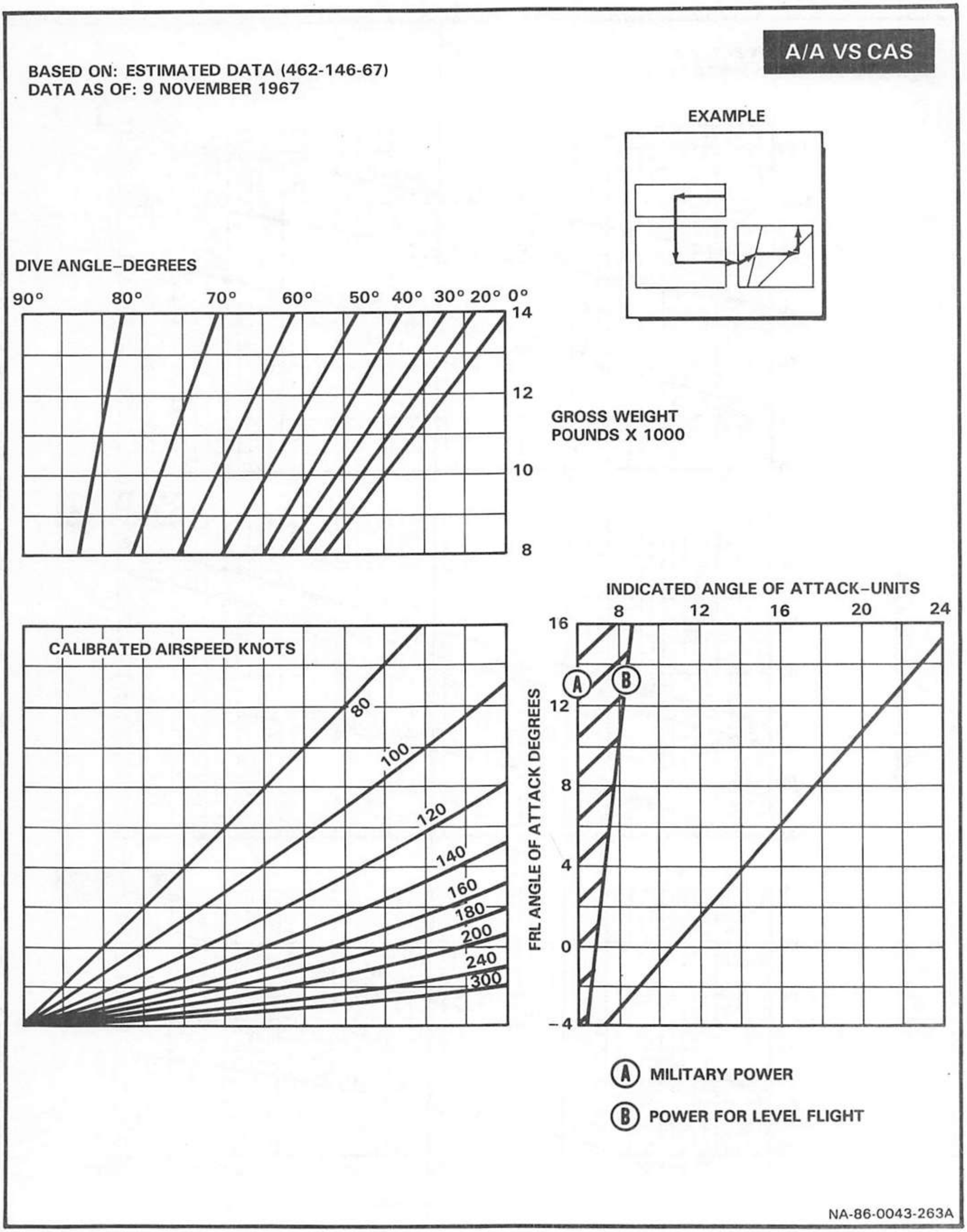


Figure 25-12. Angle-of-Attack Relationship

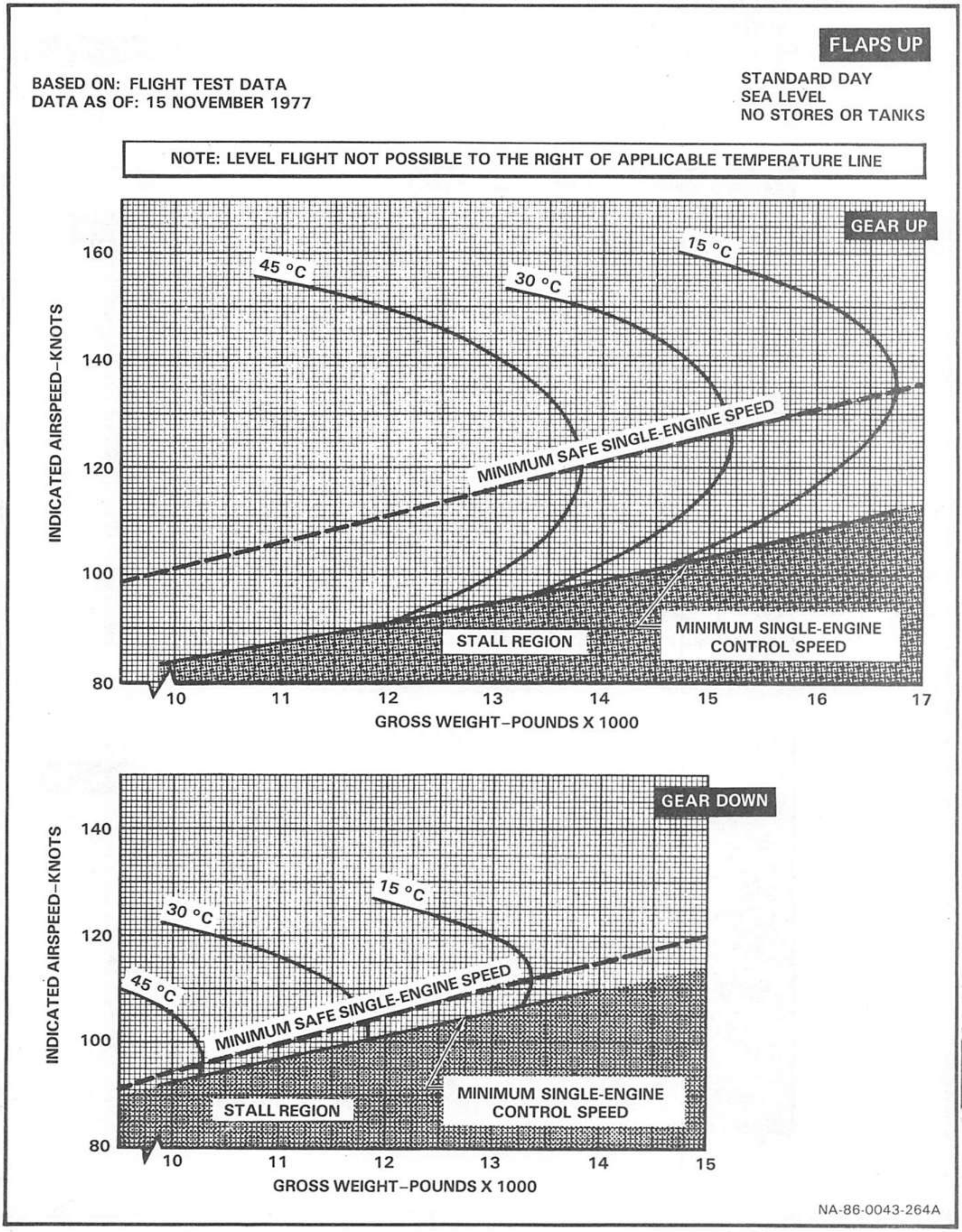


Figure 25-13. Minimum Single-Engine Speeds, Flaps Up

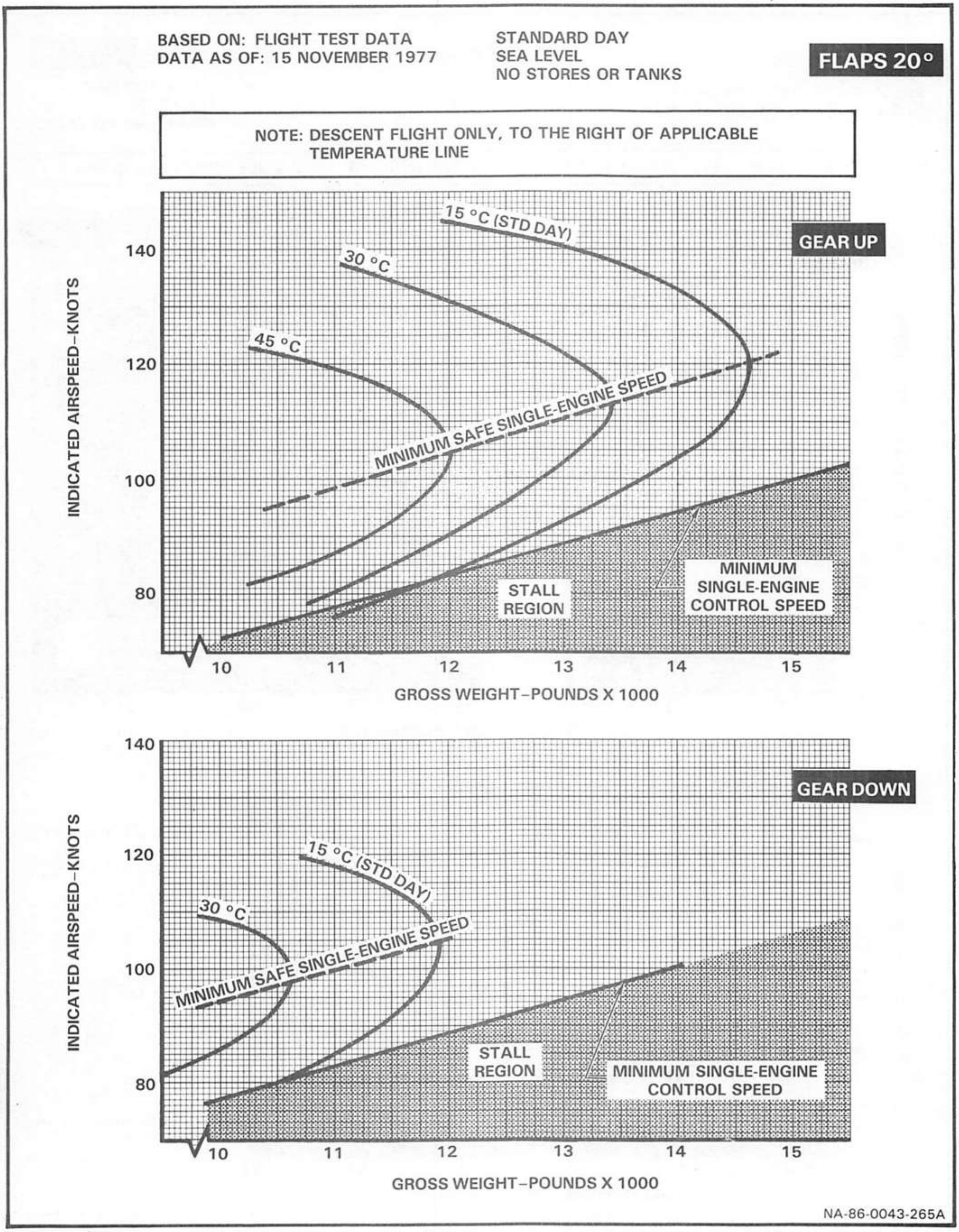


Figure 25-14. Minimum Single-Engine Speeds, Flaps 20°

CHAPTER 26

Take-Off Data

26.1 TAKE-OFF DATA

Normal take-off data presented in Figures 26-5 through 26-10 is used to calculate ground run, total distance to clear a 50-foot obstacle, refusal speed and lift-off speed.

Single-engine fly-away data is provided in Figure 26-11.

Climb-out flight path data is presented in Figures 26-12 through 26-15 to determine distance required from lift-off to clear obstacles up to 200 feet high.

26.1.1 Take-Off Distance. (Figures 26-5 through 26-8.) The Take-off Distance charts provide a means of determining take-off distance under normal or STOL operating conditions. The charts present refusal speeds, take-off speeds, ground run distance with various wind conditions and total distance over a 50-foot obstacle. These data are based on two-engine operation as a function of aircraft weight, altitude and ambient temperature. The aircraft center of gravity for chart use represents a mid center-of-gravity value.

Enter Example Chart 1 (Figure 26-1) with runway ambient temperature (A) and proceed up to the line corresponding to the field pressure altitude (B).

Move horizontally until intersecting the aircraft gross weight line (C).

NOTE

> If the aircraft gross weight is other than the value shown, use linear interpolation.

Then move down to the ground run distance (D) for a dry, hard, prepared surface runway in a no-wind condition. Continue downward intersecting the index line in the refusal speed chart and read the value of refusal speed (H) at the left side of the chart. This value of refusal speed represents the maximum speed to which the aircraft can normally accelerate and then stop in the runway length (D) using brakes only for stopping, for the no-wind condition.

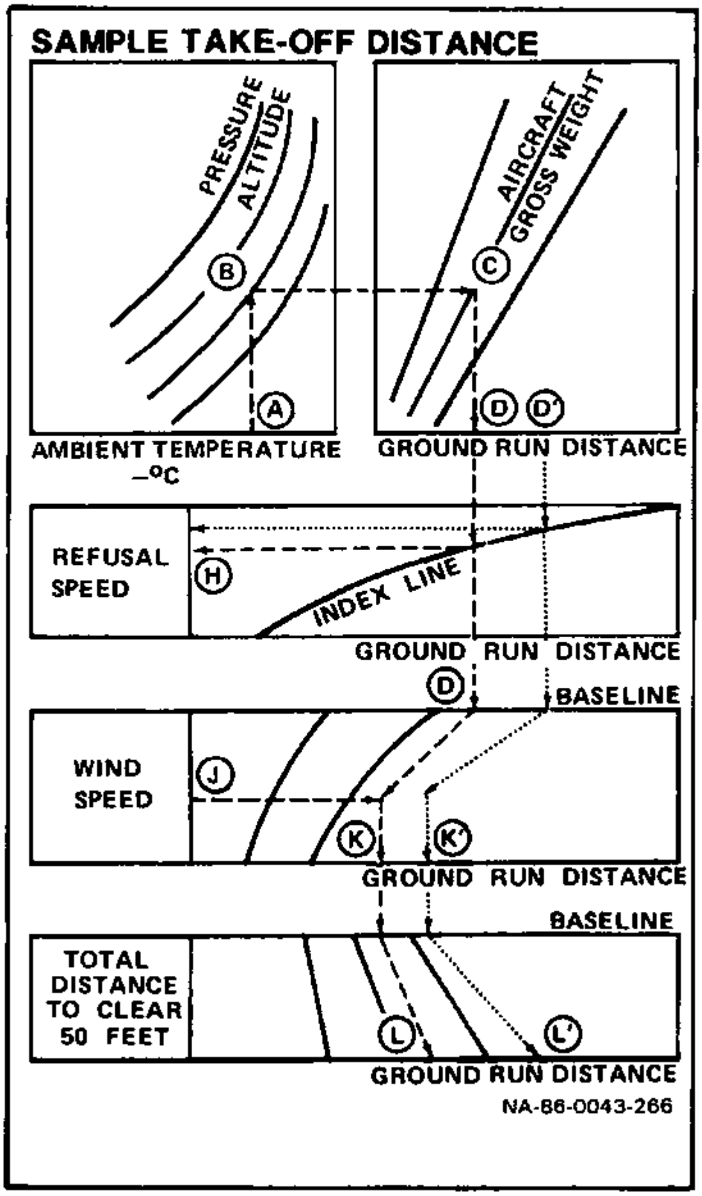


Figure 26-1. Example Chart 1

Continuing vertically downward with the value D to the baseline of the wind correction chart, then left or right parallel to the guidelines for head or tail winds until the value of the wind speed (J) is intersected. Then move vertically downward to the final corrected ground run distance (K). Continue downward to the baseline of the Total Distance chart, then parallel to the guidelines for the total distance over 50 feet (L). These data represent the capabilities of the OV-10D aircraft with the rated engine output.

Enter Example Chart 2 (Figure 26-2) with runway ambient temperature (A) and proceed up to the line corresponding to the field pressure altitude (B). Move horizontally to the expected torque reading (E) based on the engine manufacturer's rated engine at full throttle (MIL) power.

From previous engine run-ups, if rated torque cannot be obtained, the power correction nomogram must be used to determine corrected take-off requirements.

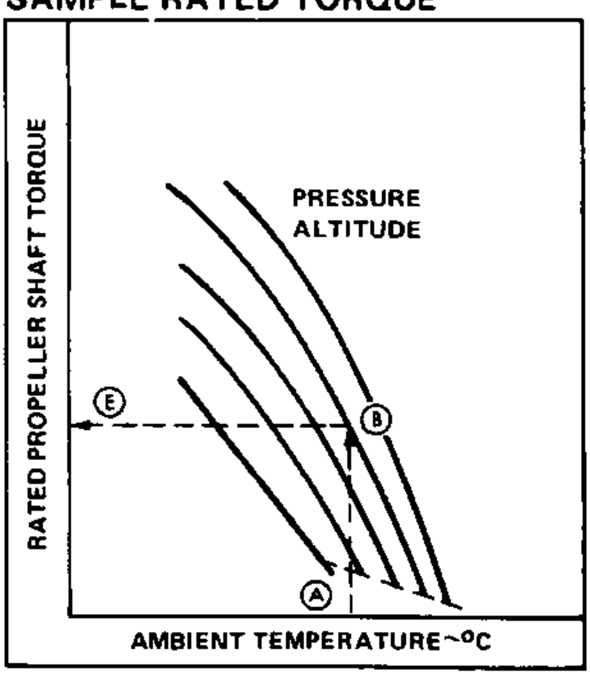
If the engine torque is below the chart value (E) for the same pressure altitude and temperature conditions, then an additional correction must be made to the ground run and air distance.

Enter the power correction nomogram (Figure 26-3, Example Chart 3) with the rated value (E) and the actual value (F) of the engine torque readings, draw a straight line through these two points, and read the multiplying factor at the intersection of the right vertical scale (G). The product of this factor (G) and the ground run (D) will produce a new corrected ground run (D').

Re-enter Example Chart 1 with the corrected ground run (D') and determine a revised refusal speed. Continue through the chart a second time as described previously.

The total distance to clear a 50-foot obstacle (L) must be corrected if the power correction nomogram was employed to correct ground run distances for deficient torque readings. Subtract the ground run distance (K') from the total distance (L') and multiply the difference by the multiplying factor (G), then add the product to the corrected ground run distance (K') for a final corrected total take-off distance over a 50-foot obstacle.

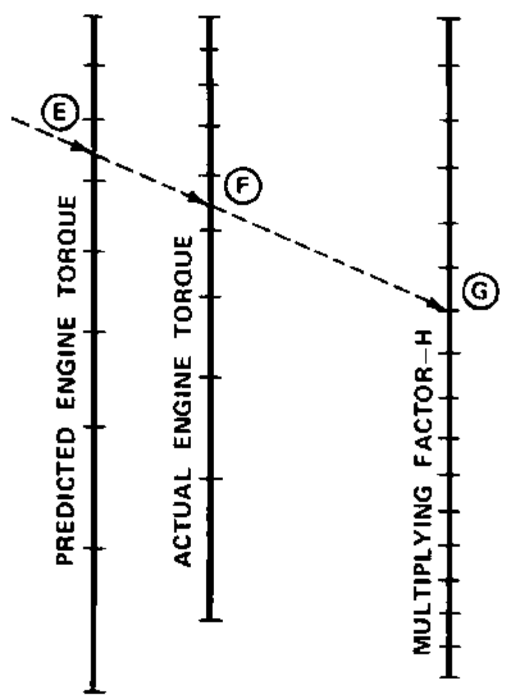
SAMPLE RATED TORQUE



NA-86-0043-267

Figure 26-2. Example Chart 2

POWER CORRECTION NOMOGRAM



NA-86-0043-268

Figure 26-3. Example Chart 3

If the actual available runway length is greater than the required ground run determined from the charts for no-wind conditions, the refusal speed may be revised upward to be compatible with the actual runway length.

Enter the refusal speed plot with the actual runway length and move up or down intersecting the index line, then read horizontally to obtain a new refusal speed.

26.1.2 Minimum Torque Versus Gross Weight To Maintain 100 FPM Rate of Climb. (Figure 26-11.) Aircraft single-engine fly-away capability after take-off with the landing gear retracted and the flaps up or flaps at 20-degree position, can be determined from the Minimum Torque vs. Gross Weight to Maintain 100 FPM Rate of Climb chart (Figure 26-11).

If an engine failure occurs during a take-off ground roll, the aircraft should be stopped. Safe stopping distance can be ensured if the refusal speed previously determined is observed. The single-engine fly-away chart (Figure 26-4, Example Chart 4) is entered at the lower left side with runway temperature (A), then moving vertically up to intersect the field pressure altitude (B). Then move horizontally until a vertical line is intersected from the actual engine torque reading (F) on the right, and the gross weight (M) is then interpolated linearly from the lines of constant gross weight.

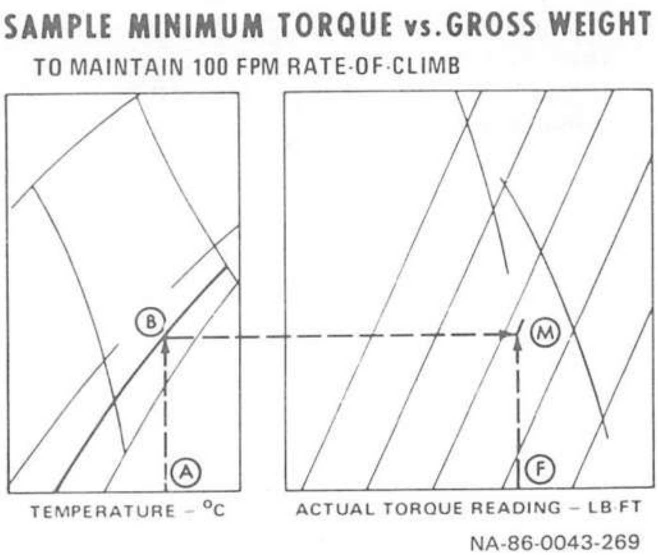


Figure 26-4. Example Chart 4

If this take-off weight value (M) is less than the initial value (C), the pilot must be prepared to jettison all external stores in the event of engine failure following take-off in order to maintain level flight. If the value of the aircraft gross weight less external stores still exceeds the chart value (M), then single-engine level flight cannot be maintained and the pilot must be prepared to return the aircraft to the runway at once. If sufficient altitude is not available to return to the runway, ejection procedures should be initiated providing the terrain does not permit a satisfactory landing. Each take-off ground run chart contains a limit line reflecting single-engine fly-away capability.

26.1.3 Take-Off Distance Example Problem. Find the ground run, total distance over a 50-foot obstacle, refusal speed, and lift-off speed utilizing normal performance technique (Figure 26-6) for the following conditions:

- Runway Temperature 32 °C
- Pressure Altitude–Sea Level
- Flap Setting–20 degrees
- Take-Off Gross Weight–13,000 pounds
- Actual Engine Torque Reading–1700 foot-pounds
- Runway–Level
- Wind Velocity–20 knots (headwind)

1. For take-off distance (D) for rated engines, read 1820 feet.

2. Refusal speed (H) is 63 knots.

3. Correct take-off distance for headwind (J) velocity of 20 knots and read total distance (K) as 1250 feet.

4. Read total distance over 50-foot obstacle (L) of 1700 feet.

5. For rated engine torque (E) of 2200 foot-pounds and actual engine torque reading (F) of 1700 foot-pounds, read power correction factor (G) of 1.30 in Figure 26-10.

6. The corrected ground run (D') is 1820 feet X 1.3 = 2366 feet.

7. New refusal speed is 70 knots.

8. Correct distance for headwind (J) velocity of 20 knots and read total distance (K') as 1600 feet.

9. Read total distance over 50-foot obstacle (L') of 2200 feet.

10. Total distance over 50-foot obstacle, must be corrected for engine torque deficiency and is determined by subtracting corrected ground run distance (K') from total distance over 50-foot obstacle (L') multiplying by power correction factor (G) and adding to the corrected ground run distance (K')

or

(2200–1600) 1.3 + 1600
780 + 1600 = 2380 feet over 50-foot obstacle.

11. With flaps and gear up and actual engine torque reading of 1700 foot-pounds, single-engine fly-away capabilities can be determined using Figure 26-11. The maximum weight at which 100-foot-per-minute rate of climb can be maintained is 12,100 pounds. If the flaps are not retracted but the gear is up, only a 10,300-pound gross weight will permit a single-engine, 100-foot-per-minute rate of climb.

26.2 CLIMB-OUT FLIGHT PATH (FIGURES 26-12 THROUGH 26-15).

The Climb-Out Flight Path charts (Figures 26-12 through 26-15) may be used to determine distance required from lift-off to clear obstacles up to 200 feet high. The performance shown, is for airspeed at take-off. Increased airspeeds will provide improved performance.

26.2.1 Climb-Out Flight Path Example Problem. Determine distance following normal take-off to clear an obstacle for the following standard day conditions:

- Landing Gear–Down
- Obstacle Height Above Runway–120 feet
- Flap Setting–20 degrees (normal take-off)
- Pressure Altitude–4000 feet
- Gross Weight–14,000 pounds

1. Distance from lift-off = 1600 feet at a climb speed of 106 knots.

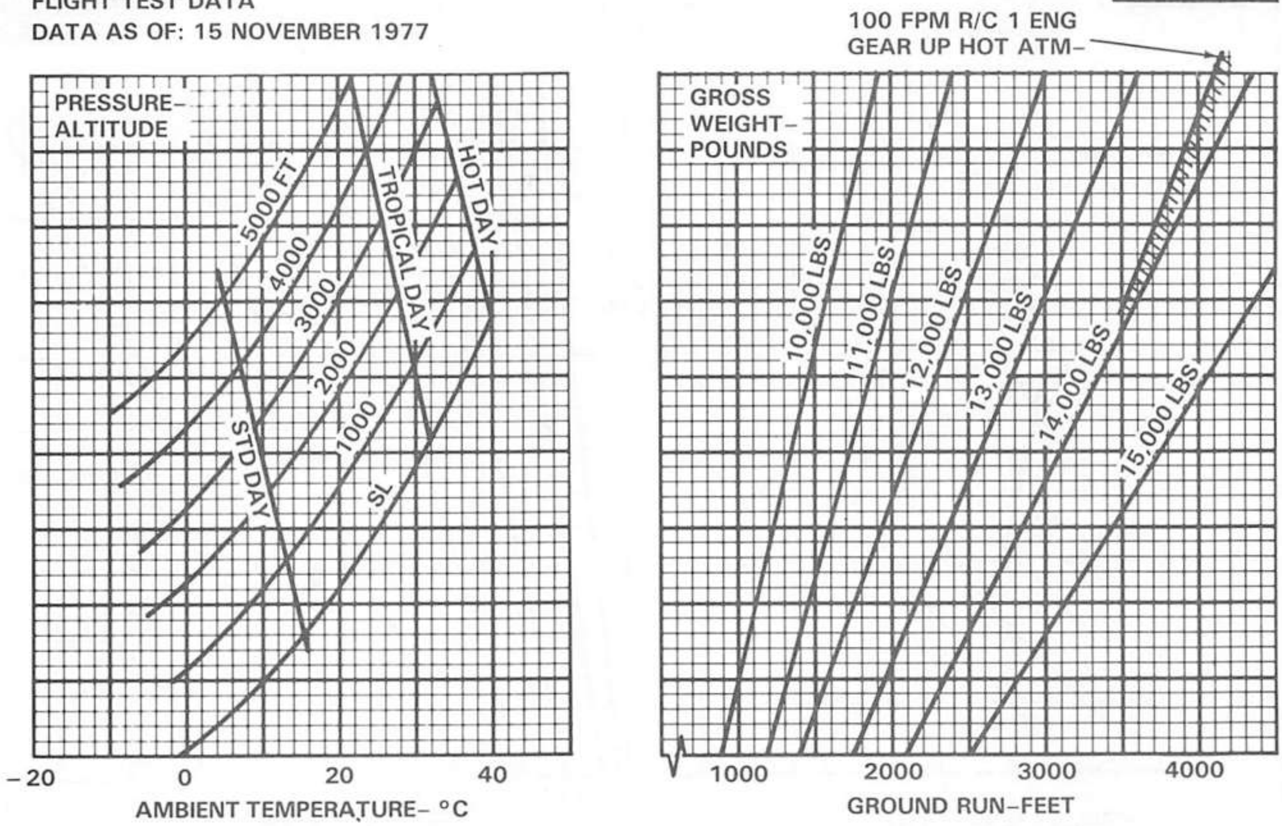
NOTE

Assuming a take-off roll distance of 2800 feet under these conditions, a total cleared surface length of 4400 feet in front of the obstacle is required for take-off and straight-ahead climb.

NORMAL PERFORMANCE

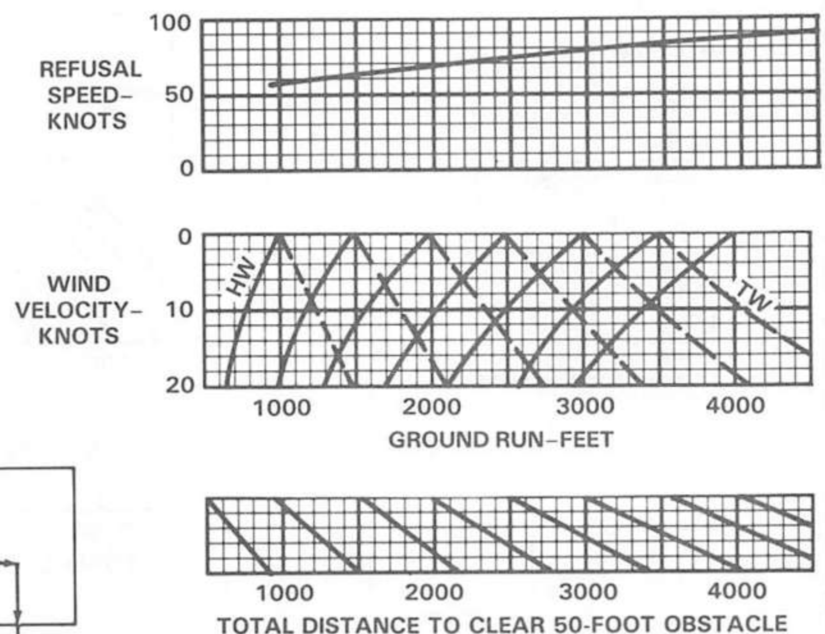
FLAPS UP

BASED ON:
FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

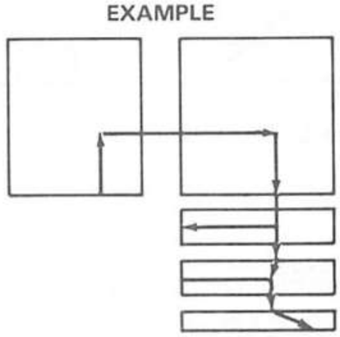


TAKE-OFF SPEED-
KNOTS IAS

GROSS WEIGHT (POUNDS)	SPEED
10,000	94.5
11,000	99.0
12,000	103.5
13,000	108.0
14,000	113.0
15,000	116.5



EXAMPLE



NOTE:
INCREASE GROUND RUN DISTANCE
4 PERCENT FOR EACH ONE PERCENT
INCREASE IN THE RUNWAY SLOPE

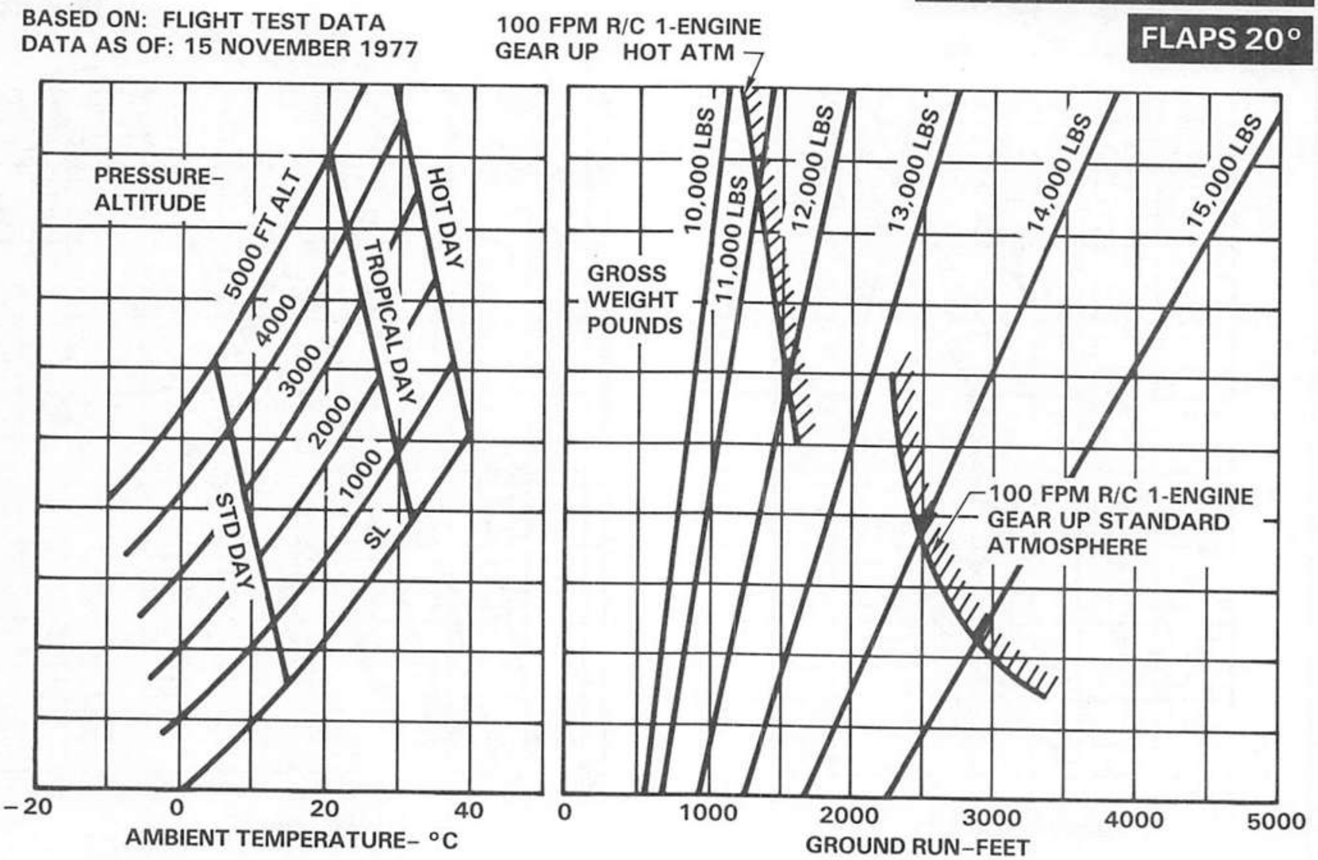
NA-86-0043-270A

Figure 26-5. Take-Off Distance, Normal Performance (Flaps Up)

NORMAL PERFORMANCE

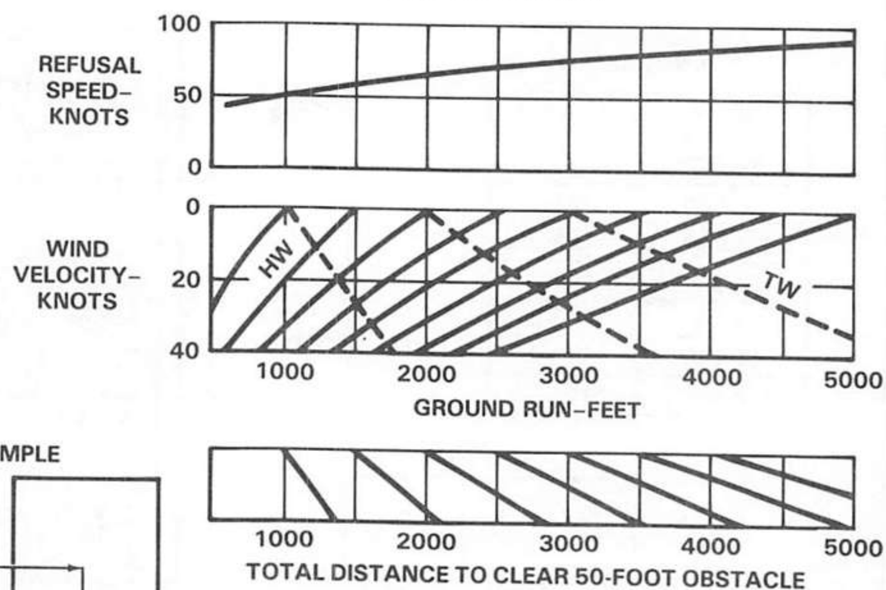
FLAPS 20°

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

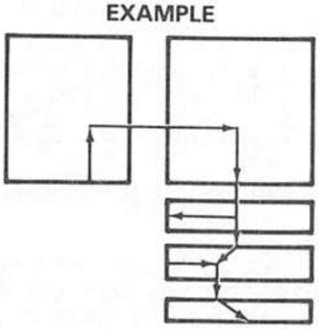


TAKE-OFF SPEED–KNOTS IAS

GROSS WEIGHT (POUNDS)	SPEED
10,000	80
11,000	85
12,000	91
13,000	98
14,000	106
15,000	114



EXAMPLE



NOTE:
INCREASE GROUND RUN DISTANCE
4 PERCENT FOR EACH 1 PERCENT INCREASE
IN THE RUNWAY SLOPE

NA-86-0043-271A

Figure 26-6. Take-Off Distance, Normal Performance (Flaps 20°)

STOL PERFORMANCE

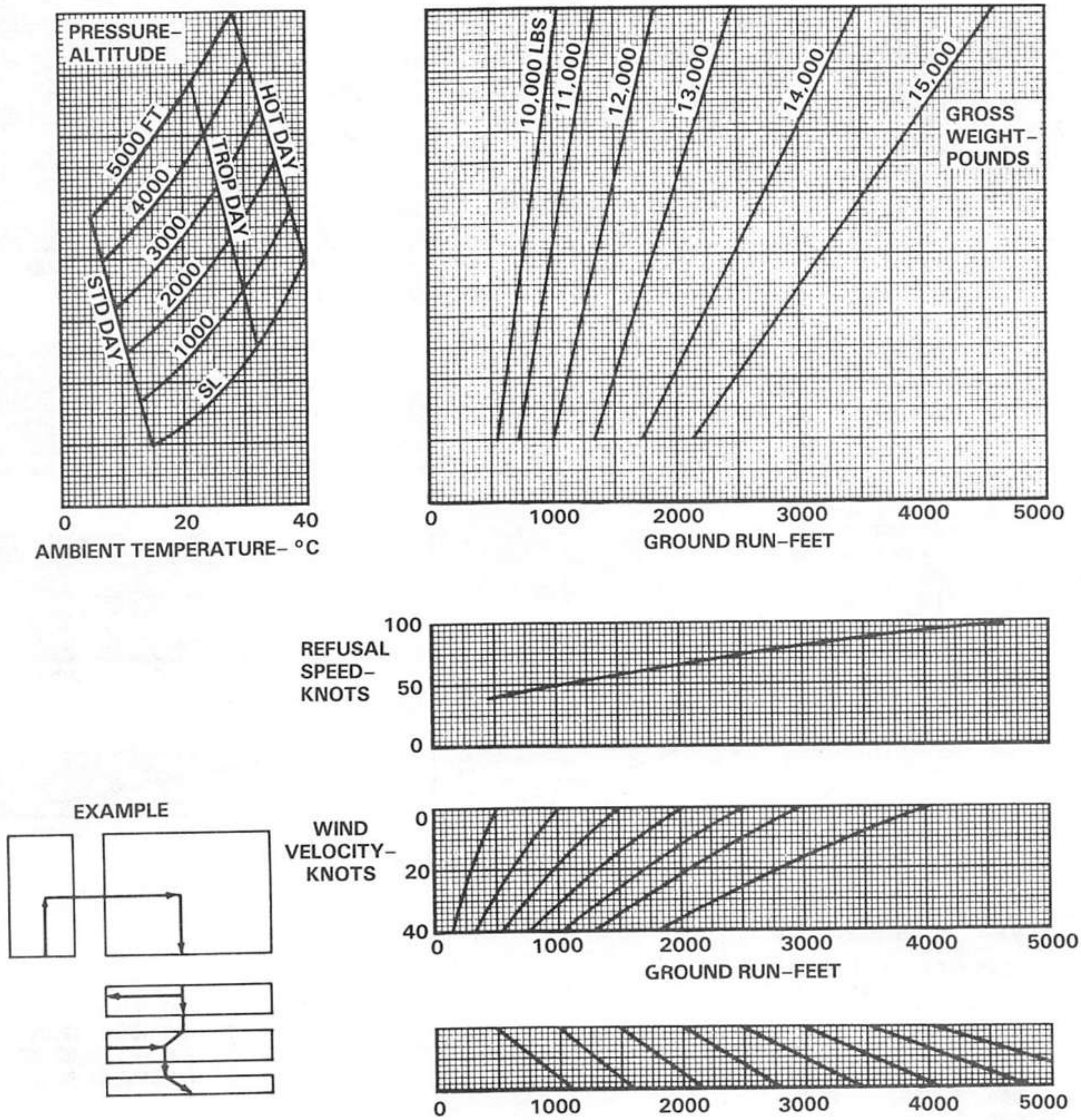
FLAPS 20°

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

NOTE:
INCREASE GROUND RUN DISTANCE 4 PERCENT FOR EACH ONE PERCENT INCREASE IN THE RUNWAY SLOPE

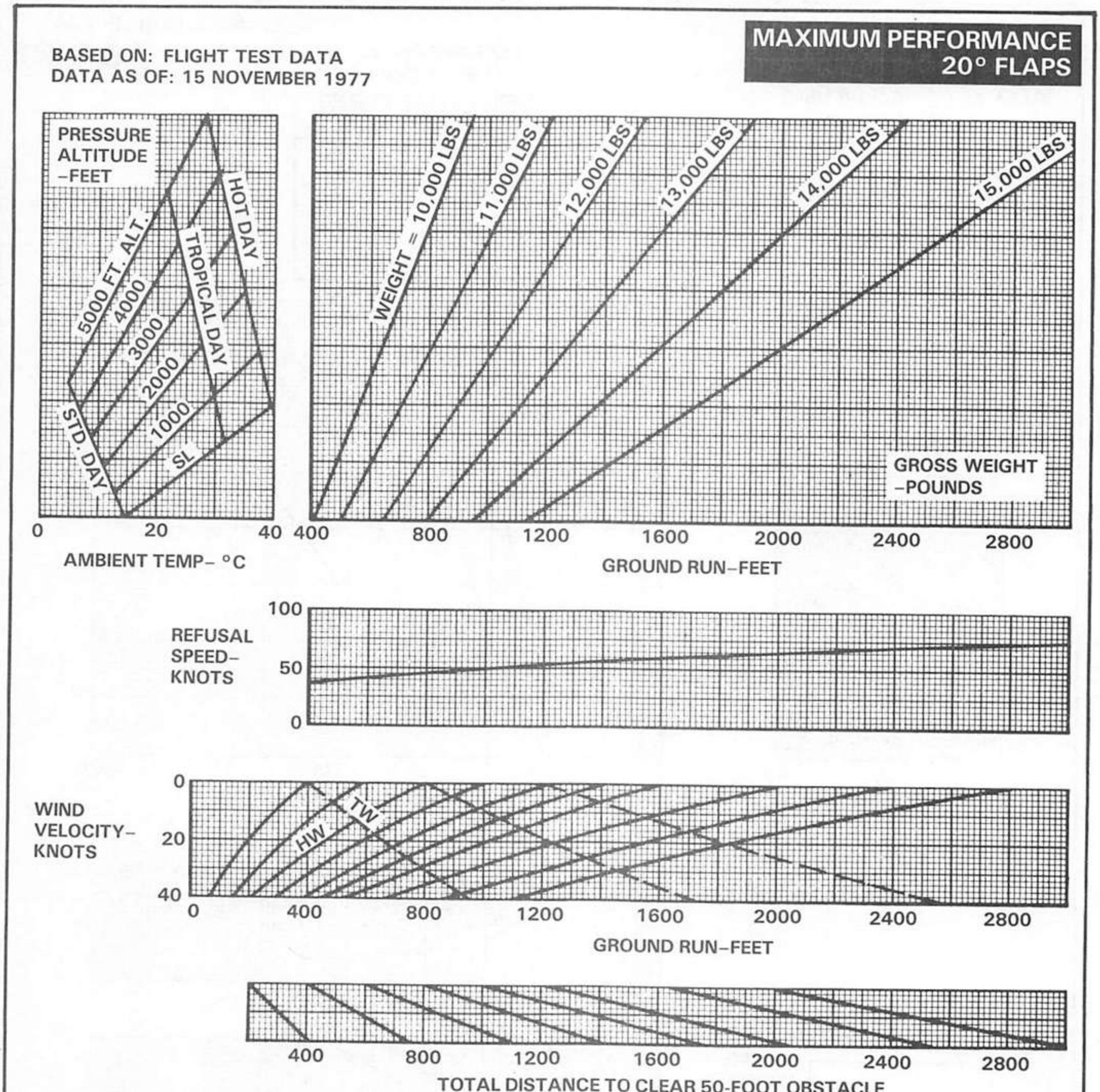
TAKE-OFF SPEED–
KNOTS IAS

GROSS WEIGHT (LBS)	SPEED (IAS)
10,000	76
11,000	82
12,000	88
13,000	94
14,000	100
15,000	106

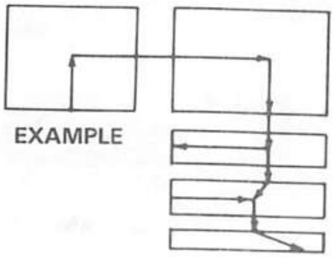


NA-86-0043-272A

Figure 26-7. Take-Off Distance, STOL Performance (Flaps 20°)



TAKE-OFF SPEED–KNOTS IAS	
GROSS WEIGHT (POUNDS)	LIFT-OFF SPEED IAS–KNOTS
10,000	68.0
11,000	71.5
12,000	75.0
13,000	78.0
14,000	82.0
15,000	85.0



NOTE:
INCREASE GROUND RUN DISTANCE 4 PERCENT FOR EACH 1 PERCENT INCREASE IN THE RUNWAY SLOPE

NA-86-0043-273A

Figure 26-8. Take-Off Distance, Maximum Performance (Flaps 20°)

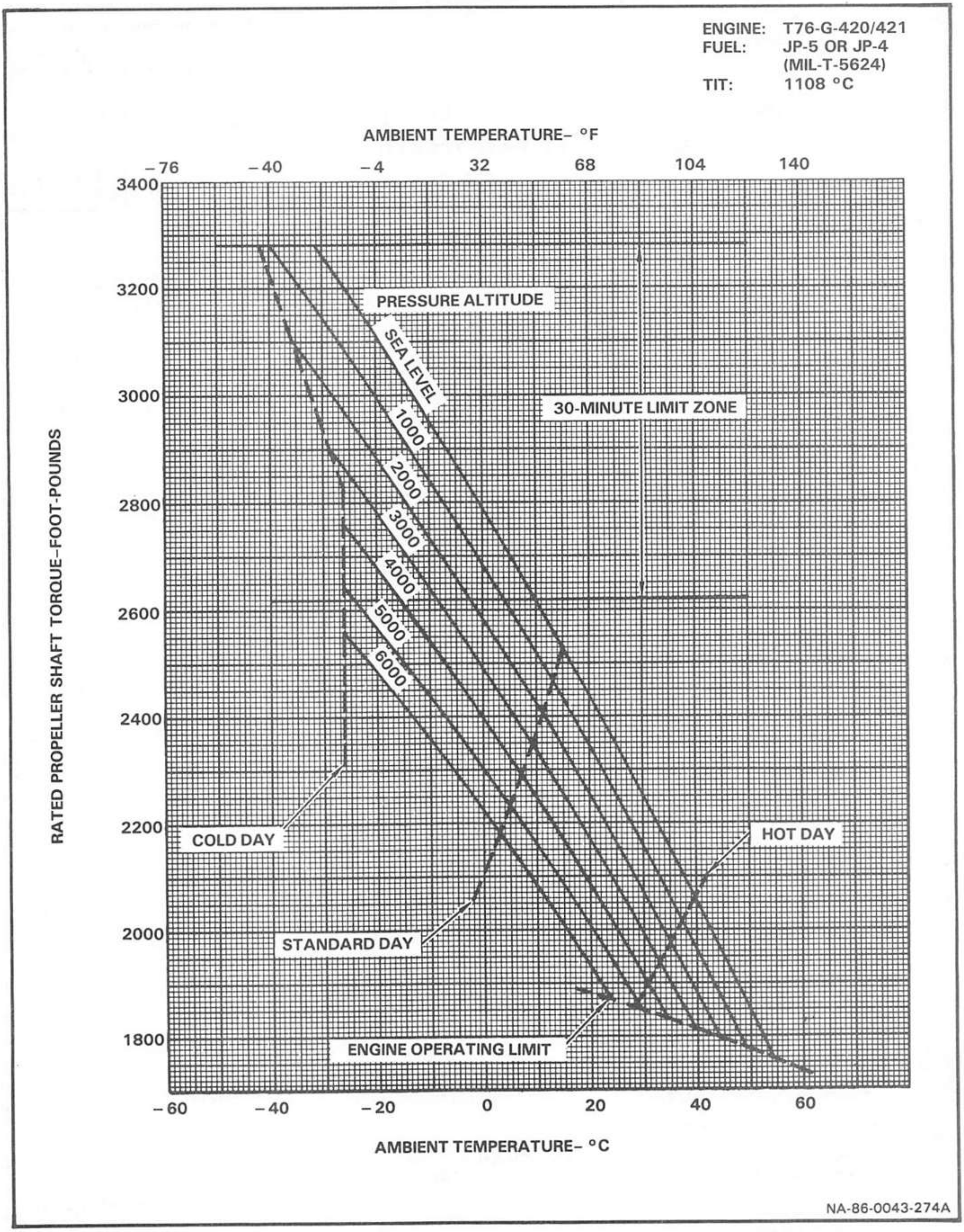
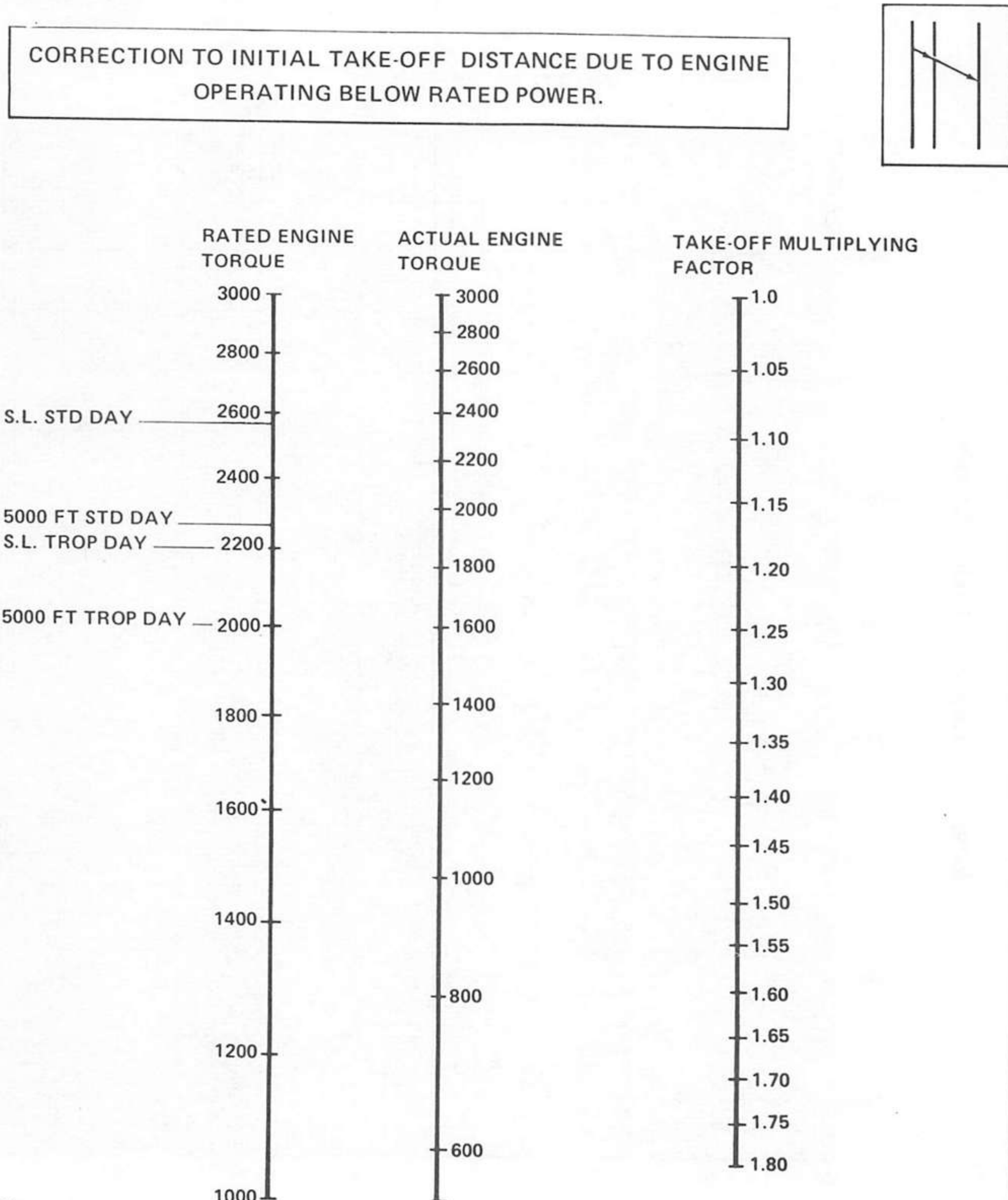


Figure 26-9. Rated Propeller Shaft Torque at Military Power (Foot-Pounds)



NOTE:

IF ENGINE TORQUE READING IS LESS THAN RATED VALUE, TAKE-OFF DISTANCE WILL INCREASE.

NA-86-0043-275

Figure 26-10. Power Correction

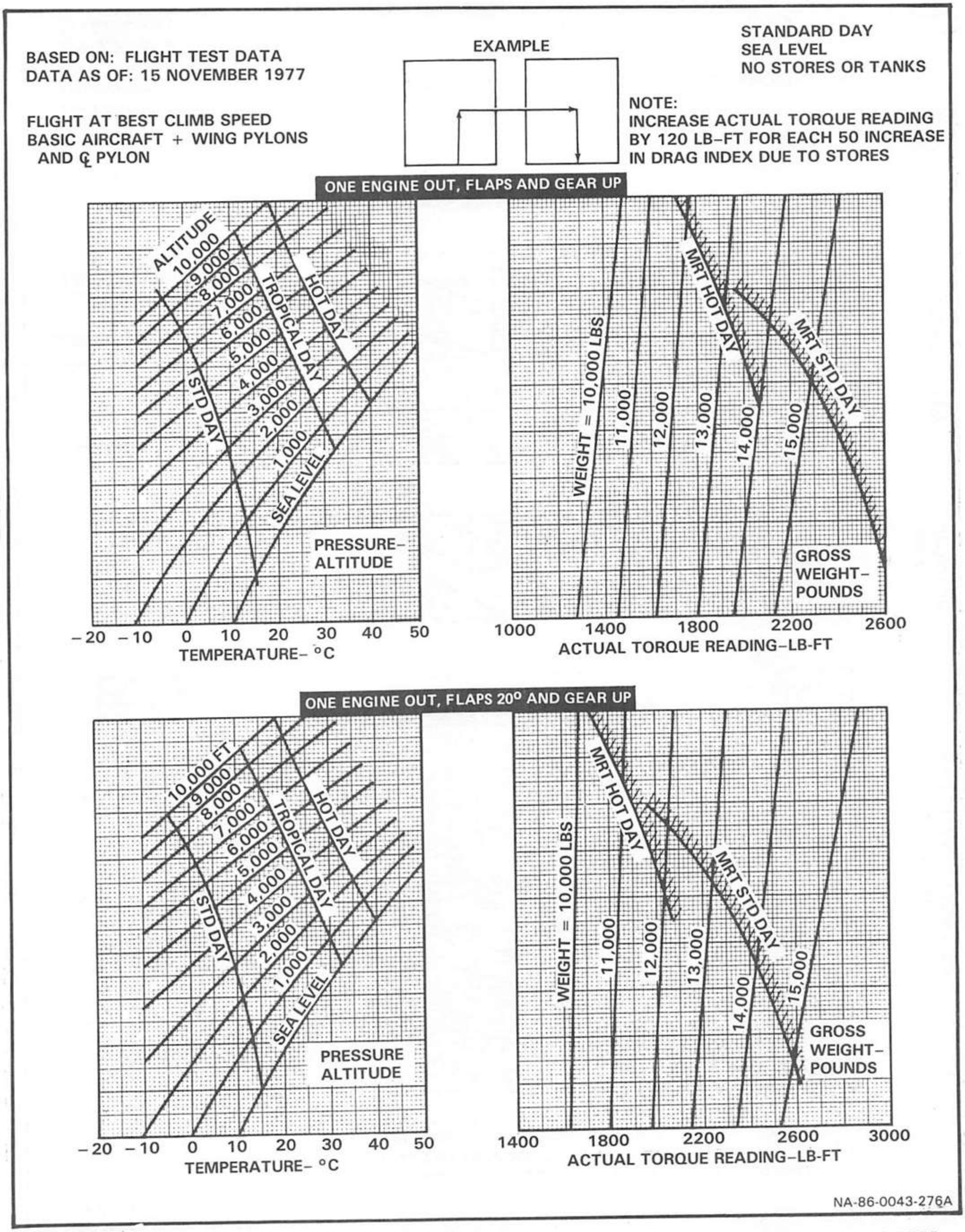


Figure 26-11. Single-Engine Minimum Torque vs. Gross Weight To Maintain 100 FPM Rate of Climb

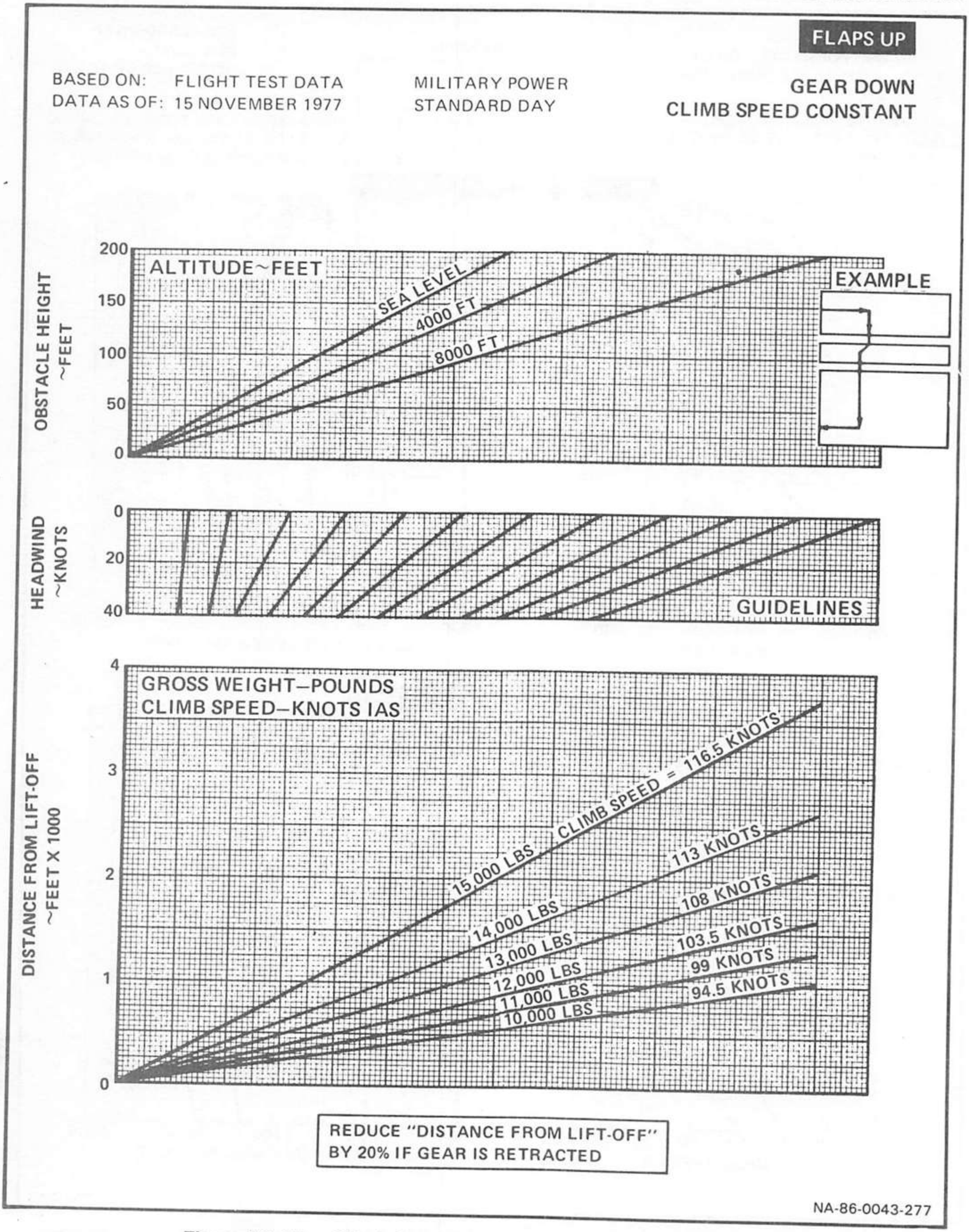


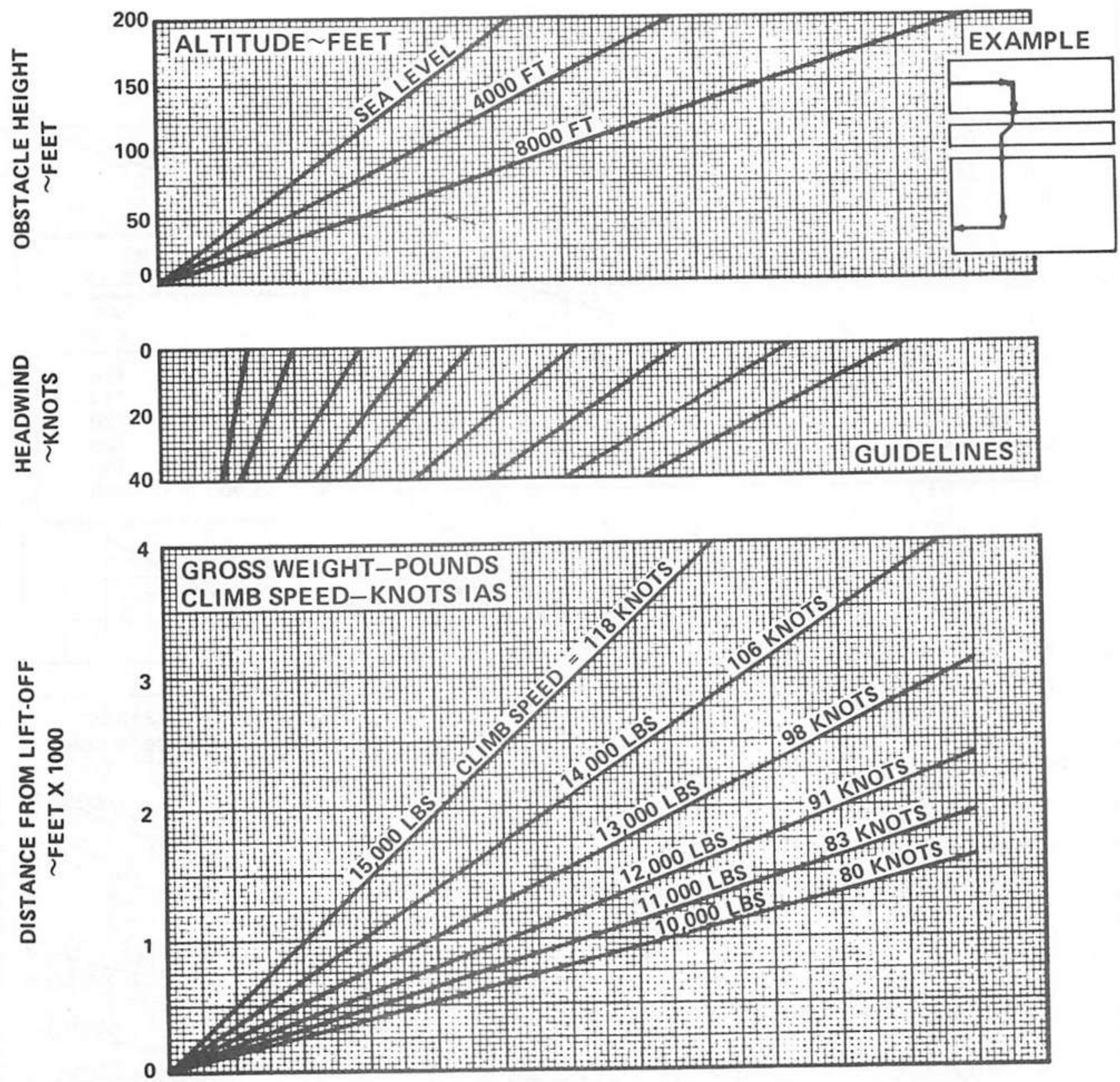
Figure 26-12. Climb-Out Flight Path (Two Engines–Flaps Up)

FLAPS 20°

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

MILITARY POWER
STANDARD DAY

GEAR DOWN
CLIMB SPEED CONSTANT



REDUCE "DISTANCE FROM LIFT-OFF" BY 20% IF GEAR IS RETRACTED

NA-86-0043-278

Figure 26-13. Climb-Out Flight Path (Two Engines–Flaps 20°)

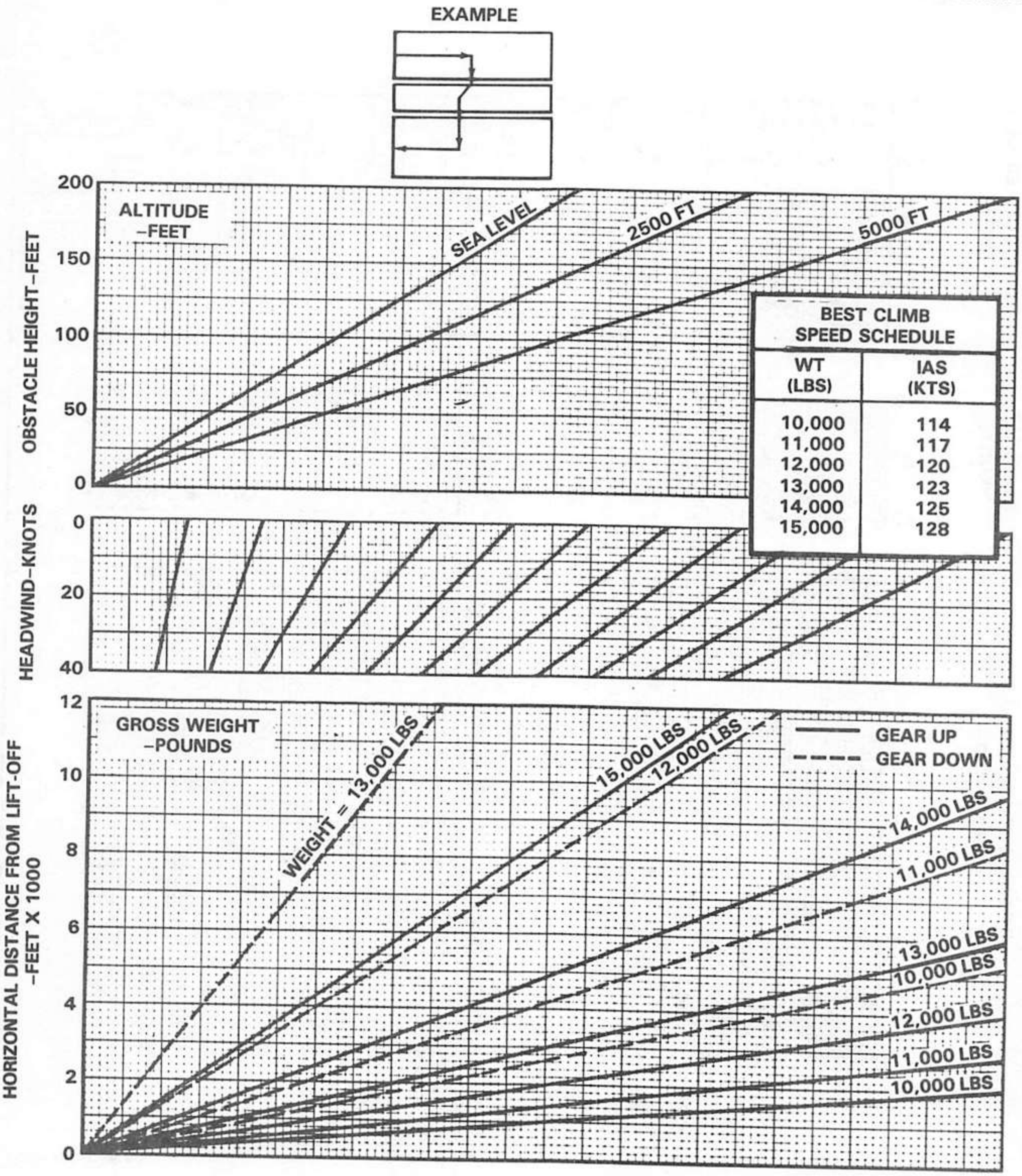
BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

MILITARY POWER
STANDARD DAY

FLAPS UP

GEAR UP AND DOWN

CLIMB SPEED CONSTANT

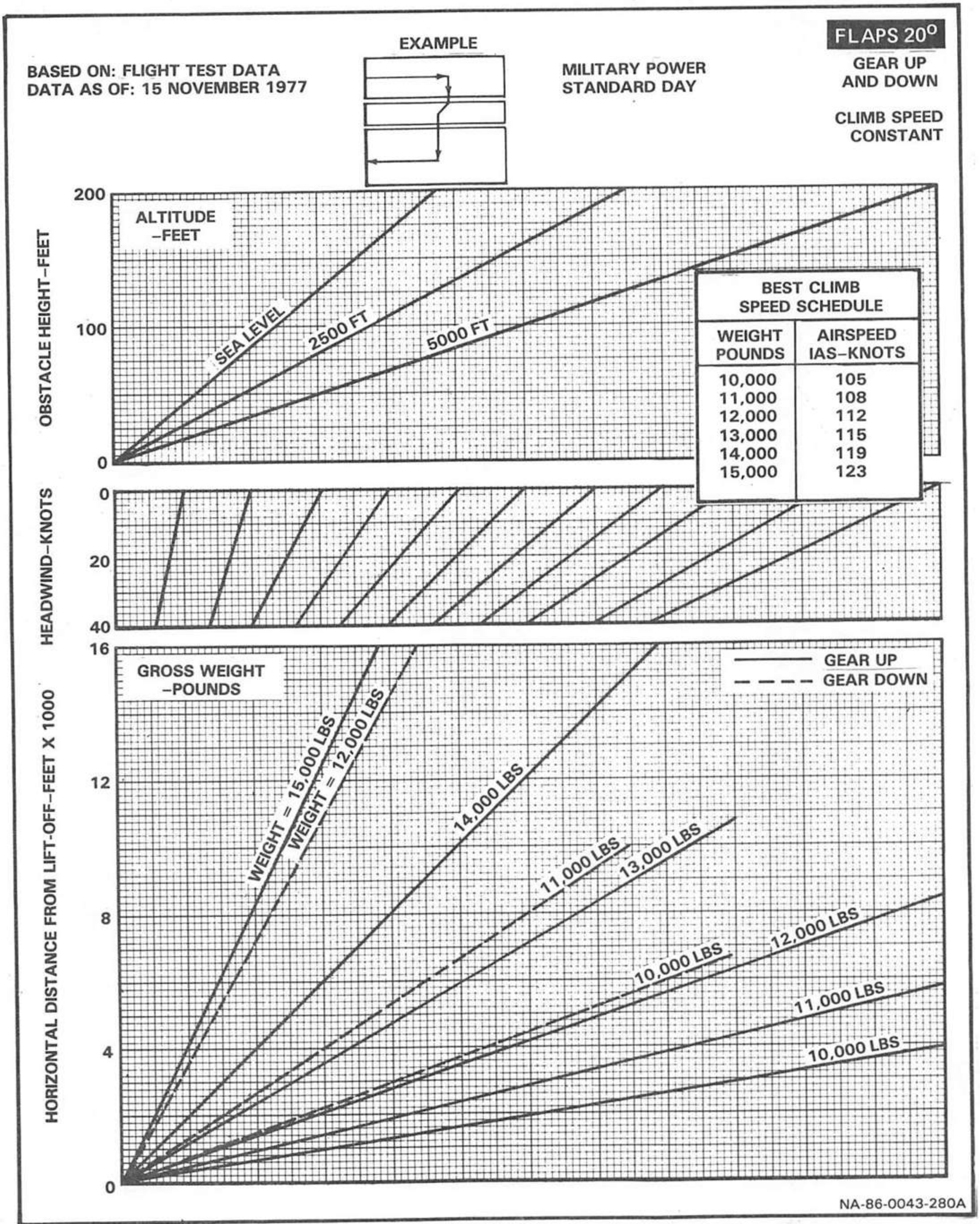


BEST CLIMB SPEED SCHEDULE

WT (LBS)	IAS (KTS)
10,000	114
11,000	117
12,000	120
13,000	123
14,000	125
15,000	128

NA-86-0043-279A

Figure 26-14. Single-Engine Climb-Out Flight Path (Flaps Up)



BEST CLIMB SPEED SCHEDULE	
WEIGHT POUNDS	AIRSPEED IAS–KNOTS
10,000	105
11,000	108
12,000	112
13,000	115
14,000	119
15,000	123

Figure 26-15. Single-Engine Climb-Out Flight Path (Flaps 20°)

CHAPTER 27

Climb Data

27.1 CLIMB DATA

27.1.1 Climb Charts. (Figures 27-1 through 27-3.) Time to climb, distance covered, and fuel required at best climb speed during Military, normal, and single-engine power climb at various gross weights, drag indexes, and ambient temperatures are shown in Figures 27-1 through 27-3. Climb data assume that recommended speeds are used.

27.1.2 Military Power Climb Example Problem. Climb from sea level to 15,000 feet:

- Gross Weight–14,000 pounds
- Drag Index–60
- Average Temperature–20 °C hot
- Wind–Zero (average)

1. Time to climb = 12.5 minutes
2. Distance covered = 32 nautical miles
3. Fuel used = 175 pounds

27.1.3 Single-Engine Climb. (Figures 27-4 through 27-9.) Single-engine rate of climb versus airspeed curves are given in Figures 27-4 through 27-9 for various ambient air temperatures, with flaps and landing gear retracted. In the event of a single-engine emergency, flaps and landing gear should be retracted since this will provide the best climb performance.

NOTE

Decrease rate of climb by 85 feet per minute for each 50 increase in Drag Index due to stores.

27.2 AIRCRAFT CEILINGS (FIGURES 27-10 THROUGH 27-12).

Optimum cruise ceiling and Military power combat ceiling at various gross weights, Drag Indexes, and ambient temperatures are shown in figure 27-10. For two-engine MRP and single-engine MRP service ceilings for various configurations, see Figures 27-11 and 27-12 respectively. To use these charts, estimate a gross weight at altitude by subtracting climb fuel, and determine a preliminary ceiling. Aircraft gross weight is adjusted for this weight reduction and ceiling is corrected for the new gross weight.

27.2.1 Aircraft Ceilings Example Problem. Find initial optimum cruise ceiling with the following conditions:

- Gross Weight–14,000 pounds
- Drag Index–60
- Ambient Temperature–10 °C hot (average)

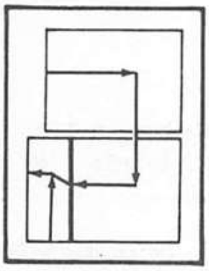
1. Initial cruise ceiling = 15,400 feet
2. Correction for climb fuel = 180 pounds
3. Corrected cruise ceiling = 15,800 feet

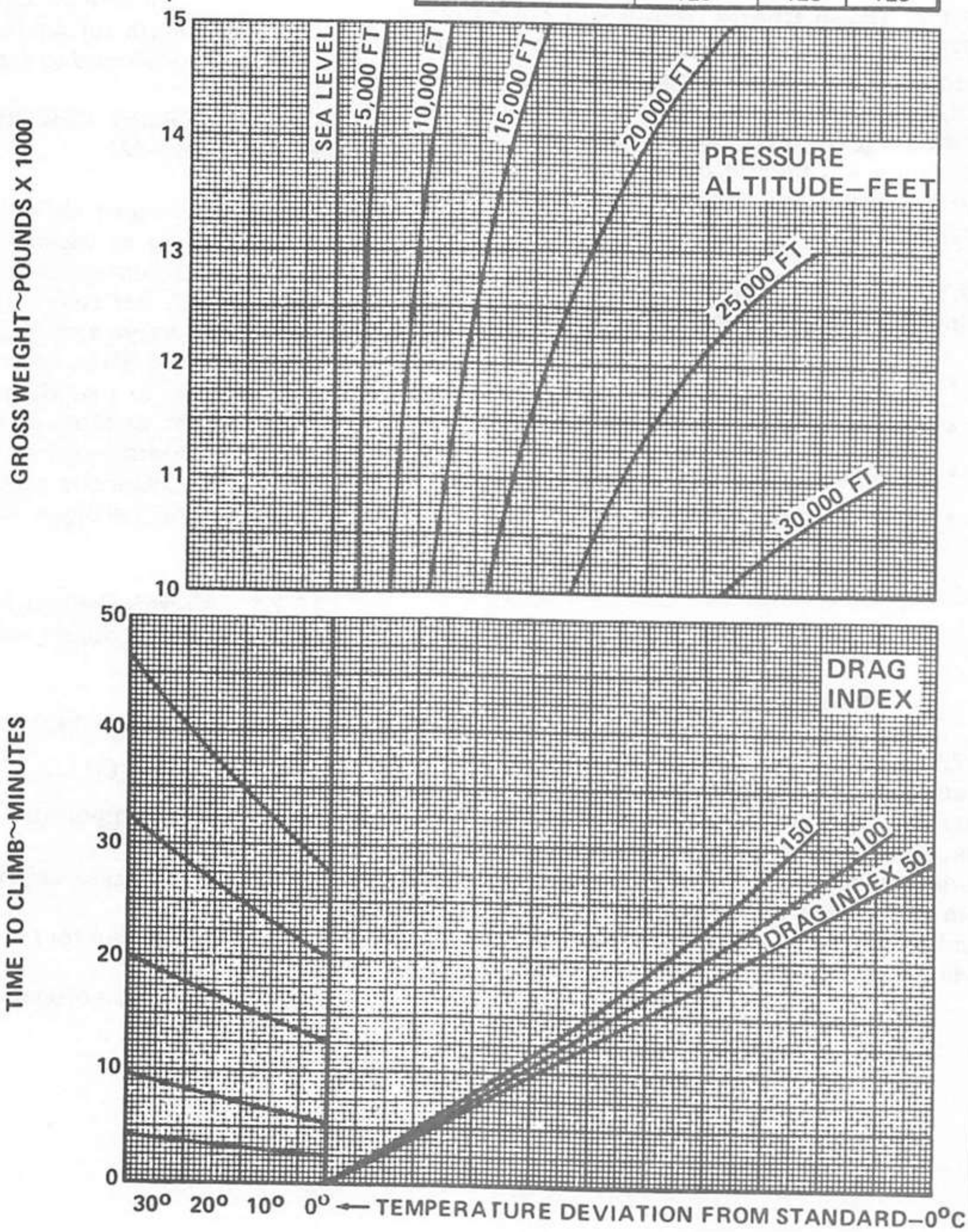
MIL CLIMB TIME

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

CLIMB SPEED SCHEDULE–KNOTS IAS			
ALTITUDE–FEET	DRAG 50	100	150
SEA LEVEL	144	139	135
5,000	139	134	130
10,000	133	129	124
15,000	129	125	123
20,000	126	123	123
25,000	125	123	123
30,000	125	123	123

EXAMPLE





STD ALT	TEMP °C
SL	15
5,000	5
10,000	–5
15,000	–15
20,000	–25
25,000	–35
30,000	–44

NA-86-0043-281

Figure 27-1. Military Power Climb (Sheet 1 of 3)

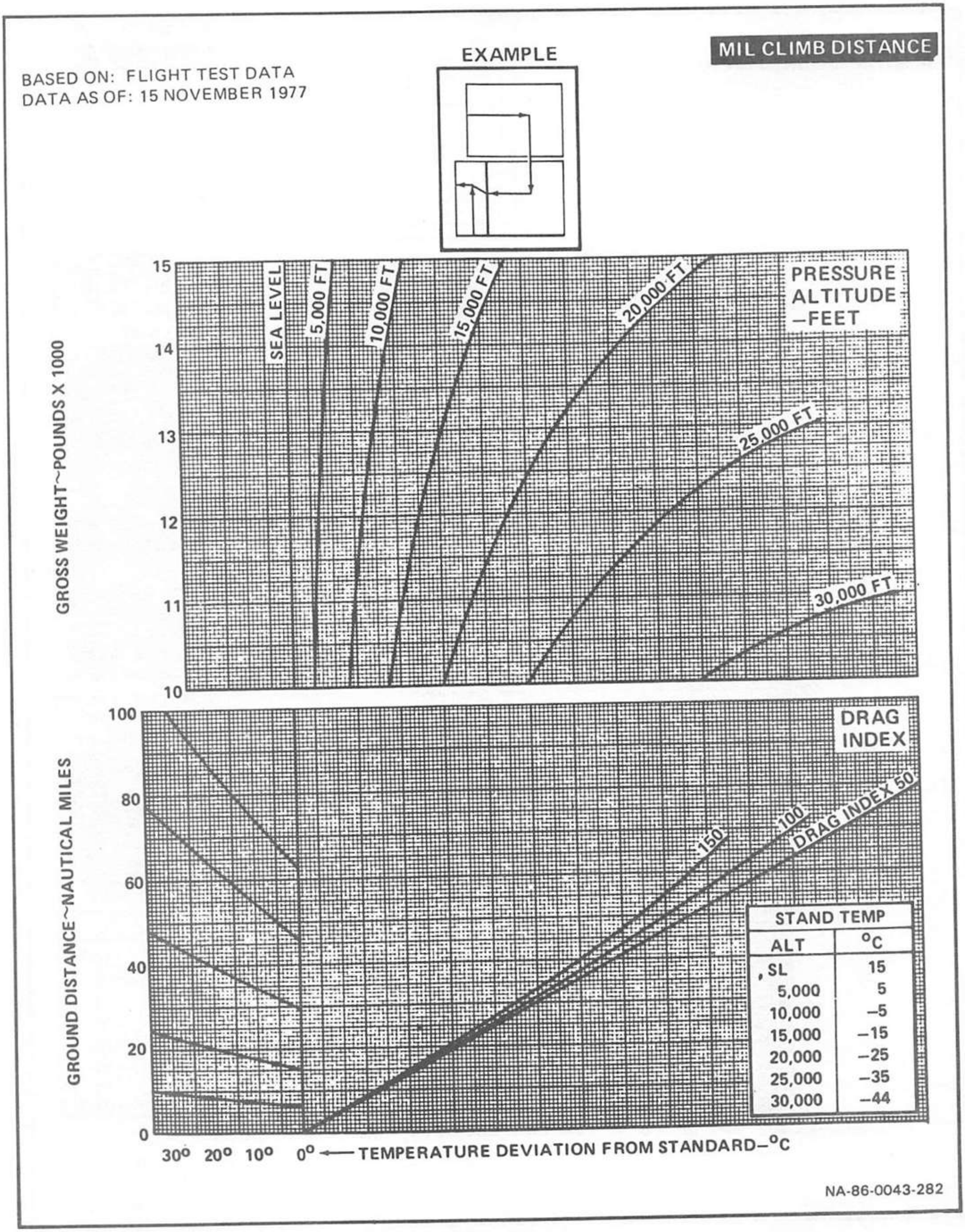
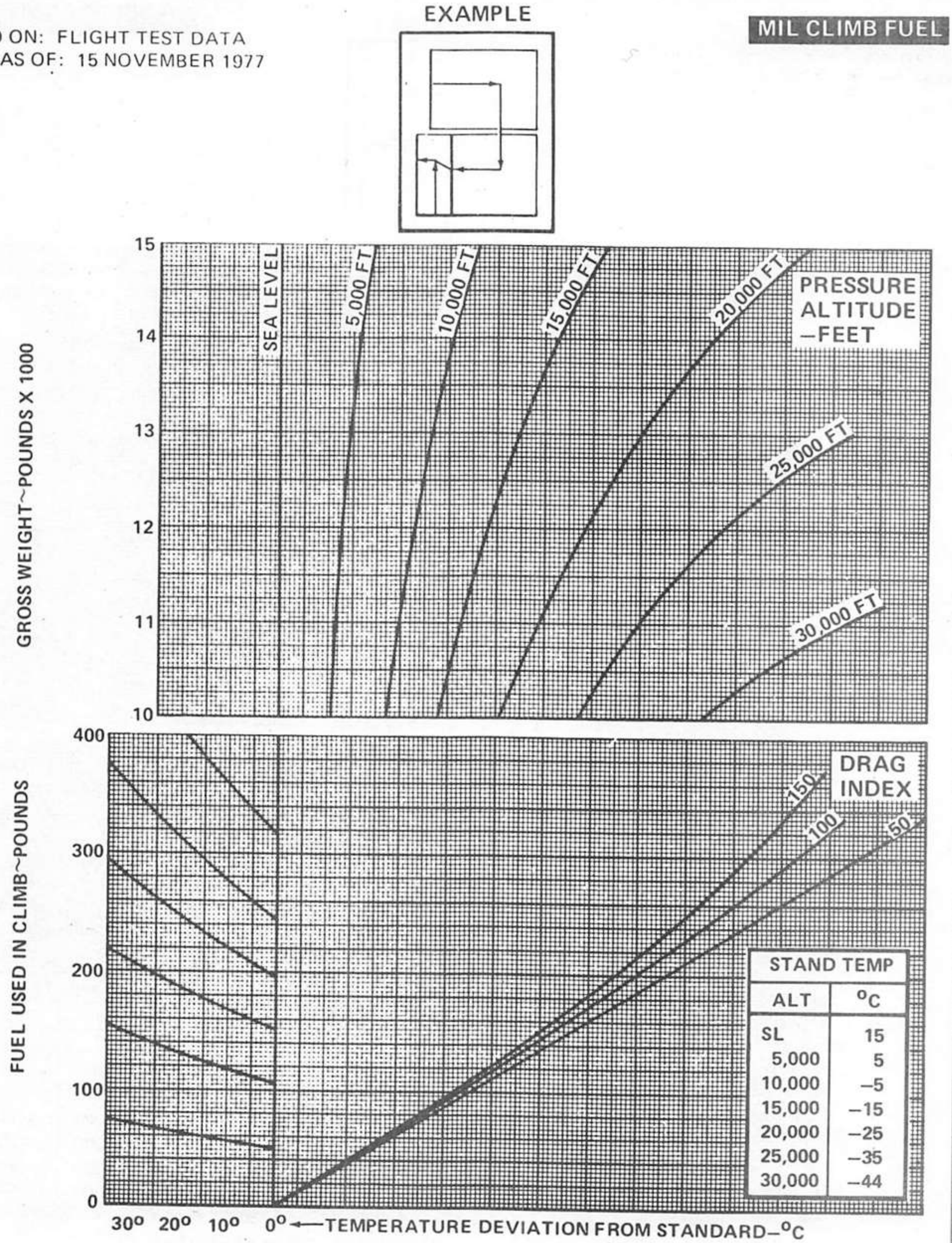


Figure 27-1. Military Power Climb (Sheet 2 of 3)

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977



STAND TEMP	
ALT	°C
SL	15
5,000	5
10,000	–5
15,000	–15
20,000	–25
25,000	–35
30,000	–44

NA-86-0043-283

Figure 27-1. Military Power Climb (Sheet 3 of 3)

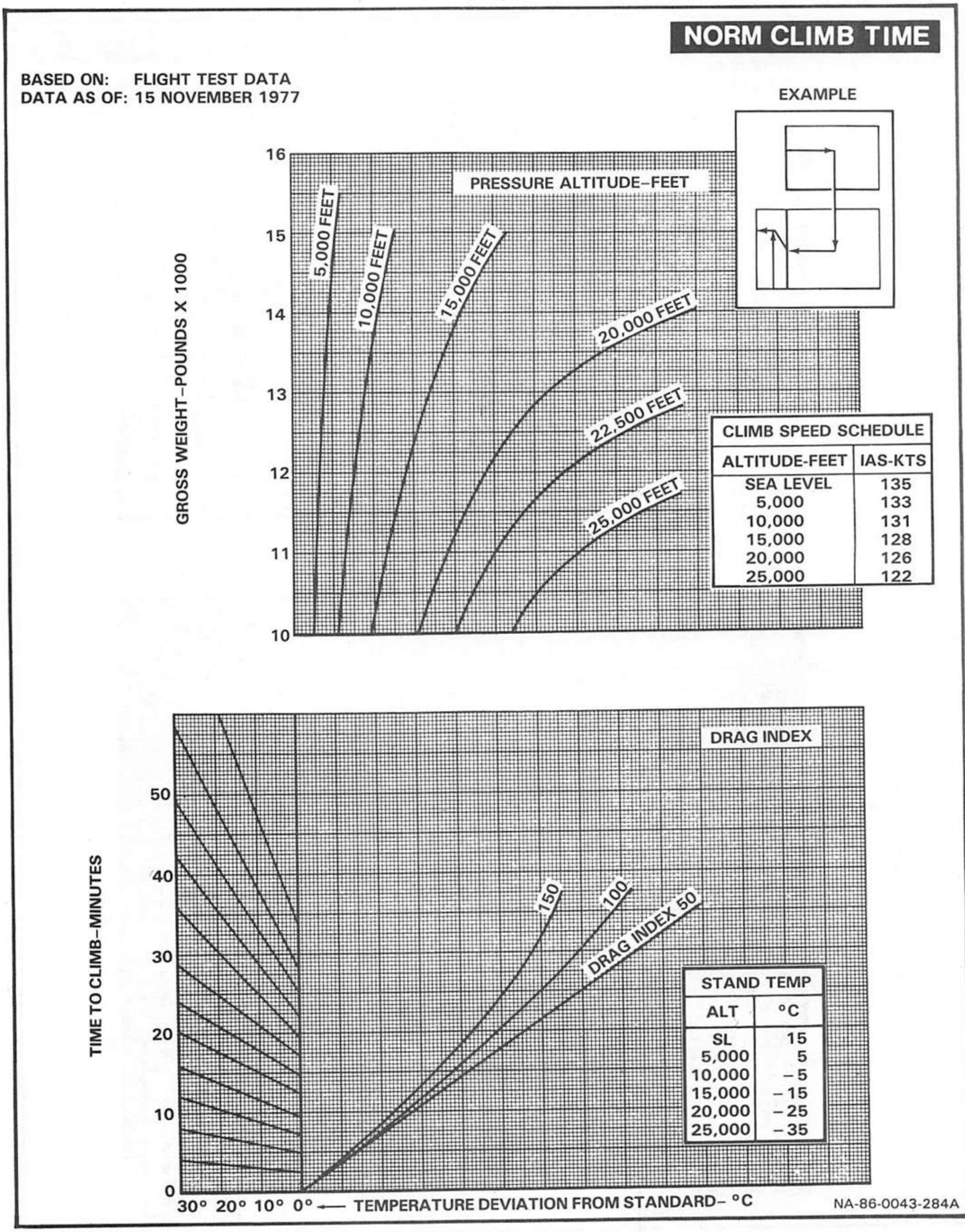
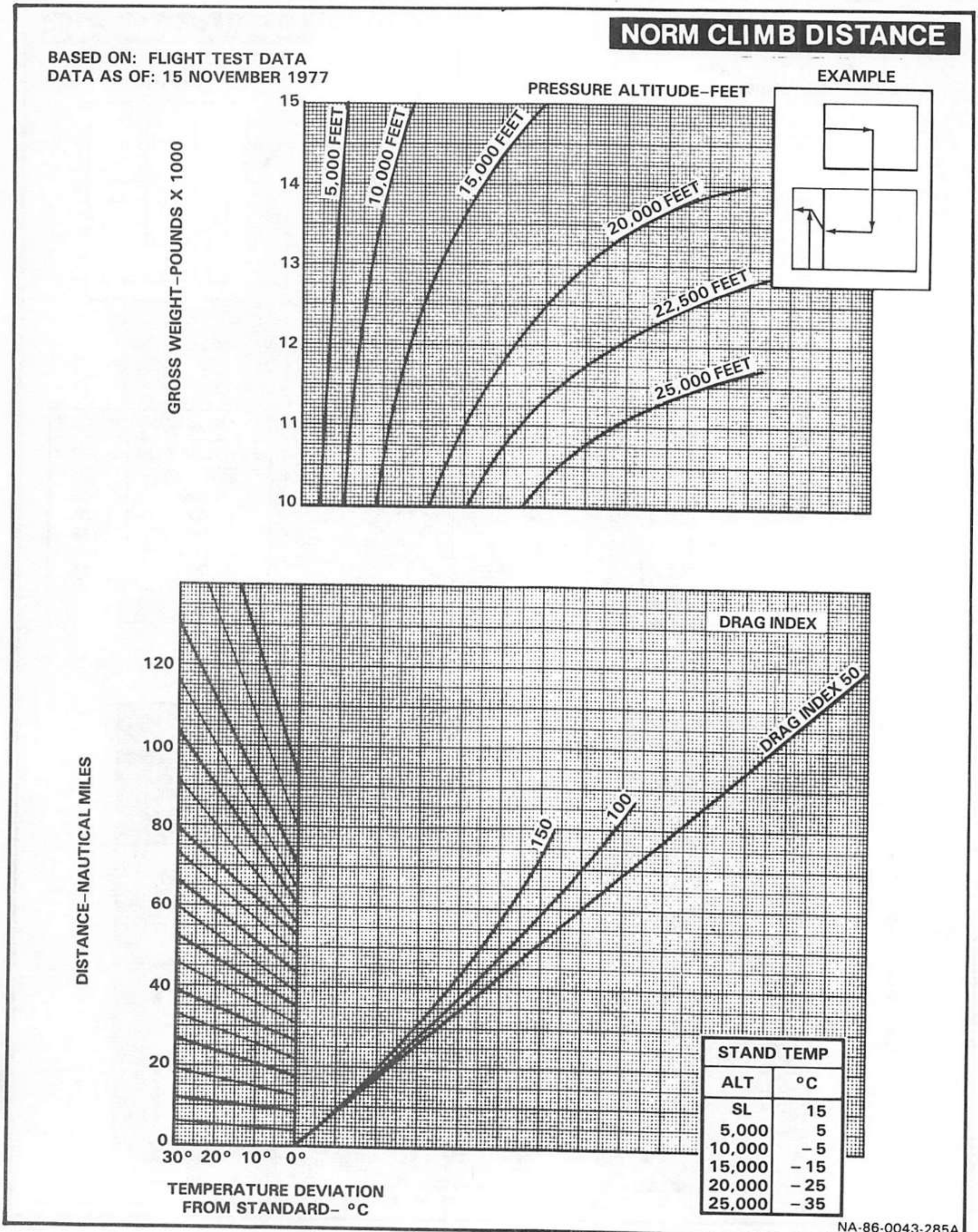


Figure 27-2. Normal Power Climb, Time (Sheet 1 of 3)

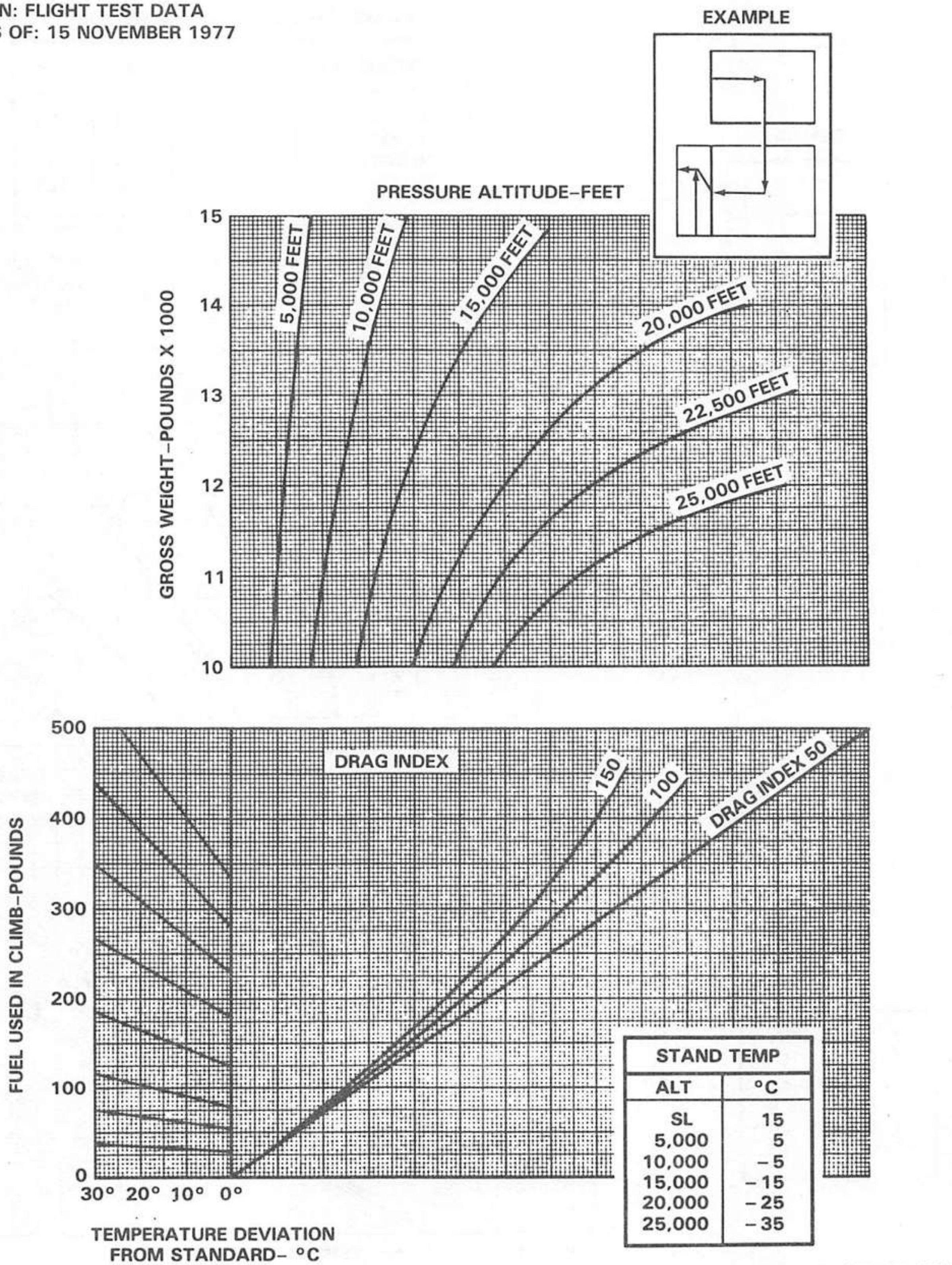


STAND TEMP	
ALT	°C
SL	15
5,000	5
10,000	−5
15,000	−15
20,000	−25
25,000	−35

Figure 27-2. Normal Power Climb, Distance (Sheet 2 of 3)

NORM CLIMB FUEL

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977



STAND TEMP	
ALT	°C
SL	15
5,000	5
10,000	−5
15,000	−15
20,000	−25
25,000	−35

NA-86-0043-286A

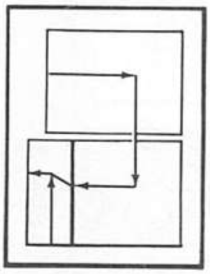
Figure 27-2. Normal Power Climb, Fuel (Sheet 3 of 3)

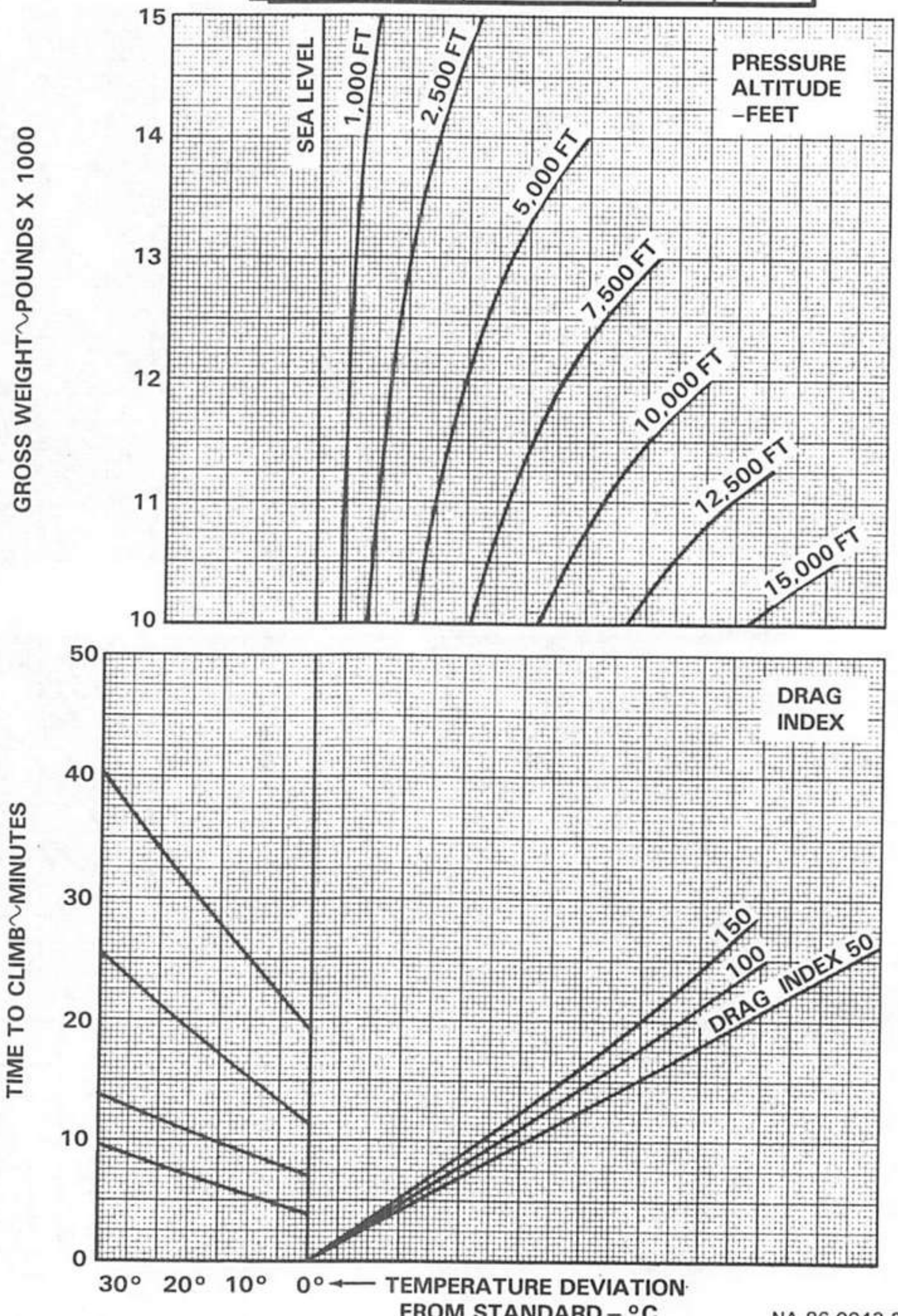
BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

MILITARY RATED POWER
1 ENG CLIMB TIME

CLIMB SPEED SCHEDULE—KNOTS IAS			
ALTITUDE—FT	DRAG 50	100	150
SL	126	123	123
5,000	123	123	123
10,000	123	123	123
15,000	123	123	123

EXAMPLE

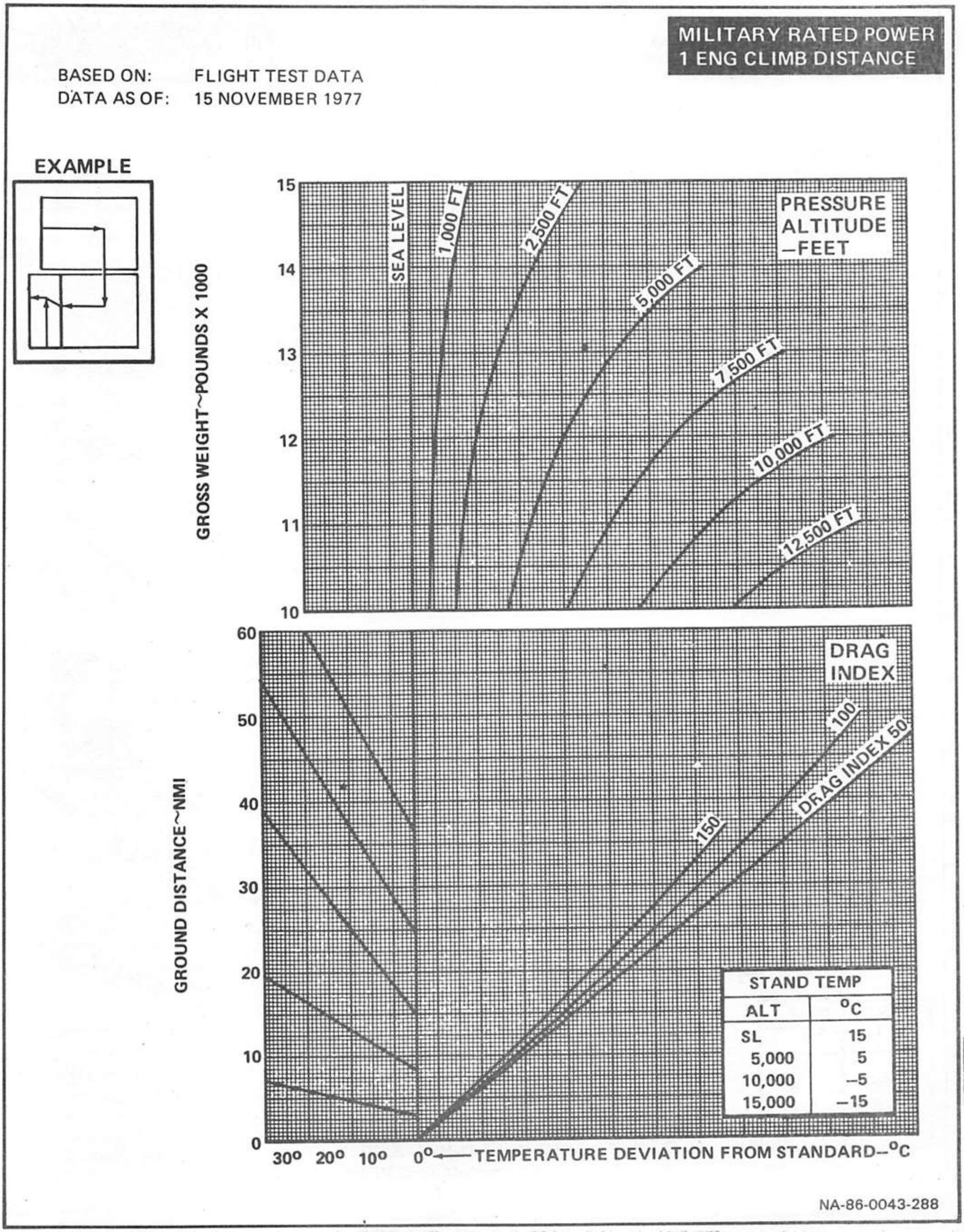




STAND TEMP	
ALT	°C
SL	15
5,000	5
10,000	−5
15,000	−15

NA-86-0043-287A

Figure 27-3. Single-Engine Climb, Military-Rated Power, Time (Sheet 1 of 3)



STAND TEMP	
ALT	°C
SL	15
5,000	5
10,000	–5
15,000	–15

Figure 27-3. Single-Engine Climb, Military-Rated Power, Distance (Sheet 2 of 3)

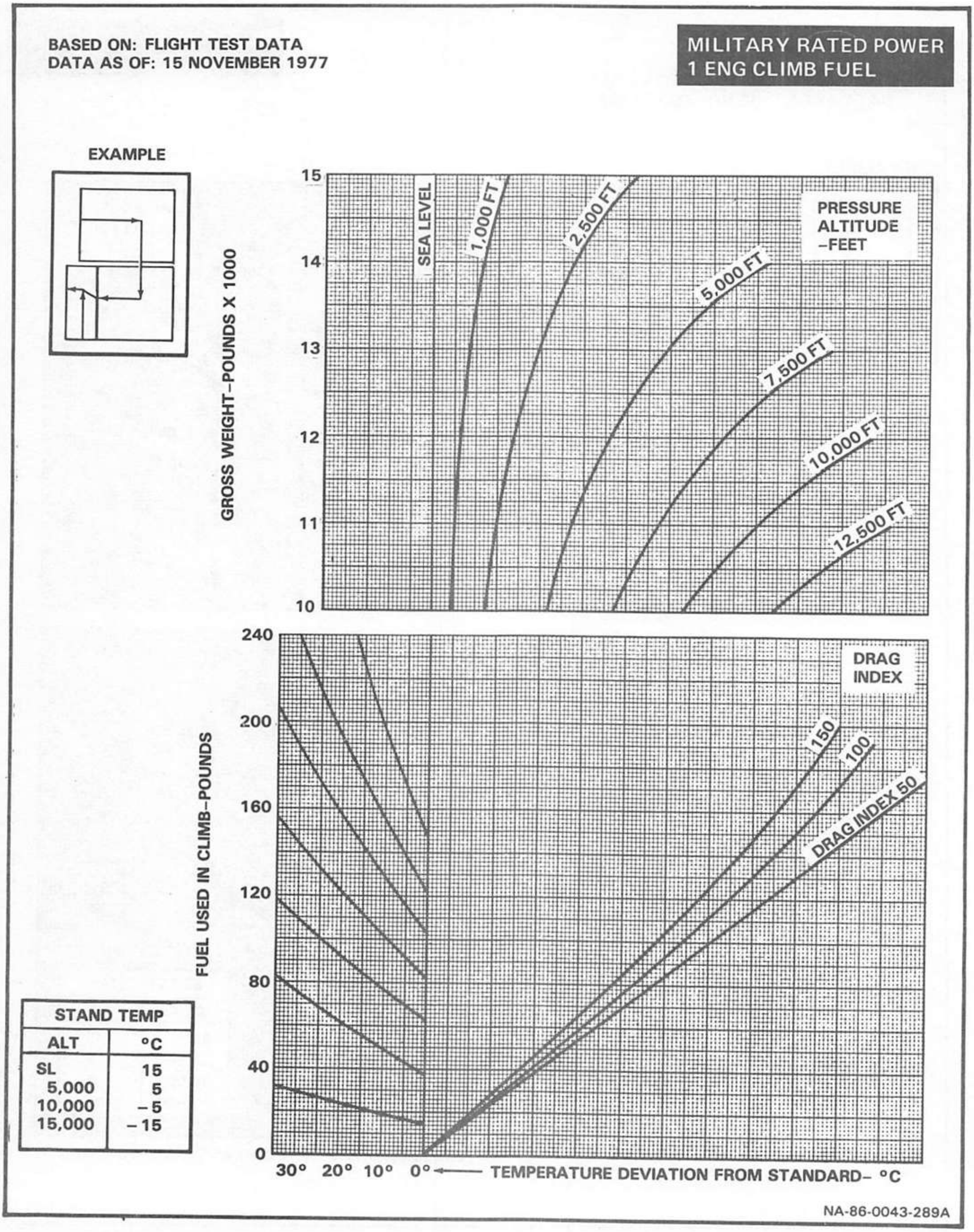


Figure 27-3. Single-Engine Climb, Military-Rated Power, Fuel (Sheet 3 of 3)

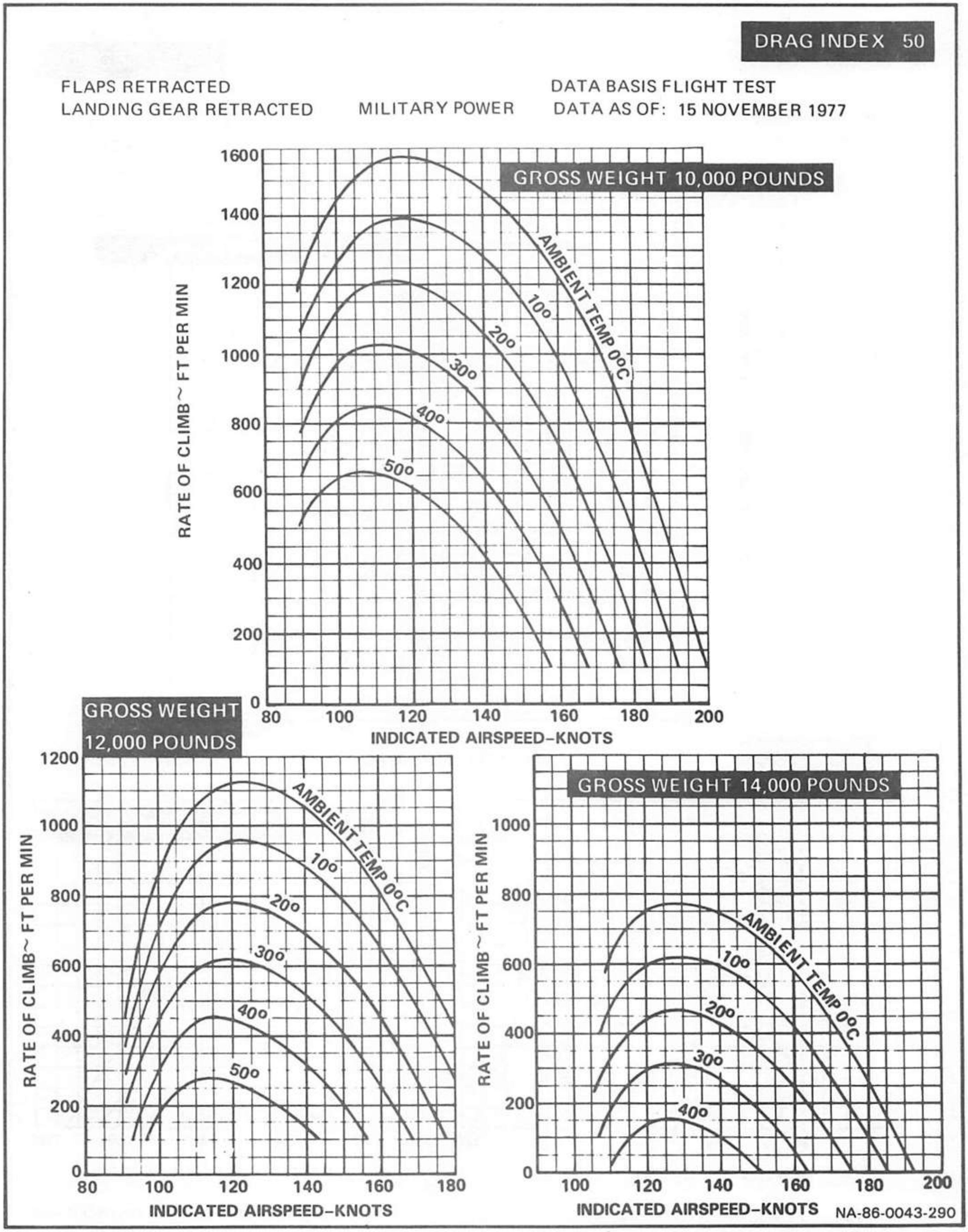


Figure 27-4. Single-Engine Climb at Sea Level Pressure Altitude (Drag Index 50)

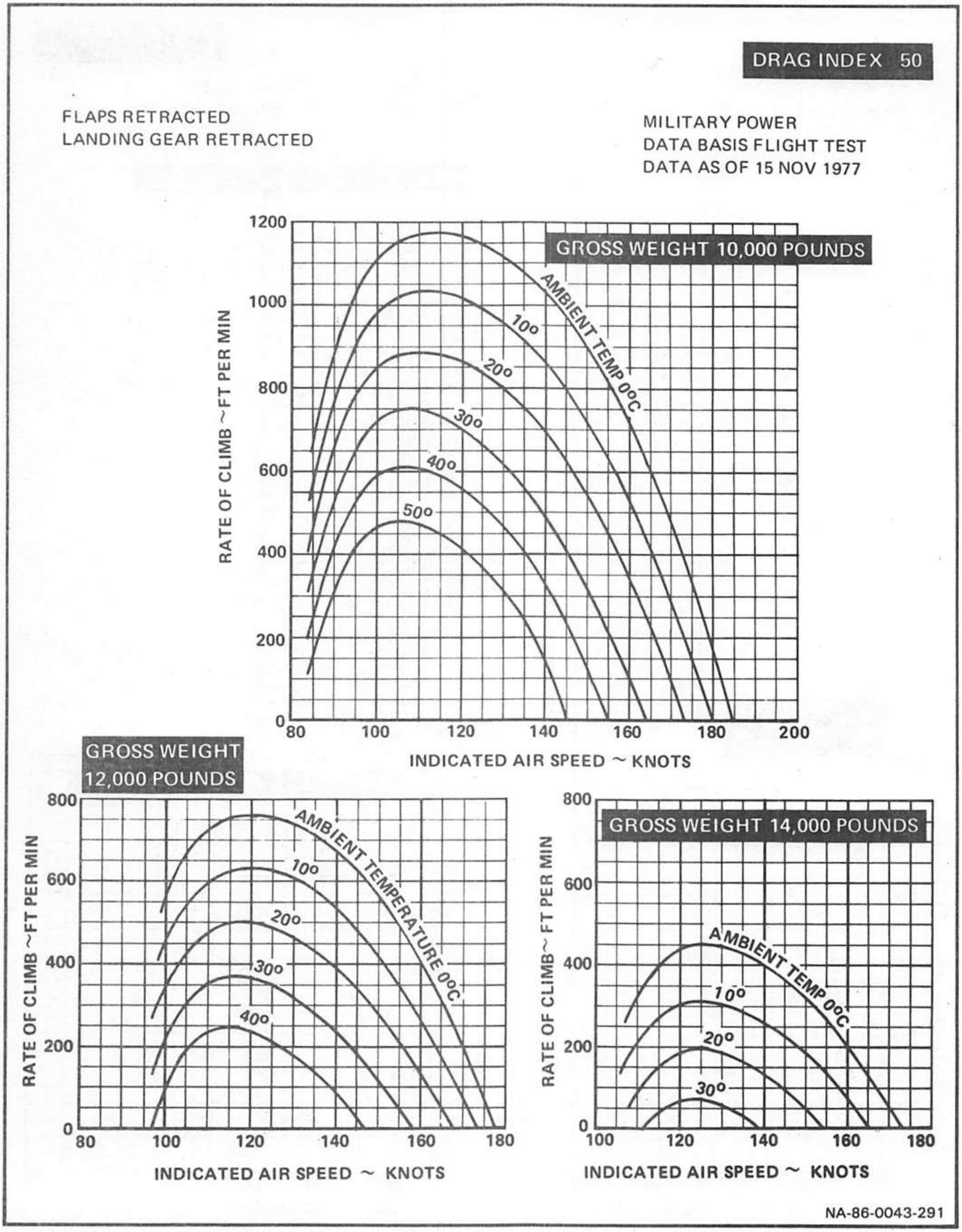


Figure 27-5. Single-Engine Climb at 4,000 Feet Pressure Altitude (Drag Index 50)

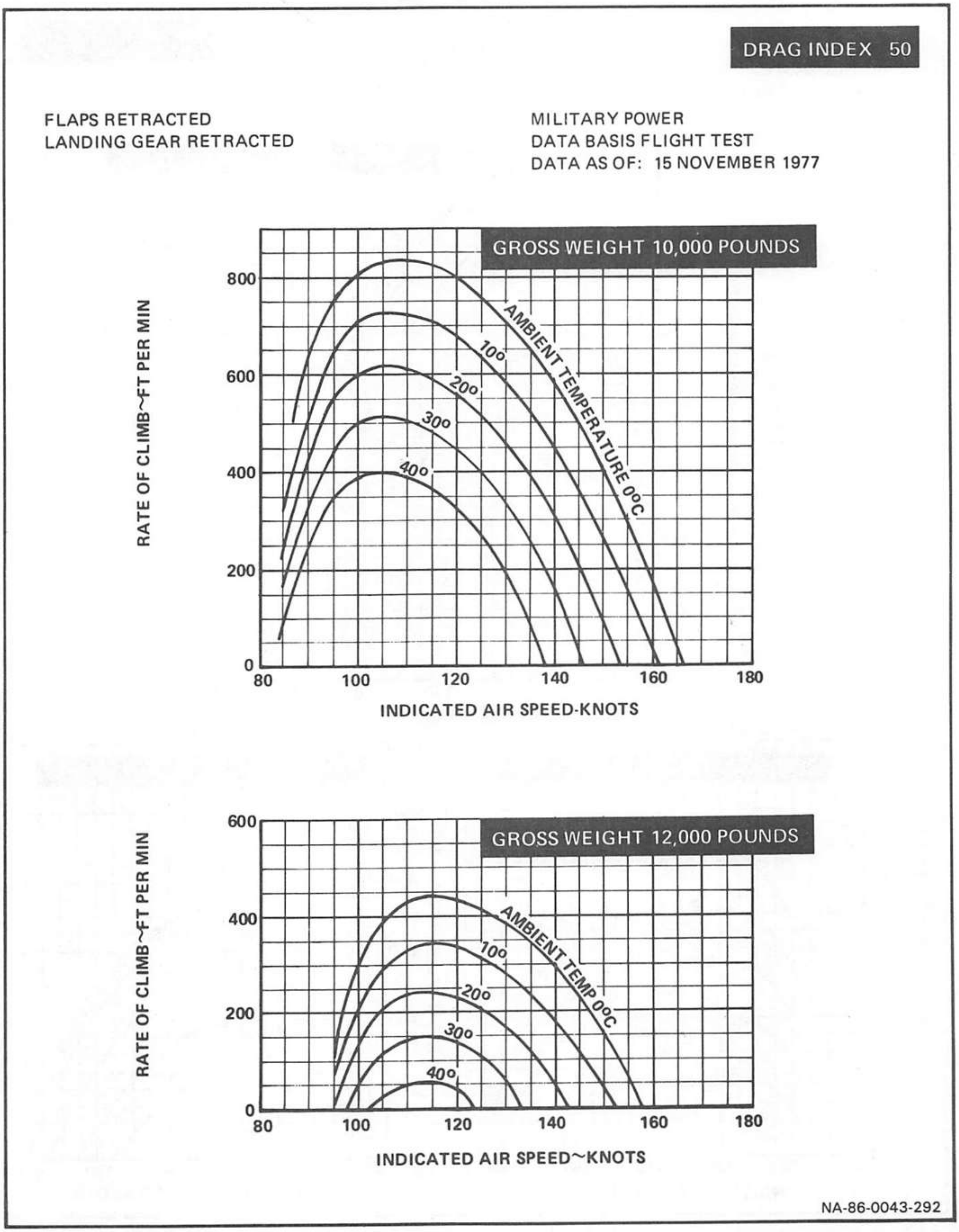


Figure 27-6. Single-Engine Climb at 8,000 Feet Pressure Altitude (Drag Index 50)

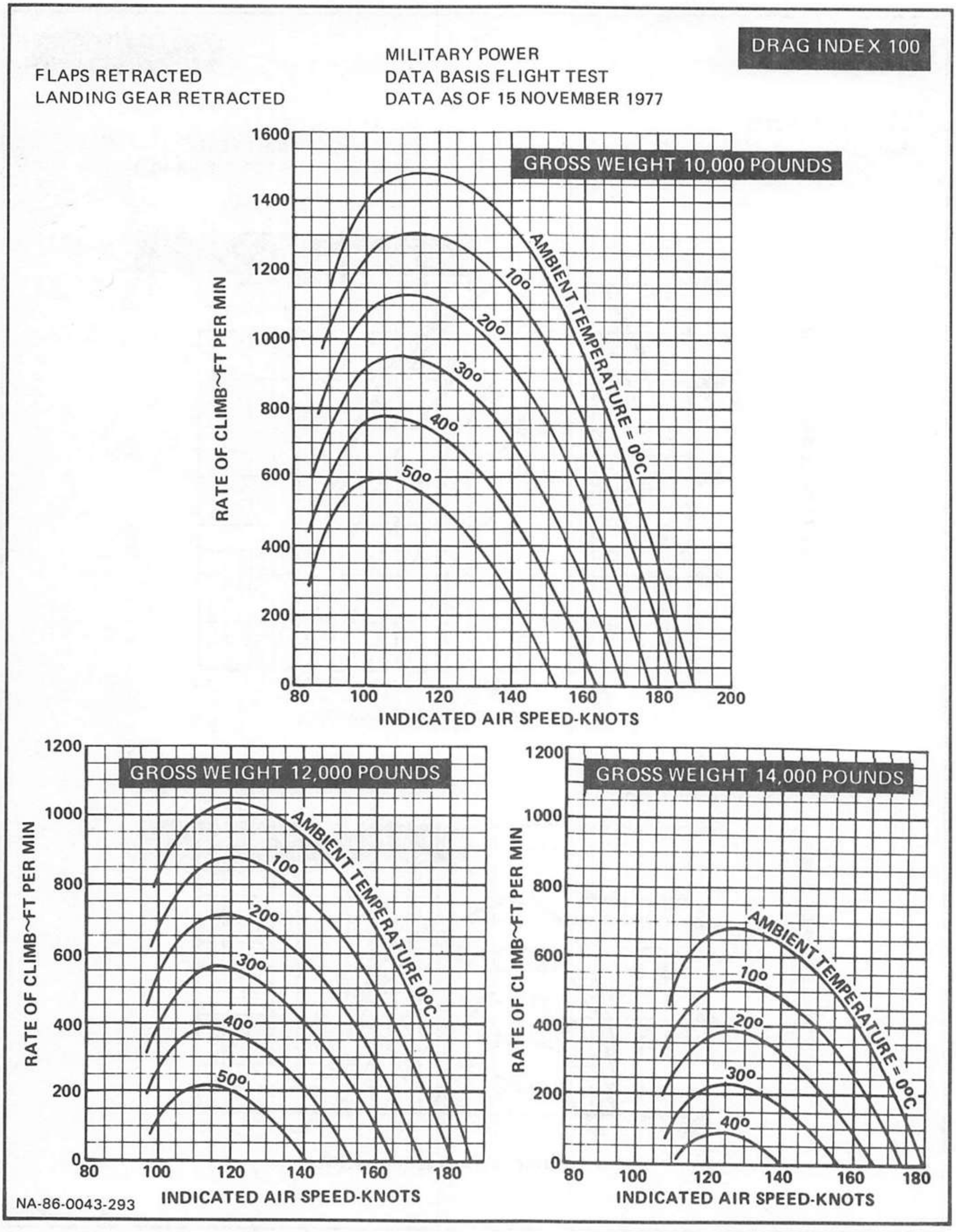
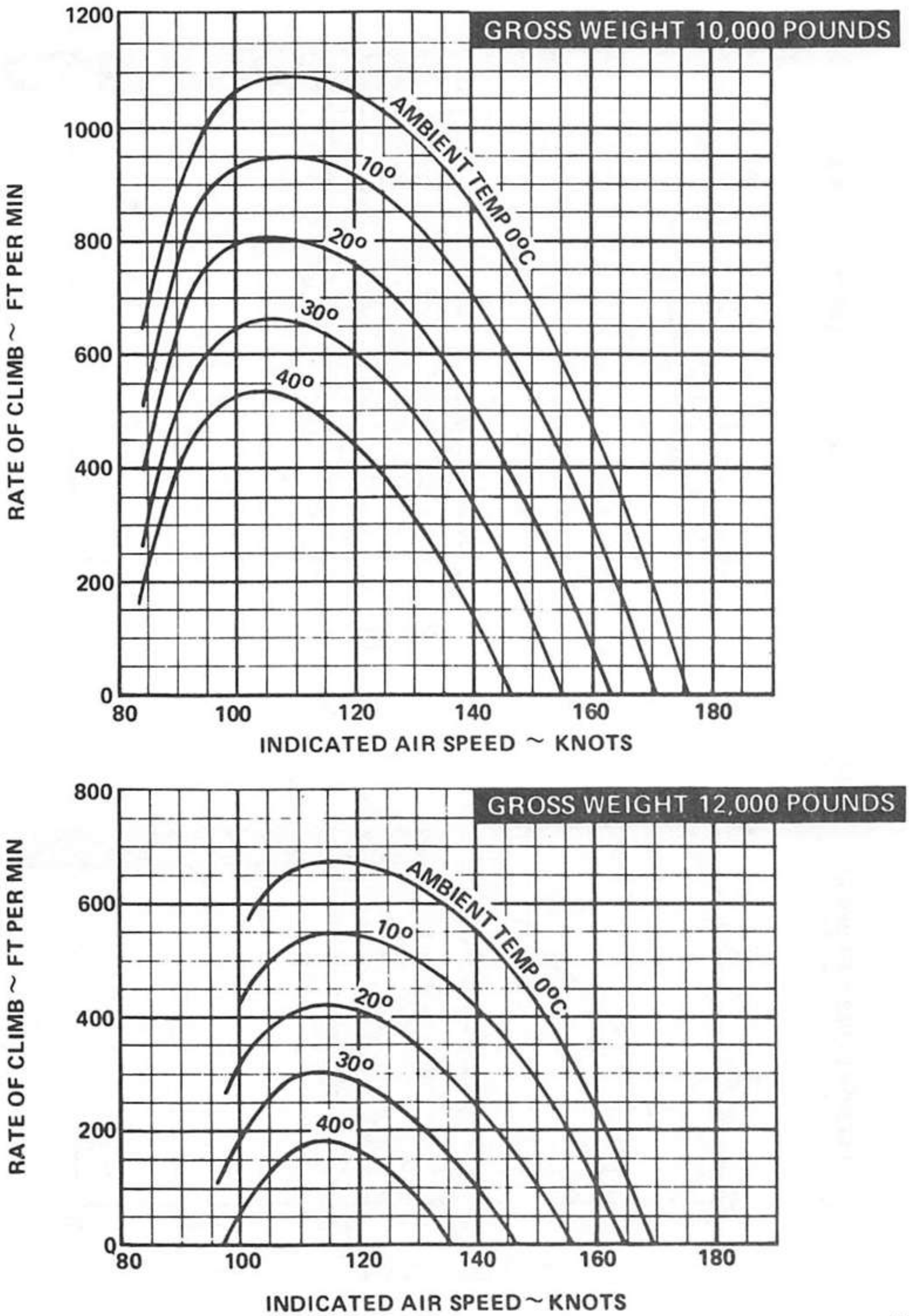


Figure 27-7. Single-Engine Climb at Sea Level Pressure Altitude (Drag Index 100)

DRAG INDEX 100

FLAPS RETRACTED
LANDING GEAR RETRACTED

MILITARY POWER
DATA BASIS FLIGHT TEST
DATA AS OF 15 NOV 1977



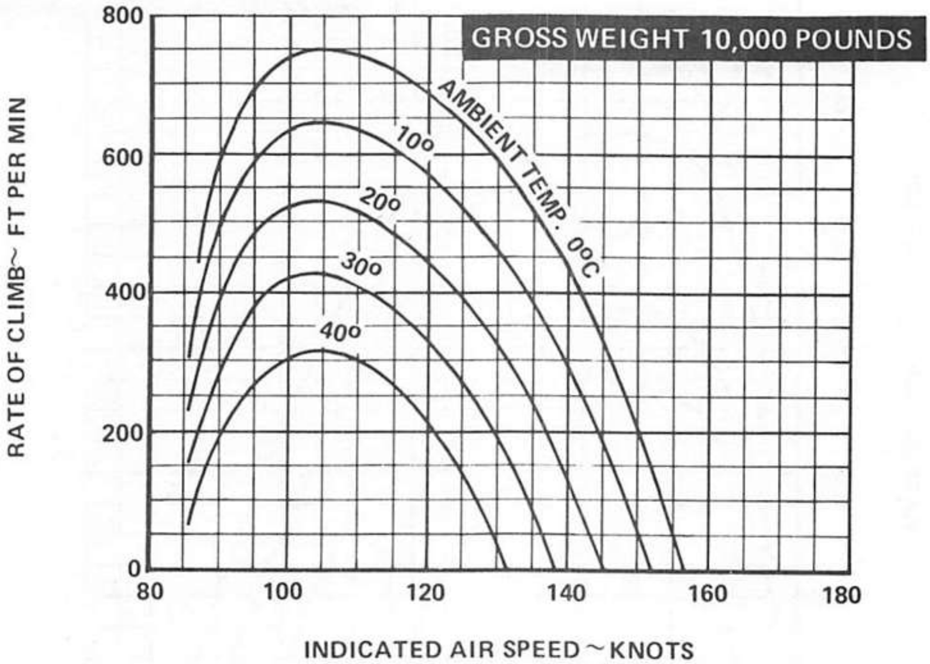
NA-86-0043-294

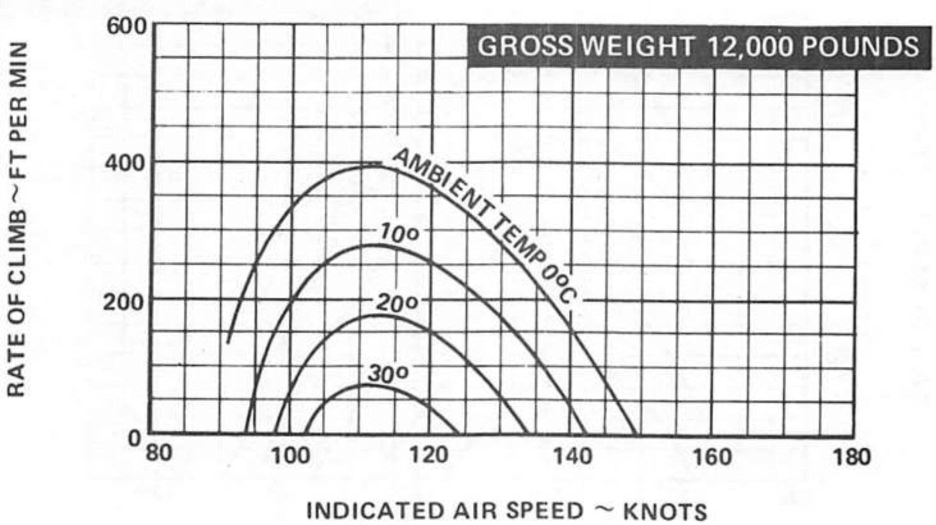
Figure 27-8. Single-Engine Climb at 4,000 Feet Pressure Altitude (Drag Index 100)

DRAG INDEX 100

FLAPS RETRACTED
LANDING GEAR RETRACTED

MILITARY POWER
DATA BASIS FLIGHT TEST
DATA AS OF 15 NOV 1977



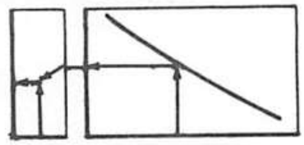


NA-86-0043-295

Figure 27-9. Single-Engine Climb at 8,000 Feet Pressure Altitude (Drag Index 100)

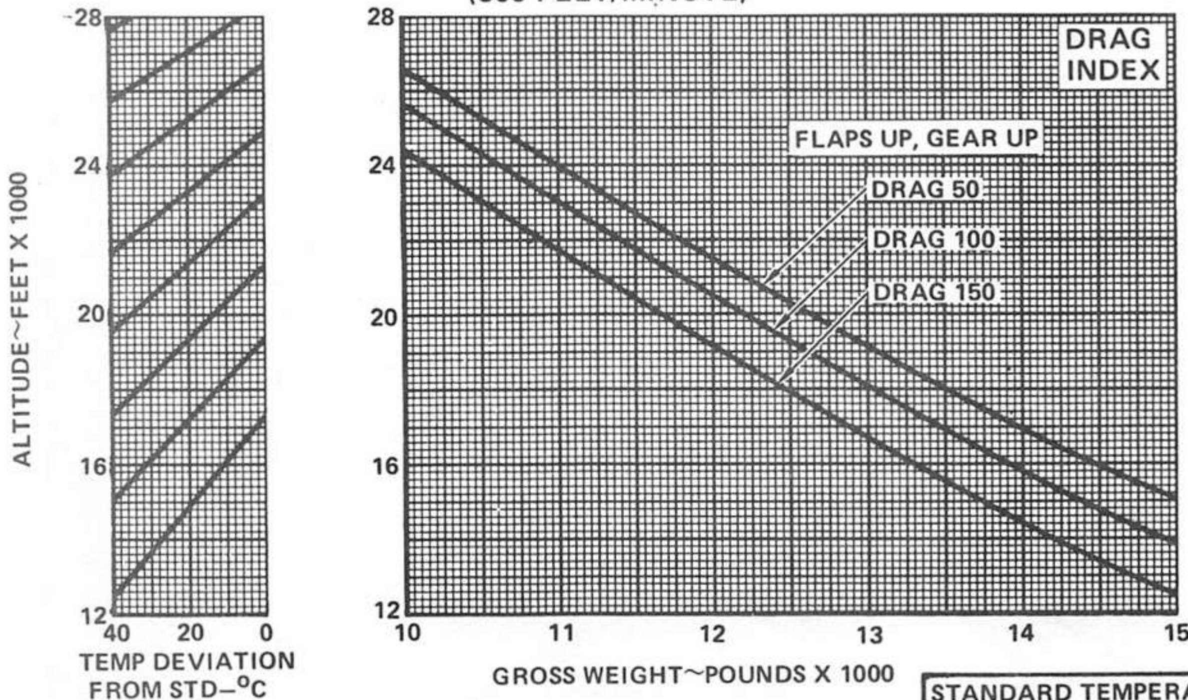
BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

EXAMPLE



OPTIMUM CRUISE ALTITUDE

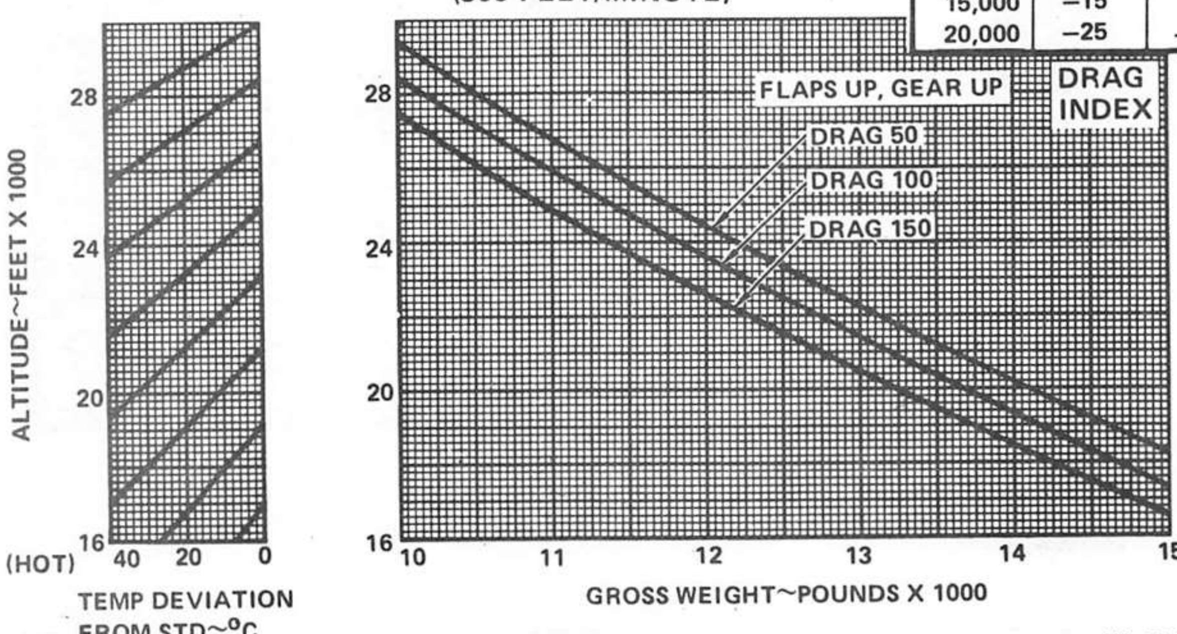
NORMAL RATED POWER
(300 FEET/MINUTE)



STANDARD TEMPERATURE		
ALT	°C	°F
SL	15	59
5,000	5	41
10,000	–5	12
15,000	–15	6
20,000	–25	–12

COMBAT CEILING

MILITARY POWER
(500 FEET/MINUTE)



NA-86-0043-296

Figure 27-10. Aircraft Ceiling–Two Engines

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

MILITARY RATED POWER
RATE OF CLIMB = 100 FPM

STAND TEMP	
ALT	°C
SL	15
5,000	5
10,000	−5
15,000	−15
20,000	−25
25,000	−35
30,000	−44

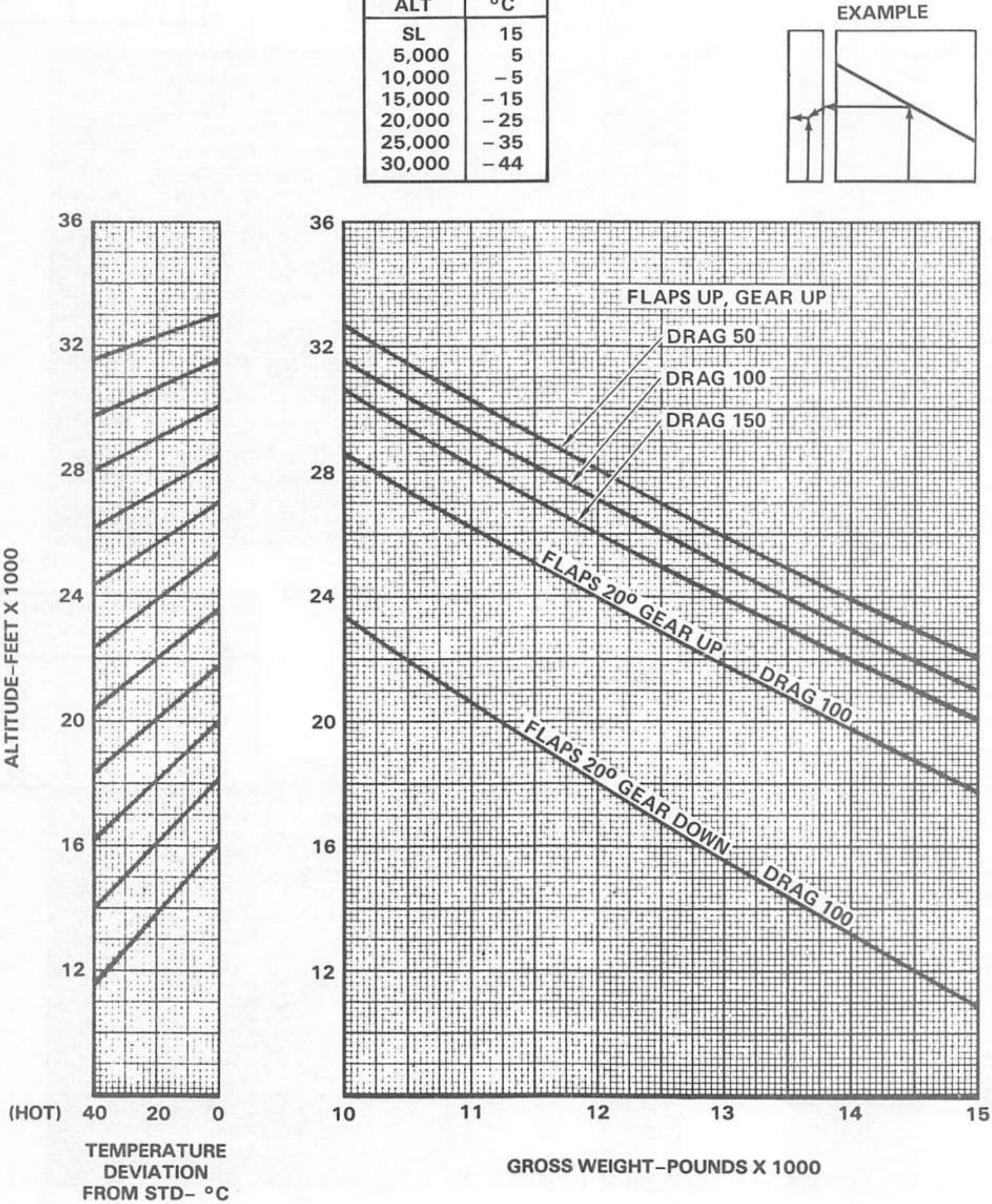


Figure 27-11. Service Ceiling–Two Engines, Military-Rated Power, 100 FPM Rate of Climb

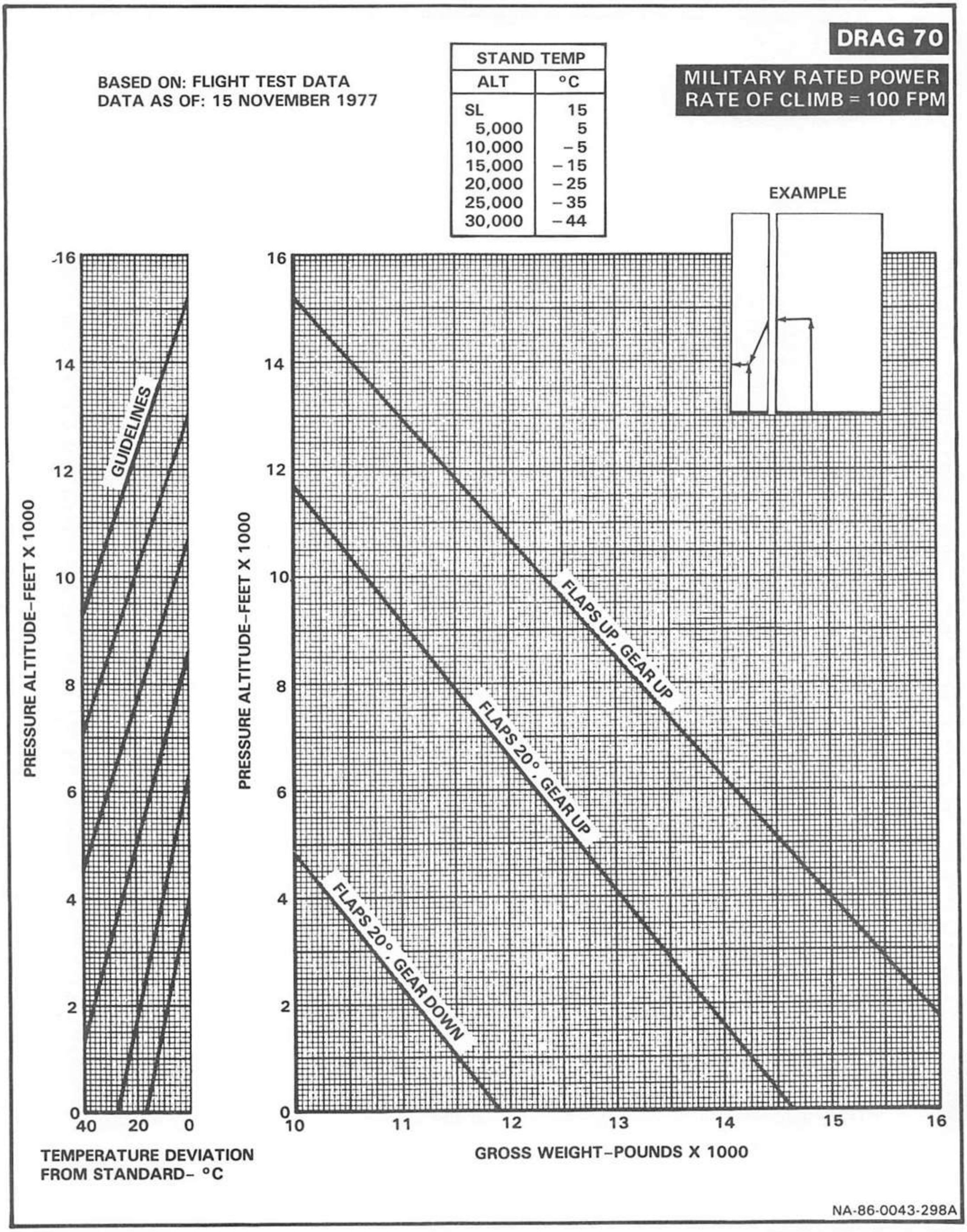


Figure 27-12. Service Ceiling–Single Engine, Military-Rated Power, 100 FPM Rate of Climb (Drag 70)

CHAPTER 28

Range Data

28.1 RANGE DATA

28.1.1 Constant-Altitude Cruise. The Constant-Altitude Cruise charts (Figures 28-1 and 28-2) may be used in preflight planning to determine speeds, fuel and time requirements for navigational flights, or preplanned missions. An average gross weight may be used for a given leg, or instantaneous data may be extracted. A standard temperature block is provided for use in determining deviation based on reported temperature at flight altitude.

28.1.1.1 Constant-Altitude Cruise Example Problem. Find fuel and time required for a 200-nautical-mile leg:

- Gross Weight–13,000 pounds
- Cruise Altitude–10,000 feet
- Drag Index–60 (use 50 Drag Index line)
- Ambient Temperature–10 °C above standard
- Wind Velocity–28 knots (head)

1. Best cruise CAS = 174 knots
2. Ground nautical miles per 100 pounds fuel = 27.4
3. Fuel quantity = 700 pounds
4. Time required = 70 minutes

28.1.2 Optimum Cruise Altitude. (Figure 28-3) During preflight planning, pilots are often faced with the task of determining what altitude should be used to obtain maximum range. This requires detailed examination of reported or forecast wind information, then computation of best altitude as a function of ground speed. The Optimum Cruise Altitude chart (Figure 28-3) permits rapid determination of best long-range cruise altitude for prevailing winds aloft. To use the chart, superimpose a plot of known effective headwind or tailwind values on the grid, then pick the altitude depicting maximum specific range (nautical miles per pounds fuel).

28.1.2.1 Optimum Cruise Altitude Example Problem. Find best cruise altitude for the following en route wind structure:

ALTITUDE (FEET)	WIND
Surface	10 knots tail
5,000	7 knots tail
10,000	4 knots tail
15,000	4 knots head
20,000	29 knots head

By examining the wind curve, it is seen that best range will result at approximately 16,000 feet (about 34 nautical miles per 100 pounds of fuel).

28.1.3 Nautical Miles Per 100 Pounds Fuel. (Figures 28-4 through 28-18) Specific range data is provided for altitudes from sea level through 25,000 feet at Drag Indexes 50, 100, and 150. These charts may be used to determine instantaneous planning data and initial engine rpm required to obtain a specified true airspeed under Standard Day conditions.

28.1.3.1 Nautical Miles Per 100 Pounds Fuel Example Problem. Find the best cruise data for 5000 feet:

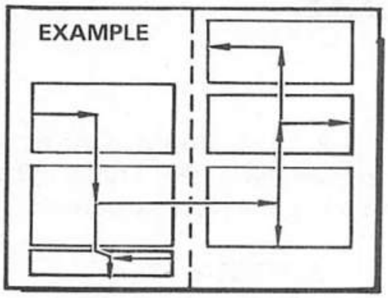
- Gross Weight–12,000 pounds
- Drag Index–90
  (Use nearest Drag Index chart in this example, 100 Drag Index)

1. Enter Drag Index 100 chart for 5000 feet (Figure 28-7).

   (a) CAS = 168
   (b) TAS = 182
   (c) Fuel Flow = 635 pounds per hour
   (d) Nautical miles per 100 pounds of fuel = 28.6
   (e) RPM = 91%

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

MAXIMUM RANGE FUEL, TIME AND NAUTICAL MILES/POUND



STAND TEMP	
ALT FT	°C
SL	15
5,000	5
10,000	−5
15,000	−15
20,000	−25

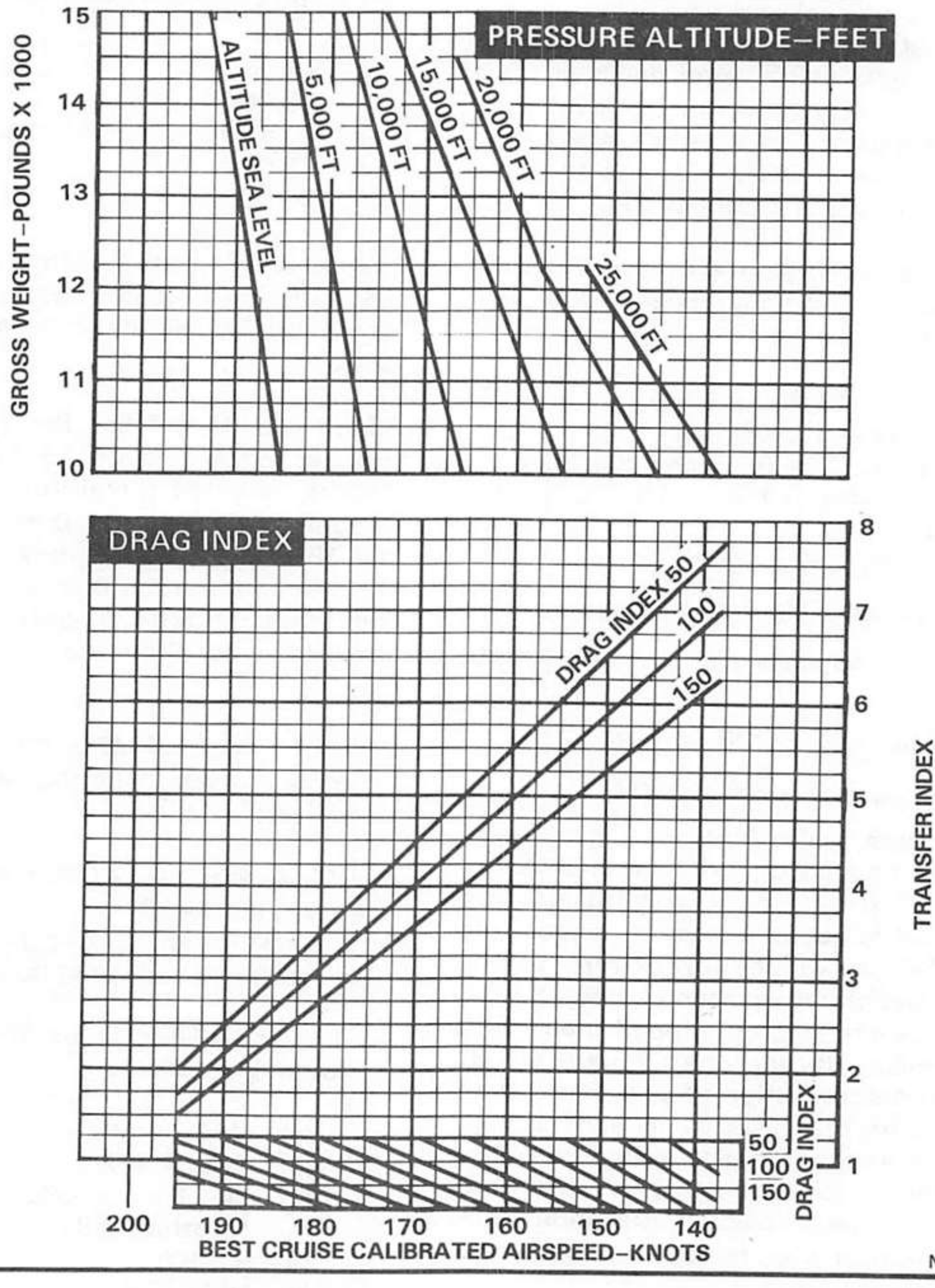


Figure 28-1. Constant Altitude Cruise (Sheet 1 of 2)

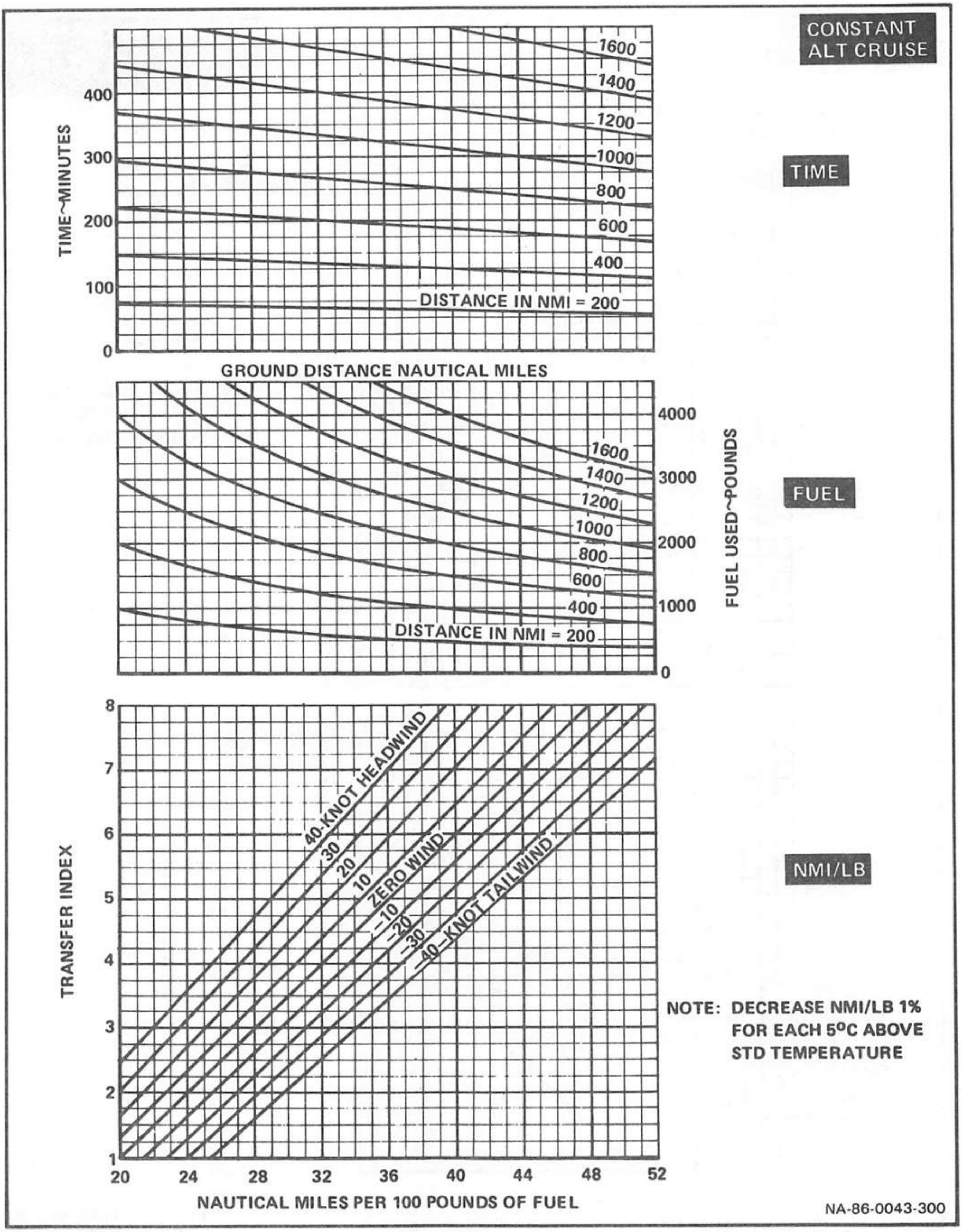
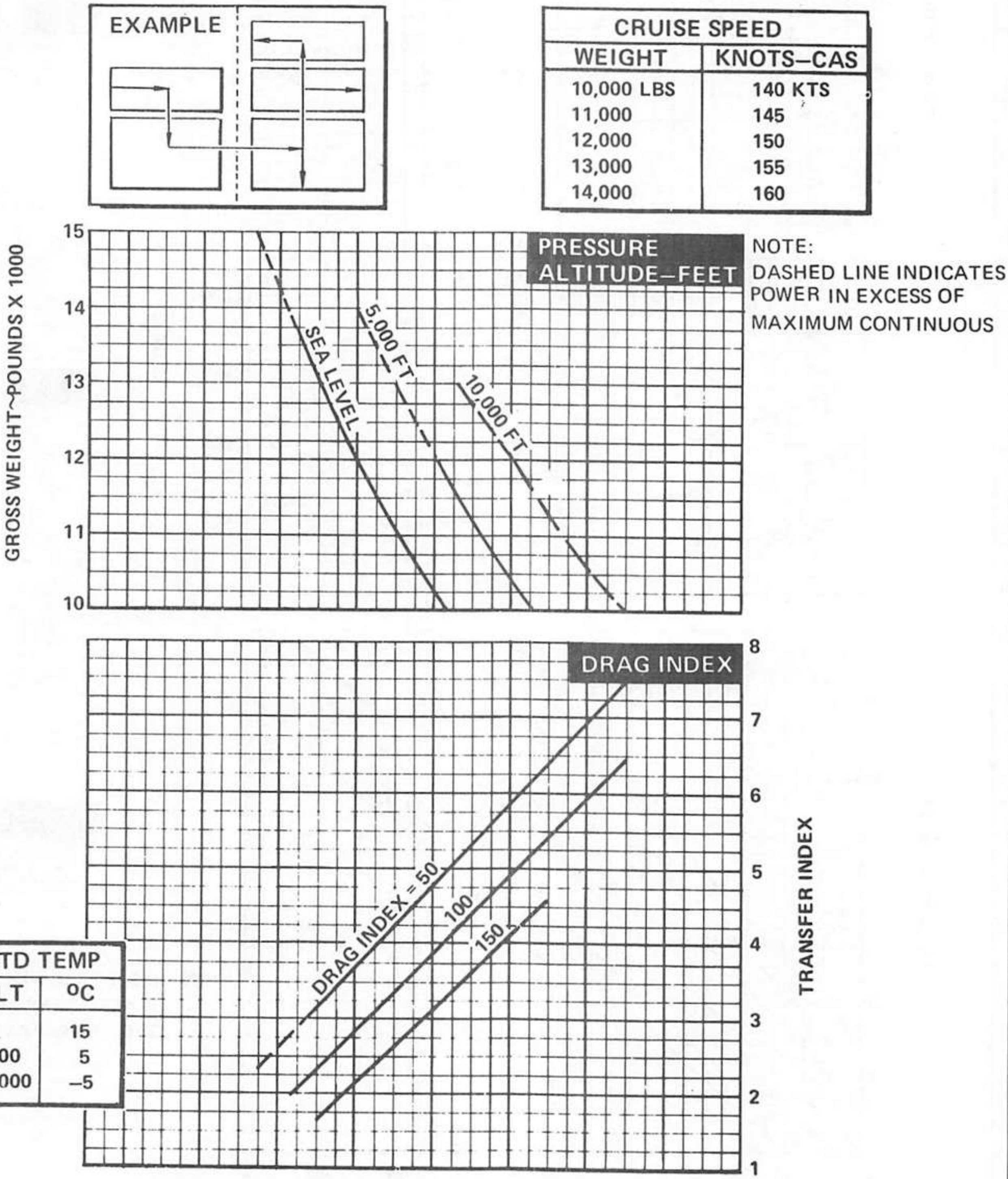


Figure 28-1. Constant Altitude Cruise (Sheet 2 of 2)

MAXIMUM RANGE
FUEL, TIME AND
NAUTICAL MILES/POUND

BASED ON: FLIGHT TEST DATA
DATE AS OF: 15 NOV 77

CRUISE SPEED	
WEIGHT	KNOTS–CAS
10,000 LBS	140 KTS
11,000	145
12,000	150
13,000	155
14,000	160



STD TEMP	
ALT	°C
SL	15
5,000	5
10,000	–5

NA-86-0043-301

Figure 28-2. Single-Engine Constant Altitude Cruise (Sheet 1 of 2)

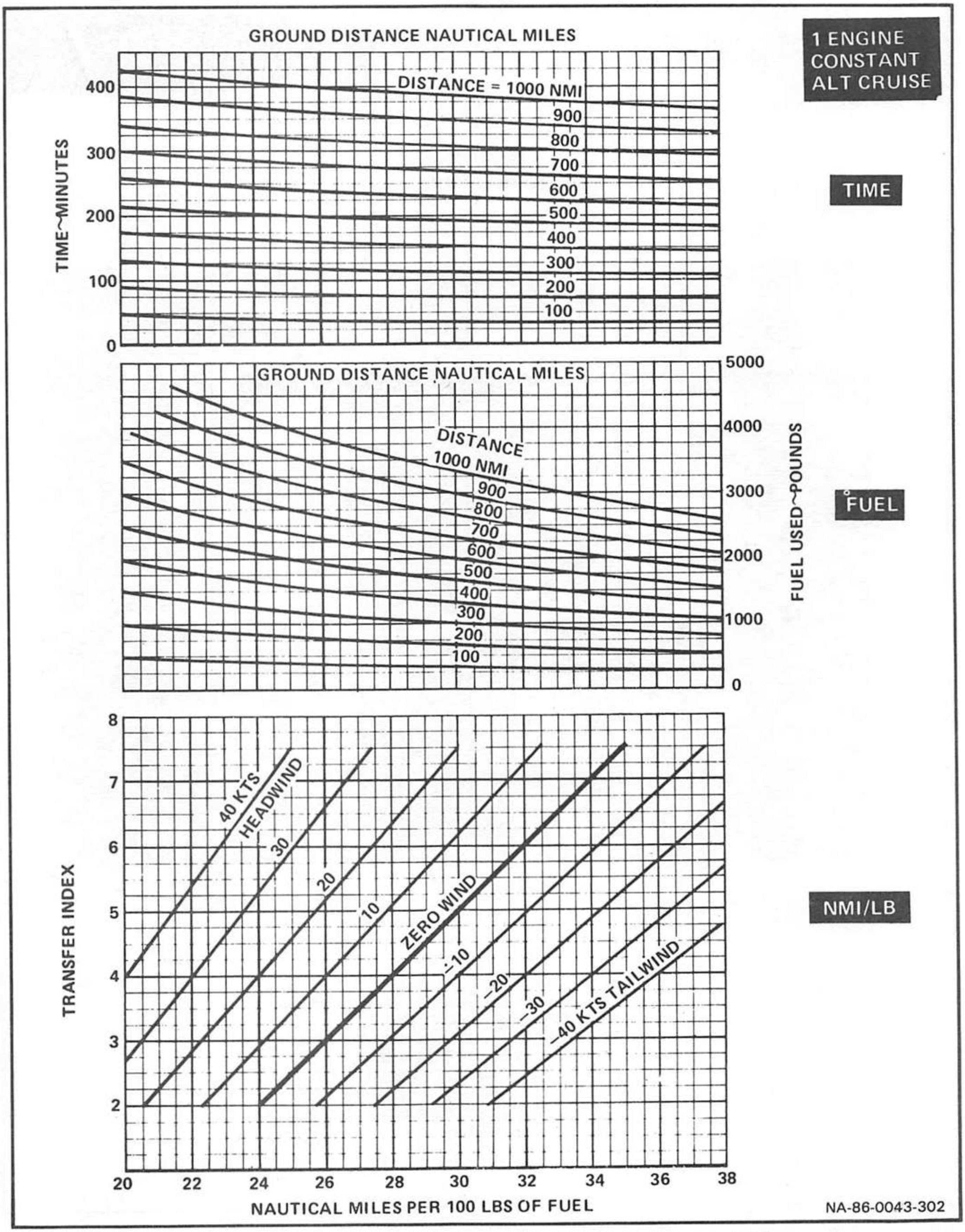
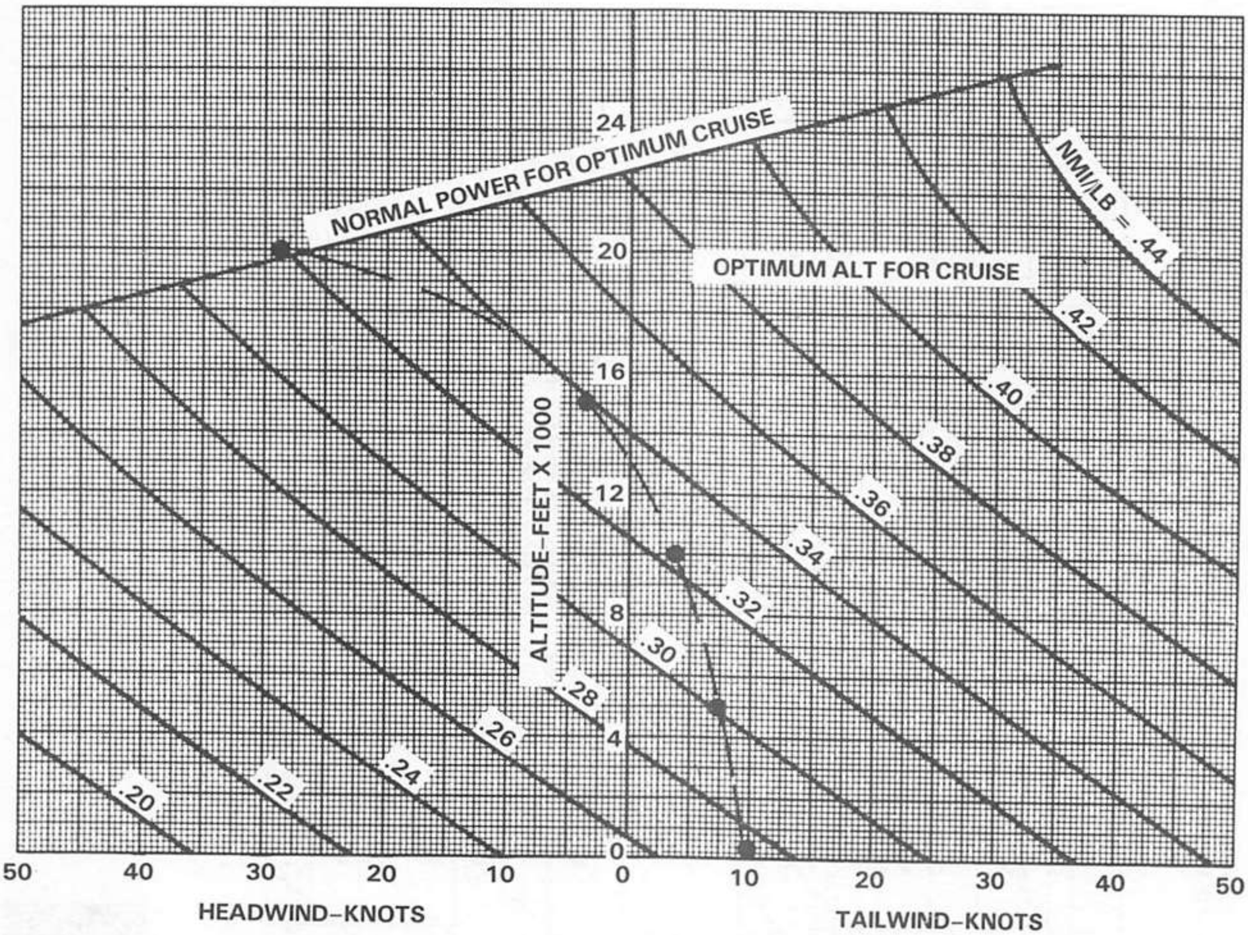


Figure 28-2. Single-Engine Constant Altitude Cruise (Sheet 2 of 2)

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

FERRY CONFIGURATION
SPONSONS, CENTERLINE PYLON

AVERAGE GROSS WEIGHT = 12,000 POUNDS



NOTE:

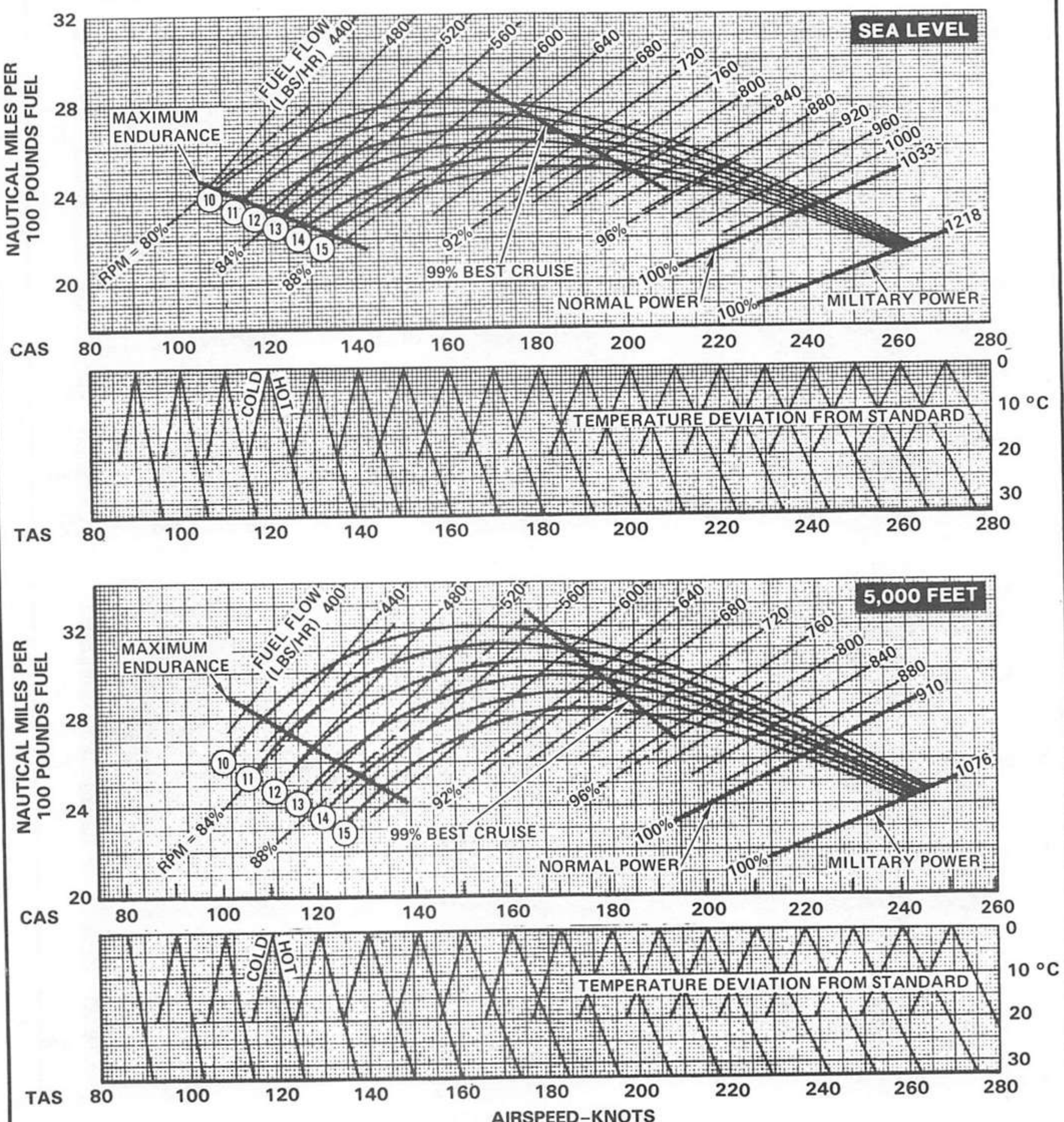
- FOR INCREASED WEIGHT, REDUCE NMI/LB 5 PERCENT PER 1000 POUNDS
- FOR LIGHTER WEIGHT, INCREASE NMI/LB 5 PERCENT PER 1000 POUNDS
- FOR OPTIMUM CRUISE AIRSPEED, INCREASE NO-WIND CRUISE SPEED 1/2 KNOT PER KNOT OF HEADWIND AND DECREASE 1/2 KNOT PER KNOT OF TAILWIND

NA-86-0043-303A

Figure 28-3. Optimum Cruise Altitude, Ferry Configuration

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

ENGINES (2) T-76 **DRAG 50**



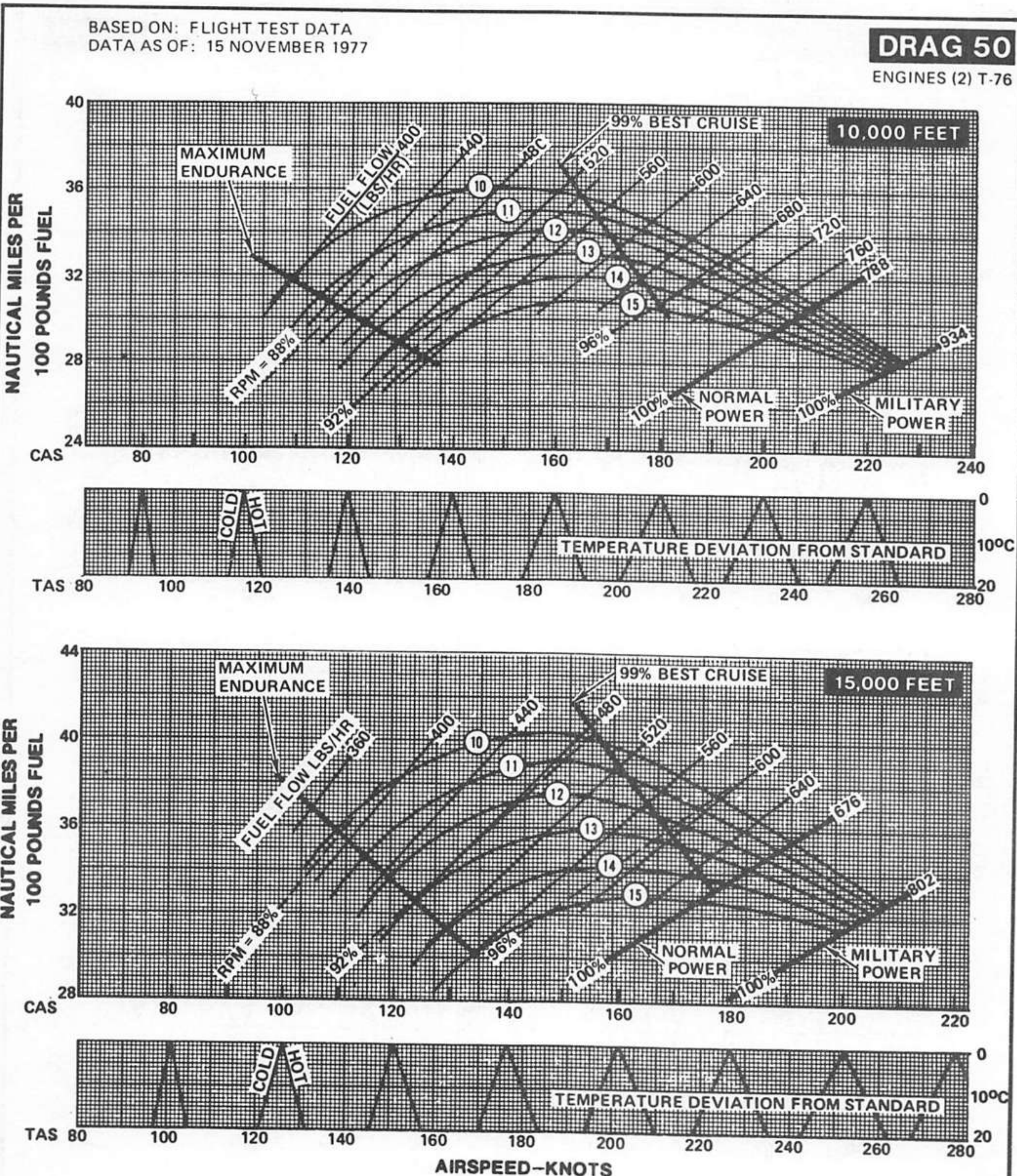
NOTE:

- CURVE VALUES FOR A NO WIND ($V_W = 0$) CONDITION TO COMPUTE FOR WIND EFFECTS: NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

GROSS WEIGHT	
⑩ 10,000 POUNDS	⑬ 13,000 POUNDS
⑪ 11,000 POUNDS	⑭ 14,000 POUNDS
⑫ 12,000 POUNDS	⑮ 15,000 POUNDS

NA-86-0043-304A

Figure 28-4. Nautical Miles Per 100 Pounds Fuel (Drag 50)



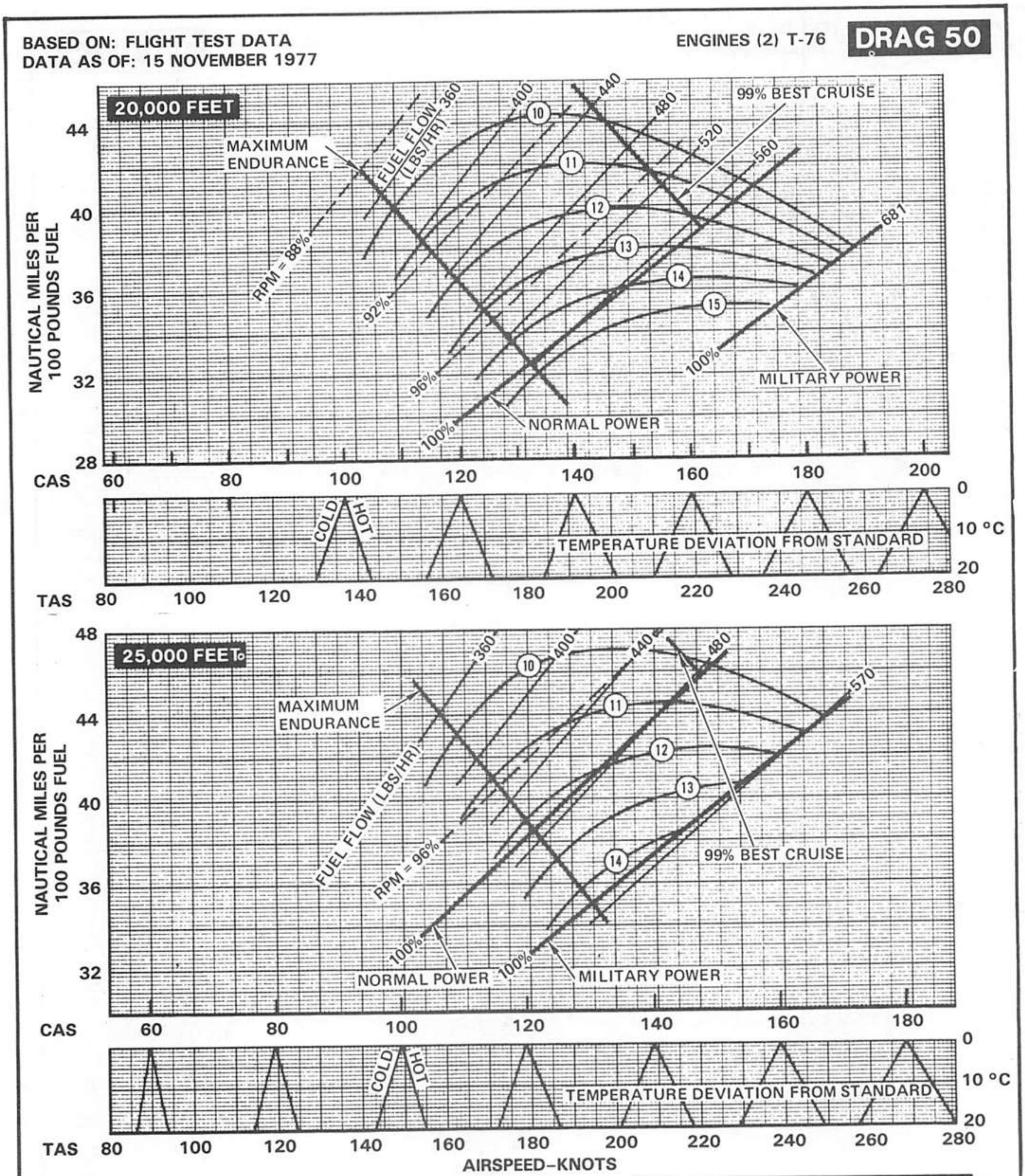
NOTE:

- CURVE VALUES FOR A NO WIND (V_W = 0) CONDITION TO COMPUTE FOR WIND EFFECTS: NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

GROSS WEIGHT	
(10) 10,000 POUNDS	(13) 13,000 POUNDS
(11) 11,000 POUNDS	(14) 14,000 POUNDS
(12) 12,000 POUNDS	(15) 15,000 POUNDS

NA-86-0043-305

Figure 28-5. Nautical Miles Per 100 Pounds Fuel (Drag 50)

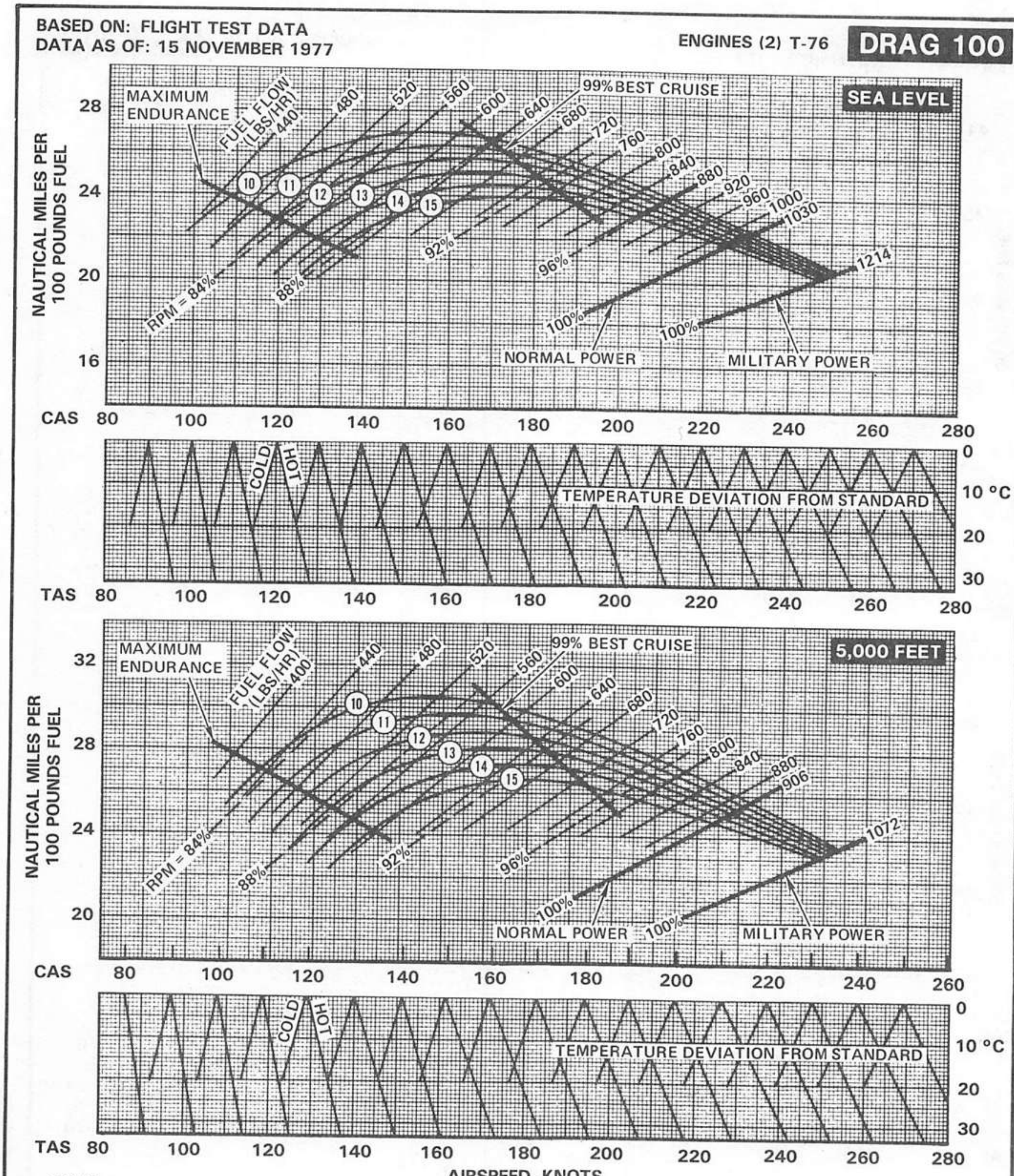


NOTE:
- CURVE VALUES FOR A NO WIND (V_W = 0) CONDITION TO COMPUTE FOR WIND EFFECTS: NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

GROSS WEIGHT	
(10) 10,000 POUNDS	(13) 13,000 POUNDS
(11) 11,000 POUNDS	(14) 14,000 POUNDS
(12) 12,000 POUNDS	(15) 15,000 POUNDS

NA-86-0043-306A

Figure 28-6. Nautical Miles Per 100 Pounds Fuel (Drag 50)



NOTE:

- CURVE VALUES FOR A NO WIND (V_W = 0) CONDITION TO COMPUTE FOR WIND EFFECTS: NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

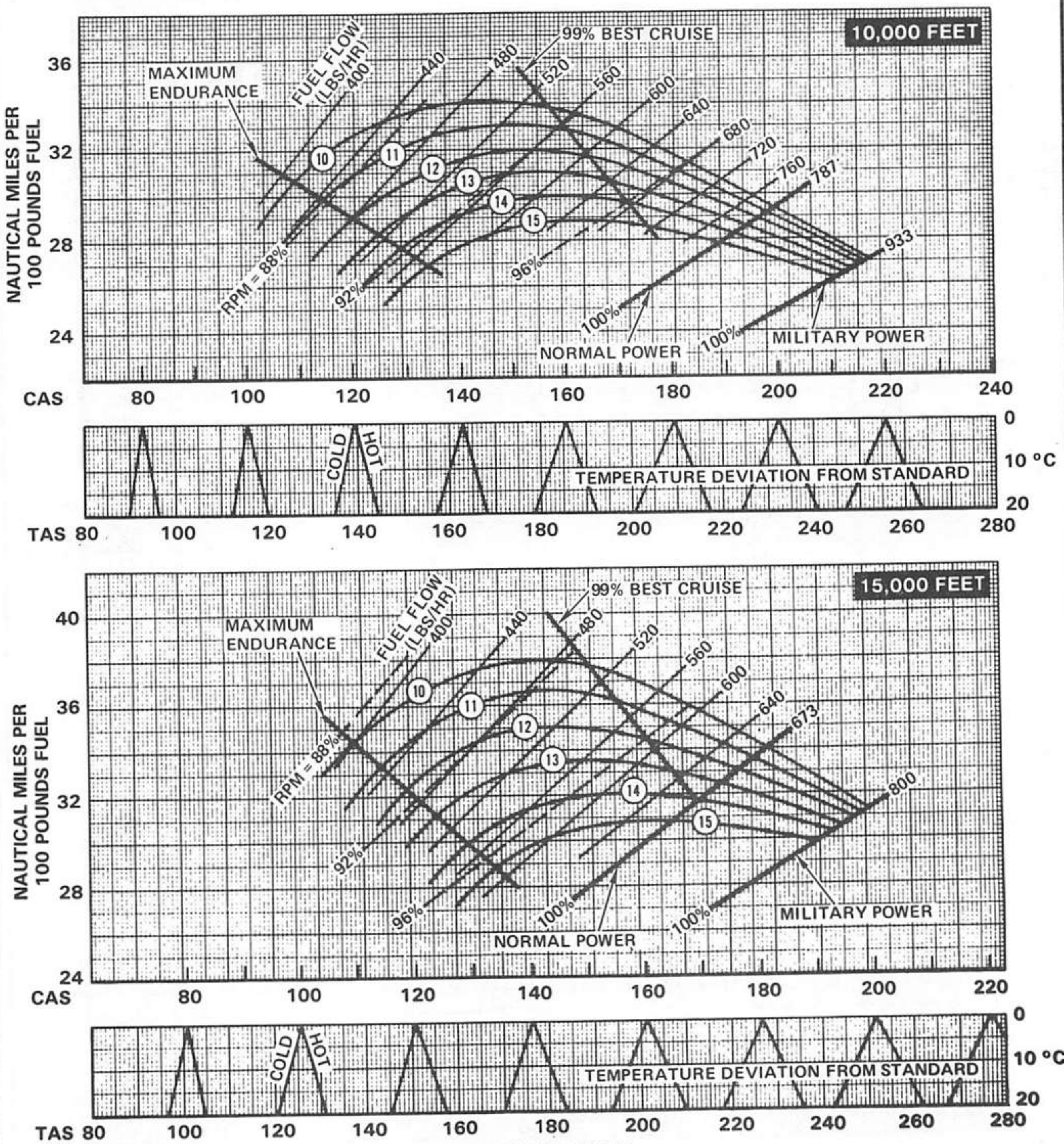
GROSS WEIGHT	
(10) 10,000 POUNDS	(13) 13,000 POUNDS
(11) 11,000 POUNDS	(14) 14,000 POUNDS
(12) 12,000 POUNDS	(15) 15,000 POUNDS

NA-86-0043-307A

Figure 28-7. Nautical Miles Per 100 Pounds Fuel (Drag 100)

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

ENGINES (2) T-76 **DRAG 100**



NOTE:

- CURVE VALUES FOR A NO WIND (V_W = 0) CONDITION TO COMPUTE FOR WIND EFFECTS: NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

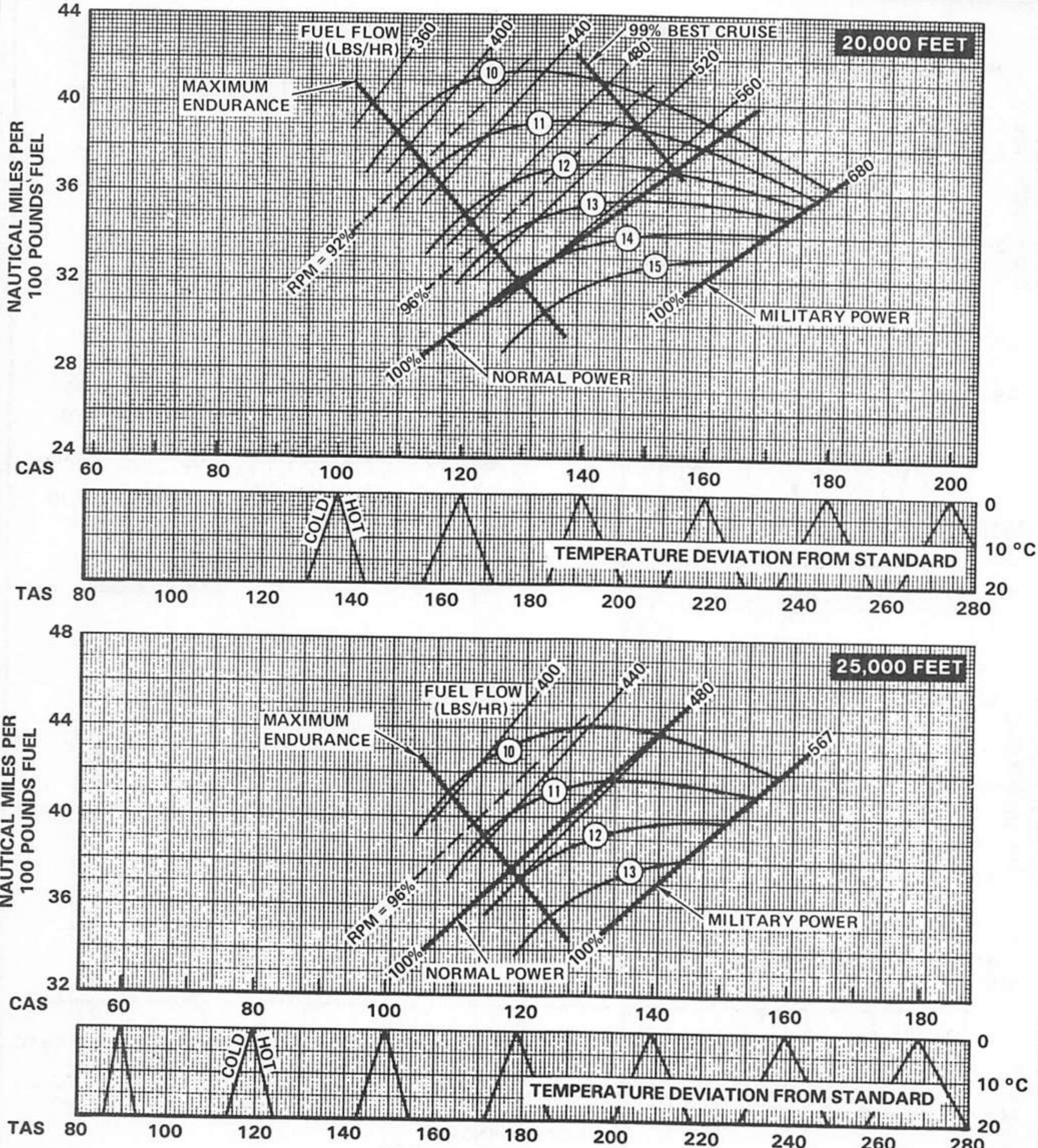
GROSS WEIGHT	
(10) 10,000 POUNDS	(13) 13,000 POUNDS
(11) 11,000 POUNDS	(14) 14,000 POUNDS
(12) 12,000 POUNDS	(15) 15,000 POUNDS

NA-86-0043-308A

Figure 28-8. Nautical Miles Per 100 Pounds Fuel (Drag 100)

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

ENGINES (2) T-76 **DRAG 100**



NOTE:
- CURVE VALUES FOR A NO WIND (V_W = 0) CONDITION TO COMPUTE FOR WIND EFFECTS: NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

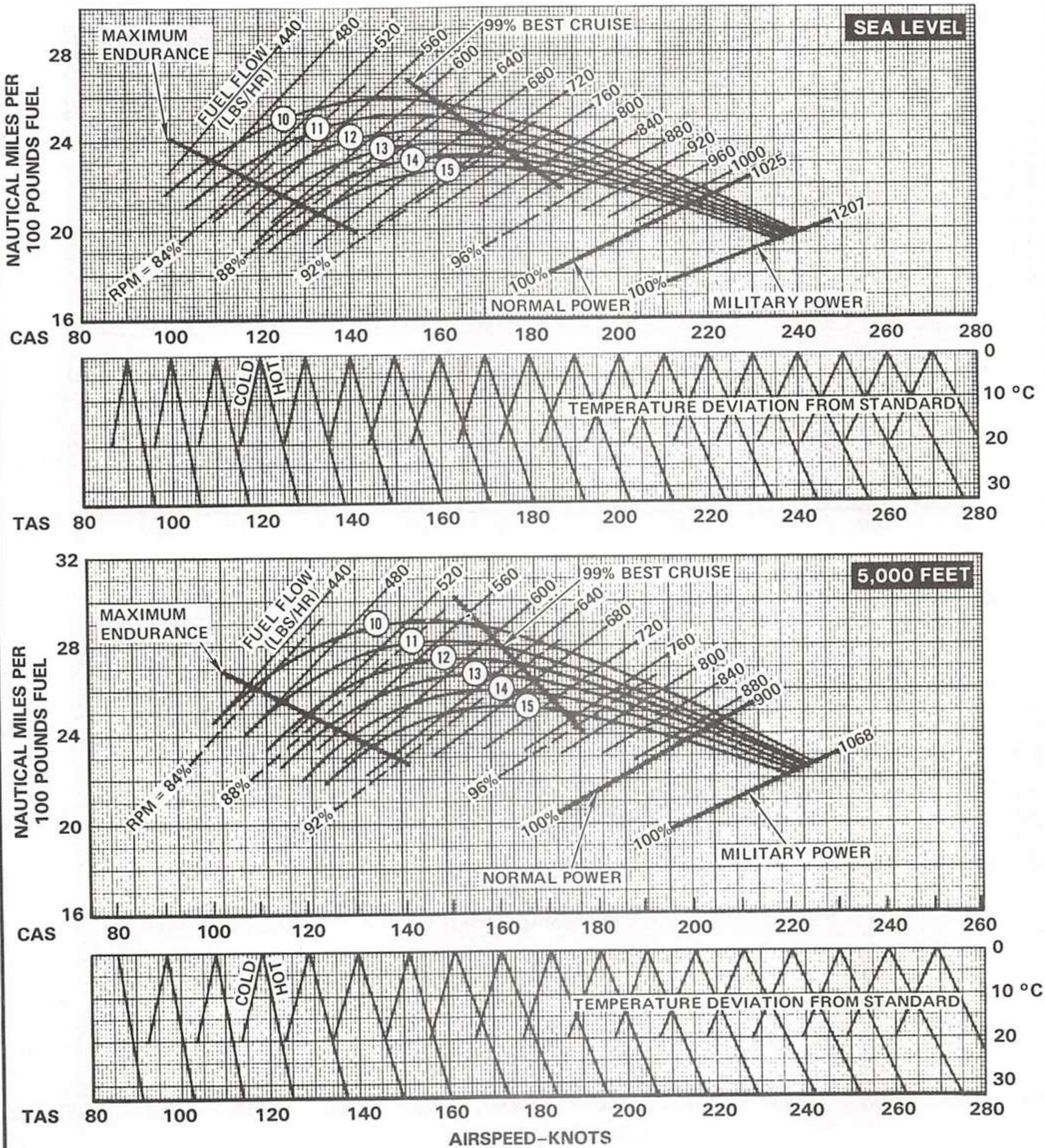
GROSS WEIGHT	
(10) 10,000 POUNDS	(13) 13,000 POUNDS
(11) 11,000 POUNDS	(14) 14,000 POUNDS
(12) 12,000 POUNDS	(15) 15,000 POUNDS

NA-86-0043-309A

Figure 28-9. Nautical Miles Per 100 Pounds Fuel (Drag 100)

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

ENGINES (2) T-76 **DRAG 150**



NOTE:
- CURVE VALUES FOR A NO WIND (V_W = 0) CONDITION
  TO COMPUTE FOR WIND EFFECTS:
  NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

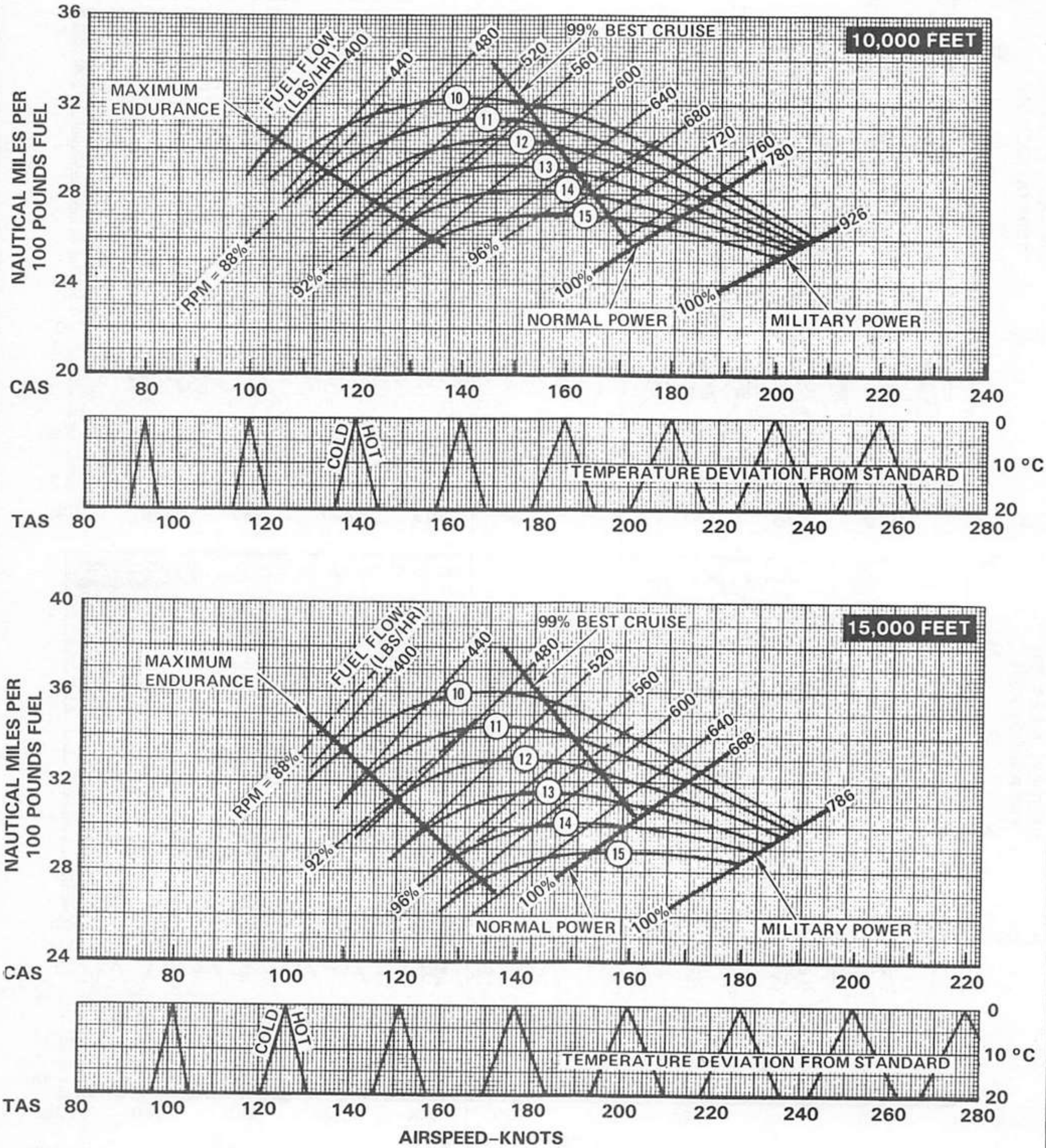
GROSS WEIGHT	
(10) 10,000 POUNDS	(13) 13,000 POUNDS
(11) 11,000 POUNDS	(14) 14,000 POUNDS
(12) 12,000 POUNDS	(15) 15,000 POUNDS

NA-86-0043-310A

Figure 28-10. Nautical Miles Per 100 Pounds Fuel (Drag 150)

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

ENGINES (2) T-76 **DRAG 150**



NOTE:
- CURVE VALUES FOR A NO WIND ($V_W = 0$) CONDITION TO COMPUTE FOR WIND EFFECTS: NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

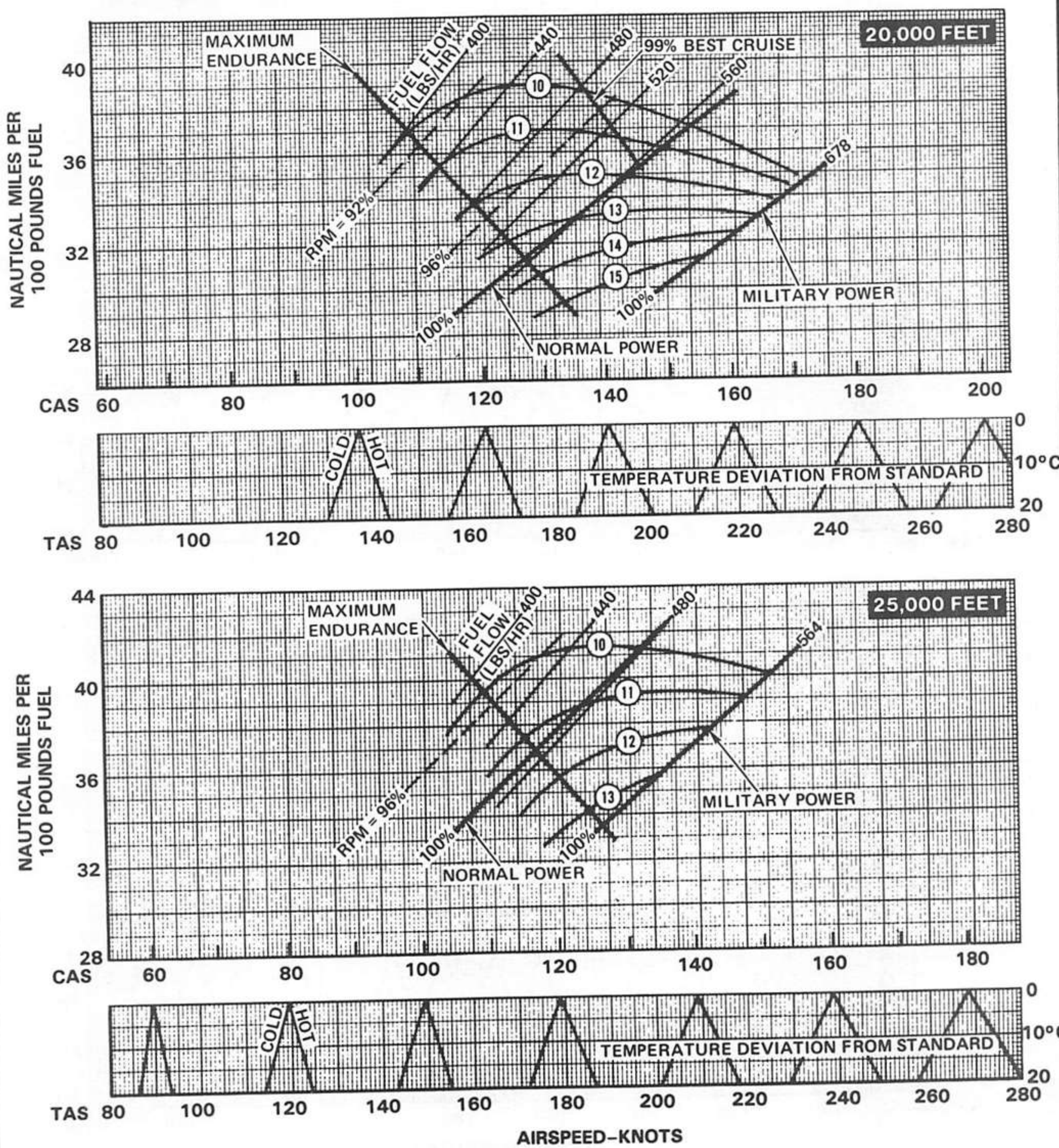
GROSS WEIGHT	
⑩ 10,000 POUNDS	⑬ 13,000 POUNDS
⑪ 11,000 POUNDS	⑭ 14,000 POUNDS
⑫ 12,000 POUNDS	⑮ 15,000 POUNDS

NA-86-0043-311A

Figure 28-11. Nautical Miles Per 100 Pounds Fuel (Drag 150)

ENGINES (2) T-76 **DRAG 150**

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

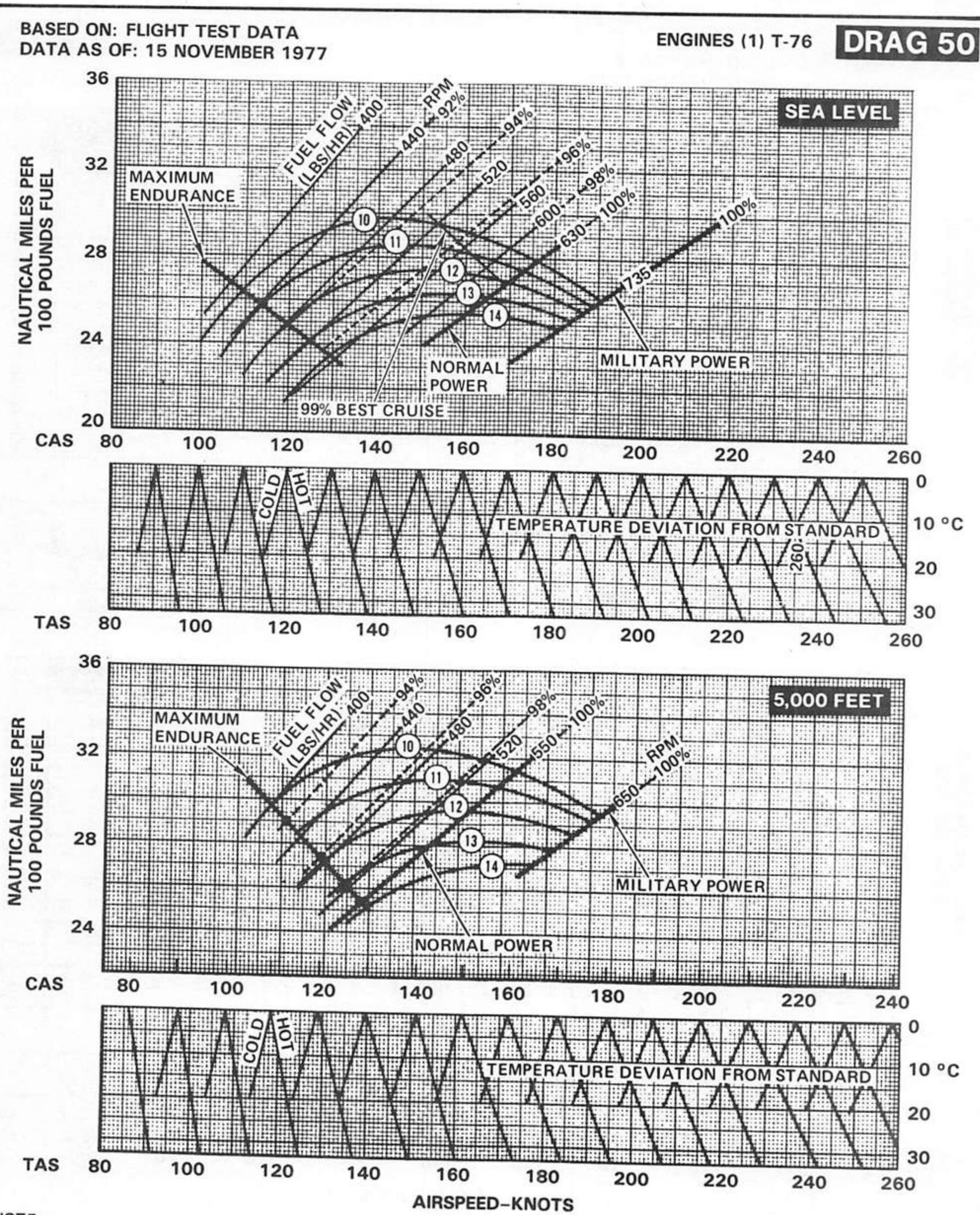


NOTE:
- CURVE VALUES FOR A NO WIND ($V_W = 0$) CONDITION
  TO COMPUTE FOR WIND EFFECTS:
  NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

GROSS WEIGHT	
(10) 10,000 POUNDS	(13) 13,000 POUNDS
(11) 11,000 POUNDS	(14) 14,000 POUNDS
(12) 12,000 POUNDS	(15) 15,000 POUNDS

NA-86-0043-312A

Figure 28-12. Nautical Miles Per 100 Pounds Fuel (Drag 150)



NOTE:

- CURVE VALUES FOR A NO WIND ($V_W = 0$) CONDITION TO COMPUTE FOR WIND EFFECTS:
  NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

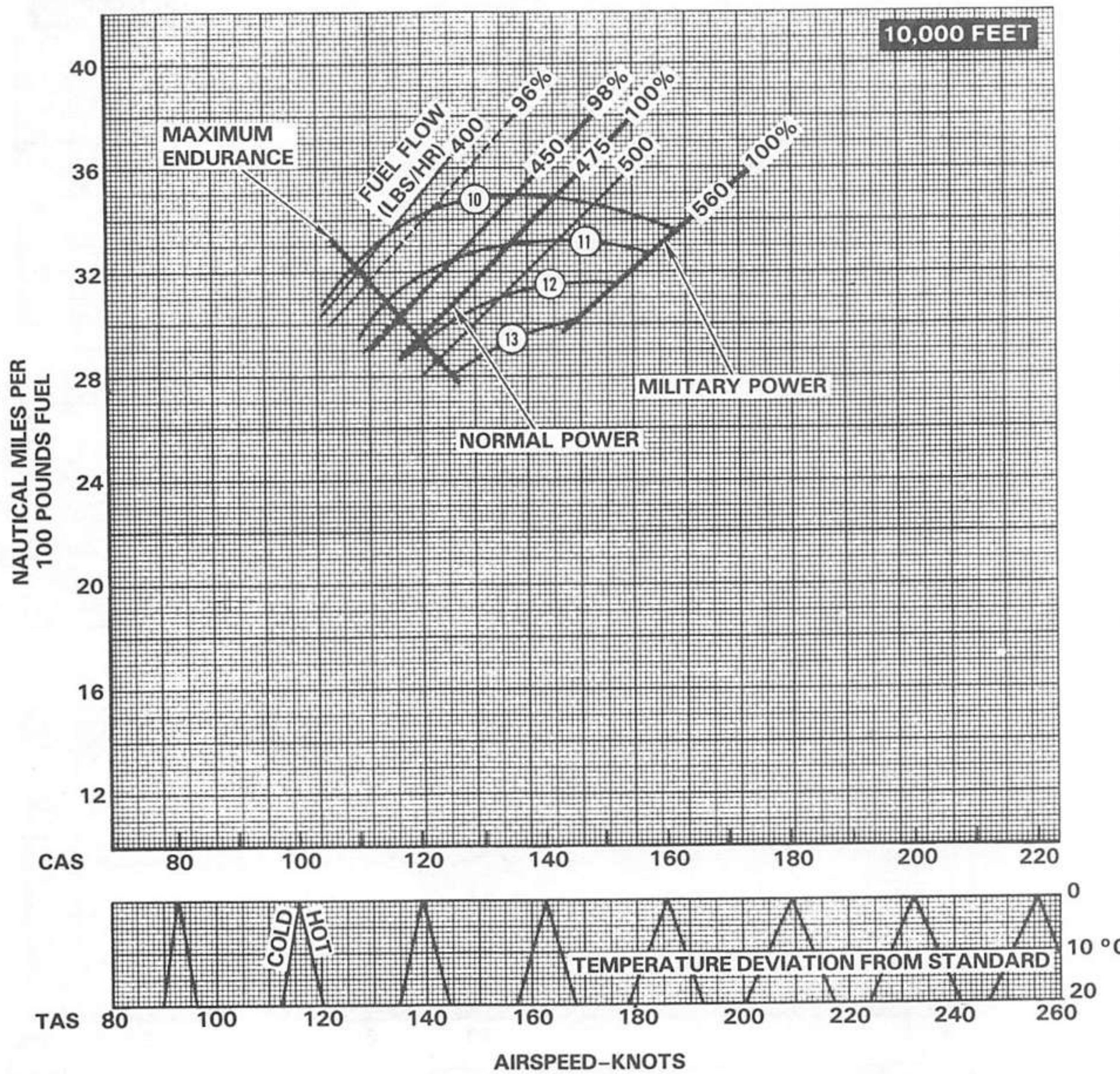
GROSS WEIGHT	
(10) 10,000 POUNDS	(13) 13,000 POUNDS
(11) 11,000 POUNDS	(14) 14,000 POUNDS
(12) 12,000 POUNDS	

NA-86-0043-313A

Figure 28-13. Nautical Miles Per 100 Pounds Fuel–Single-Engine (Drag 50)

DRAG 50
ENGINES (1) T-76

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977



NOTE:

- CURVE VALUES FOR A NO WIND ($V_W = 0$) CONDITION TO COMPUTE FOR WIND EFFECTS:
  NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3 PERCENT FOR EACH 10 °C ABOVE STANDARD TEMP

GROSS WEIGHT
(10) 10,000 POUNDS
(11) 11,000 POUNDS
(12) 12,000 POUNDS
(13) 13,000 POUNDS

NA-86-0043-314A

Figure 28-14. Nautical Miles Per 100 Pounds Fuel–Single-Engine (Drag 50)

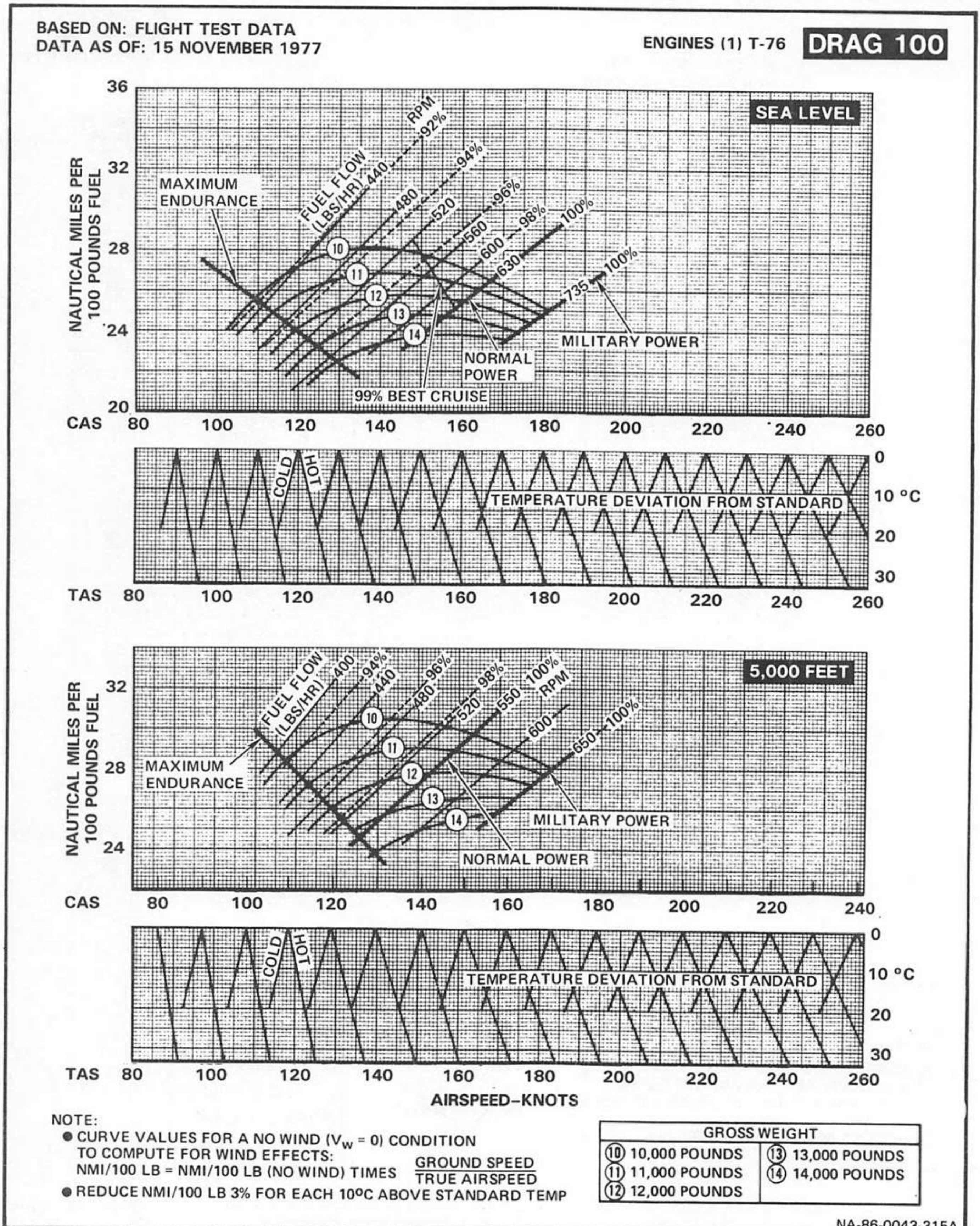
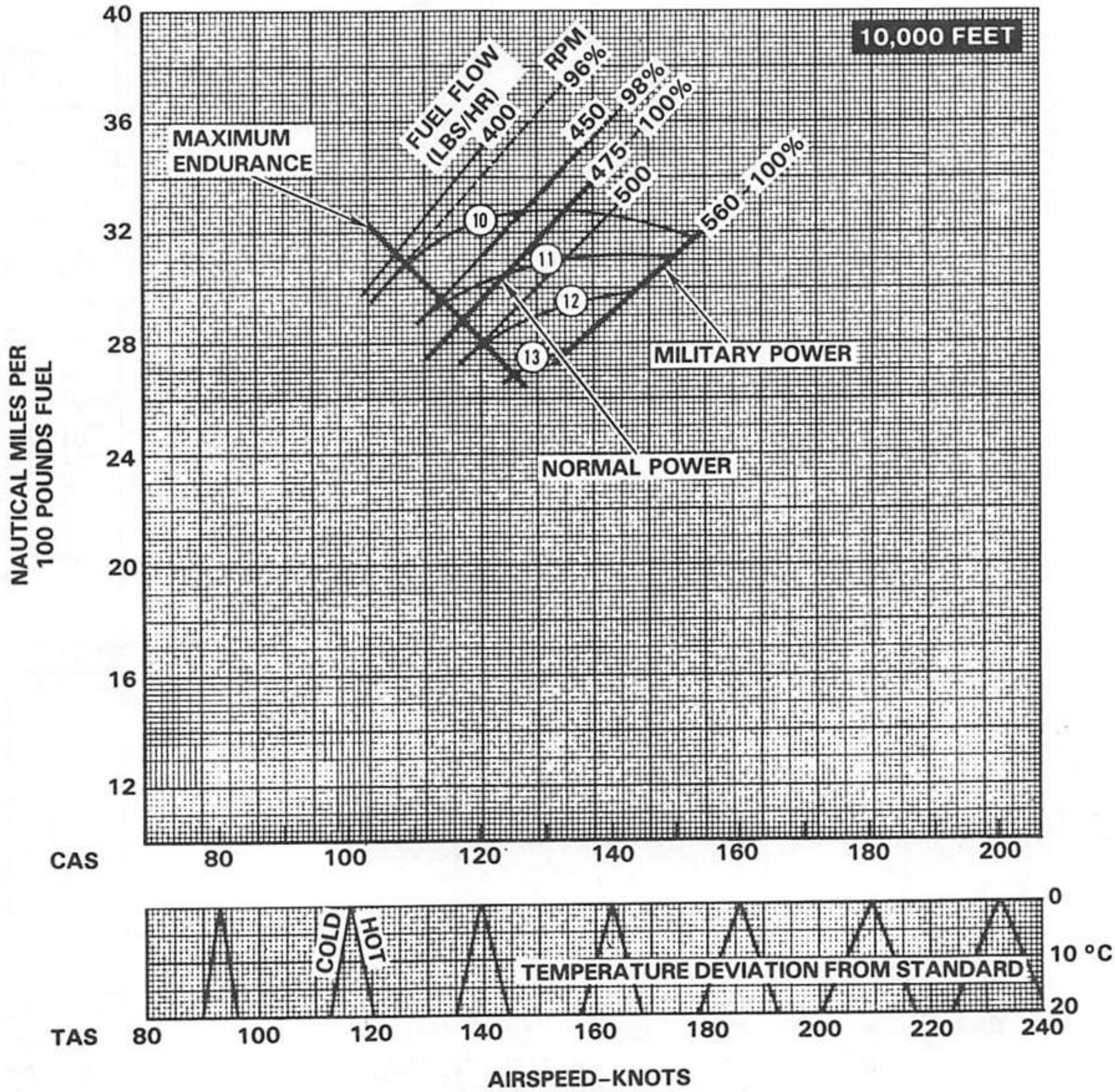


Figure 28-15. Nautical Miles Per 100 Pounds Fuel–Single-Engine (Drag 100)

DRAG 100

ENGINES (1) T-76

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977



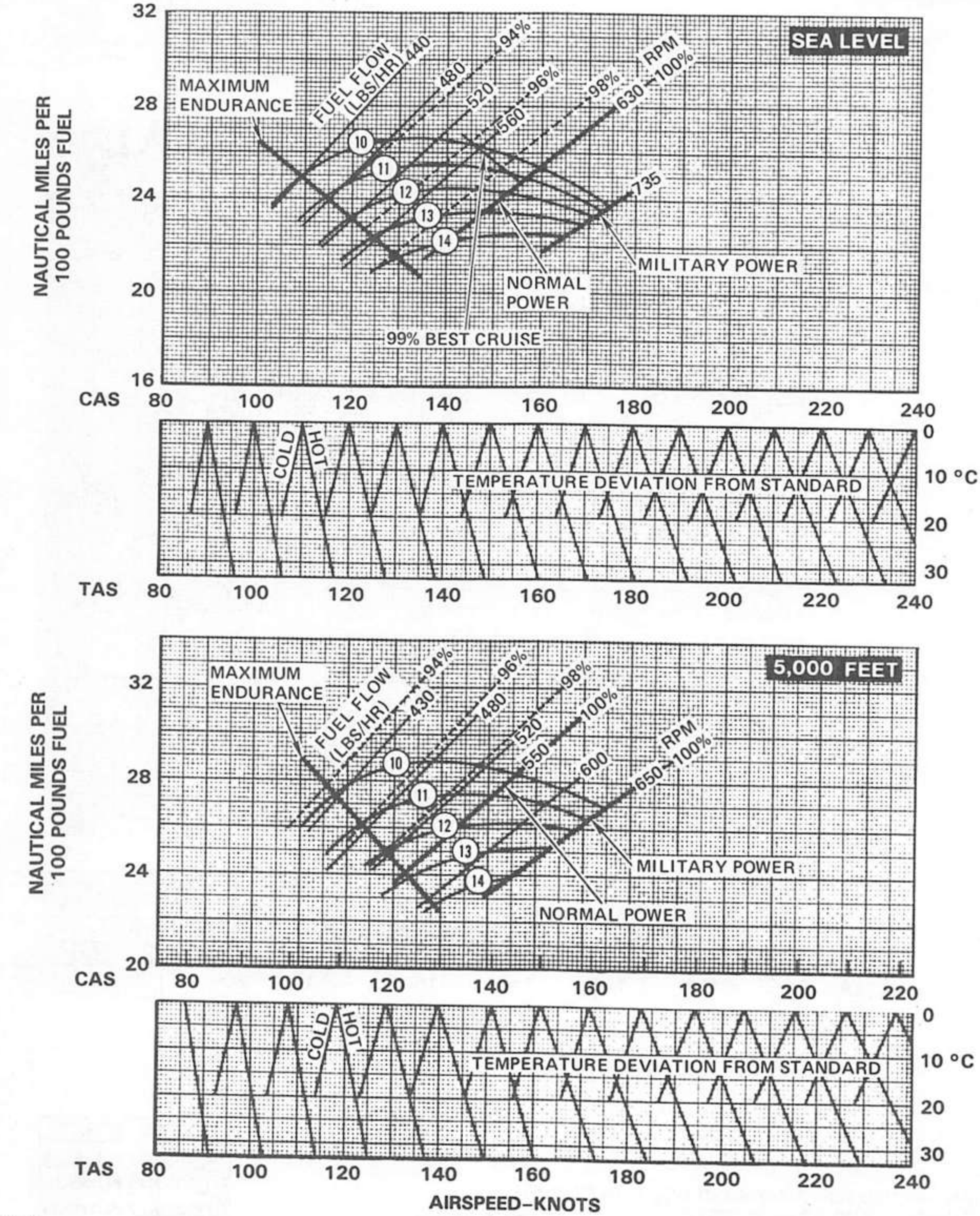
GROSS WEIGHT
(10) 10,000 POUNDS
(11) 11,000 POUNDS
(12) 12,000 POUNDS
(13) 13,000 POUNDS

NOTE:

- CURVE VALUES FOR A NO WIND ($V_W = 0$) CONDITION TO COMPUTE FOR WIND EFFECTS: NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3 PERCENT FOR EACH 10 °C ABOVE STANDARD TEMP

NA-86-0043-316A

Figure 28-16. Nautical Miles Per 100 Pounds Fuel–Single-Engine (Drag 100)



NOTE:
- CURVE VALUES FOR A NO WIND (V_W = 0) CONDITION TO COMPUTE FOR WIND EFFECTS:
  NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3% FOR EACH 10°C ABOVE STANDARD TEMP

GROSS WEIGHT	
(10) 10,000 POUNDS	(12) 12,000 POUNDS
(11) 11,000 POUNDS	(13) 13,000 POUNDS

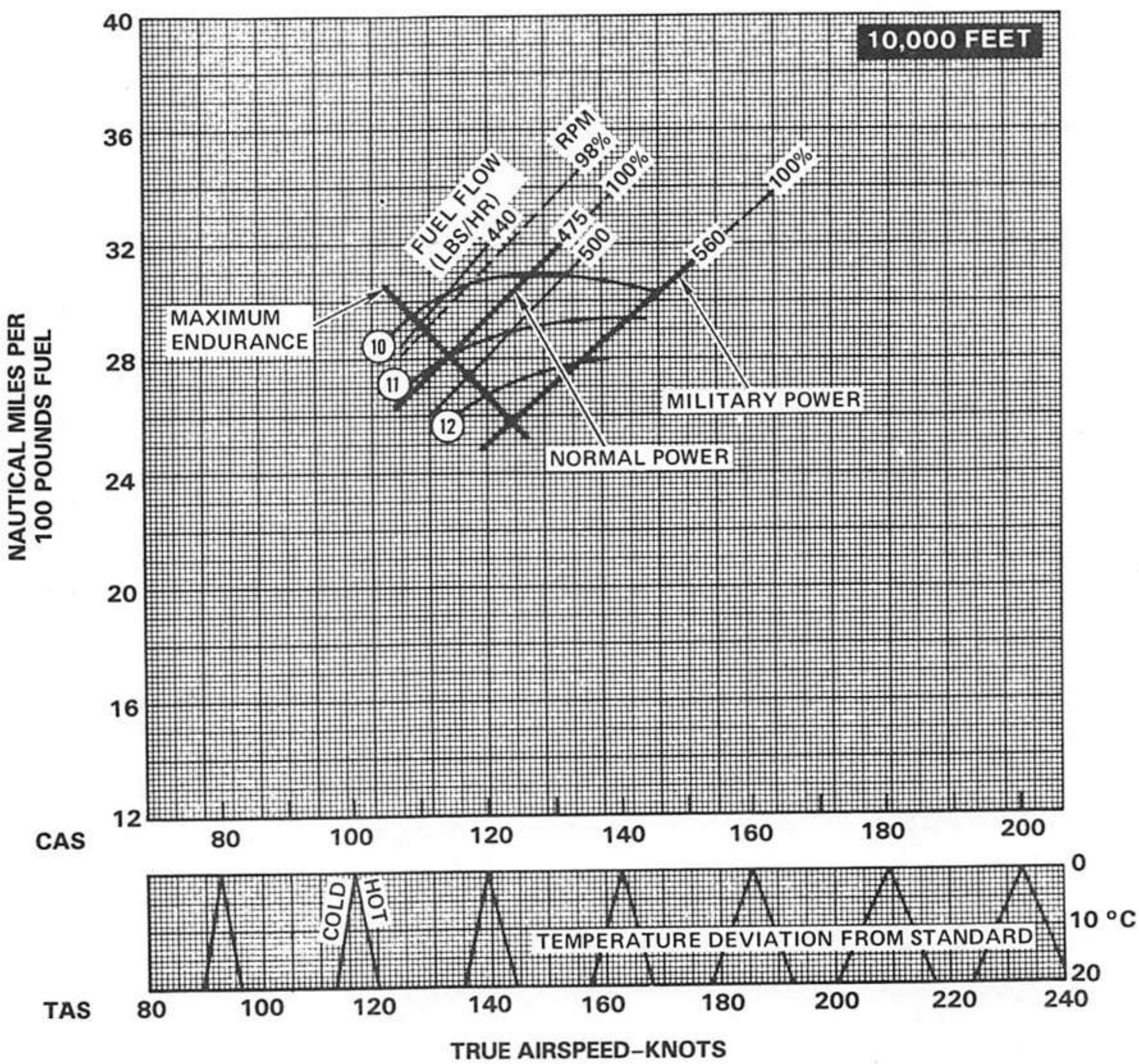
NA-86-0043-317A

Figure 28-17. Nautical Miles Per 100 Pounds Fuel–Single-Engine (Drag 150)

DRAG 150

ENGINES (1) T-76

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977



NOTE:

- CURVE VALUES FOR A NO WIND ($V_W = 0$) CONDITION
  TO COMPUTE FOR WIND EFFECTS:
  NMI/100 LB = NMI/100 LB (NO WIND) TIMES $\frac{\text{GROUND SPEED}}{\text{TRUE AIRSPEED}}$
- REDUCE NMI/100 LB 3 PERCENT FOR EACH 10 °C ABOVE STANDARD TEMP

GROSS WEIGHT
(10) 10,000 POUNDS
(11) 11,000 POUNDS
(12) 12,000 POUNDS

NA-86-0043-318A

Figure 28-18. Nautical Miles Per 100 Pounds Fuel–Single-Engine (Drag 150)

CHAPTER 29

Endurance Data

29.1 ENDURANCE DATA

29.1.1 Constant-Altitude, Maximum Endurance. (Figures 29-1 and 29-2) The Constant-Altitude Maximum Endurance charts provide fuel required for various drag indexes, gross weights, altitudes, and times.

29.1.1.1 Constant-Altitude Maximum Endurance Example Problem. Find fuel required and best speed to loiter for 2 hours (normal two-engine operation, Figure 29-1).

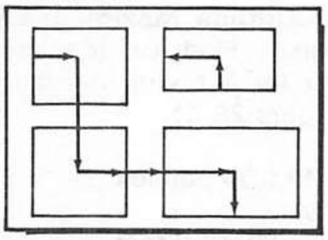
- Gross Weight–12,000 pounds
- Drag Index–100
- Pressure Altitude–10,000 feet
- Ambient Temperature–Standard

1. Best speed = 120 knots CAS
2. Fuel required = 960 pounds

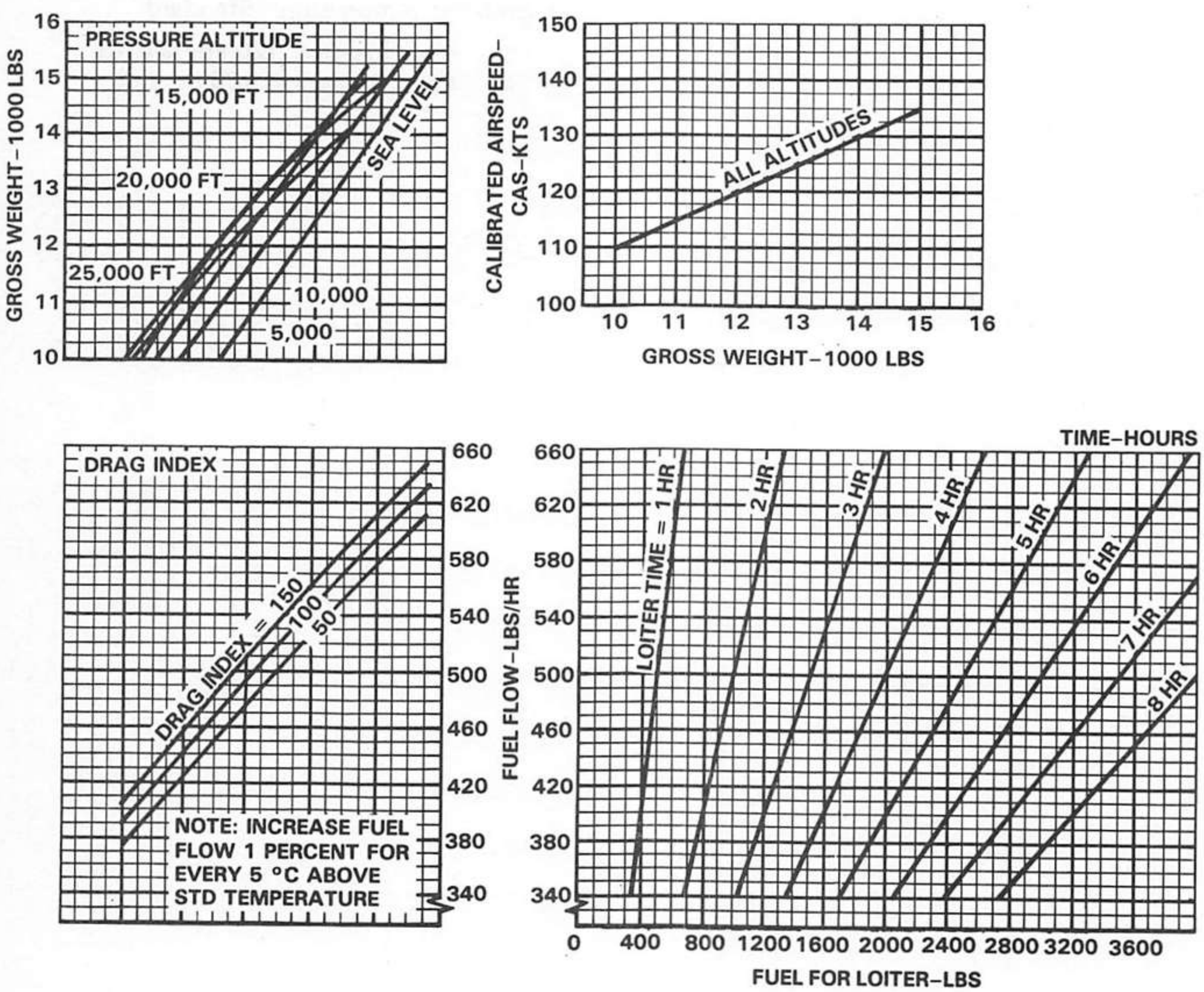
MAX ENDURANCE

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

EXAMPLE:



STAND TEMP	
ALTITUDE	°C
SL	15
5,000	5
10,000	−5
15,000	−15
20,000	−25



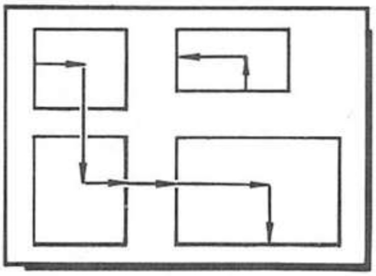
NA-86-0043-319A

Figure 29-1. Constant Altitude–Maximum Endurance

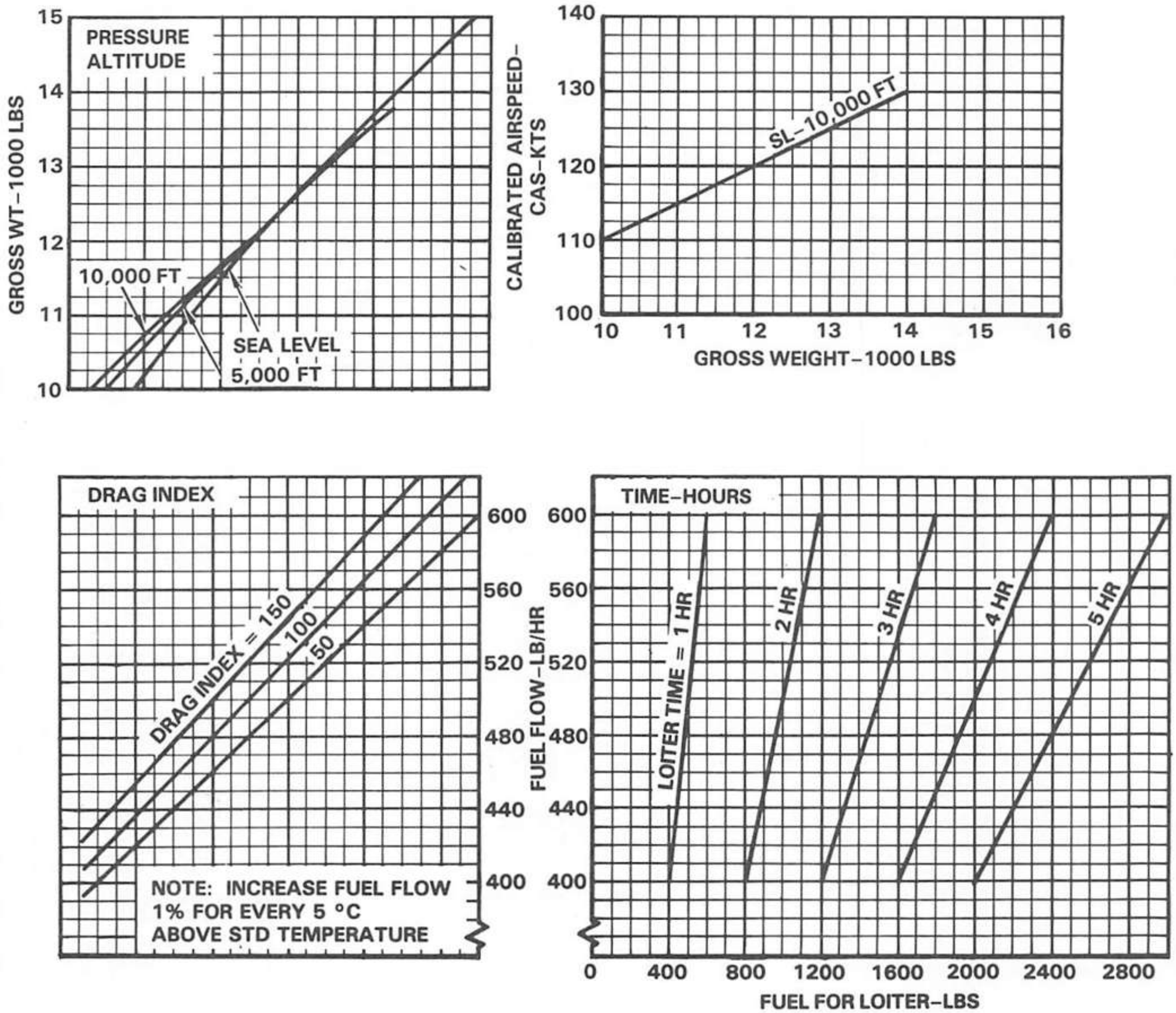
MAX ENDURANCE

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

EXAMPLE:



STANDARD TEMP	
ALTITUDE	°C
SL	15
5,000	5
10,000	−5
15,000	−15
20,000	−25



NA-86-0043-320A

Figure 29-2. Constant Altitude–Maximum Endurance, Single-Engine

CHAPTER 30

Descent Data

30.1 DESCENT DATA

Descent data depict the maximum nautical miles per pound of fuel obtainable during operational descents from altitude down to the landing pattern or target area.

30.1.1 Rate-of-Descent and Descent Speed in Normal Descent. (Figure 30-1.) The rate-of-descent and descent speed during a normal descent (Figure 30-1) can be determined for the cruise configuration with both engines at idle power for descents from 32,000 feet and weights up to 15,000 pounds.

30.1.1.1 Rate-of Descent and Descent Speed in Normal Descent Example Problem. Determine the desired speed at idle power to establish the optimum rate of descent for maximum penetration, miles per pound of fuel, and the value of the rate of descent in cruise configuration.

- Gross Weight–12,000 pounds
- Altitude–14,000 feet

1. Rate of descent = 1,300 feet per minute
2. Descent speed = 136 KCAS

30.1.2 Distance, Time, and Fuel Used in Normal Descent. (Figure 30-2.) The distance, time, and fuel requirements of a normal descent can be determined from Figure 30-2 for descents from 32,000 feet and gross weights up to 14,000 pounds.

30.1.2.1 Distance, Time, and Fuel Used in Normal Descent Example Problem. Find the distance, time, and fuel used during a normal descent in the cruise configuration and both engines at idle power.

- Gross Weight–12,000 pounds
- Altitude–14,000 feet

1. Distance = 35 nautical miles
2. Time = 14 minutes
3. Fuel used = 66 pounds

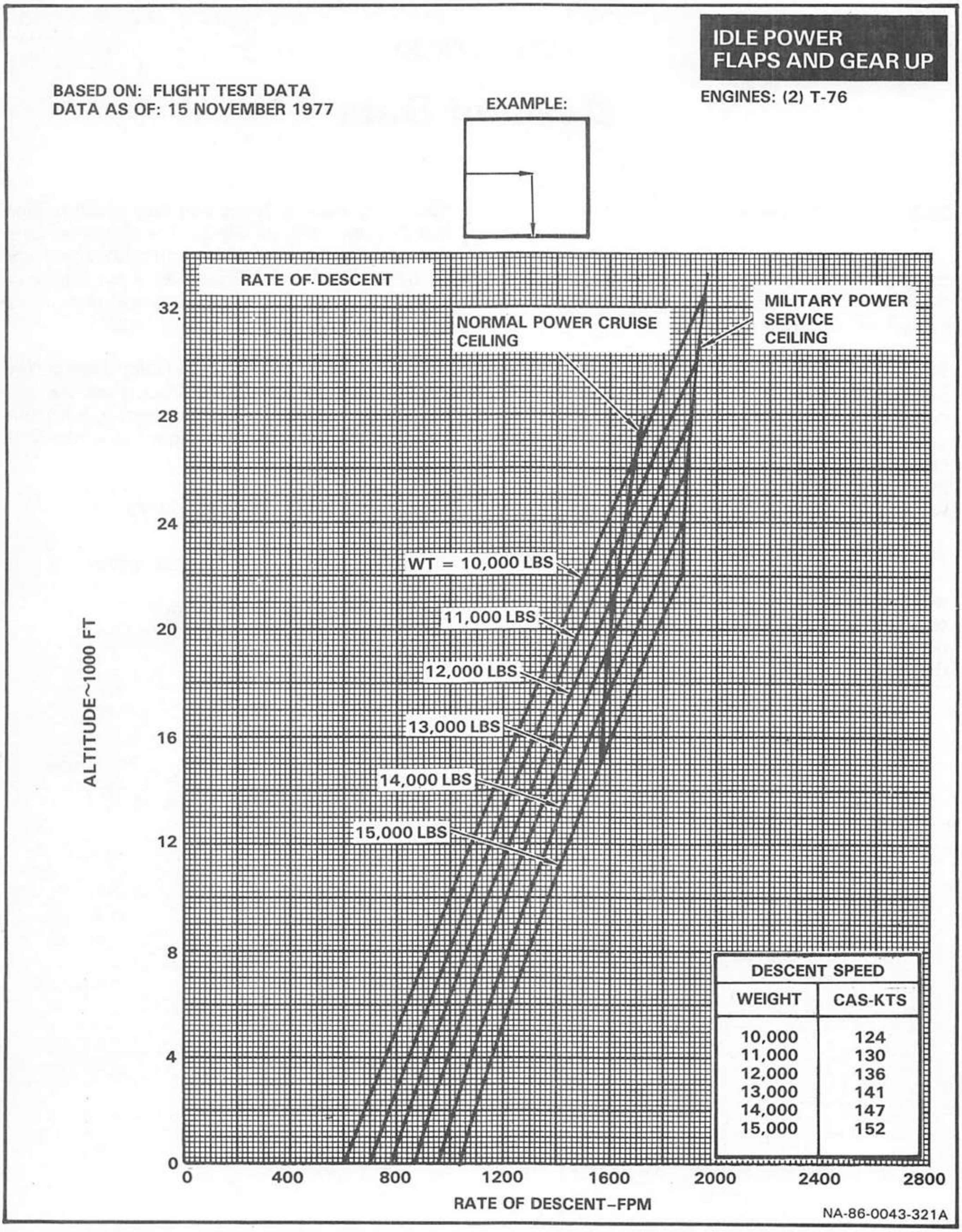


Figure 30-1. Normal Descent

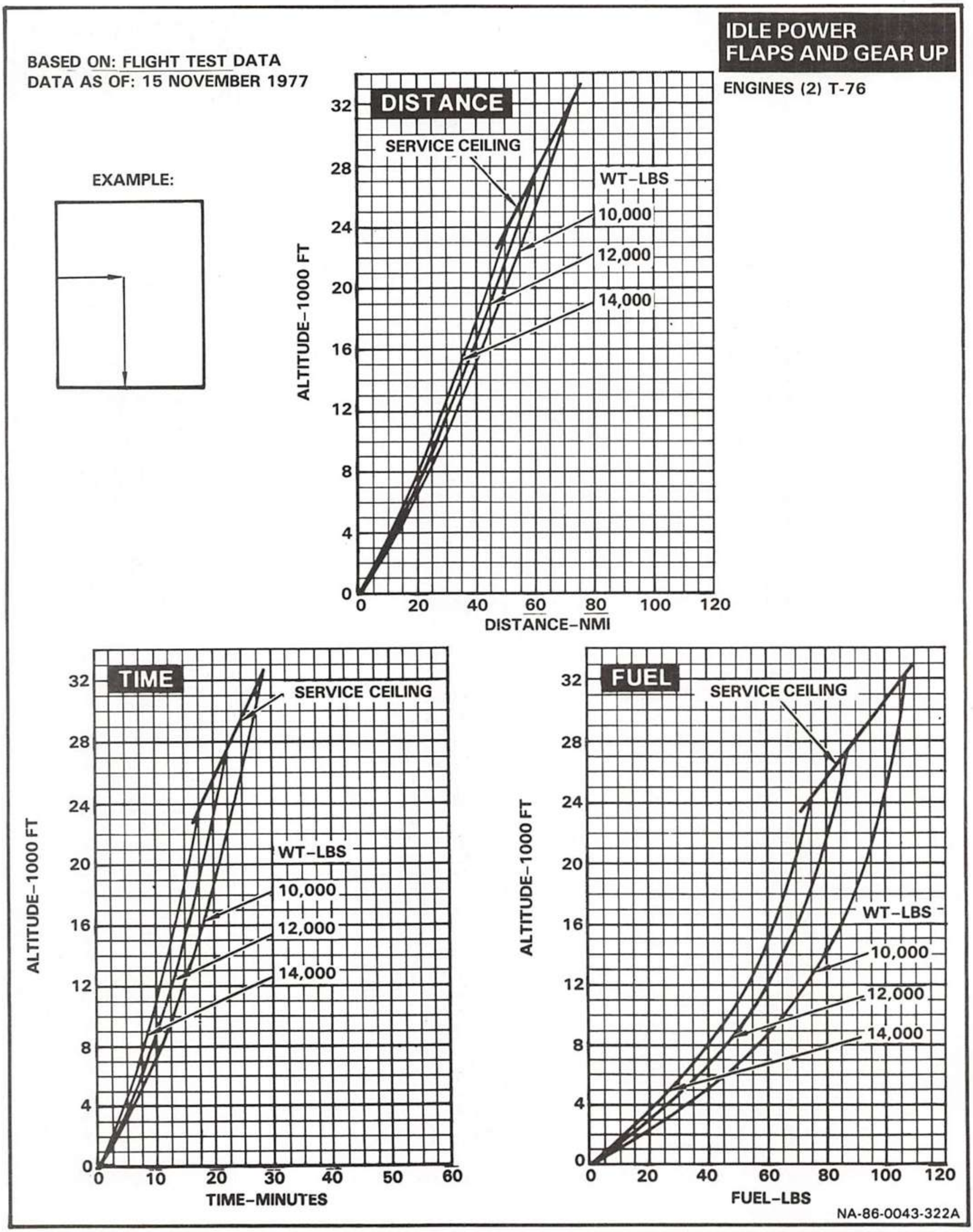


Figure 30-2. Normal Descent

CHAPTER 31

Landing Data

31.1 LANDING DATA (FIGURES 31-1 THROUGH 31-2)

31.1.1 Landing Distance. The Landing Distance chart determines landing roll for normal performance on hard-surface runways for various flap settings. Landing roll distance may be determined for idle or full-reverse power at various gross weights and ambient temperatures (Figures 31-1 through 31-2).

31.1.2 Landing Distance Example Problem. Find landing roll for normal performance braking and reverse thrust and for braking only (IDLE power):

- Gross Weight–12,000 pounds
- Flap Setting–20 degrees (normal performance)
- Pressure Altitude–2000 feet
- Ambient Temperature–30 °C
- Wind Velocity–10 knots (head)

1. Braking and full reverse distance = 1055 feet
2. Braking only (idle power) distance = 1899 feet (chart distance X 1.8)

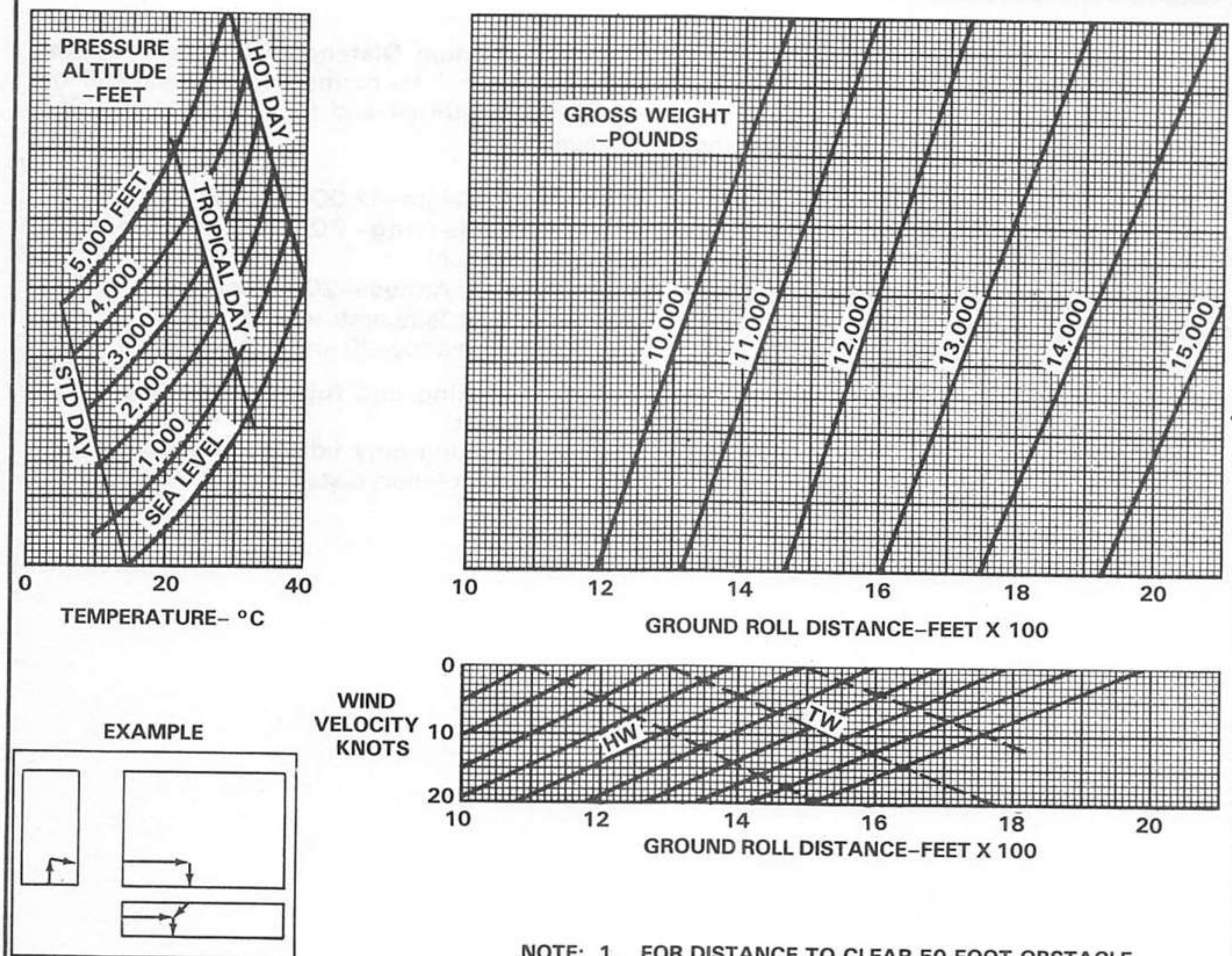
NORMAL PERFORMANCE

FLAPS UP

MIRROR APPROACH
FULL REVERSE THRUST

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

DRY HARD RUNWAY



NOTE: 1. FOR DISTANCE TO CLEAR 50-FOOT OBSTACLE, INCREASE GROUND RUN 70 PERCENT.

2. FOR EACH KNOT ABOVE RECOMMENDED APPROACH SPEED, INCREASE GROUND RUN 25 FEET.

3. FOR LANDING WITH NO REVERSE THRUST, INCREASE GROUND RUN 80 PERCENT.

4. REFER TO AIRSPEED LIMITS, PART 1, CHAPTER 4.

5. FOR LANDING WITHOUT BRAKES, INCREASE GROUND RUN 80 PERCENT.

LANDING SPEEDS	
GROSS WEIGHT (POUNDS)	TOUCHDOWN SPEEDS –IAS–KNOTS
10,000	107
11,000	111
12,000	117
13,000	121
14,000	126
15,000	131

NA-86-0043-323A

Figure 31-1. Landing Distance, Normal Performance (Flaps Up)

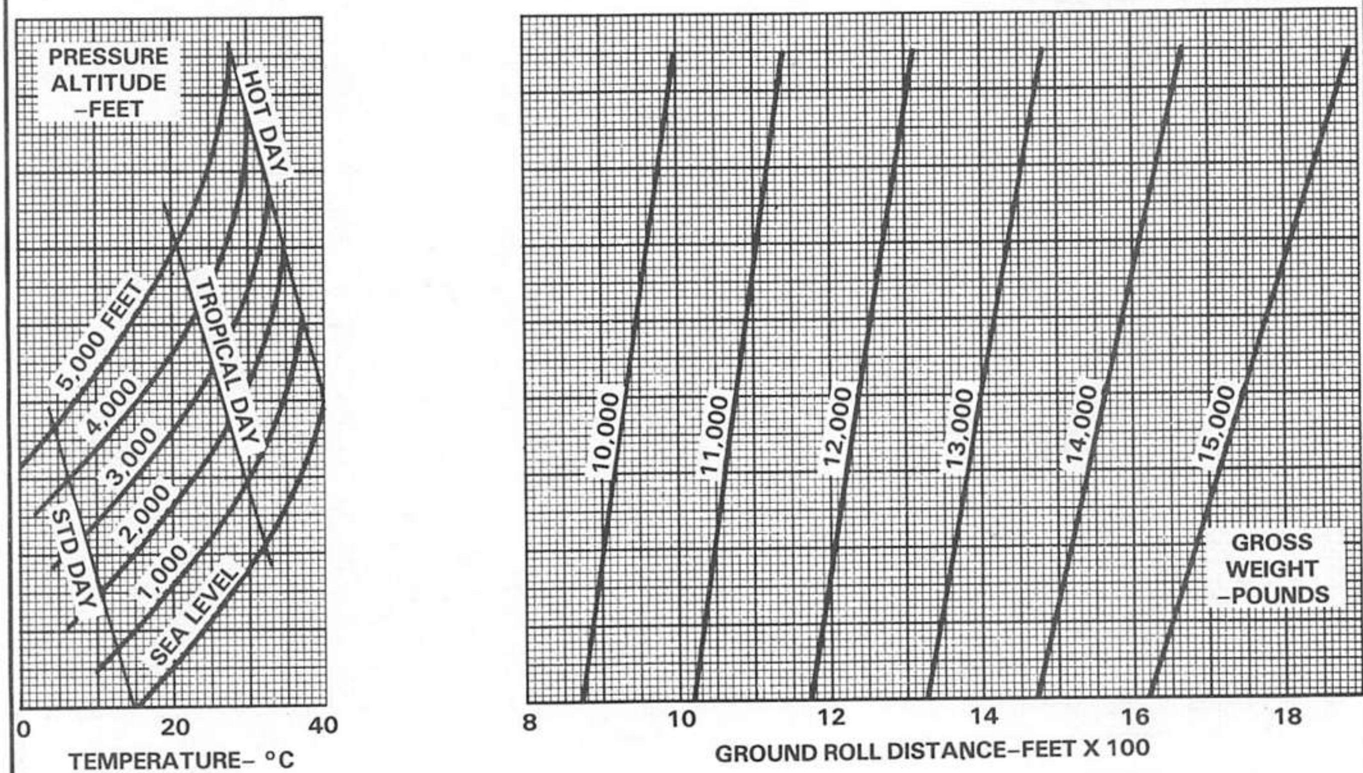
NORMAL PERFORMANCE

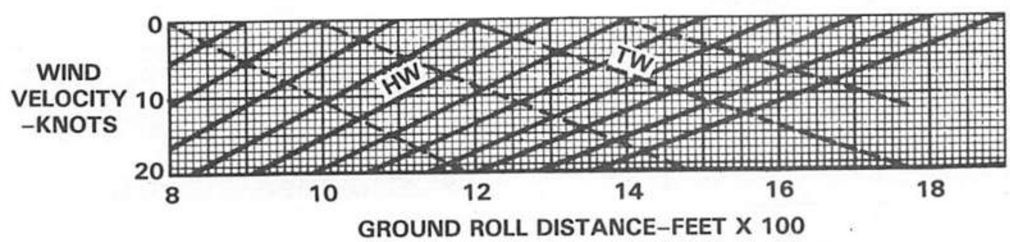
FLAPS 20°

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

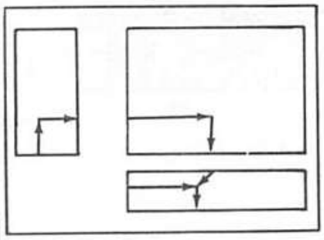
DRY HARD RUNWAY

MIRROR APPROACH
FULL REVERSE THRUST





EXAMPLE



LANDING SPEEDS	
GROSS WEIGHT (POUNDS)	TOUCHDOWN SPEEDS MIRROR LANDING –IAS–KNOTS
10,000	87
11,000	94
12,000	101
13,000	108
14,000	115
15,000	122

NOTE:
1. FOR DISTANCE TO CLEAR 50-FOOT OBSTACLE UTILIZING 10 FPS SINK RATE, INCREASE GROUND RUN 70 PERCENT.
2. FOR DISTANCE TO CLEAR 50-FOOT OBSTACLE UTILIZING 7 FPS SINK RATE, INCREASE GROUND RUN 120 PERCENT.
3. FOR EACH KNOT ABOVE RECOMMENDED APPROACH SPEED, INCREASE GROUND RUN 20 FEET.
4. FOR LANDING WITHOUT REVERSE THRUST, INCREASE GROUND RUN 80 PERCENT.
5. FOR LANDING WITHOUT BRAKES, INCREASE GROUND RUN 80 PERCENT.

NA-86-0043-324A

Figure 31-2. Landing Distance, Normal Performance (Flaps 20°)

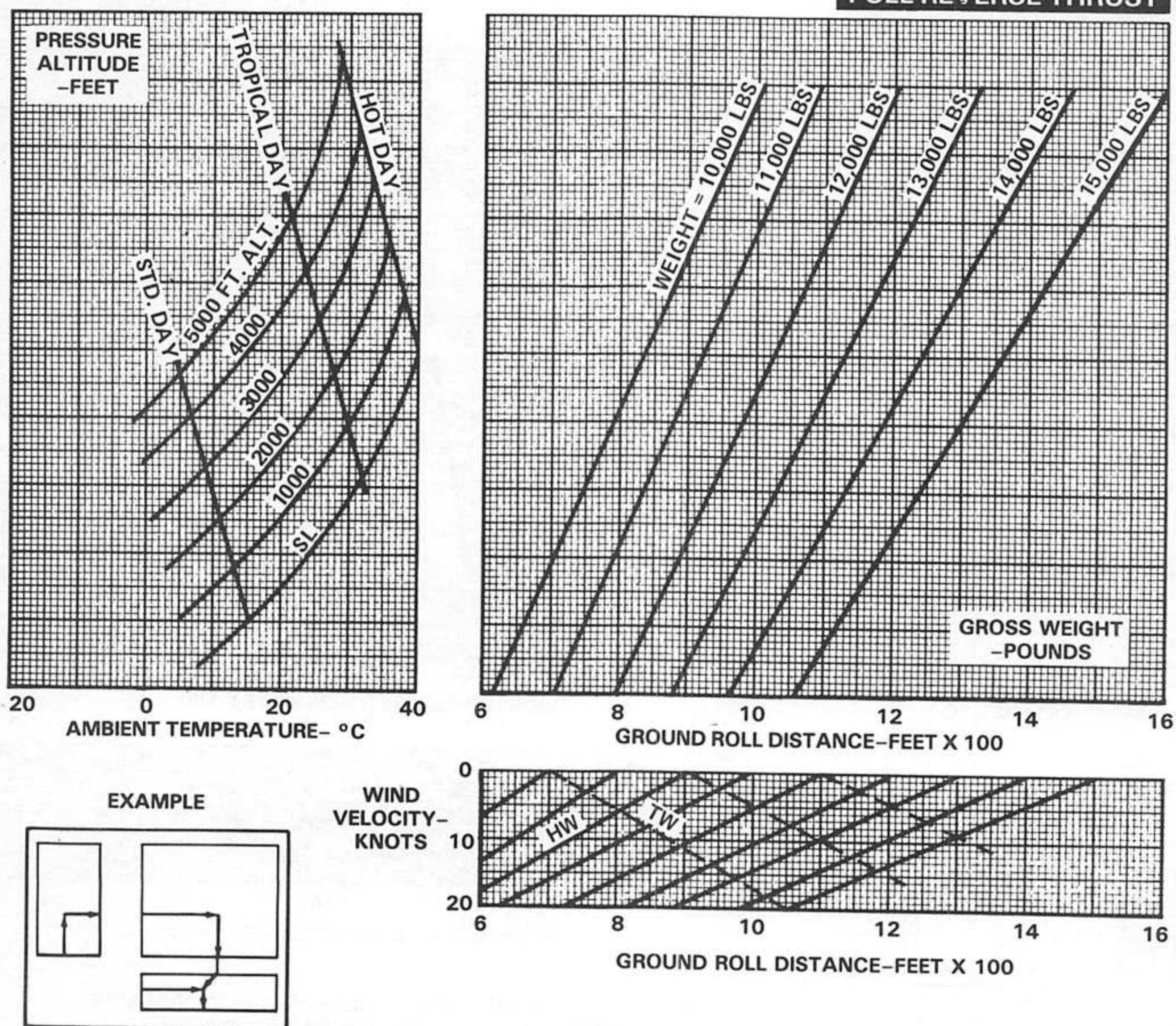
STOL PERFORMANCE

FLAPS 20°

MIRROR APPROACH
FULL REVERSE THRUST

BASED ON: FLIGHT TEST DATA
DATA AS OF: 15 NOVEMBER 1977

DRY HARD RUNWAY



LANDING SPEEDS	
GROSS WEIGHT (POUNDS)	TOUCHDOWN SPEEDS IAS-KNOTS
10,000	80
11,000	84
12,000	88
13,000	92
14,000	95

NOTE:

1. FOR EACH KNOT ABOVE RECOMMENDED APPROACH SPEED, INCREASE GROUND RUN 20 FEET.
2. FOR LANDING WITHOUT REVERSE THRUST, INCREASE GROUND RUN 50 PERCENT
3. FOR LANDING WITHOUT BRAKES, INCREASE GROUND RUN 80 PERCENT.

NA-86-0043-325A

Figure 31-3. Landing Distance STOL Performance (Flaps 20°)

CHAPTER 32

Mission Planning

32.1 ALTITUDE LOST IN DIVE RECOVERY (FIGURE 32-1)

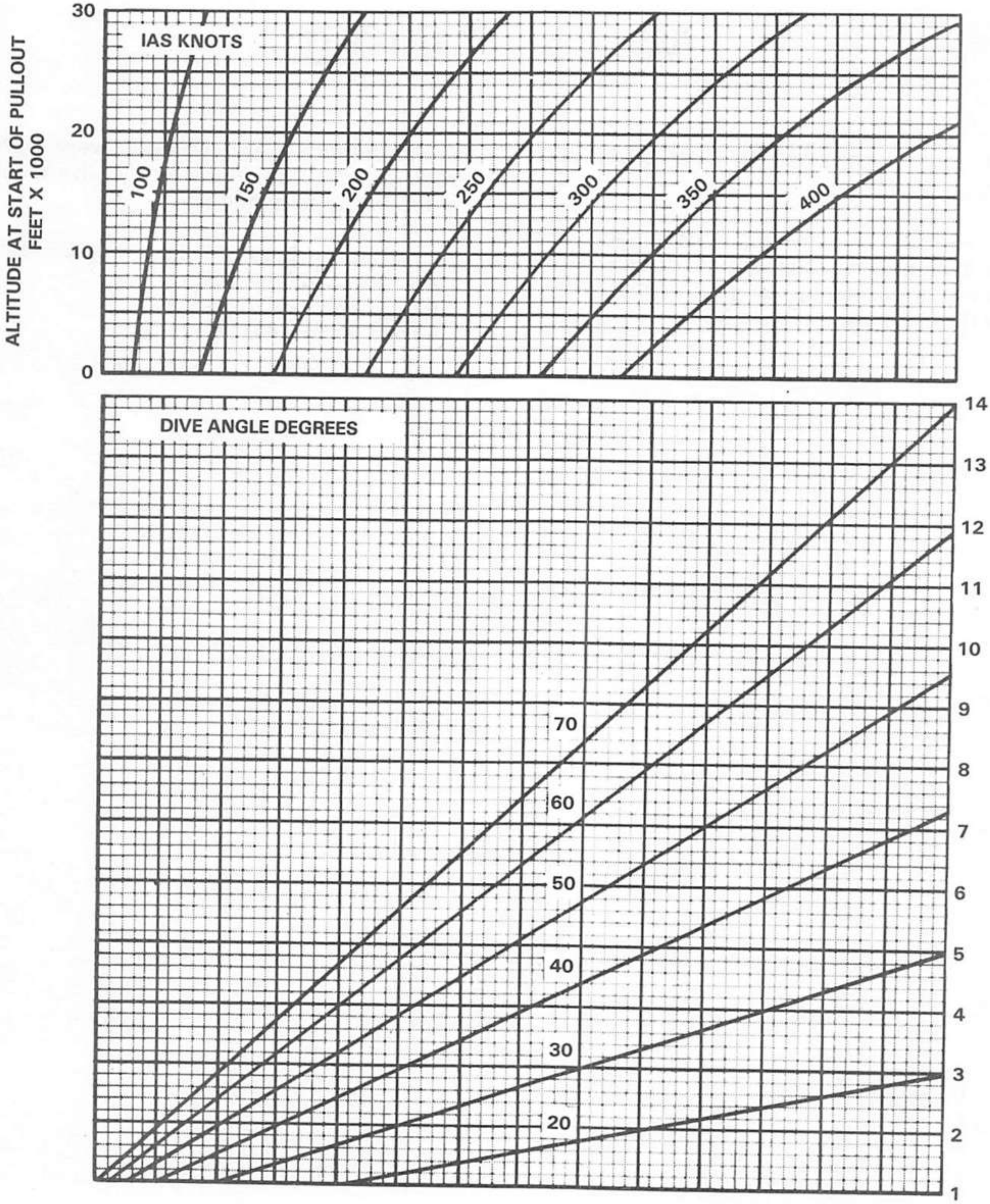
Altitude lost in recovering to level flight at various dive angles, airspeeds, and load factors may be determined by using the Altitude Lost in Dive Recovery chart (Figure 32-1).

32.1.1 Altitude Lost in Dive Recovery Example Problem. Find altitude lost in the dive recovery for the following conditions:

- Altitude at Start of Pullout–10,000 feet
- Airspeed–250 KIAS
- Dive Angle–50 degrees
- Load Factor–4.0 "g's"

1. Altitude lost = 980 feet

BASED ON: ESTIMATED DATA (NA-66H-882)
DATA AS OF: 1 SEPTEMBER 1968



NA-86-0043-326A

Figure 32-1. Altitude Lost in Dive Recovery (Sheet 1 of 2)

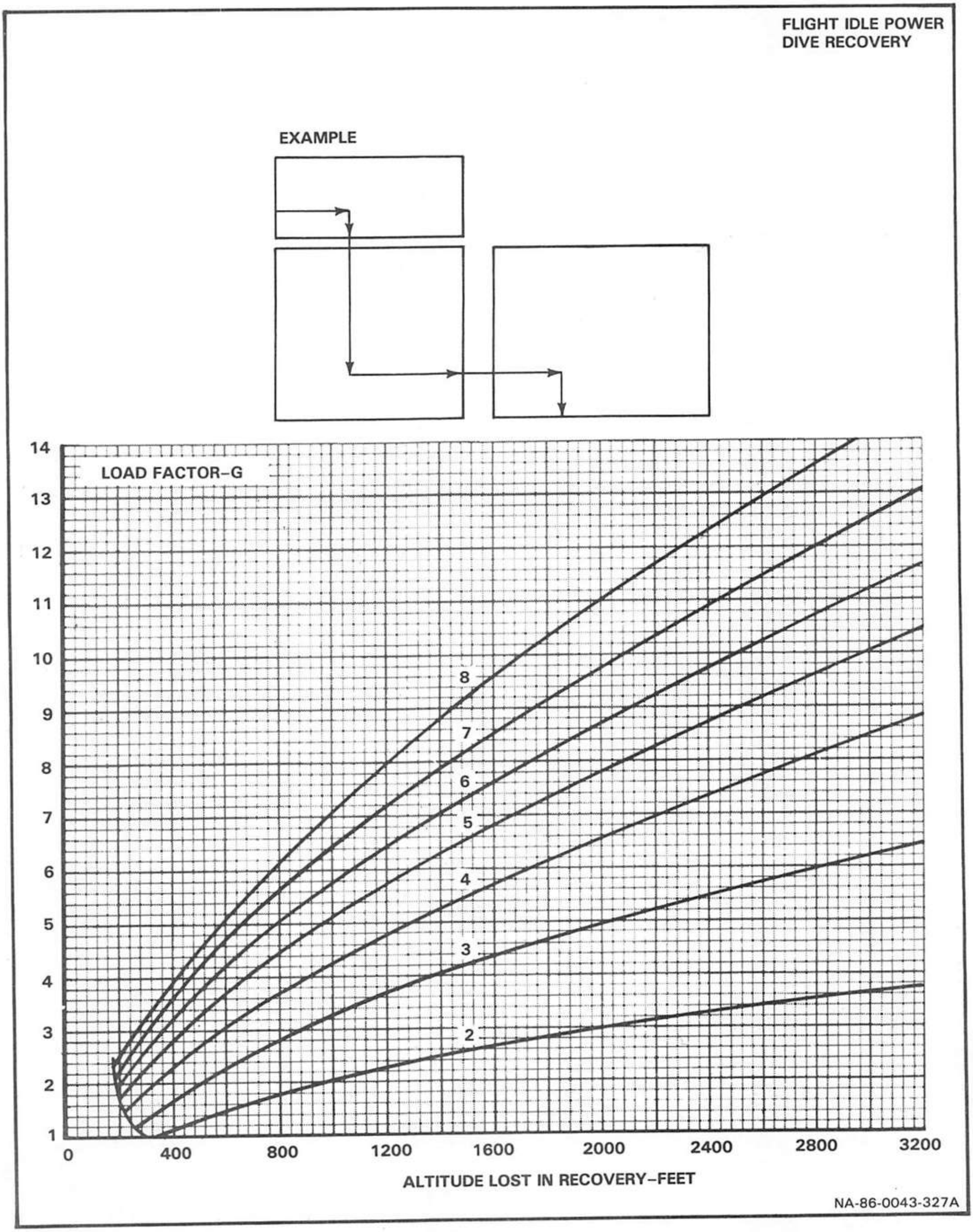


Figure 32-1. Altitude Lost in Dive Recovery (Sheet 2 of 2)

INDEX

T

★U.S. GOVERNMENT PRINTING OFFICE:1988 526-011/84002

AIRCRAFT FUEL SYSTEM

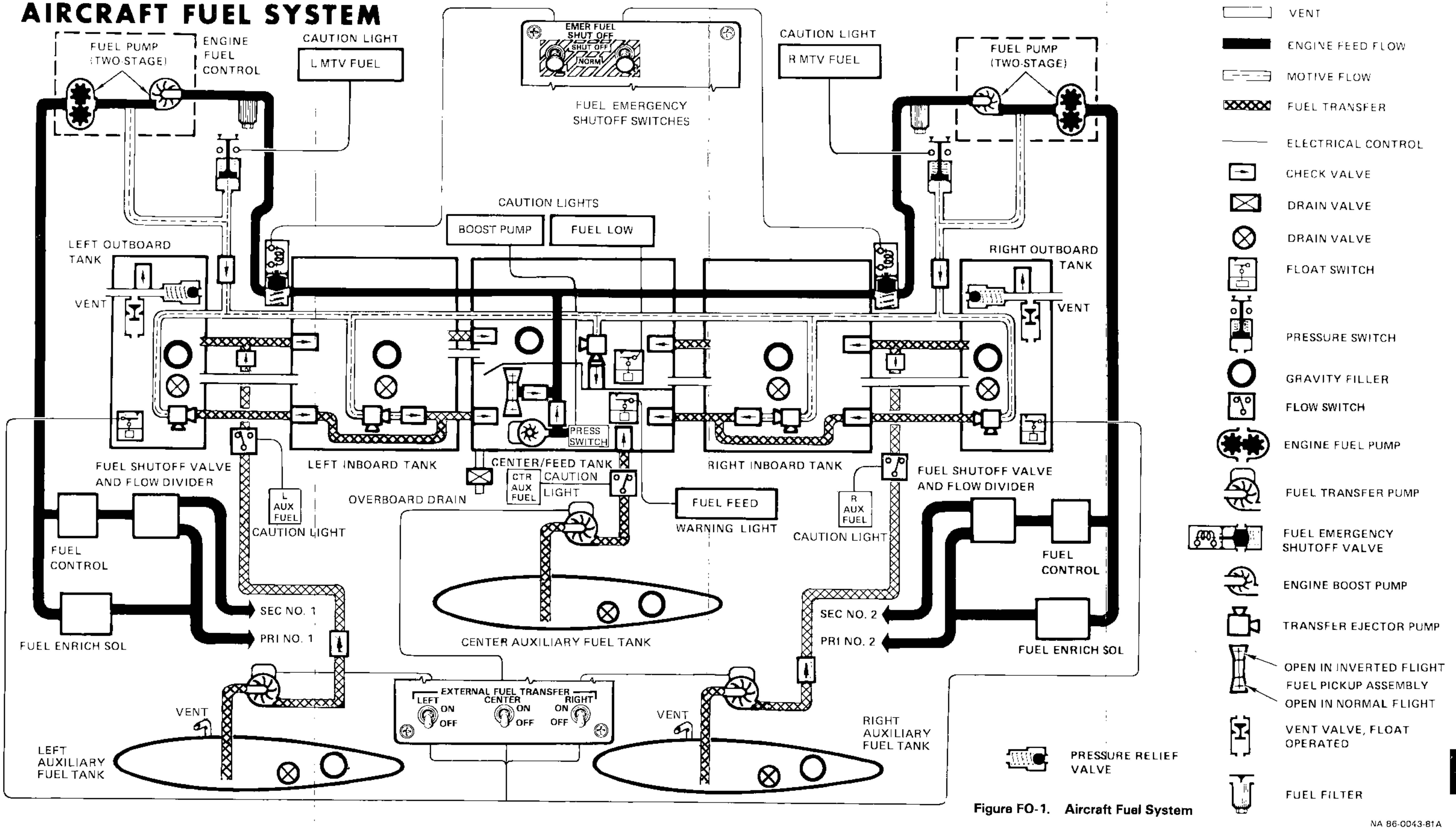
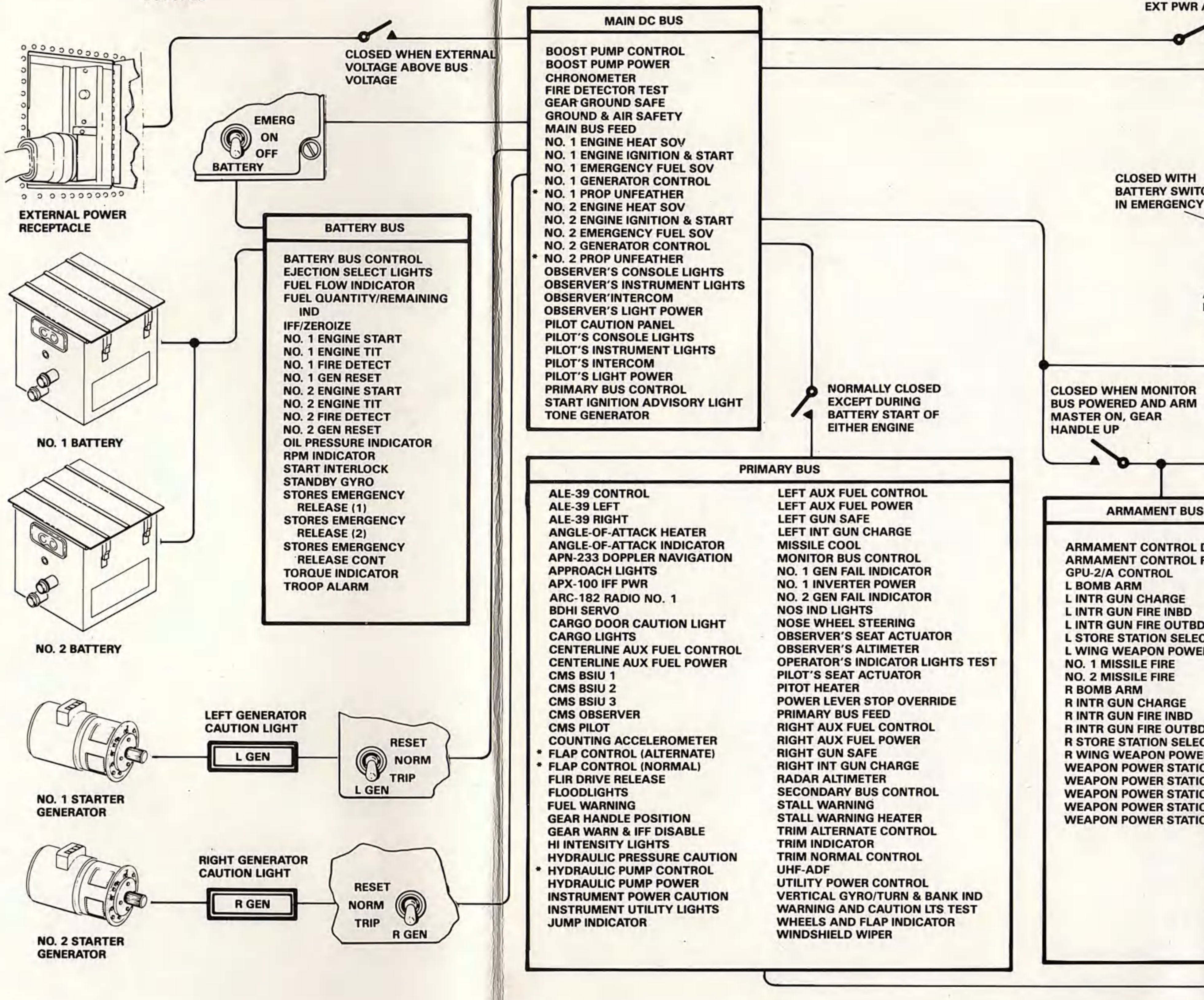
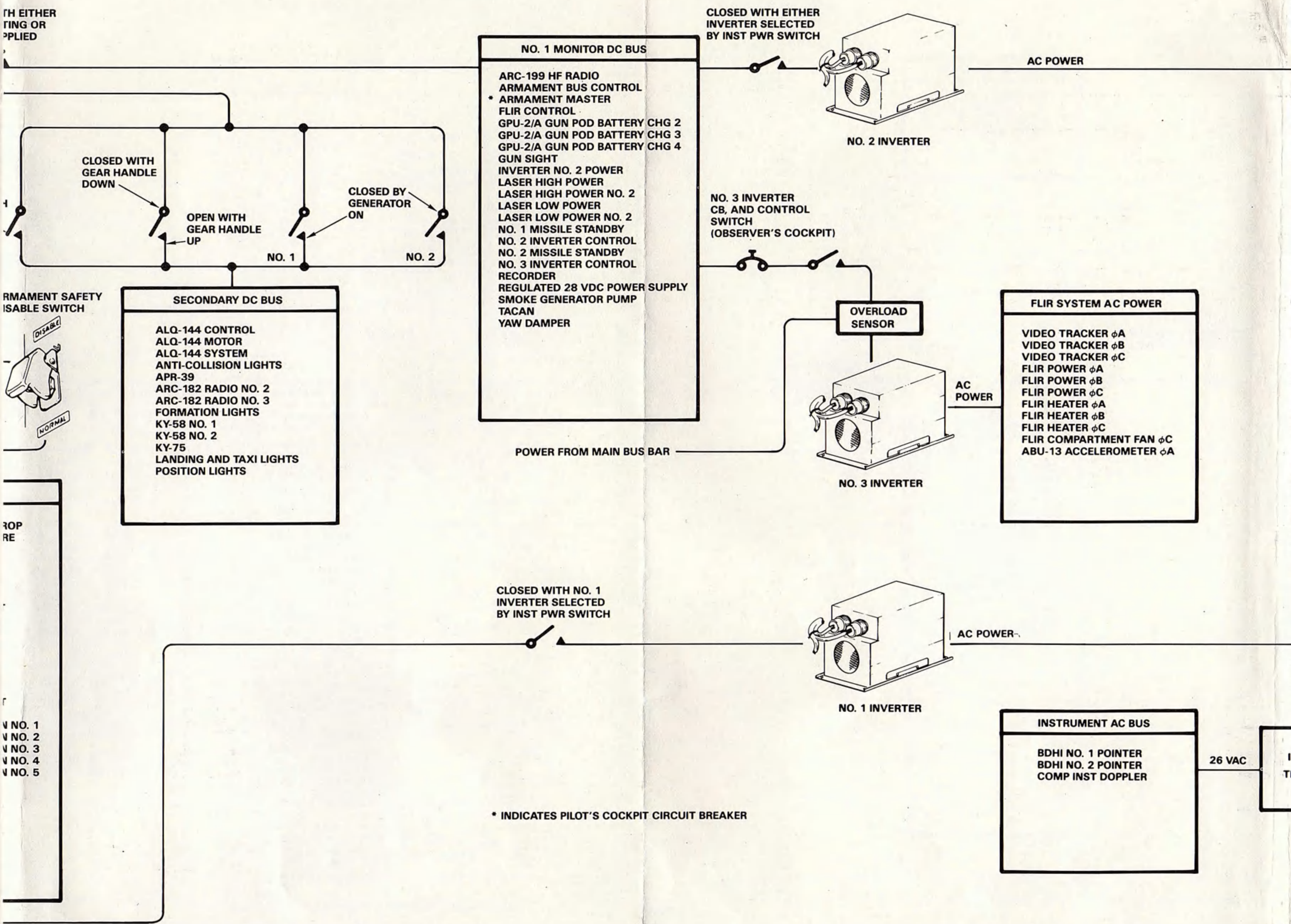


Figure FO-1. Aircraft Fuel System

ELECTRICAL POWER DISTRIBUTION

DC POWER





TH EITHER
TING OR
PPLIED
NO. 1 MONITOR DC BUS
ARC-199 HF RADIO
ARMAMENT BUS CONTROL
* ARMAMENT MASTER
FLIR CONTROL
GPU-2/A GUN POD BATTERY CHG 2
GPU-2/A GUN POD BATTERY CHG 3
GPU-2/A GUN POD BATTERY CHG 4
GUN SIGHT
INVERTER NO. 2 POWER
LASER HIGH POWER
LASER HIGH POWER NO. 2
LASER LOW POWER
LASER LOW POWER NO. 2
NO. 1 MISSILE STANDBY
NO. 2 INVERTER CONTROL
NO. 2 MISSILE STANDBY
NO. 3 INVERTER CONTROL
RECORDER
REGULATED 28 VDC POWER SUPPLY
SMOKE GENERATOR PUMP
TACAN
YAW DAMPER
CLOSED WITH EITHER
INVERTER SELECTED
BY INST PWR SWITCH
AC POWER
NO. 2 INVERTER
CLOSED WITH
GEAR HANDLE
DOWN
OPEN WITH
GEAR HANDLE
UP
CLOSED BY
GENERATOR
ON
NO. 1
NO. 2
NO. 3 INVERTER
CB, AND CONTROL
SWITCH
(OBSERVER'S COCKPIT)
RMAMENT SAFETY
ISABLE SWITCH
DISABLE
NORMAL
SECONDARY DC BUS
ALQ-144 CONTROL
ALQ-144 MOTOR
ALQ-144 SYSTEM
ANTI-COLLISION LIGHTS
APR-39
ARC-182 RADIO NO. 2
ARC-182 RADIO NO. 3
FORMATION LIGHTS
KY-58 NO. 1
KY-58 NO. 2
KY-75
LANDING AND TAXI LIGHTS
POSITION LIGHTS
OVERLOAD
SENSOR
AC
POWER
FLIR SYSTEM AC POWER
VIDEO TRACKER ϕA
VIDEO TRACKER ϕB
VIDEO TRACKER ϕC
FLIR POWER ϕA
FLIR POWER ϕB
FLIR POWER ϕC
FLIR HEATER ϕA
FLIR HEATER ϕB
FLIR HEATER ϕC
FLIR COMPARTMENT FAN ϕC
ABU-13 ACCELEROMETER ϕA
POWER FROM MAIN BUS BAR
NO. 3 INVERTER
ROP
RE
CLOSED WITH NO. 1
INVERTER SELECTED
BY INST PWR SWITCH
AC POWER
NO. 1 INVERTER
INSTRUMENT AC BUS
BDHI NO. 1 POINTER
BDHI NO. 2 POINTER
COMP INST DOPPLER
26 VAC
IN
TR
N NO. 1
N NO. 2
N NO. 3
N NO. 4
N NO. 5
* INDICATES PILOT'S COCKPIT CIRCUIT BREAKER

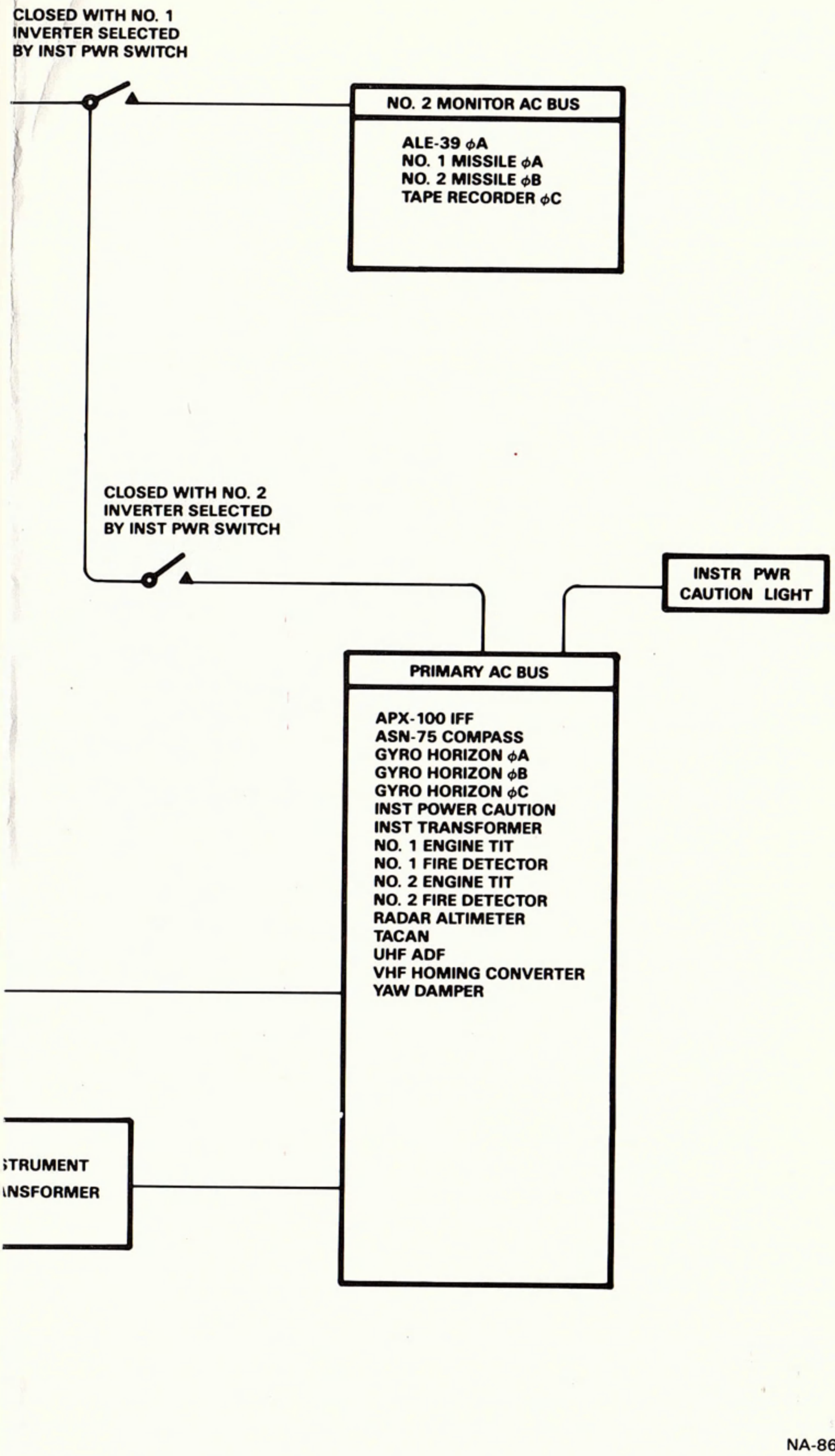


Figure FO-2. Electrical Power System

HYDRAULIC POWER SYSTEM

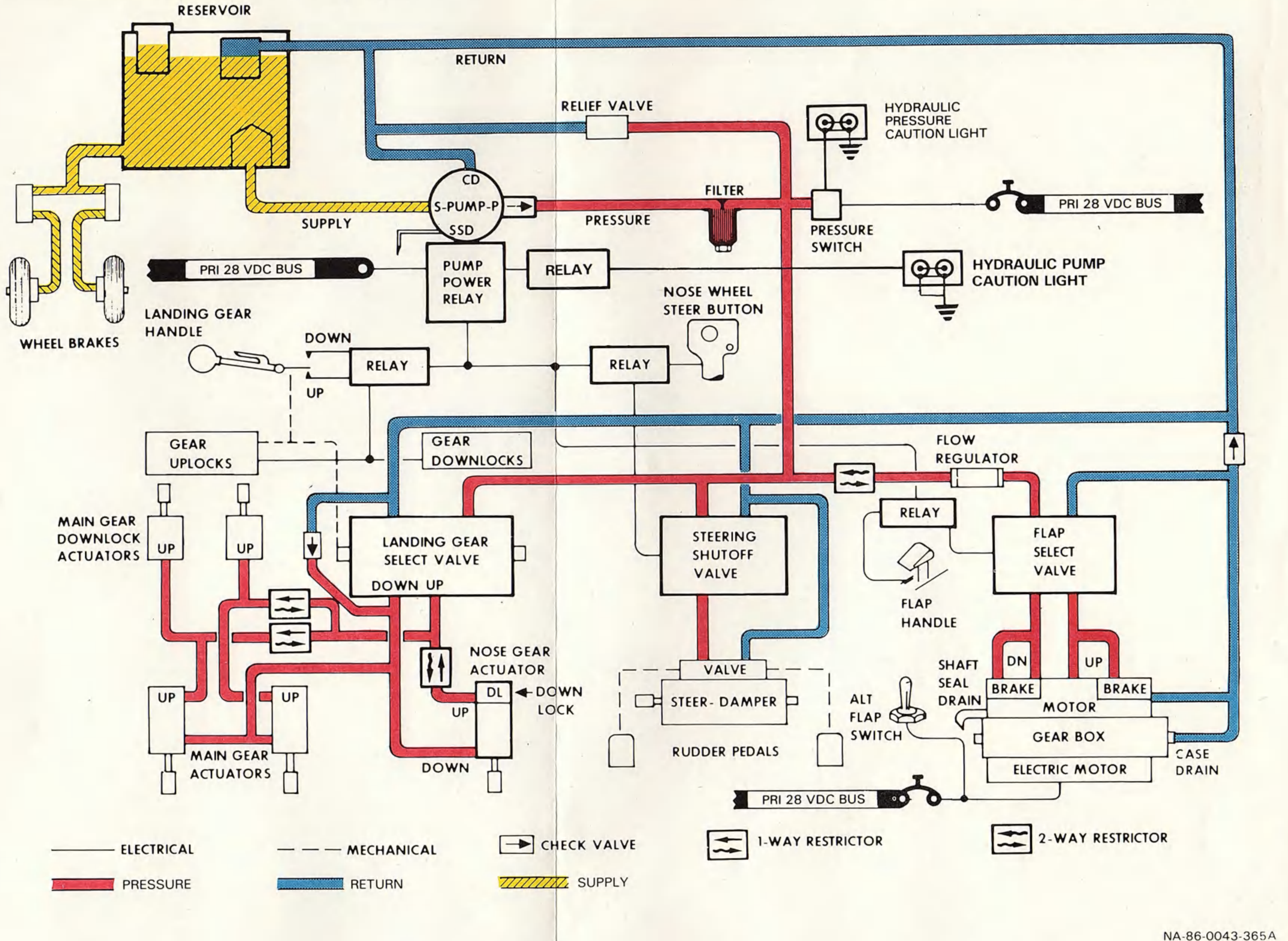


Figure FO-3. Hydraulic Power System

FLIGHT CONTROL SYSTEM

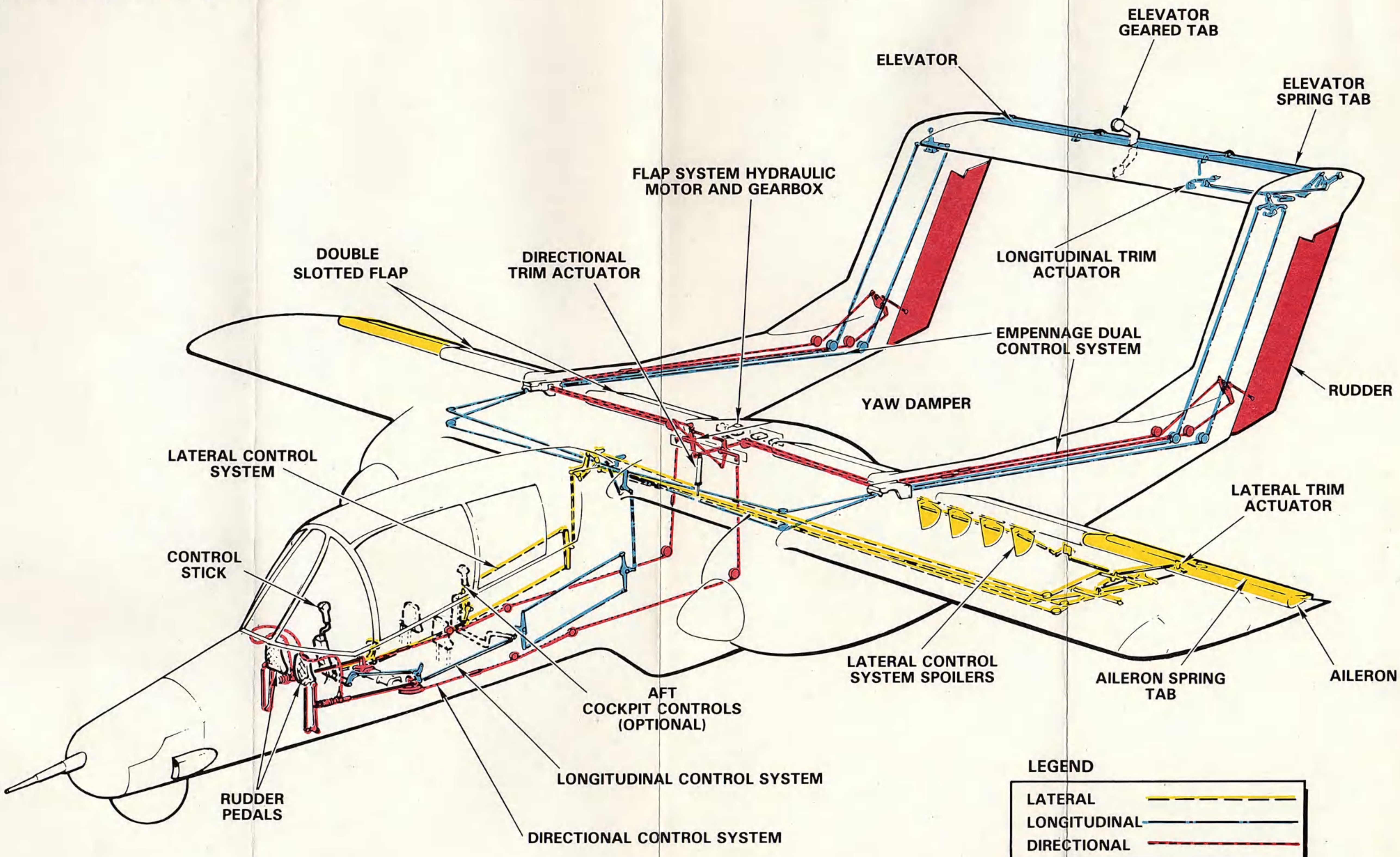


Figure FO-4. Flight Control System

LIST OF EFFECTIVE PAGES

Effective Pages	Page Number
Change 1	1 (Reverse Blank)
Original	3 (Reverse Blank)
Original	5 thru 6B (Reverse Blank)
Original	7 thru 10
Change 1	11
Original	12, 13
Change 1	14
Original	15
Change 1	16
Original	17
Change 1	18 thru 20
Original	21 thru 28
Change 1	29
Original	30
Change 1	31
Original	32 thru 35 (Reverse Blank)
Change 1	37 (Reverse Blank)
Original	39 (Reverse Blank)
Original	41 thru 43 (Reverse Blank)
Original	(Obverse Blank) 46
Original	47 (Reverse Blank)
Original	I-1-1 thru I-1-6
Change 1	I-1-7, I-1-8
Original	I-1-9 thru I-1-13 (Reverse Blank)
Original	I-2-1 thru I-2-18
Change 1	I-2-19, I-2-20
Original	I-2-21 thru I-2-24
Change 1	I-2-25
Original	I-2-26 thru I-2-43
Change 1	I-2-44, I-2-45
Original	I-2-46 thru I-2-53
Change 1	I-2-54
Original	I-2-55 thru I-2-57
Change 1	I-2-58
Original	I-2-59 thru I-2-61
Change 1	I-2-62
Original	I-2-63 thru I-2-71 (Reverse Blank)

Effective Pages	Page Number
Original	I-3-1 thru I-3-6
Original	I-4-1 thru I-4-5
Change 1	I-4-6 thru I-4-8
Original	I-4-9 (Reverse Blank)
Original	49 (Reverse Blank)
Original	II-5-1, II-5-2
Change 1	II-5-3 (Reverse Blank)
Original	51 (Reverse Blank)
Original	III-6-1, III-6-2
Original	III-7-1 thru III-7-4
Change 1	III-7-5
Original	III-7-6 thru III-7-8
Change 1	III-7-9
Original	III-7-10 thru III-7-13
Change 1	III-7-14, III-7-15
Original	II-7-16, III-7-17 (Reverse Blank)
Original	III-8-1 thru III-8-3 (Reverse Blank)
Change 1	III-9-1 thru III-9-3
Original	III-9-4 thru III-9-6
Original	III-10-1
Change 1	III-10-2
Original	III-10-3
Change 1	III-10-4 thru III-10-8a (Reverse Blank)
Original	III-10-9 thru III-10-11 (Reverse Blank)
Original	53 (Reverse Blank)
Original	IV-11-1 thru IV-11-8
Change 1	IV-11-9, IV-11-10
Original	55 (Reverse Blank)
Original	V-12-1
Change 1	V-12-2, V-12-3 (Reverse Blank)
Original	V-13-1 thru V-13-3 (Reverse Blank)
Change 1	V-14-1
Original	V-14-2

LIST OF EFFECTIVE PAGES

Effective Pages	Page Number
Change 1	V-14-3, V-14-4
Original	V-14-5
Change 1	V-14-6
Original	V-14-7
Change 1	V-14-8, V-14-9 (Reverse Blank)
Original	V-15-1 thru V-15-3
Change 1	V-15-4 thru V-15-6
Original	V-15-7, V-15-8
Original	V-16-1, V-16-2
Change 1	V-16-3
Original	V-16-4
Change 1	V-16-5
Original	V-16-6 thru V-16-27 (Reverse Blank)
Original	VI-17-1 thru VI-17-5 (Reverse Blank)
Original	57 (Reverse Blank)
Original	VI-18-1 thru VI-18-5 (Reverse Blank)
Original	59 (Reverse Blank)
Original	VII-19-1 thru VII-19-25 (Reverse Blank)
Original	VII-19-27 thru VII-19-57 (Reverse Blank)
Original	VII-19-59 thru VII-19-61
Change 1	VII-19-62
Original	VII-19-63, VII-19-64
Change 1	VII-19-65 thru VII-19-68
Original	VII-19-69, VII-19-70
Change 1	VII-19-71 thru VII-19-72D
Original	VII-19-73
Change 1	VII-19-74
Original	VII-19-75 thru VII-19-81 (Reverse Blank)
Original	VII-19-83 thru VII-13-89 (Reverse Blank)
Original	VII-20-1 (Reverse Blank)

Effective Pages	Page Number
Original	61 (Reverse Blank)
Original	VIII-21-1 thru VIII-21-16
Change 1	VIII-22-1, VIII-22-2
Original	VIII-22-3 thru VIII-22-13
Change 1	VIII-22-14 thru VIII-22-16
Original	VIII-22-17 thru VIII-22-32
Original	63 (Reverse Blank)
Original	IX-23-1 thru IX-23-4
Original	65 (Reverse Blank)
Original	X-24-1 thru X-24-23 (Reverse Blank)
Original	67 (Reverse Blank)
Original	XI-25-1 thru XI-25-20
Original	XI-26-1 thru XI-26-15 (Reverse Blank)
Original	XI-27-1 thru XI-27-19 (Reverse Blank)
Original	XI-28-1 thru XI-28-21 (Reverse Blank)
Original	XI-29-1 thru XI-29-3 (Reverse Blank)
Original	XI-30-1 thru XI-30-43 (Reverse Blank)
Original	XI-31-1 thru XI-31-4
Original	XI-32-1 thru XI-32-3 (Reverse Blank)
Original	Index-1
Change 1	Index-2
Original	Index-3
Change 1	Index-4 thru Index-6
Original	Index-7
Change 1	Index-8
Original	Index-9 (Reverse Blank)
Original	FO-1 (Reverse Blank)
Original	FO-3 (Reverse Blank)
Original	FO-5 (Reverse Blank)
Original	FO-7 (Reverse Blank)
Change 1	LEP-1 (Reverse Blank)